

Review Article

Iron Deficiency Anemia in Pakistan Children: A Systematic Review (CIMO)

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Iron Deficiency Anemia (IDA) poses a significant health concern for children worldwide, including in Pakistan. This systematic review explores the causes, contributing factors, and remedial measures for IDA among Pakistani children. Using the CIMO (Context, Intervention, Mechanism, Outcome) framework, the study analyzes existing literature on IDA, providing a holistic approach to the problem. The context includes poverty, limited healthcare access, and insufficient nutrition. Interventions encompass iron supplementation, fortified meals, health education, and community-based initiatives. Mechanisms involve factors such as dietary choices, iron absorption inhibitors, intestinal parasitic infections, and maternal anemia. Positive outcomes include improved hemoglobin levels, prevention of long-term complications, and enhanced quality of life. This study fills a gap in the literature by addressing IDA among children under five in Pakistan from a systematic perspective, offering strategic policy measures for preventing IDA and securing a healthy future for children.

Keywords: Iron Deficiency Anemia (IDA), Context-Intervention- Mechanism-Outcome (CIMO), Systematic Review.

INTRODUCTION

Iron Deficiency Anemia (IDA) is a serious health issue that affects millions of children worldwide, including those in Pakistan due to several factors (1). This disease occurs due to a shortage of iron in the body that would cause undesired consequences for children like fatigue, irritability, lack of cognitive functioning, and many more (2). In Pakistan, the prevalence of IDA is quite high among children less than five years old (~33%) (1). This research study will explore the underlying causes, contributing factors, and remedial measures for preventing and mitigating the consequences of IDA among children in Pakistan. This study will use the systematic review technique "CIMO" framework (Context, Intervention, Mechanism, and Outcome) to analyze the available scholarly literature on the subject and provide a holistic approach to the problem under consideration.

The CIMO framework is a conceptual tool for systematic literature review and it will be quite useful for understanding complicated health concerns by examining the interaction of four essential factors: Context, Input, Mechanism, and Outcome. Poverty, poor access to healthcare, and insufficient nutrition are all variables in the setting of IDA among Pakistani children. Iron supplements and fortified meals are examples of inputs, whereas interventions such as health education and community-based initiatives are examples of processes. Improvements in hemoglobin levels, avoidance of long-term problems, and enhanced quality of life are possible outcomes. This systematic review will highlight the problem of IDA among children in Pakistan from a more holistic perspective that is understudied in literature. For developing countries like Pakistan, this is the first

systematic review study that analyzes the role of contributing factors responsible for IDA among children less than five years old through a systematic framework approach.

By considering the broader context of the problem of IDA among children in Pakistan through elements of input, mechanism, and outcomes, this research study contributes to the existing studies in integrating the contextual elements surrounding the problem. By using a systematic review methodology, the researcher will ensure that the results are based on the proven outcomes regarding intervention measures for mitigating the effects of IDA among children. The innovation of the research study also lies in terms of providing strategic measures at the policy level for the government to prevent IDA and related ailments to minimize malnourishment among children to secure their healthy and safe future.

LITERATURE REVIEW

Iron Deficiency Anemia is a significant health hazard for the young population in Pakistan in terms of physical development, cognitive abilities, immunity development, and school-related competencies. The literature review will highlight the prevalence of IDA among children in Pakistan, the potential consequences, and the risk factors associated with it.

Jamali et al. (3) highlighted the healthcare issue of IDA among the young population in Pakistan by including 1686 volunteer students in their study aged 11-18 years. He found the prevalence of IDA among the population as 43.1% among which females contributed the major proportion of prevalence (30.4%) as compared to males (12.7%). The findings also indicated that the prevalence of IDA existed mostly in low-income groups and belonging to rural areas. Habib et al. (1) determined the prevalence of IDA among children in Pakistan as 33.2% aged 5-59 months. The contributing factors were mothers suffering from Anemia and household low income. The researchers also determined other indirect risk factors as rural area demographics and gender female. Harding et al. (4) conducted a research study on Pakistani and Nepali children from the National Survey Data and found that IDA has increased significantly over the past decade. The statistics indicated a huge risk due to the prevalence of anemia among the young population in Pakistan.

