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Review Article

Determinants of Anemia Among Children Aged 6-23 Months in Ethiopia: A Systematic Review and Meta-analysis

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Abstract

Introduction: Anemia is a public health problem mainly affecting young children aged less than 5 years old globally. The aim of the present study was to assess the pooled prevalence of anemia and its determinants in "children aged 6-23 months" in Ethiopia. Methods: "EMBASE", "Web of Science", "Medline", "Scopus", "PubMed", and "Google Scholar" electronic databases were utilized to search published articles on this topic. Results: The estimated pooled prevalence of anemia in "children aged 6-23 months" was 58.78% (95%CI: 52.13, 65.43). Subgroup analysis showed that the pooled prevalence of anemia was 54.63% (95%CI: 47.41,61.86) among regional-based studies, 68.15% (95%CI: 61.57, 74.73) among national-based studies, 58.25% (95%CI: 51.40,65.10) for articles published 2015-2019, 59.33% (95%CI: 48.71, 69.94) for articles published 2020-2021, 62.93% (95%CI: 54.00,71.86) for sample size >600, and 54.43% (95%CI: 48.03, 60.82) for sample size <600. Poor dietary diversity (AOR=2.81, 95%CI: 2.51, 3.11), having history of diarrhea over the last two weeks (AOR=3.97, 95%CI: 2.39, 5.56) and household food insecurity (AOR=2.72, 95%CI: 2.34, 3.10) were determinants of anemia. Conclusion: The pooled prevalence of anemia in "children aged 6-23 months" was high. Dietary diversity status, history of diarrhea over the last two weeks, and household food insecurity were determinants of anemia. Health education program should be provided.

Keywords

6-23 Months Children, Anemia, Associated Factors, Ethiopia, Determinants

1. Introduction

Anemia is hemoglobin concentration under a specified cut-off point. The cut-off point depends on smoking habit, age, gender, and physiological status as per "world health organization" (WHO, 2008). Anemia in children aged below five is when the hemoglobin concentration is less than 110g/L at sea level [1]. The clinical manifestation of anemia in children include pale skin, sore or swollen tongue, enlarged spleen, lack of energy, irritability, fatigue, fast heartbeat, and wanting to eat odd substances like dirt or ice [2]. Although the cause of anemia is dependent on the type of anemia, the most common causes include; inherited diseases, nutritional deficiencies, autoimmune diseases, infections bleeding, certain cancerous conditions and bleeding [3]. The risk factors of anemia for children include diet low in iron, living in poverty or immigrating from developing countries, premature or low birth weight, early use of cow's milk, blood loss, long-term illnesses and family history of an inherited type of anemia [4]. From the study done in Ethiopia: maternal anemia, poor

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wealth status, increased fertility, and childhood malnutrition were also considered risk factors among preschool children [5].

Anemia is a public health problem mainly affecting young children aged less than 5 years old globally. According to the WHO (2022) estimates that worldwide 42% of children less than 5 years were anemic [6]. The prevalence of anemia among children aged 6-59 months was 39.8%, which is equivalent to two hundred sixty nine million children in the year 2019 [7]. The prevalence of anemia was 29.73% in children aged 6-23 months from Huaihua [8], 32.93% among preschool children from Caribbean and Latin America [9], 55.32% in children aged 6-59 months from low- and middle-income countries [10], and 11.8% in children aged 6 months from Beijing [11]. WHO (2019) estimated that the prevalence of anemia was 60.2% in Africa among children under five years [7]. The prevalence of anemia was 78.4% in children's under five years old in Ghana [12]. The prevalence of anemia was 65.7% in children aged 6-23 months in Wolaita zone, southern Ethiopia [13], 41.1% in under 5 years old children's in Guguftu health center, south Wollo, Ethiopia [14], 52% in children aged 6-23 months in Damot, Ethiopia [15], and 41.7% in under 5 years old children's attending Hawassa University Referral and Teaching Hospital, Ethiopia [16].

The complication of anemia depends on its cause, but the most common complications are joint pain, bone marrow failure, problems with development, and leukemia or other cancers [4]. Anemia, being a serious public health problem, is also a high risk for child mortality. Anemia may have a negative consequence on the economy and national development and the entire population [1]. Anemia have a negative consequence on the child's cognitive and motor development [7].

A study reported in 2013 involving 187 countries worldwide showed that anemia accounted for 65.5 million years of life living with disability in 1990, 11.2% of worldwide years of life living with disability from all causes, and in 2010 the value increased to 68.4 million years of life living with disability's, 8.8% of worldwide years of life living with disability from all causes [17]. In India, the estimated yearly cost of iron deficiency anemia amount to intangible cost among children aged 6-59 month was 8.3 million daily-adjusted life years and a loss of 24,001 USD this is equivalent to 1.3% of gross domestic product, which was reported on 2015 [18]. Consequently, Sickle cell anemia, 8.4% of children died from Chicago clinic with a 5-year period [19]. In 2017, 25% of under five years children died in Rio De Janerio [20].

In less developed countries, anemia is accountable for significant mortality and morbidity [21]. In Nigeria, the 2011 study report shows that there was high level of mortality rate among under five children [22]. In Sub-Saharan Africa (SSA), the severity of anemia in children aged 6-59 months persists to be a serious public health problem from 2021 [23] to 2022 [24]. Since early 1960s in south Ghana, anemia has resulted about 58.1% deaths in children beyond the neonatal period [25]. In 2011, due to sickle cell anemia, 7.3% of children less than 5 years died in Tanzania [26]. A study done in northwest part of Ethiopia in 2017 shows that anemia remains a public health problem [27].

