



RISK FACTORS FOR IRON DEFICIENCY ANEMIA AMONG ADOLESCENTS IN DEVELOPING COUNTRIES: STUDY LITERATURE REVIEW

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ABSTRACT

Adolescents experience physiological and psychological growth to establish the basis for maturity. The biological well-being of adolescents requires improved nutrition. Intake of foods rich in micronutrients such as iron, zinc, and vitamin A, which are relevant to supporting biological metamorphosis in adolescents, can influence growth and well-being. The aim of this study is to holistically identify the main risk factors affecting adolescents that contribute to anemia in developing country developing. A systematic review was conducted following the guidelines provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The current review defines adolescents as individuals ranging in age from 10 to 19 years. A total of 2,252 articles were retrieved from the database, of which 618 duplicates were removed and 1,492 records were issued after filtering by title and abstract. 142 articles were fully assessed for notability, and 127 articles were also excluded based on inclusion and exclusion criteria. Finally, 15 studies were included in the systematic review. The review showed that food intake practices, parasite infections, menstruation, the increasing age of adolescent girls, and the low educational status of guardians are the main risk factors for iron deficiency anemia among adolescents in most developing countries.

Keywords: adolescents; anemia; iron

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INTRODUCTION

Adolescents experience physiological and psychological growth that sets the foundation for maturity. The biological well-being of adolescents requires improved nutrition. (Amirul Fitri Rahim et al., 2021). The intake of foods rich in micronutrients such as iron, zinc, and vitamin A relevant to supporting biological metamorphosis in adolescents can affect their growth and well-being. (Sarkar et al., 2021; Trushna et al., 2024). The majority of teenagers usually skip breakfast, fruits, vegetables, and milk every day, reducing their food intake (Said & Shaab Alibrahim, 2022; Sk & Banerjee, 2021). Adolescents with such dietary practices show deficiencies in micronutrients such as iron, calcium, zinc, folic acid, and vitamins A, D, and C (Ayoub et al., 2022; Leppäniemi et al., 2023). These deficiency exposes teens to enduring nutrition and health vulnerabilities.

Iron, folate, and vitamin B12 deficiencies contribute to nutritional anemia in adolescents (Garcia-Casal et al., 2023; Shahadat Khan et al., 2022). Among the different types of nutritional anemia, iron deficiency anemia is the most common (Khan et al., 2023; Ranjan et

al., 2018; Takeshima et al., 2023). Iron deficiency anemia (IDA) is measured by indicators such as hemoglobin, serum ferritin, transferrin receptors, saturation/total transferrin iron binding capacity, and zinc protoporphyrin (Pfeiffer & Looker, 2017; S. Lynch, 2010). Anemia is largely defined as low hemoglobin levels in blood or hemoglobin less than 120 g/l in adolescents (De Benoist et al., 2008).

Statistics show that about 30–35% of the world's population suffers from iron deficiency anemia, which affects about 47.5% of people living in Africa (Garcia-Casal et al., 2023; Laelago et al., 2023). The populations most at risk of iron deficiency anemia are children less than FVE years old, adolescents, women of reproductive age, pregnant women, and nursing mothers (Abera et al., 2023).

To ameliorate the prevalence and consequences of iron deficiency anemia in adolescents, a review study recommends identifying local risk factors for iron deficiency anemia to aid in effective management and prevention (Chilot et al., 2023). Predictors of iron deficiency anemia among adolescents have been reported by different studies in several countries (Adokorach et al., 2024; Jung et al., 2023; Zhu et al., 2021). In developing countries, risk factors for IDA include, but are not limited to, malaria, worm infestations, low dietary iron intake, micronutrient deficiencies, human immunodeficiency viruses, and congenital abnormalities (Obeagu, 2023). Various contributing factors to IDA reported by many studies negatively impact adolescent health (Abu-Baker et al., 2021). Due to this, several interventions have failed to reduce the high prevalence of IDA among adolescents in the long term (Sharma et al., 2024).