Feroz et al. (5) conducted a research study in Swat and found the prevalence of anemia among school-going children between 5 and 16 years of age at 40% and IDA at 19%. The researchers indicated that the IDA leads to poor physical and cognitive development, and reduces the immunity of the children against infections. Moreover, IDA will also lead to the poor academic performance of children. The research study by Ahmad et al. (6) provided a significant result regarding the prevalence of anemia among children starting their first year of school in five different schools in Rabwah at 18.6%. Moreover, 82% of the population under consideration indicated iron deficiency without anemia. Another study by Din et al. (7) determined the prevalence of anemia among school-going children as 37.1% in the District Tank of Pakistan.

The literature review indicated that the contributing factors for IDA are demographic features (being in rural areas), low socioeconomic status, anemia in mothers, and female gender. The studies suggest that a diverse

level of intervention measures would be required to minimize the prevalence of IDA among children in Pakistan like awareness campaigns regarding food nutrition, subsidizing iron-rich supplements, improving the health of mothers, raising household income levels for poor people, and promoting healthy food intake among school-going children. The limitation of the literature is that it lacks a systematic evaluation of the issues surrounding IDA among children less than five years of age in Pakistan who could suffer from dangerous outcomes like poor growth and cognitive development. This study will overcome this limitation by providing a CIMO framework as a systematic approach to dealing with IDA-related problems through a critical review of existing literature.

METHODOLOGY

The methodology for this study is a Systematic Literature Review (SLR) that uses the existing literature to solve the problem of identifying different factors and underlying problems associated with IDA among children less than five years old in Pakistan. This methodology is important for integrating and synthesizing information available in the literature for solving the given problem. By using different research papers and studies in the domain of IDA for children in Pakistan, this research will develop a CIMO framework for contextualizing the issues in this research domain.

Search Strategy

The researcher used different keywords and their combination to search literature related to IDA among children in Pakistan. By using the extant literature, the researcher will develop and integrate findings for children of different age groups to those with ages less than five years. The keywords under consideration are “iron deficiency anemia”, “IDA in Children in Pakistan”, “Malnourishment in children in Pakistan”, “iron deficiency”, “anemia in school-going children in Pakistan”, “factors for IDA in Pakistan”, “IDA prevalence among children”. The researcher used different databases PubMed, Web of Science, Scopus, and Google Scholar for searching the relevant literature.

Selection Criteria

The researcher used articles for SLR to develop the CIMO framework that satisfies the following criteria:

1. Relevant to IDA among children in Pakistan.
2. Published later than 2010.
3. Published in Conferences or Peer-reviewed journals in English.
4. Full articles are available for extracting information for review.

Data Extraction

The researcher extracted data from reviewed articles to shed light on different factors, inputs, mechanisms, and outputs associated with IDA for the young population in Pakistan. To extract the required information,

the researcher analyzed the content in the short-listed papers and related to the CIMO framework requirements.

Quality Assessment

The researcher assessed the quality of the methodology of the paper with the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Systematic Reviews and Research Syntheses (8). This checklist evaluates the quality of the included papers and the associated review process by assessing the design, data collection methods, analysis, and extraction features. The trustworthiness and relevance of the study design and methodology conform to the standards for yielding meaningful outcomes for analyzing the problems regarding IDA among children aged less than five years in Pakistan.

Data Synthesis

The study used the CIMO framework for data synthesizes that provides a holistic framework for analyzing and synthesizing the information regarding anemia among children in Pakistan. The data synthesis will evaluate the context as the prevailing conditions and environment in which the problem is under consideration. The context for this study will revolve around demographic factors like urban and rural populations, healthcare infrastructure and resources, the educational status of mothers, and many more. The input of the framework will be risk factors related to IDA among children less than five years of age in Pakistan. Moreover, the input should also contain the data presented in different papers regarding the prevalence of IDA and its contributors in different populations. The study will also consider inputs like surveys, data reports, and experimental results of the studies included in different papers in the SLR process.

