



Overview of Iron Deficiency Anemia in Iranian Children and Adolescents

Maryam Naseri¹, Hashem Lashgari Kalat², Maryam Mirzaei³, Najmeh Soltani Nejad⁴,
*Mohammad Hasan Mohammadi⁵

¹Fellowship of Pediatric Intensive Care, Department of Pediatrics, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. ²Department of Pediatrics, Clinical Research Development Center of Children's Hospital, Hormozgan University of Medical Sciences, Bandar Abbas, Iran. ³Department of Obstetrics and Gynecology, Faculty of Medicine, Jiroft University of Medical Sciences, Jiroft, Iran. ⁴Kerman University of Medical Sciences, Keran, Iran. ⁵Department of Pediatrics, Zabol University of Medical Sciences, Zabol, Iran.

Abstract

Background: Iron deficiency anemia (IDA) is a significant global health issue, particularly affecting children and adolescents. The present study aims to review the existing research on the prevalence of IDA and iron deficiency (ID) in Iranian children and adolescents.

Materials and Methods: Online databases such as PubMed, Scopus, Web of Science, EMBASE, CIVILICA, and the Google Scholar were searched for related reviews and systematic reviews up to February 2024. Two reviewers evaluated the quality of eligible studies and conducted the selection procedure.

Results: Five systematic reviews and two additional reviews, involving a total of 159 studies, were selected. The results indicated that the overall prevalence of ID and IDA among Iranian children and adolescents was 24.18% (ranging from 17.95% to 27.7%) and 16.73% (ranging from 10.6% to 21.4%), respectively. The prevalence of IDA was 7.9% (95% CI: 4.1–11.7) in males and 8.5% (95% CI: 6.1–10.8) in females under 18 years of age. In children under 6 years, the prevalence of ID and IDA was 27.7% and 18.2%, respectively. Notably, boys exhibited a higher prevalence of IDA at 17.7% compared to girls at 14.4%. Recent data highlights the differences in prevalence rates among genders, age groups, and geographical locations. Additionally, several factors contribute to the risk of developing IDA, including age (specifically in children under 2 years), family size (larger families), maternal factors (such as children born to anemic mothers or those with low birth weight), and dietary habits (notably a lack of iron-fortified milk consumption).

Conclusion: The overall prevalence of IDA varies widely among children and adolescents. By promoting awareness of dietary needs and implementing effective screening programs, healthcare providers can significantly reduce the incidence of IDA in younger populations.

Key Words: Adolescents, Children, Iron Deficiency Anemia, Iran, Prevalence.

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*Corresponding Author:

Mohammad Hasan Mohammadi, MD, Department of Pediatrics, Zabol University of Medical Sciences, Zabol, Iran.

Email: mohammadimh@yahoo.com

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1- INTRODUCTION

Iron Deficiency Anemia (IDA) is a significant global public health issue affecting diverse populations in both emerging and developed countries. This condition is characterized by a deficiency in the number of red blood cells or hemoglobin, which leads to insufficient oxygen transport in the body and has profound health implications (1). Anemia is particularly concerning as a public health issue, especially among children. The World Health Organization (WHO) defines anemia as a condition where the hemoglobin concentration falls below specified thresholds based on age. For children under six years, anemia is defined as a hemoglobin level of less than 11 gm/dL, while for older children, the threshold is set at 12 gm/dL (2, 3). Anemia occurs when there are not enough healthy red blood cells or hemoglobin to transport sufficient oxygen to body tissues. This condition can result in symptoms such as fatigue, weakness, dizziness, and shortness of breath. According to the WHO, anemia can result from several factors, including nutrient deficiencies (notably iron), infections, chronic diseases, and inherited disorders (3).

The global prevalence of iron deficiency anemia (IDA) among children under five years was reported at 39.7% in 2019, marking it as the highest prevalence among all age groups (4). Approximately 20% to 25% of preschool children worldwide are estimated to be affected by IDA, with the highest rates found in South Asia and Africa (5). In a focused analysis of Iranian children under six years, the prevalence of iron deficiency was reported at 27.7%, with IDA affecting about 18.2% of this population (6). A systematic review indicated that the overall prevalence of IDA among Iranian adolescents under 18 years is approximately 13.9%, with iron deficiency rates reaching 26.9%. Specifically, among males, the prevalence

of IDA is 7.9%, while it is 8.5% for females (7). In Indonesia, a study found an IDA prevalence of 16% in the age group of 12 to 18 years (8), while another study indicated that approximately 5.8% of adolescents were affected by IDA (8). A systematic review highlighted that certain regions in Iran, such as Southern Kerman, Southern Khorasan, and Sistan-Baluchestan, exhibited the highest prevalence rates of IDA, reaching up to 44% (9). Additionally, a study noted that schoolgirls aged 7-12 years had an anemia prevalence of about 15%, with rural areas showing higher rates compared to urban counterparts (10).