Incorporation of micronutrient powder into young child and infant feeding interventions is a viable strategy for improving children's intake of micronutrients and decreasing risk of anemia [28]. The control interventions of prenatal anemia are found to lessen the risk of moderate/severe anemia [29]. A study done in China demonstrated a duration of ying yang bao consumption was positively correlated with hemoglobin levels. Home food fortification with ying yang bao is effective and feasible for nutrition promotion in young child and infant in high-risk regions [30].

2. Methods

2.1. Research Questions

1) What is the pooled prevalence of anemia in children aged 6-23 months in Ethiopia?
2) What are the determinants of anemia in children aged 6-23 months in Ethiopia?

2.2. Study Setting

The present study was done by reviewing relevant studies done in Ethiopia. Ethiopia is located in the Horn of Africa. The capital city of Ethiopia is Addis Ababa [31].

2.3. Search Strategies

Various electronic databases were utilized to search published articles on this topic. For instances "EMBASE", "Web of Science", "PubMed", "Scopus", and "Google Scholar". Published articles up to the date of November 05/2022 were included in the search. We have utilized the Boolean operators "AND" and "OR" to integrate the search terms. For PubMed database, these search terms were used; ("anaemia" [All Fields] OR "anemia" [MeSH Terms] OR "anemia" [All Fields] OR "anaemias" [All Fields] OR "anemias" [All Fields]) AND ("6-23" [All Fields] AND ("month" [All Fields] OR "months" [All Fields]) AND ("child" [MeSH Terms] OR "child" [All Fields] OR "children" [All Fields] OR "child s" [All Fields] OR "children s" [All Fields] OR "childrens" [All Fields] OR "childs" [All Fields])) AND ("ethiopia" [MeSH Terms] OR "ethiopia" [All Fields] OR "ethiopia s" [All Fields]). Furthermore, a manual search was also performed for additional articles published on this topic.

2.4. Eligibility Criteria

Inclusion criteria:
1) *Study setting:* all relevant studies done in Ethiopia.
2) *Study subjects:* "children aged 6–23 months".
3) *Publication status:* published articles.

4) *Language:* English language.
5) *Study design:* cross-sectional studies.
6) *Publication date:* articles published up to November 05/2022.
7) *Methodological quality:* by using a "modified Newcastle-Ottawa Scale" (NOS) quality assessment criteria for cross-sectional studies, all articles with ≥5 out of 10 were included into this study.

Exclusion criteria: articles which were not fully accessible and did not clearly define the outcome variable were excluded.

2.5. Outcome of Interest

The outcome of interest in this study was anemia among children aged 6–23 months. Hemoglobin concentration was used to determine anemia status of the participants by obtaining finger-prick blood samples. Hemoglobin level was adjusted for altitude using the United Nations International Children's Emergency Fund (UNICEF)/WHO guideline. Hemoglobin concentration < 11.0 g/dl was regarded as anemic. Whereas, hemoglobin concentrations of ≥ 11.0 g/dl was regarded as normal [32, 33].

The main outcome was the prevalence of anemia as demonstrated in the articles used. The outcome is reported as percentage of anemia or the number of anemia cases (n)/ total number of "children aged 6-23 months" (N). Both parameters were compulsory to calculate the pooled prevalence of anemia in the present meta-analysis. The pooled prevalence of anemia was calculated by dividing the number of "children aged 6-23 months" who have anemia with the total number of children aged 6-23 months of sample size multiplied by a hundred (100).

2.6. Data Extraction

Thomson Reuters EndNote version 8 was used to collect the results of searched articles, after the export of retrieved articles from all databases. We have used a Microsoft excel to extract the data from the nominated articles by using the standardized data extraction format prepared. During this, the inclusion criteria was utilized carefully. For data extraction the information used were author names, prevalence, year of article publication, study region, sample size, and predictors. The two authors (LTG* and ADW) have checked and screened the articles depending on titles and abstracts of all probable articles to be encompassed in the present study. Furthermore, the two authors (LTG* and ADW) have evaluated the articles methodological quality by using the modified NOS critical appraisal tool for cross-sectional studies [34] independently.

2.7. Quality Assessment

Only cross-sectional studies were encompassed in the present study. The quality of the included articles was assessed using the NOS quality assessment criteria for cross-sectional studies [34, 35]. All articles with ≥5 out of 10 quality assessment scores were regarded as a high-quality score [36]. NOS quality assessment scores of articles comprised into the present study are provided as *(supplementary 1 file)*. A methodological quality score has been displayed for each article (Table 1).

2.8. Statistical Analysis

For analysis STATA version 11 statistical software was used of present systematic and meta-analysis. The pooled prevalence was estimated by using a random effects model. Cochran's Q chi-square statistics and I^2 statistics were used to check a heterogeneity among the studies [37]. In the present study, heterogeneity was interpreted as no heterogeneity if I^2 value is 0%, low heterogeneity if I^2 value is 25% to 50%, moderate heterogeneity if I^2 value is 50% to 75%, and high heterogeneity if I^2 value is ≥75% [38]. To compare an overall estimate across groups and check whether the grouping supports explain some of the observed between a study heterogeneity, a subgroup analysis was used. The publication bias was evaluated visually by using a funnel plot, and objectively by using Begg's test and Egger's test [39]. The trim-and-fill analysis was used to account for any publication bias. Region, publication year, and sample size categories were used for subgroup analysis. The pooled prevalence of anemia and pooled effect for determinants with 95%CI was presented by using a forest plot figure. Lastly, $p < 0.05$ was considered statistically significant for all analyses.