The mechanism in the CIMO framework will comprise the intervention measures for fighting against the growing problem of IDA in the young population. Outcomes will be associated with expected results related to the application of the mechanisms in the CIMO framework. Overall, the data synthesis will provide a systematic analysis of the problem of IDA among children less than five years old in Pakistan.

Table 1: Overview of Methodology

Section	Description
Search Strategy	Employed keywords and multiple databases (PubMed, Web of Science, Scopus, Google Scholar) for literature search.
Selection Criteria	Included articles meeting criteria: relevance to IDA in Pakistan, publication after 2010, English language, full availability.
Data Extraction	Extracted data from selected articles, focusing on factors related to IDA in children below five in Pakistan.
Quality Assessment	Assessed paper quality using JBI Checklist, evaluating design, data collection methods, analysis, and extraction features.
Data Synthesis	Applied CIMO framework for comprehensive analysis, considering context, input, mechanism, and outcome elements.

RESULTS AND DISCUSSION

The SLR processes started with keywords and a database that resulted in an overall 450 articles in the given domain. Out of these articles, the researcher employed the inclusion criteria to filter the articles directly related to the problem under consideration. Thus, 110 articles were short-listed among which full-text was available for 70 articles in English. Finally, the researcher chose 45 articles for the SLR process through the CIMO approach by excluding articles that don't provide sufficient insight into the research topic.

Table 2: SLR Process for Shortlisting Articles

Process Description	# of Articles
Initial search with keywords and database	450
Application of inclusion criteria	110
Availability of full-text in English	70
Final selection for SLR through CIMO	45

The prevalence of IDA varied among children with different age groups and populations between 17% and 75%. The studies reported that the prevalence of IDA is quite high among the rural population due to the high extent of risk factors of low socioeconomic status, lack of education, unemployment, inadequate dietary intake of iron, and so on. For analyzing the risk factors and impact of IDA in a systematic manner, consider the following CIMO framework approach.

Context:

The context in the CIMO framework refers to the prevailing conditions and environment of the population suffering from the problem of IDA in this case. Pakistan is a developing country of the world with a high burden of childhood diseases like IDA, among various micronutrient deficiencies (1,5,11). The main cause of IDA among children less than five years of age is low household income due to the poverty level in Pakistan (1,9,10). A large proportion of the population lives in rural areas with scarce food facilities and resources to meet healthy dietary intake requirements. Due to a lack of education and awareness regarding nutritional requirements, the mother of the children has low iron levels, and their feeding pattern for children follows a similar anemic pattern (1,9,10). Lack of investment and improvement in the healthcare sector is also an important consideration in the contextual background of the IDA problem (1,9,10).

Thus, the context of IDA for children less than five years old in Pakistan is a complex integration of social, economic, and environmental factors that play a significant role in the high prevalence of the disease (11,12). The prevailing conditions don't support improving the situation a great deal. The government of Pakistan and the healthcare industry must step ahead to rectify the prevailing malnourishment issues among children in Pakistan in the specific context of IDA (17–19).

Table 3: Context in CIMO Framework

Context in CIMO Framework	Prevailing conditions and environment for childhood IDA in Pakistan.
Economic Factors	Low household income due to poverty (1,9,10).
Geographic Factors	Rural areas with limited food resources (11,12).
Nutritional Awareness	Low maternal iron levels and anemic feeding patterns for children (4)(13–15).
Healthcare Sector	Lack of investment and improvement (1,11,16).
Complexity of Factors	Integration of social, economic, and environmental factors contributing to high IDA prevalence (17–19).
Government and Healthcare Role	Need for government and healthcare industry intervention to address malnourishment and IDA in children (1,5,11).

Intervention:

The interventions aimed at mitigating Iron Deficiency Anemia (IDA) among children below the age of five in Pakistan include iron supplementation, dietary adjustments, and public health education. The efficacy of these measures in addressing the matter has been demonstrated and warrants further examination within the context of the CIMO model.