Iron deficiency anemia is a significant health concern during childhood and adolescence due to its profound impact on physical and cognitive development. Iron plays a crucial role in neurodevelopment, and a deficiency in early life can lead to long-lasting cognitive impairments, including difficulties with concentration, attention-deficit hyperactivity disorder (ADHD), irritability, and decreased academic performance. Studies indicate that the cognitive effects of IDA can persist into adulthood if not addressed early (11, 12).

Iron is crucial for adolescents as it supports oxygen transport and energy metabolism, both essential during periods of rapid growth. Adolescents require increased iron intake due to the expansion of blood volume and muscle mass, particularly in athletes, who face even higher demands due to physical activity (13, 14). Anemia not only affects physical health but also academic performance. A study involving 250 schoolgirls found that 80% had some form of anemia, correlating with poor menstrual health and reduced academic achievement (15). The assessment of anemia among Iranian children and adolescents highlights a persistent public health challenge. Despite varying prevalence rates across studies, the

need for targeted interventions remains crucial to mitigate the impact of iron deficiency anemia in this demographic. Continued research and updated data are essential for effective policy-making and health strategies moving forward. Over the past few years, several systematic reviews and narrative studies have been published on the prevalence of IDA among Iranian children and adolescents, yielding varying results. Given the importance of health in this population, this study aimed to review and evaluate the prevalence of iron deficiency (ID) and iron deficiency anemia (IDA) among Iranian children and adolescents, while also comparing these prevalence rates with those reported in previous studies.

2- MATERIALS AND METHODS

This overview includes all reviews, systematic reviews, and meta-analyses written in Persian or English that report on the prevalence of iron deficiency (ID) and iron deficiency anemia (IDA) among Iranian children and adolescents under 18 years of age. We searched the electronic databases of Scopus, EMBASE, Web of Science, CIVILICA, Medline (via PubMed), and Google Scholar for full-text articles with no time restrictions up to February 15, 2024. Two independent researchers conducted the search process, while one supervisor resolved any discrepancies.

The search terms included "iron," "iron deficiency," "iron deficiency anemia," "anemia," "children," "adolescents," "prevalence," and "Iran," utilizing Boolean operators such as "AND" and "OR."

We evaluated the quality of the included studies using the Assessment of Multiple Systematic Reviews (AMSTAR2) instrument. AMSTAR2 is a critical appraisal tool specifically designed to evaluate the methodological quality of systematic reviews (SRs), and meta-analyses (MAs) of healthcare

interventions. This tool consists of 16 items, with seven deemed critical for determining high-quality reviews. Each item is answered with "yes," "partial yes," "no," or "no meta-analysis conducted." Studies are categorized based on the number of "yes" responses they receive:

- High Quality: Studies with 13 or more "yes" answers
- Moderate Quality: Studies with 9 to 12 "yes" answers
- Low Quality: Studies with 5 to 8 "yes" answers
- Critically Low Quality: Studies with 4 or fewer "yes" answers (16-18).

3- RESULTS

Finally, seven related studies were selected, including five systematic reviews (n = 157 articles and 51,996 subjects), and two narrative reviews. The quality evaluation of each systematic review using the AMSTAR2 tool indicated that all five systematic reviews were of moderate quality. The key characteristics of the included studies are summarized in **Table-1** and in the following sections:

1. A study conducted in 2023 (n=7 articles) aimed to perform an umbrella systematic review of the available evidence on the prevalence of IDA in Iranian children and pregnant women. The results indicated that the prevalence of IDA was 15.71% among pregnant women and 19.91% among young children. Additionally, the prevalence in urban and rural regions was 16.32% and 12.75%, respectively. In the eastern, western, central, southern, and northern regions of Iran, the estimated prevalence rates were 17.8%, 7.97%, 19.97%, 13.45%, and 17.82%, respectively (19).