2.9. Reporting the Results

The present study was done on the prevalence of anemia and its determinants in children aged 6–23 months in Ethiopia. The "Preferred Reporting Items for Systematic reviews and Meta-Analyses" (PRISMA) 2020 flowchart diagram, and PRISMA 2020 checklist [40] were used for the present systematic review and meta-analysis. PRISMA 2020 checklist is provided as *(supplementary 2 file)*.

2.10. Ethical Approval and Consent to Participate

Since the study is a systematic review and meta-analysis, ethical approval is not applicable. This is because there was no data collected from the people for the purpose of this study, rather the study was completed by reviewing the articles published on the topic of the study. Informed Consent is not applicable.

3. Result

3.1. Search Results

Various electronic databases were used to search all related

articles conducted in Ethiopia. A total of 3090 articles were obtained. Out of this, only 10 articles were fit the eligibility criteria and involved in this study (Figure 1).

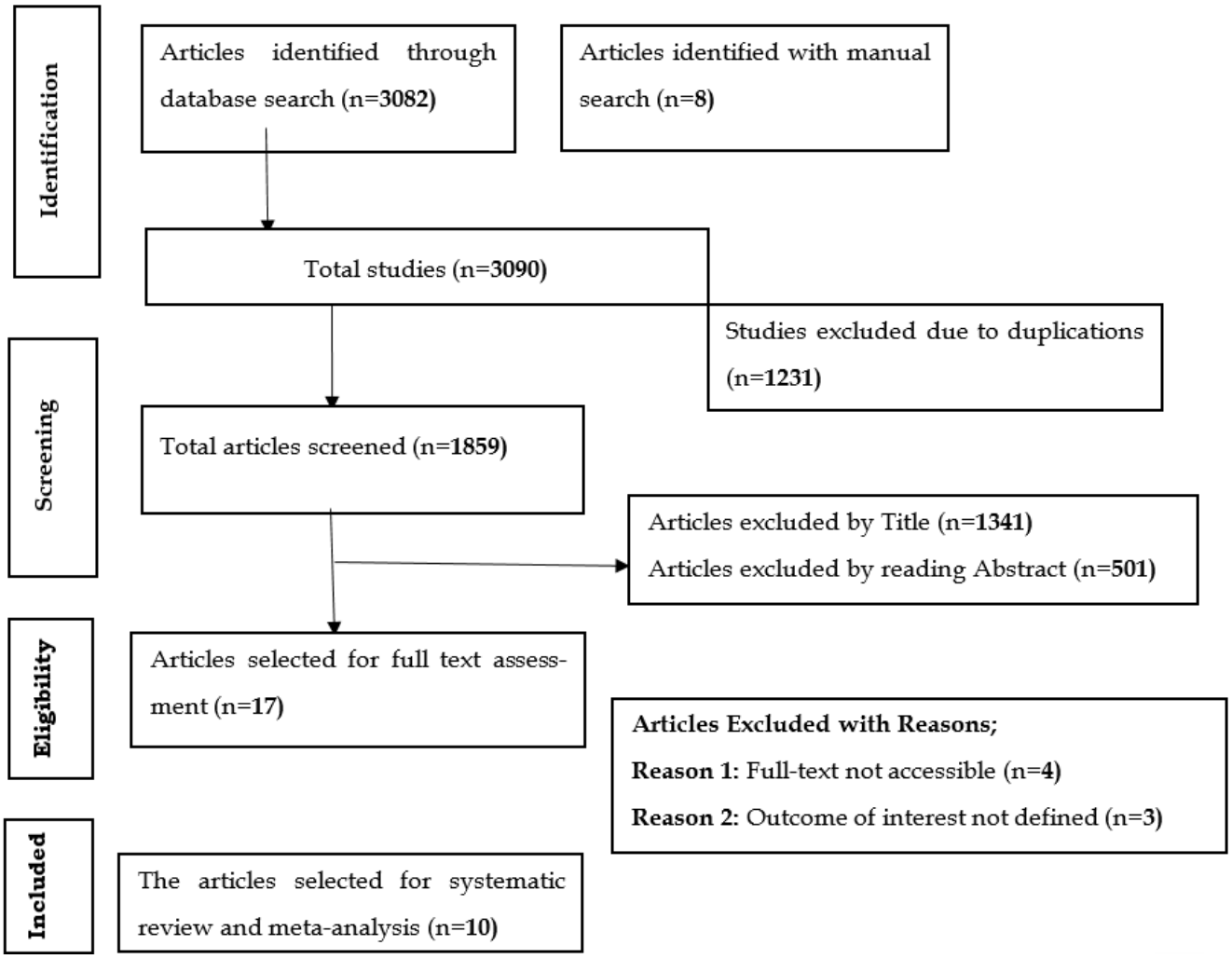

Figure 1. *PRISMA flowchart diagram of the study selection for systematic review on prevalence of anemia and its determinants. Note: (Figure 1) was Adapted from "Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021; 372: n71. https://doi.org/10.1136/bmj.n71." [40].*

3.2. Characteristics of the Included Studies

10 cross sectional studies were comprised in the present study. 2554 was the largest sample size and 216 was the smallest sample size. The largest prevalence was 72.3% and the smallest prevalence of anemia 44.4% (Table 1).