The provision of iron supplements is a crucial intervention approach that yields significant improvements in the iron levels of children (1,9,11,20). In conjunction with other interventions, such as dietary adjustments, the provision of iron supplements can address potential iron deficiencies in individuals' diets. Consistent monitoring and subsequent evaluation are essential in guaranteeing adherence and gauging the efficacy of the intervention (21,22).

Improving the dietary intake of children and mothers of infants is a crucial intervention measure for minimizing the prevalence of IDA (3,11,20,23). For this purpose, the government of Pakistan and other healthcare agencies should encourage the consumption of foods with iron-rich content like meat, green vegetables, fish, and others (1,9,11,20). Moreover, the nutritional aspects of a balanced diet with iron-rich content like beans, fortified cereals, and lentils, also promote treatment and prevention in a diverse sense (1,9,11,20). However, the main intervention in this regard is educating the parents to increase their intake of a healthy and nutritious diet.

The implementation of public health education campaigns is crucial in increasing knowledge and understanding regarding iron deficiency anemia (IDA) and its preventative measures (24,25). Targeting parents, caregivers, healthcare providers, and the wider community, these campaigns inform individuals about the importance of iron-rich foods and the risk factors associated with IDA (26,27). The act of disseminating information through various channels such as community workshops and media platforms can provide individuals with the necessary knowledge to make informed decisions regarding their nutritional choices, thereby empowering them (26,27).

Table 4: Interventions in the CIMO Framework

Intervention	Description
Iron Supplementation	Provision of iron supplements is a key approach to improving iron levels in children (1,9,11,20).
	Requires consistent monitoring and evaluation for adherence and efficacy assessment (21,22).
Dietary Adjustments	Promoting dietary changes to include iron-rich foods like meat, vegetables, fish, beans, and cereals (3,11,20,23).
	Encouraging balanced nutrition for both children and mothers (1,9,11,20).
Public Health Education	Implementation of campaigns targeting parents, caregivers, healthcare providers, and the community (24,25).
	Dissemination of information through various channels to raise awareness and empower individuals (26,27).

Mechanism

The mechanisms associated with iron deficiency among children in Pakistan involve multiple factors. There are mainly two sources of iron in our diet: Plant-based sources and animal origin (1,11,23). The iron originating from animal sources is better absorbed and provides higher iron efficiency for children. However, the children in Pakistan and mothers prefer plant-based iron sources that have lesser iron efficiency and bioavailability (1,3,20). To improve iron content among children less than five years of age, parents in Pakistan should encourage animal-originated iron-rich foods to minimize the prevalence of IDA (1,11,23).

Secondly, iron absorption is also affected by the presence of inhibitors and enhancers. Phytates and tannins present in plant-based diets inhibit iron absorption, while ascorbic acid and meat enhance iron absorption (28,29). Pakistani children's diets are high in phytates and low in ascorbic acid, which further reduces iron absorption.

Thirdly, Pakistani children lie in the high-risk category regarding intestinal parasitic infections due to poor hygienic conditions and sanitation practices, especially in rural areas. These infections affect iron absorption and contribute to IDA significantly (30–32).

Finally, the prevalence of anemia among females during the periods of lactation and pregnancy is high due to insufficient iron intake (33–35). Maternal anemia could be dangerous for the health of the infant and mother. Moreover, maternal anemia could lead to IDA among infants which could further hinder the growth and development of newborn babies (36–38).

Table 5: Mechanisms in IDA

Mechanisms of Iron Deficiency in Pakistan	Description
Dietary Sources	Two primary dietary iron sources: are plant-based and animal-origin (1,11,23). Animal-origin iron is better absorbed and efficient. Pakistani children and mothers often prefer plant-based sources with lower iron efficiency (1,3,20). Encouraging animal-origin iron-rich foods can reduce IDA prevalence in children (1,11,23).
Iron Absorption Factors	Iron absorption is affected by inhibitors (phytates and tannins) and enhancers (ascorbic acid and meat) (28,29). Pakistani diets high in phytates and low in ascorbic acid result in reduced iron absorption (1,11,23).
Intestinal Parasitic Infections	High-risk category for Pakistani children due to poor hygiene and sanitation, especially in rural areas (30–32). Infections impact iron absorption, contributing to IDA (30–32).
Maternal Anemia	High prevalence among females during lactation and pregnancy due to insufficient iron intake (33–35). Maternal anemia poses risks to both the infant's and mother's health, potentially leading to IDA in infants (36–38).