2. A systematic review conducted in 2023 (n=28 articles) aimed to determine the global prevalence and associated factors of iron deficiency and iron deficiency anemia

among children under five years of age. The results indicated that the global prevalence of iron deficiency anemia was 16.42% (95% CI: 10.82, 22.01), while the prevalence of iron deficiency was 17.95% (95% CI: 13.49, 22.41). Factors associated with iron deficiency anemia included being under two years of age (OR = 1.26; 95% CI: 1.14, 1.38), and living in a large family (OR = 1.38; 95% CI: 1.18, 1.58). Additionally, having anemic mothers (OR = 1.20; 95% CI: 1.05, 1.36), being of low birth weight (OR = 1.15; 95% CI: 1.01, 1.36), and not consuming iron-fortified milk (OR = 1.28; 95% CI: 1.10, 1.46) were identified as factors associated with iron deficiency in children under five (20).

3. A systematic review conducted in 2019 (n=6 articles) aimed to estimate the prevalence of iron deficiency anemia among Iranian children. The results indicated that the prevalence rates of iron deficiency and iron deficiency anemia in Iranian children under six years of age were 27.7% (95% CI: 11.9–43.5), and 18.2% (95% CI: 14.3–22), respectively. Furthermore, the prevalence of iron deficiency anemia was higher in boys (17.7%, with a 95% CI of 5.9–29.5) than in girls (14.4%, with a 95% CI of 4.5–24.2) (6).

4. A systematic review conducted in 2017 (n=89 articles) aimed to estimate the prevalence of iron deficiency anemia among high school students in Iran. The

results indicated that the prevalence of iron deficiency anemia was 10.6%, with a 95% CI: 9.7-11.5, up until 2014 (21).

5. A systematic review conducted in 2016 (n=27 articles) aimed to estimate the prevalence of iron deficiency anemia in Iranian children and adolescents. The results indicated that the overall prevalence of IDA in this age group was 13.9% (95% CI: 10.8–17.1), while the overall prevalence of iron deficiency (ID) was 26.9% (95% CI: 19.7–34.1). The prevalence of IDA was found to be 7.9% (95% CI: 4.1–11.7) in males and 8.5% (95% CI: 6.1–10.8) in females aged under 18 years (7).

6. A study conducted in 2017 aimed to review the prevalence of anemia in both developing and developed countries. The results indicated that the prevalence of anemia among adolescents aged 14 to 20 years in Iran was 21.4% (22).

7. A comparative review conducted in 2013 aimed to examine and compare the existing protocols for iron supplementation in three countries: India, Iran, and England. The results indicated that the highest prevalence of anemia was found among third-grade elementary school children. Specifically, elementary school students living in Tehran exhibited the highest prevalence of anemia. Additionally, the prevalence of anemia among female school students aged 7 to 12 years was approximately 15% (23).

Table-1: The general characteristics of included systematic reviews (n=5).

Author, Publication year, (Reference)	Study Design	Time	Sample size	Number of studies	Age group	Prevalence	Quality assessment of studies*
Dehghani et al., 2024, (19)	Systematic review and meta-analysis	up to April 2023	5,890	7	Children under six years old	The prevalence of iron deficiency anemia (IDA) was 19.91% among young children.	moderate quality
Gedfie et al., 2022, (20)	Systematic review	up to March 2021	27,896	28	Children under five years old	The prevalence of iron deficiency anemia (IDA) was 16.42%, while the	moderate quality

						prevalence of iron deficiency (ID) was 17.95%.	
Nazari et al., 2019, (6)	Systematic review and meta-analysis	2001-2018	1,700	6	Children under six years old	The prevalence of iron deficiency (ID) and iron deficiency anemia (IDA) was 27.7% and 18.2%, respectively.	moderate quality
Alipoor et al., 2017, (21)	Systematic review	1996-2014	5,017	89	High school students	The prevalence of iron deficiency anemia (IDA) among the population was 10.6%.	moderate quality
Akbari et al., 2016, (7)	Systematic review and meta-analysis	1990-2016	11,493	27	under 18 years of age	The prevalence of iron deficiency anemia (IDA) was 13.9%, while the prevalence of iron deficiency (ID) was 26.9%.	moderate quality

* Based on AMSTAR-2 instrument (16).

4- DISCUSSION

This overview aimed to evaluate the prevalence of iron deficiency (ID) and iron deficiency anemia (IDA) among Iranian children and adolescents. It revealed that the overall prevalence of ID and IDA in this demographic was 24.18% and 16.73%, respectively. In children under six years of age, the prevalence of ID and IDA was found to be 27.7% and 18.2%, respectively. Additionally, a significant difference in the prevalence of IDA was observed among genders, age groups, and geographical locations.

Anemia is a significant global health issue, affecting approximately one-fourth of the world's population and contributing to substantial morbidity and mortality. It is particularly prevalent in low- and middle-income countries, with severe implications for women and children. The World Health Organization estimates that anemia is responsible for around one million deaths annually, with a disproportionate impact on regions such as Africa and Southeast Asia, where three-quarters of these deaths occur (3, 24).