Table 1. *Characteristics of the Studies included in the present Systematic Review and Meta-analysis.*

Author	Publication year	Region	Data collection method	Data collection period	Study design	Sampling technique	Response rate	Sample size	Prevalence of Anemia	Quality score
Alemayehu et al. [13]	2019	SNNPR	Interviewer administered questionnaire	May -June 2016	community-based cross-sectional study	Multi-stage sampling	99.7%	990	65.7%	8
Gebrehaweria	2020	National	Extracted	January to	population-	stratified two-	-	2554	72.3%	8

Author	Publication year	Region	Data collection method	Data collection period	Study design	Sampling technique	Response rate	Sample size	Prevalence of Anemia	Quality score
and Lemma [41]			from the EDHS 2016	June 2016	based cross-sectional survey	stage cluster sampling				
Malako et al. [15]	2019	SNNPR	Interviewer administered questionnaire	In April 2017	Community Cross-sectional survey	A multistage sampling	95.78%	477	52%	8
Sorsa et al. [42]	2021	Oromia	Interviewer administered questionnaire	January 1–July 31, 2019	A community-based cross-sectional study	Multistage, random, and systematic sampling	-	917	44.4%	7
Woldie et al. [43]	2015	Amhara	Interviewer administered questionnaire	March to May, 2014	Institution based cross-sectional study	Systematic random sampling	97%	347	66.6%	9
Molla et al. [44]	2020	Amhara	Interviewer administered questionnaire	February 1 to March 2, 2018	A community-based cross-sectional study	Cluster sampling	92.0%	531	47.5%	9
Heinrichs et al. [45]	2021	National	Extracted from the EDHS 2005	-	population-based cross-sectional survey	a stratified, two-stage cluster sampling design	93%	1,290	71%	9
Malako et al. [46]	2018	SNNPR	Interviewer administered questionnaire	March to April 2017	A community-based cross-sectional study	Multistage sampling	92.91%	485	52.6%	9
Roba et al. [47]	2016	Oromia & Tigray	Interviewer administered questionnaire	January to February 2014 and July to August 2014	A community-based cross-sectional study	Simple random	98.2%	216	53.7%	9
Heinrichs et al. [45]	2021	National	Extracted from the EDHS 2005	-	population-based cross-sectional survey	a stratified, two-stag cluster sampling design	93%	1,290	61%	9

Note: SNNPR, Southern Nations, Nationalities and Peoples; EDHS, Ethiopian demographic and health survey.

3.3. Prevalence of Anemia

The random effect model was used to estimate the pooled prevalence of anemia. It was estimated to be 58.78% (95%CI: 52.13,65.43). The significance level of heterogeneity was (I^2 = 97.7%: p=0.000) (Figure 2).

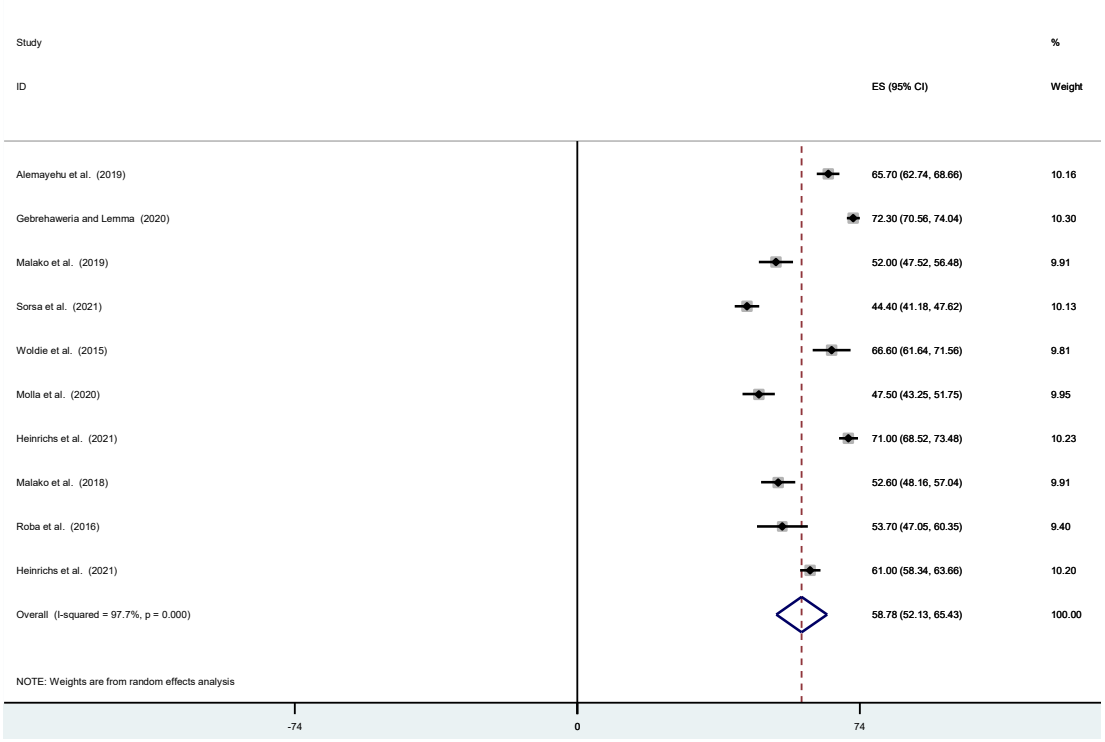

Figure 2. *Forest plot of the pooled prevalence of anemia.*

3.4. Subgroup Analysis

3.4.1. Subgroup Analysis by Region

The pooled prevalence of anemia was (54.63%, 95%CI [47.41,61.86]; I^2=95.3%, p=0.000) among regional based studies. Whereas, among the national based studies, the pooled prevalence of anemia was (68.15%, 95%CI [61.57, 74.73]; I^2=96.0%, p=0.000) (Figure 3).