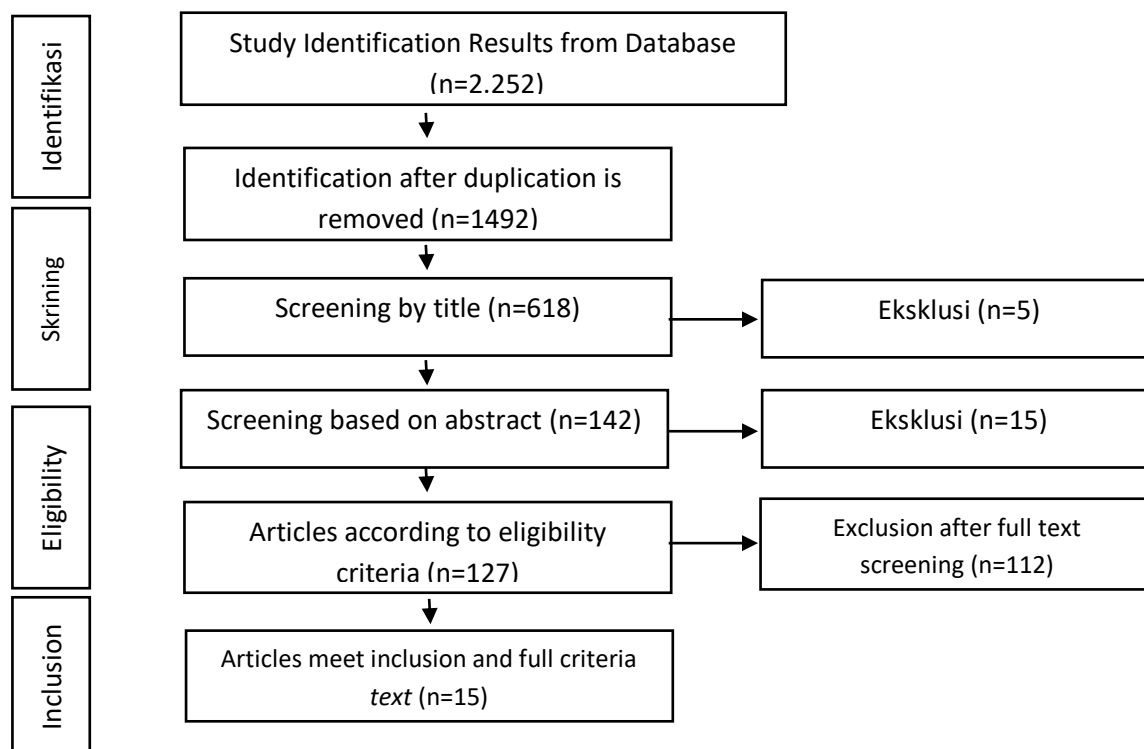
Iron deficiency anemia negatively impacts the educational and economic well-being of adolescents (Lukovac et al., 2024). It has been associated with stunting, wasting, underweight, poor cognitive function, low physical activity, and attention deficit hyperactivity disorder in adolescents (Anie et al., 2006; Jáuregui-Lobera, 2014; Mikki et al., 2011; Mousa, Higazi, Saleh, et al., 2016; Soman et al., 2017; YILMAZ et al., 2023). Iron deficiency anemia is now recognized as the leading cause of disability-adjusted life years in adolescents (Hanifiha et al., 2022). The aim of this study was to holistically identify the major risk factors affecting adolescents that contribute to anemia among adolescents living in developing countries.

METHOD

This is a systematic review conducted following the guidelines provided by the Preferred Reporting Items for Systematic Review and Metaanalysis (PRISMA) (Moher et al., 2010). The current review defines teens as individuals with ages ranging from 10 to 19 years ranging from 2014 to 2023. The list of developing countries under consideration is based on the classification of countries by the United Nations Children's Fund (Anthony & UNICEF., 2011). A comprehensive search of articles published from January 1990 to December 2020 was sourced from Google Scholar, PubMed, Scopus, Science Direct, and the Cochrane Library. Search terms used either singly or in combination include risk factors for anemia, iron deficiency anemia, determinants of anemia, predictors of anemia, anemia in adolescents, low hemoglobin, anemia, and adolescents.