Recent data highlights the differences in prevalence rates of ID and IDA among genders, age groups, and geographical locations. Based on the results, the overall prevalence of ID and IDA among Iranian children and adolescents was estimated to be 24.18% and 16.73%, respectively. Specifically, the prevalence of IDA was 7.9% in males and 8.5% in females under the age of 18 years. The prevalence of ID and IDA in children under six years of age is notably significant, with a systematic review revealing that the prevalence rates were 27.7% for ID and 18.2% for IDA among this age group. This study also highlighted that boys exhibited a higher prevalence of IDA at 17.7%, compared to girls at 14.4% (6).

Iron deficiency anemia has distinct causes across different age groups, influenced by factors such as dietary intake, physiological needs, and health conditions (25-27). In Iran, iron deficiency is a significant nutritional concern for infants and young children, primarily due to two main factors: inadequate dietary iron intake and increased iron requirements during rapid growth phases.

- **Inadequate dietary iron intake:** This is the most common cause. Infants who are exclusively breastfed beyond four months without iron supplementation are at risk.
- **Increased iron requirements:** Rapid growth during infancy and early childhood increases iron needs (28).

Adolescents, especially girls, face a significant risk of iron deficiency anemia due to various physiological and dietary factors. Here are the key contributors:

- **Menstrual Blood Loss:** Heavy menstrual bleeding, or menorrhagia, is a significant health concern that can lead to IDA, particularly in adolescent girls. This condition is characterized by excessive blood loss during menstruation, which can exceed 80 mL per cycle. Such blood loss can deplete the body's iron stores if not adequately compensated through dietary intake or supplementation (29).
- **Growth Spurts:** Adolescence is a critical period marked by rapid growth and increased nutritional needs, particularly for iron. During this stage, the body's iron requirements rise significantly—up to 15 mg daily for adolescent girls and 11 mg for boys—due to factors such as increased blood volume and muscle mass development (29, 30).
- **Dietary Factors:** Diet plays a crucial role in iron status among adolescents and significantly influences their overall health. Several dietary factors contribute to iron deficiency anemia (IDA), particularly in this age group:
 - **Poor Dietary Choices:** Many adolescents have diets that are high in fast foods and snacks, often resulting in low iron intake. Studies indicate that individuals who follow snack and fast-food patterns are at a higher risk of developing IDA.

- **Restrictive Diets:** Vegetarian or vegan diets can also lead to lower iron intake, as plant-based sources of iron (non-heme iron) are less bioavailable than heme iron found in meat.
- **Meal Skipping:** Irregular eating patterns and skipping meals can further limit iron intake, compounding the risk of deficiency (29-32).

Evidence indicates that IDA is a significant public health issue in Iran, with varying prevalence rates across different geographical regions. The prevalence of IDA in Iran shows notable differences between urban and rural populations. Specifically, urban areas report a prevalence of 16.32%, while rural areas have a higher prevalence of approximately 12.75% (7, 33).

In addition, specific regional estimates of IDA prevalence in Iran reveal significant disparities across the country:

- Eastern region: 17.8%
- Western region: 7.97%
- Central region: 19.97%
- Southern region: 13.45%
- Northern region: 17.82%.

These statistics illustrate the complex landscape of iron deficiency anemia in Iran, highlighting the need for targeted public health interventions to address this pressing issue effectively. The central region exhibits the highest prevalence of iron deficiency anemia at 19.97%, while the western region has the lowest prevalence at 7.97%. These differences are influenced by multiple factors, including variations in nutritional intake, health education, and local health policies that affect access to resources and awareness of iron deficiency. Understanding these regional disparities is crucial for implementing targeted public health interventions aimed at reducing IDA prevalence in specific areas, particularly in regions with higher rates. Effective

strategies include improving dietary practices, enhancing health education, and ensuring better access to iron supplements and healthcare services tailored to the needs of each region (7, 33).

In this overview, several factors contributed to the risk of developing iron deficiency anemia (IDA), including age (under 2 years), family size (large families), maternal factors (children born to anemic mothers or those with low birth weight), and dietary habits (a lack of iron-fortified milk consumption).