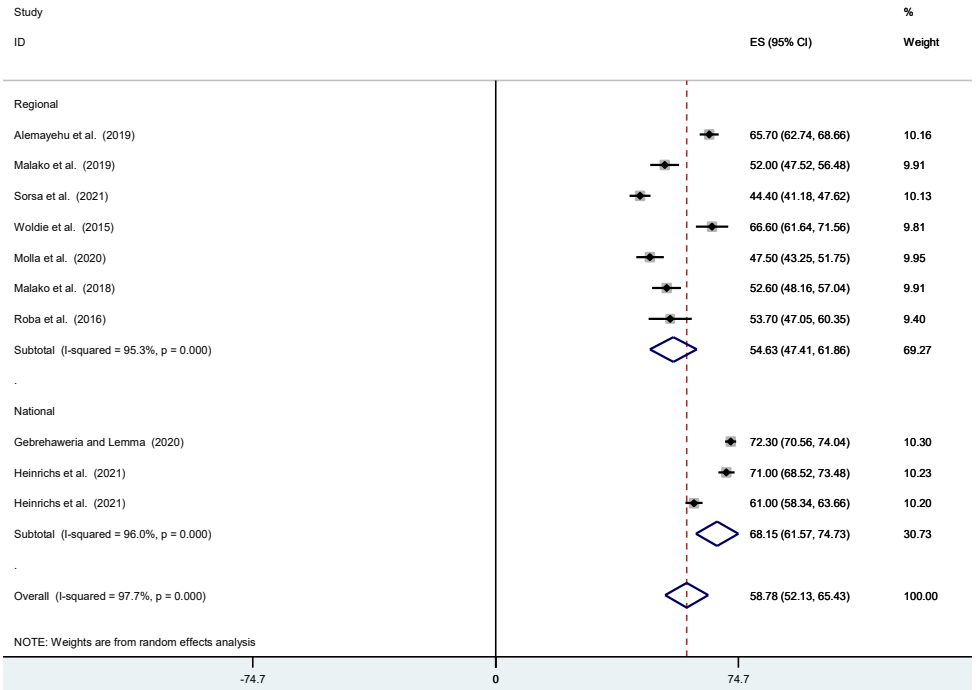

Figure 3. *Subgroup analysis by region on the pooled prevalence of anemia.*

3.4.2. Subgroup Analysis by Year of Publication

The pooled prevalence of anemia was (58.25%, 95%CI [51.40,65.10]; I^2=91.6%, p=0.000) for articles published 2015-2019. Whereas, for articles published 2020-2021, the pooled prevalence anemia was (59.33%, 95%CI [48.71, 69.94]; I^2=98.8%, p=0.000) (Figure 4).