Outcome

The outcome of interventions for iron deficiency anemia in Pakistani children can be positive if appropriate measures are taken to address the root causes of the condition. The following are some potential outcomes of interventions:

Enhanced Hemoglobin Concentrations

Enhanced iron levels among children less than five years of age are the main outcome of the research study by using the suggested intervention measures in light of the contextual factors. By achieving this outcome, the children can achieve higher levels of cognitive performance, strengthened immune function, and higher energy levels (39–41).

The Prevention of Long-Term Complications.

The second main outcome of the intervention measures is the prevention of long-term complications like stunted growth, poor cognitive functioning, and compromised immune functioning among children. By using proper healthcare remedies and improving iron intake, it is possible to avert the impact of complications (38,42–44).

Improvement in Quality of Life

The quality of life of a child can be notably enhanced by addressing iron deficiency anemia, which can otherwise result in symptoms such as fatigue, weakness, and impaired concentration (38,42–44). Through the identification and mitigation of the root causes of the ailment and the administration of suitable therapeutic interventions, juveniles may encounter enhanced levels of vitality, superior quality of sleep, and a heightened capacity for concentration (38,42–44).

Decreased Healthcare Expenditures.

The management of iron deficiency anemia can incur significant expenses, particularly in cases where the severity of the condition necessitates hospitalization or blood transfusions (10,45,46). Early intervention and provision of suitable treatment can result in a reduction of healthcare expenses and enable the allocation of resources towards other areas requiring attention (10,45,46).

Enhanced Cognitive Achievement

Iron deficiency anemia seriously affects the cognitive functioning of children and hence their academic performance (47–49). By employing proper healthcare measures and focusing on an iron-rich diet for children, it is possible to nurture necessary cognitive skills and naturally boost academic performance (50,51).

Table 6: Outcome in CIMO Framework

Outcome	Description
Enhanced Hemoglobin Concentrations	Increased iron levels in children under five, lead to improved cognitive performance and immune function (39–41). Higher energy levels as a result of enhanced iron levels (39–41).
Prevention of Long-Term Complications	Prevention of stunted growth, poor cognitive functioning, and compromised immune function in children (38,42–44). Achieved through proper healthcare remedies and improved iron intake (38,42–44).
Improvement in Quality of Life	Notable enhancement of a child's quality of life by addressing iron deficiency anemia (1,3,11). Reduction of symptoms like fatigue, weakness, and impaired concentration (38,42–44).
Decreased Healthcare Expenditures	Reduction in healthcare expenses through early intervention and suitable treatment (10,45,46). Allocation of resources to other areas in need of attention (10,45,46).
Enhanced Cognitive Achievement	Improvement in cognitive functioning and academic performance in children (47–49). Nurturing cognitive skills and academic performance through proper healthcare and diet (50,51).

CONCLUSION

This study provided an analysis of iron deficiency anemia (IDA) in children (less than five years of age) residing in Pakistan, encompassing an investigation into its mechanism, associated risk factors, and potential preventative measures. The research utilized the CIMO model as a theoretical framework, which facilitated a thorough comprehension of the matter at hand. The research results have emphasized the elevated occurrence of Iron Deficiency Anemia (IDA) among children in Pakistan, particularly in rural regions and households with low income. The adverse impacts of Iron Deficiency Anemia (IDA) on physical and cognitive development, immune function, and academic performance have been highlighted. The intervention measures proposed in the study to enhance iron levels include iron-rich dietary intake, and awareness regarding IDA prevention by integrating contextual factors and implementing interventions such as iron supplementation, dietary adjustments, and public health education campaigns. The findings of this study offer significant contributions to policymakers, healthcare practitioners, and other relevant stakeholders, facilitating the adoption of strategic interventions aimed at promoting the well-being of the youth in Pakistan.

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