The Te review focused on studies with the primary goal of identifying risk factors for iron deficiency anemia (IDA) among adolescents living in developing countries. Studies conducted among adolescents without underlying health conditions were included. Studies were conducted among adolescents with pregnancy, breastfeeding, sickle cell, genetic hemoglobin, or underlying conditions, mixed age groups, and other forms of anemia excluded. Studies with inaccessible full articles, non-

English-written articles, and articles published before 1990 are also excluded. The results assessed in this review are risk factors for iron deficiency anemia among adolescents. The primary outcome was risk factors directly related to adolescents that contribute to iron deficiency anemia. Secondary outcomes are risk factors indirectly associated with adolescents, leading to iron deficiency anemia. The main information from each study is extracted by one researcher. Key information for this review includes: author, country, year, gender, age, sample size, and risk factors for iron deficiency anemia. A total of 2,252 articles were taken from the database, 618 duplicates were removed and 1,492 records were excluded after filtering based on titles and abstracts, 142 articles were fully assessed for notability, and 127 articles were also excluded based on inclusion and exclusion criteria. Finally, 15 studies were included in the review.



RESULTS

Study Characteristics

All studies included in this review were cross-sectional and were published between 1990 and 2020. Five studies were conducted in Ethiopia (Fage et al., 2020; Gebreyesus et al., 2019; Regasa & Haidar, 2019; Shaka & Wondimagegne, 2018); four studies were also conducted in India (Agrawal et al., 2018; Kaur et al., n.d.; Thomas et al., 2015); two studies were conducted in Kenya (Leenstra et al., 2004; Nelima, 2015); and one study was conducted in Ghana (Wiafe et al., 2020), Mesir (Bendary et al., 2023), Nepal (Chalise et al., 2018), and Iran (Ramzi et al., 2011). Only two of the studies had national representation (Chalise et al., 2018; Wiafe et al., 2020). Eight of the studies recruited adolescent girls exclusively, and seven of the studies recruited adolescents of mixed sex. It has sample sizes ranging from 137 to 2,032. Participants were aged 10–19 years.

Study Quality Assessment

Study quality assessment using quality control checklists. All studies were cross-sectional, and attributes from the quality criteria checklist were modified for maximum use in assessment. Attributes such as "comparable study group" and "blinding use" do not apply to assessments from studies. All studies had positive quality ratings.

Factors Related to Adolescent Iron Deficiency Anemia

Various studies assess the factors that contribute to iron deficiency anemia among adolescents in developing countries. For this review, factors have been grouped into direct factors: dietary intake practices, malaria infection, worm infestations, adolescent girls, blood loss, and indirect factors: educational status, socioeconomic status, rural areas, family size, religion, and walking barefoot.

Food Intake Practices.

Ten studies assessed the association between iron deficiency anemia and dietary intake practices among adolescents. The study showed that vegetarian dietary practices increase the likelihood of anemia among adolescents (Agrawal et al., 2018; Kaur et al., n.d.; Thomas et al., 2015). report that vegetarian adolescents have a higher likelihood of anemia than those who consume a mixed diet (OR = 8.5, 95% CI = 5.7–12.8). In another cross-sectional study, vegetarian adolescents had a 4.4% greater chance of becoming anemic than their peers who did not practice vegetarianism (Thomas et al., 2015). Two studies reported dietary diversity. Studies document that low dietary diversity significantly increases the risk of adolescents (AOR = 3.57, 95% CI: 1.88–6.75) (Fentie et al., 2020) and adults (AOR = 2.33, 95% CI: 1.2–4.86) (Fage et al., 2020) becoming anemic. Furthermore, low dietary iron intake significantly increased anemia among adolescents (Kaur et al., n.d.; Nelima, 2015). Two studies reported skipping meals and meal frequency (Shaka & Wondimagegne, 2018; Wiafe et al., 2020). Teens who skip meals and have a low frequency of eating have a high chance of becoming anemic. One study among adolescents in Ghana showed that snacking was not significantly associated with anemia ($I = 0.484, p > 0.05$) (Wiafe et al., 2020).