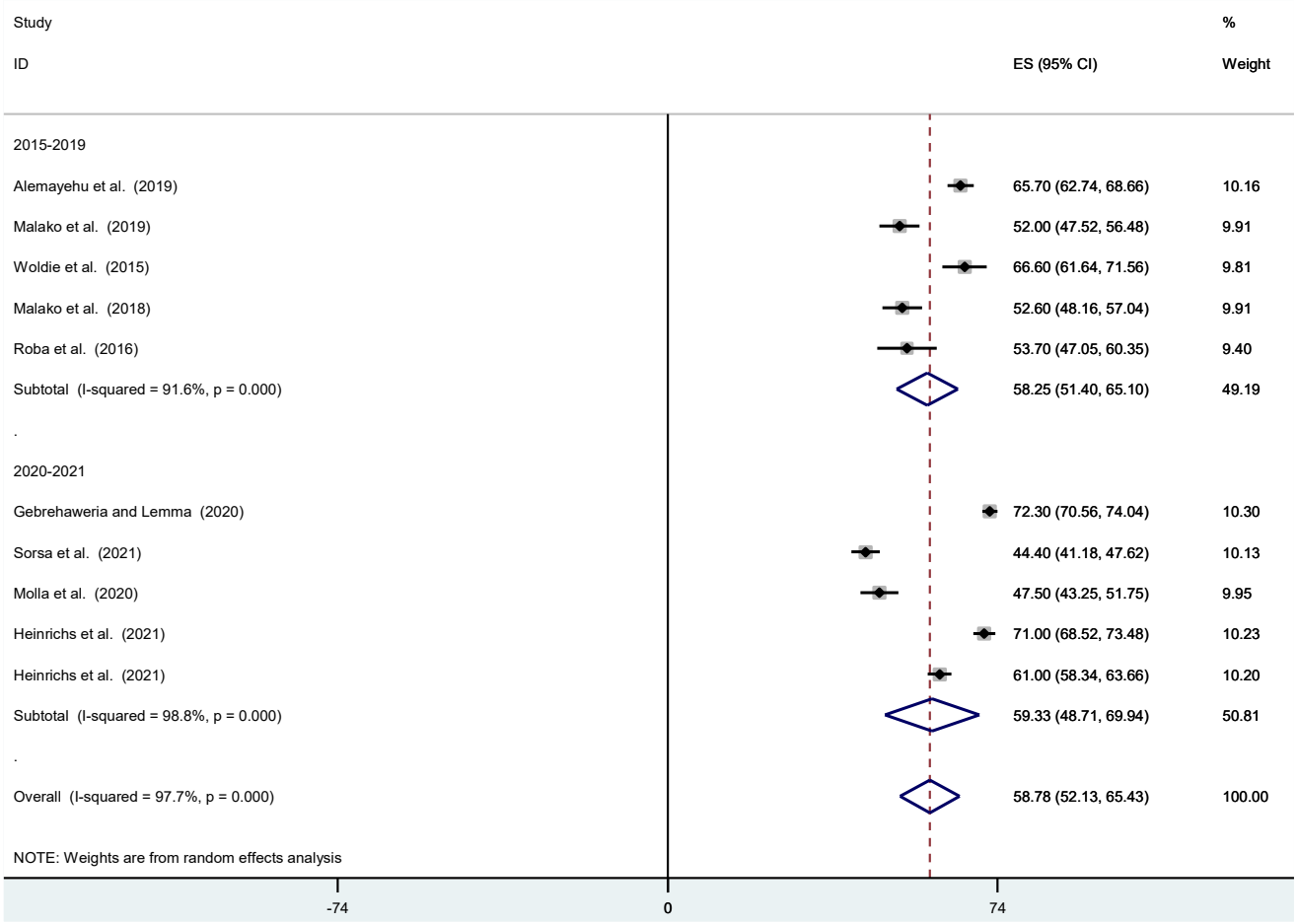

Figure 4. *Subgroup analysis by articles publication year on the pooled prevalence of anemia.*

3.4.3. Subgroup Analysis by Sample Size

The pooled prevalence of anemia was (62.93%, 95%CI [54.00,71.86]; I^2=98.4%, p=0.000) for sample size >600. Whereas, for sample size <600, the pooled prevalence of anemia was (54.43%, 95%CI [48.03, 60.82]; I^2=88.5%, p=0.000).

3.5. Publication Bias and Heterogeneity

According to the I^2 statistics, there was a significant heterogeneity among the included studies (I^2 = 97.7%, p=0.000) (Figure 2). The funnel plot displays the asymmetrical distribution of the included articles, and this suggests that there was publication bias. As the p-value is > 0.05 (0.210), there is no statistical evidence of publication bias using the Begg's test. Furthermore, As the p-value is <0.05 (0.029), there is statistical evidence of publication bias using the Egger's test.

3.6. Trim and Fill Analysis

The publication bias was evidenced by visual funnel plot asymmetry and statistical significance of Egger's Test. However, the subsequent trim-and-fill analysis showed that no trimming was performed, and the data were unchanged.

3.7. Sensitivity Analysis

The Sensitivity analysis for the present meta-analysis was performed by using the random effects model. The result indicated that there was no single study that influence the prevalence of anemia.

3.8. Determinants of Anemia

3.8.1. Dietary Diversity Status

Children exposed to poor dietary diversity were 2.81 times more likely anemic [AOR=2.81, 95%CI: 2.51, 3.11, I^2=0.0%, p-value=0.514] as compared to their counterparts who were exposed to a good dietary diversity (Figure 5).

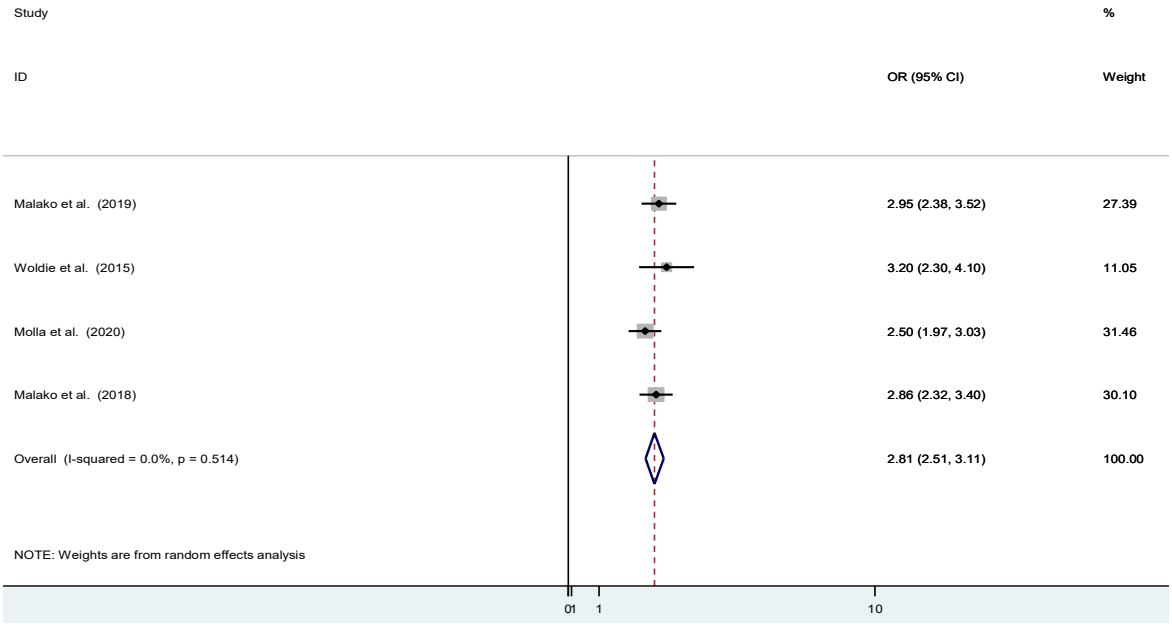

Figure 5. *The pooled effect of dietary diversity on anemia among children aged 6-23 months in Ethiopia.*

3.8.2. History of Diarrhea over the Last Two Weeks

Children who had history of diarrhea over the last two weeks were 3.97 times more likely anemic [AOR=3.97, 95%CI: 2.39,5.56, I^2=81.2%, p-value=0.021] as compared to children who had no history of diarrhea over the last two weeks (Figure 6).