Anemia, particularly iron deficiency anemia, significantly impacts physical growth, cognitive development, and reproductive health in children and adolescents. Studies indicate that IDA leads to growth retardation, cognitive impairments, and increased morbidity, especially in developing countries. The prevalence of anemia is linked to factors such as malnutrition, poverty, and maternal education, which exacerbate its effects on children's health (34, 35). Studies indicate that inadequate dietary intake, particularly among adolescent girls, significantly contributes to anemia prevalence, with rates reaching 47.4% in rural India (36), and 38% in Bangladesh (26). Socioeconomic factors play a crucial role; families with lower income and education levels are more likely to have anemic children (37). Furthermore, maternal education is a key determinant, as literate mothers tend to have healthier children (38).

Some of the consequences of anemia are:

- **Growth Delays:** Iron deficiency anemia can lead to delayed physical growth in children and adolescents. This delay may manifest as stunted growth or reduced weight gain, potentially having long-term implications for overall health and development. Studies indicate that children with IDA are at a higher risk of

experiencing growth retardation compared to their iron-sufficient peers, which can affect their physical development into adulthood (39-41). Chronic anemia negatively impacts linear growth during all stages, including infancy, childhood, and adolescence. In particular, infants with chronic IDA may experience delayed cognitive, motor, and affective development that can have lasting effects (42).

- **Cognitive impairments:** Children with Iron Deficiency Anemia often exhibit impaired neurocognitive functions, which can hinder their academic performance and learning capabilities. Research indicates that these children score lower on intelligence tests and cognitive assessments, revealing significant deficits in areas such as attention span, memory, and problem-solving skills (43-45). For example, infants with IDA demonstrate lower recognition memory and slower processing speeds, effects that can persist into later childhood and even adulthood (45, 46).

- **Reproductive health risks:** Reproductive health risks are significant for adolescent girls with iron deficiency anemia (IDA). Anemia during adolescence can complicate pregnancy outcomes, increasing the likelihood of preterm birth and low birth weight. Furthermore, the physiological demands of menstruation, combined with inadequate iron intake, can exacerbate health issues during critical developmental periods (41, 46).

To effectively combat anemia, a comprehensive approach is essential. This includes strategies such as iron fortification of staple foods, the use of micronutrient powders, daily iron supplementation for young children, adherence to blood supplement tablets,

nutrition education, and community engagement. By implementing these targeted interventions, we can significantly improve nutritional status and health outcomes in affected populations:

- **Iron Fortification:** Fortifying staple foods, such as wheat flour, with iron has been shown to significantly reduce the prevalence of anemia. Studies indicate that this method can lead to notable improvements in hemoglobin levels among affected populations.
- **Micronutrient Powders:** Using micronutrient powders is another effective strategy for reducing the risk of anemia in children. These powders can be easily integrated into daily meals and have demonstrated positive outcomes in various studies.
- **Daily Iron Supplementation:** For infants and young children, daily iron supplementation is crucial. In contrast, intermittent supplementation has proven effective for adolescent girls, addressing their specific nutritional needs during critical growth periods.
- **Blood Supplement Tablets:** Promoting adherence to blood supplement tablets can significantly enhance hemoglobin levels. This approach has been highlighted as a necessary component of anemia management strategies.
- **Nutrition Education:** Implementing educational programs focused on balanced nutrition can improve dietary habits among children and adolescents. Such programs are essential for ensuring compliance with supplementation efforts.
- **Community Engagement:** Involving families in anemia prevention strategies fosters better adherence to health recommendations (47-51).

By focusing on these interventions, we can address the multifaceted causes of anemia and improve overall health outcomes in vulnerable populations.

5- CONCLUSION

The prevalence of iron deficiency (ID), and iron deficiency anemia (IDA) among Iranian children and adolescents is a significant health concern. Recent data indicate that the overall prevalence of ID is approximately 24.18% (ranging from 17.95% to 27.7%), while the prevalence of IDA stands at 16.73% (ranging from 10.6% to 21.4%). Among individuals under 18 years, iron deficiency anemia was reported at 7.9% (95% CI: 4.1–11.7) for males and 8.5% (95% CI: 6.1–10.8) for females. In children under six years, the prevalence rates are notably higher, with ID at 27.7% and IDA at 18.2%. Boys exhibit a higher prevalence of IDA at 17.7% compared to girls at 14.4%.

Recent data underscores significant differences in the prevalence of IDA among various demographics in Iran, highlighting the influence of gender, age, and geographic factors on these rates. Several factors, including age, family size, maternal factors, and dietary habits, significantly contribute to the risk of developing IDA in children and adolescents. To reduce anemia in Iranian children and adolescents, a multifaceted approach is essential, focusing on dietary interventions, supplementation, and education.

6- CONFLICT OF INTEREST: None.

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