Parasitic infections

Six studies reported parasitic infections. Malaria and worm infestations, specifically Schistosomiasis and Ova ascaris, were common parasitic infections found among adolescent girls in the studies included in this review. Five studies showed that worm infestation significantly increased the likelihood of anemia incidence in adolescents (Nelima, 2015; Ramzi et al., 2011; Thomas et al., 2015). One cross-sectional study reported that malaria significantly increased the likelihood of anemia in adolescents (OR = 3.68, 95% CI: 1.69–7.98) (Nelima, 2015).

Teenage Girls

Eight studies reported an association between adolescent girls and anemia (Chalise et al., 2018; Fage et al., 2020; Fentie et al., 2020; Nelima, 2015). Studies show significant and higher chances of adolescent girls having anemia. Four out of eight studies showed that older adolescents had a higher likelihood of anemia (As et al., n.d.; Chalise et al., 2018; Nelima, 2015; Regasa & Haidar, 2019).

Blood Loss/Menstruation

Five studies (Fentie et al., 2020; Leenstra et al., 2004; Ramzan et al., 2023; Regasa & Haidar, 2019) assessed the relationship between anemia and menstruation. A review of VE studies shows that excessive bleeding during menstruation significantly increases the likelihood of anemia (Fentie et al., 2020; Nelima, 2015). According to (Fentie et al., 2020), adolescent girls who bleed for more than 5 days have an increased risk (AOR = 2.25, 95% CI: 1.17–4.33) of being anemic (Regasa & Haidar, 2019) reporting menstruation to be a statistically significant risk factor for anemia in adolescents. However, (Ramzan et al., 2023) did not find a significant link between menstruation and anemia in adolescents.

Education Status

Among four studies that reported education status as a risk factor for anemia, three showed that maternal education was a major determinant. El Sahn et al. reported that the risk of anemia increased significantly with decreasing education level (OR = 3.5, 95% CI: 10.90–6.32). Adolescents with education up to the junior high school level or lower were found to have an increased likelihood of becoming anemic.

Socioeconomic Status

The REE study assessed the relationship between socioeconomic status and anemia. Results show that low socioeconomic status increases the likelihood of anemia in adolescents (Agrawal et al., 2018; Fentie et al., 2020). All studies found adolescents with low socioeconomic backgrounds had a greater likelihood of becoming anemic (OR = 2.16, 95% CI: 1.17–4.33; OR = 2.86, 95% CI: 1.16–7.04; OR = 1.4, 95% CI: 1.13–1.8 Fentie et al; Agrawal et al; dan El Sahn et al.

Rural areas

Two studies reported anemia in rural areas (Regasa & Haidar, 2019; Shaka & Wondimagegne, 2018). Study E shows that adolescents living in rural areas have an increased risk of anemia. Regasa and Haidar found that the odds were statistically significant.

Family Size

Two studies assessed the association between family size and anemia (Ramzi et al., 2011; Shaka & Wondimagegne, 2018). Studies show that large family size increases the likelihood of anemia (Ramzi et al., 2011), showing a significant association, while Shaka and Wondimagegne (2018) show the opposite.

Religion

Only one study investigated the relationship between religion and anemia. However, the results showed no religious significance for anemia among adolescents (Agrawal et al., 2018).

Walking Barefoot

Only one study reported that adolescents who walked barefoot had a higher chance of developing anemia (Chalise et al., 2018). According to the authors, adolescents who walked barefoot had a 1.78 chance of developing anemia (AOR = 1.78, 95% CI: 1.08, 2.94).

DISCUSSION

The prevalence of anemia among adolescents is a public health concern, although the application of interventions varies. The management and prevention of iron deficiency anemia is complex, suggesting that different factors contribute to IDA in different geographic settings. The study assessed the risk of iron deficiency anemia among adolescents in developing countries. A risk factor for iron deficiency anemia among adolescents is conglomerate. However, dietary intake practices, low educational status, parasitic infections, older adolescent girls, menstruation, and low socioeconomic status are major risk factors predisposing adolescents to iron deficiency anemia.