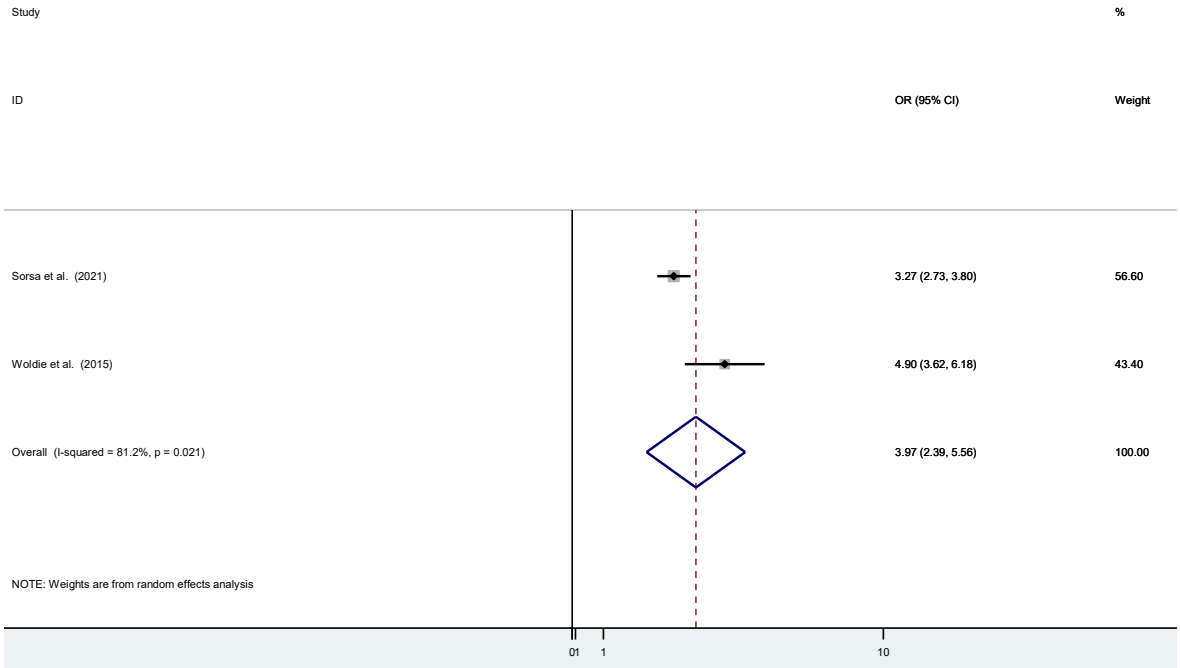

Figure 6. *The pooled effect of history of diarrhea over the last two weeks on anemia.*

3.8.3. Household Food Insecurity

Children who were exposed to household food insecurity were 2.72 times more likely anemic [AOR=2.72, 95%CI: 2.34, 3.10, I^2=0.0%, p-value=0.919] as compared to children who were exposed to food security (Figure 7).

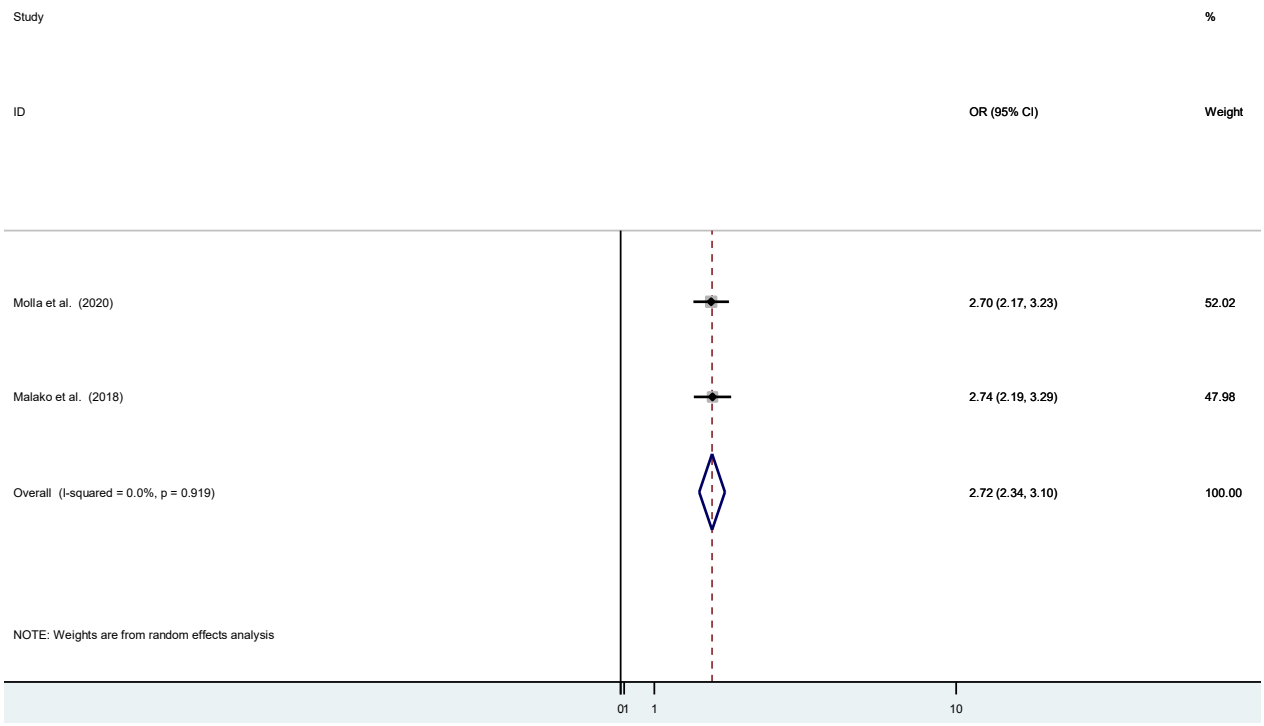

Figure 7. *The pooled effect of household food insecurity on anemia.*

4. Discussion

Anemia among children is a serious problem which remains a burden globally. Furthermore, its impact is significantly increasing in developing countries like SSA. This study was proposed to determine the pooled prevalence of anemia and determinants in "children aged 6-23 months" in Ethiopia. The pooled prevalence of anemia was 58.78% (95%CI: 52.13,65.43) in this study. This finding was lower than the study report from 32 SSA countries which reported the prevalence of anemia of children aged 6–23 months in SSA as 76.6% [24]. This might be because of the study report from 32 SSA countries utilized the demographic health survey of those countries.

The present study finding was higher than the studies done in Huaihua, Hunan Province, China (29.73%) [8]. The variation could be due that the difference in a study setting (institutional based), and sociodemographic characteristics of the study participants. The present study finding was also higher than the study done in Qiannan area of Guizhou province, China (47.59%) [48]. The variation could be the difference in the population characteristics and the specified anemia type assessed in this study. The present study finding was also higher than the study conducted in Madura rural, Indonesia (46.7%) [49].

The present study finding was also higher than the three years (2016–2018) report of prevalence of anemia in 6–23 months old infants and young children in China (27.0%) [50]. The present study finding was also higher than another community-based, cross-sectional survey done in Pinghu, a newly developing city in Zhejiang Province, China (36.6%) [51]. The present study finding was also higher than a study conducted at Karangklesem village, south Purwokerto (35.07%) [52]. This could be due to the difference in sociodemographic characteristics of the participants. However, the present study finding was consistent with the study done in Huzhu County, China, which revealed prevalence of anemia in children aged 6–23 months, 59.1% [53].

The subgroup analysis of this study revealed that there was a difference of the pooled prevalence of anemia with region, publication year and sample size categories. The pooled prevalence of anemia was (54.63%, 95%CI [47.41,61.86]; I^2=95.3%, p=0.000) among regional based studies. Whereas, among the national based studies, the pooled prevalence of anemia was (68.15%, 95%CI [61.57, 74.73]; I^2=96.0%, p=0.000). The pooled prevalence of anemia was (58.25%, 95%CI [51.40,65.10]; I^2=91.6%, p=0.000) for articles published 2015-2019. Whereas, for articles published 2020-2021,

the pooled prevalence of anemia was (59.33%, 95%CI [48.71, 69.94]; I^2=98.8%, p=0.000). The pooled prevalence of anemia was (62.93%, 95%CI [54.00,71.86]; I^2=98.4%, p=0.000) for sample size >600. Whereas, for sample size <600, the pooled prevalence of anemia was (54.43%, 95%CI [48.03, 60.82]; I^2=88.5%, p=0.000).

Regarding the determinants of anemia, children exposed to poor dietary diversity were 2.81 times more likely anemic [AOR=2.81, 95%CI: 2.51,3.11, I^2=0.0%, p-value=0.514] as compared to their counterparts who were exposed to a good dietary diversity. Children who had history of diarrhea over the last two weeks were 3.97 times more likely anemic [AOR=3.97, 95%CI: 2.39,5.56, I^2=81.2%, p-value=0.021] as compared to children who had no history of diarrhea over the last two weeks. This was consistent with a study done in Huaihua, Hunan Province, China (29.73%) [8]. Children who were exposed to household food insecurity were 2.72 times more likely anemic [AOR=2.72, 95%CI: 2.34,3.10, I^2=0.0%, p-value=0.919] as compared to children who were exposed to food secure.

5. Limitations of the Study

Despite the topic is interesting, critical and time-based study, there was a scarcity of articles published on this topic. Furthermore, some of the determinants of anemia were not consistently measured. Therefore, it was difficult to include them to estimate their pooled effects on this outcome of interest.

6. Conclusion

The present study displayed that the pooled prevalence of anemia among “children aged 6-23 months” was high. Dietary diversity status, history of diarrhea over the last two weeks and household food insecurity status were statistically significant determinants of anemia.

The findings of present study would enhance the improvement of this problems. It will encourage the development of different guidelines and strategies to abate this serious burden. Therefore, various concerned bodies such as stakeholders, healthcare providers, healthcare institutions, policy makers and implementers, government and non-governmental originations would get this essential information to emphasize this critical problem. Lastly, the authors suggest that any concerned body should promote mothers of “children aged 6-23 months” to alert them about risk factors of anemia.

Abbreviations

AOR	Adjusted Odds Ratio
CI	Confidence Interval
EDHS	Ethiopian Demographic and Health Survey
NOS	Newcastle-Ottawa Scale
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SNNPR	Southern Nations, Nationalities and Peoples
SSA	Sub-Saharan Africa
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

Author Contributions

Lidiya Tekle Gebreyohannes: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Addisu Dabi Wake: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Data Availability Statement

The datasets used and analyzed during the present study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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