Food Intake Practices

Adolescents prefer to explore their dietary environment and, thus, consume foods that are pleasing to the eye with little or no consideration of the nutrients needed for their growth and well-being. Most teens binge on junk food due to a neglect of nutritious diets (Imoisili et al., 2020). These poor food choices affect nutrient needs, leading to micronutrient deficiencies,

especially anemia. The negative influence of IDA on learning, scholastic performance, and achievement among adolescents contributes to dropout rates (Bahrami et al., 2020; Mousa, Higazi, & Ali, 2016). Adolescents with low educational status cannot acquire employable skills, thus affecting their economic status (Stryzhak, 2020). Unskilled labor pays less because guardians cannot provide their children with a good education and also meet their nutritional needs. These teens also become mothers of children with iron deficiency anemia to perpetuate the cycle of anemic consequences. In this review, most studies found that vegetarian dietary practices increased the risk of anemia among adolescents (Agrawal et al., 2018; Kaur et al., n.d.; Thomas et al., 2015). Inadequate dietary iron intake (Kaur et al., n.d.; Nelima, 2015) and low dietary diversity (Fage et al., 2020; Fentie et al., 2020) came second in contributing to IDA among adolescents. Most rich in iron are expensive food sources in developing countries (Mwangi et al., 2017). Other dietary intake practices, such as skipping meals, lower meal frequency, lower food diversity, household food insecurity, and snacking, also increase the risk of IDA among adolescents. Poor nutrition has become a major risk factor for IDA among adolescents. (Kanodia et al., 2016; Thomas et al., 2015).

Teenage Girl

Our review shows that adolescent girls have a higher risk of developing iron deficiency anemia, especially older girls. It is thus not surprising that eight of the twelve studies focused on adolescent girls (As et al., n.d.; Fentie et al., 2020; Gebreyesus et al., 2019; Regasa & Haidar, 2019). Older girls may prefer eating out, skipping meals, and dieting to maintain a certain body curvature, making them more susceptible to IDA. Most guardians have less control over older teenage girls' food intake. Fear of weight gain and low nutritional knowledge influence adolescent eating habits and contribute to IDA (Balçı et al., 2012; Banna et al., 2016). Menstruation and childbearing have increased the chances of anemia in older adolescents. A national study in Namibia, Malawi, Zimbabwe, and Mozambique showed that anemic mothers had a higher chance of giving birth to children with low hemoglobin levels (Ntenda et al., 2018).

Worm infestation

The prevalence of worm infestations is estimated to be around 1.5 billion, with the majority of populations from sub-Saharan Africa, the Americas, China, and East Asia (Assari, 2018). Roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*), hookworms (*Necator americanus* and *Ancylostoma duodenale*), and other worms have been implicated in anemia by causing gastrointestinal blood loss, poor nutrient absorption, inhibition or suppression of appetite, and infection, which is common among adolescents (Lazarte et al., 2015; Thomas et al., 2015).

Guardian Education

Low educational status of guardians, especially mothers, has been associated with a high risk of anemia in adolescents in a variety of settings and studies (Agrawal et al., 2018; Upadhye & Upadhye, 2017). Mothers with limited formal education may not be able to read and understand food labels. The level of nutritional knowledge of the mother is very important because she is the main kitchen person in most homes in terms of food preparation, dietary choices, and family intake. The educational status of mothers has been shown in the normal hemoglobin levels of children (Amugsi, 2020). Fathers and adolescents' education levels rarely cause iron deficiency anemia in our target group.

Socioeconomic Status

Higher maternal education and employment status reduce the likelihood of iron deficiency anemia in children (Ojoniyi et al., 2019). Guardians with low educational status have low-skilled jobs with poor wages (Assari, 2018). Low socioeconomic status as unemployment affects household purchasing power. Teenagers rely heavily on guardians or parents for their financial and dietary needs. Households with low socioeconomic status face risks of food insecurity, low dietary diversity, and inadequate food intake, which pose health risks.

Strengths and Limitations

This study provides an overview of the risk factors for iron deficiency anemia among adolescents in developing countries. The sample size of most studies was not nationally representative, and adolescent girls were the target for most studies. Therefore, the results cannot be generalized.

CONCLUSION

Reviews show that dietary intake practices, parasitic infections, menstruation, an increase in adolescent girls, and low guardian education status are major risk factors for iron deficiency anemia among adolescents in most developing countries.

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