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ORIGINAL RESEARCH

# Prevalence and Determinants of Iron Deficiency Anemia Among Children Under Five Years at Luwero General Hospital, Uganda

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**Background:** Iron deficiency anemia is a public health concern among children under five years old. This study aimed to determine the prevalence and determinants of iron deficiency anemia among children under five years attending Luwero General Hospital, Luwero District.

**Patients and Methods:** This cross-sectional study included 380 children under five years old who attended Luweero Hospital. Participants were selected using a simple random sampling technique, and caregivers were interviewed using a structured questionnaire to collect demographic information. Laboratory tests performed were; hemoglobin and ferritin level, to evaluate anemia severity. Iron deficiency anemia was defined as serum ferritin levels below 12 µg/L. Association between determinants and iron deficiency was attained by developing bivariate and multivariate logistic regression models using STATA software version 14, and a p value of <0.05 was considered significant.

**Results:** This study found that anemia was prevalent amongst children under five years, affecting 38.4% (n = 146) of the sample, with iron deficiency anemia (IDA) identified in 16.6% (n = 63). Majority of the children with iron deficiency anemia had moderate anemia 32 (50.8%). At multivariate analysis, several factors were independently associated with iron deficiency anemia (IDA); male gender (aOR: 2.29, 95% CI: 1.20–4.35, p = 0.012), and children that had infection in the past 3 months (aOR: 5.62, 95% CI: 2.94–10.74, p < 0.000). However, parental age of 20–29 years (aOR: 0.21, 95% CI: 0.06–0.73, p = 0.014) and 30–39 years (aOR: 0.17; 95% CI: 0.05–0.59; p = 0.005) were independently associated with a significantly reduced odds of iron deficiency anemia (IDA).

**Conclusion:** The study highlights that iron deficiency anaemia is a significant health concern affecting 16.6% of the children studied. Male sex and a recent history of infection were found to be significant independent risk factors for IDA. Conversely, parental age between 20 and 39 years was identified as a strong independent protective factor, with the most pronounced reduction in IDA odds observed among children of parents aged 30–39. Anemia screening and intervention programs should be proactively targeted towards male children, especially those with a recent history of infection.

**Keywords:** iron deficiency anaemia, children under five years, determinants

## Introduction

Anemia in children under 5 years old is a global public health burden and is prevalent in about 2 billion (25%) individuals worldwide.[1] In children aged 6–59 months, the global prevalence of anemia was 39.8% (36.0%–43.8%) in 2019, translating to 269 million anemic children. The prevalence of anemia is 6% in the United States, 20% in Europe and Central Asia, and 16% in the United Kingdom.[2] Iron deficiency anemia accounts for a larger portion of this anemia.[2] According to reports from Qinghai province, the prevalence of anemia ranges from 59.1% to 75.74%, with 43% of

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children aged 6–24 months in West China being affected.[3] Childhood anemia has a detrimental impact on children's health, particularly their physical development. It can permanently harm their ability to move, think, and behave.[4]

Low and Middle income countries are affected the most,[1] and African Region had the greatest rate of anemia in children under five.[5] The prevalence of anemia in African children aged 6–59 months in 2019 was 60.2%.[6] Anemia in children under five still remains a serious public health concern even after multiple interventions by African governments and other concerned stakeholders.[7] Anemia can be caused by a variety of factors, including parasitic diseases like malaria, inherited hemoglobinopathies, and deficiencies in micronutrients like iron, folic acid, vitamin A, or B12.[4] Iron deficiency is a common cause of childhood anemia, accounting for 87–93% of cases.[8] Several observational studies have shown that low birth weight, preterm delivery, and maternal anemia can all independently increase the risk of anemia in infants.[8–10] In addition, there is a strong correlation between childhood anemia and family wealth, social demographic traits, supplemental food introduction, and feeding practices.[11] Starchy cereals that are low in fats, proteins, and minerals that mothers give children like gruel made from rice, maize, millet and sorghum as a major complementary food predisposes them to anemia.[12]

Iron deficiency anemia (IDA) is still difficult to diagnose in low- and middle-income nations because tests including serum iron, total iron binding capacity (TIBC), complete blood count, and serum ferritin levels are expensive and unaffordable.[13,14] It has been shown that because of their higher iron needs throughout crucial growth phases, children under the age of five are more susceptible to IDA.[15] According to the World Bank, iron deficiency anemia accounts for the majority of the 52% national prevalence of anemia.[2] Studies on anemia have not been carried out in large numbers in Uganda; nonetheless, those that have been done indicate a noteworthy incidence of anemia in children under five. Gulu reported 46.6%,[16] and 49.4% was reported in Namutumba.[17]

Therefore, the aim of this study was to determine the prevalence of iron deficiency anemia and determinants among children under 5 years attending Luwero General Hospital.

# Materials and Methods

## Study Design

This was a laboratory based, cross-sectional study conducted at Luwero General Hospital in Luwero district.

## Study Site

This study was conducted at Luwero General Hospital, a healthcare facility serving a population of approximately 500,000 people in the region. With a capacity of 400 beds, the hospital provides general medical services, including maternal and child healthcare, laboratory diagnostics, and specialized clinics for conditions such as sickle cell disease and HIV/AIDS. Situated 65.4 km from Kampala, Uganda's capital, the hospital is located at geographical coordinates 0.8343°N, 32.4990°E.

## Study Population

Children under 5 years at Luwero General Hospital.

### Inclusion Criteria

- Age under 5 years.
- Parents/guardians provided written informed consent for participation.

### Exclusion Criteria

- Children with chronic or congenital Illnesses (eg, sickle cell disease)
- Children on anti-malarial treatment

## Sample Size Calculation

The sample size was determined using the Kish Leslie (1965) formula of sample size determination; $n = \frac{Z^2 P(1-p)}{d^2}$

Where, n = Sample size required.

d = Sampling error/degree of error that this research was able to accept (desired precision) 5%.

P = Prevalence of IDA among children below 5 years in western Uganda which was 44.5% as prevalence.[18]

Z = Critical value of a standard normal deviation curve that corresponds to 95% confidence interval (CI) which is equal to 1.96.

$$n = \frac{(1.96^2) \times 0.445 \times 0.555}{(0.05^2)}$$

n = 380

Hence, this study enrolled 380 study participants.

## Sampling Procedure

A simple random sampling technique was employed to select participants for the study using the raffle method. Each eligible child was assigned a unique number, which was then written on separate pieces of paper. These papers were placed in a container and thoroughly shuffled to ensure randomness. The required sample size was obtained by blindly drawing every even numbers one at a time until the desired sample size was reached. This method minimized selection bias and ensured that every eligible child had an equal chance of being included in the study.

## Data Collection/Laboratory Procedure

Informed consent was obtained from the parents/guardians of each child who met the inclusion criteria. A standard, structured questionnaire was used to collect demographic data (Age, sex, weight, parents/caregiver's age, education level, family income and malaria infection) from the caregivers of children under five years. For caregivers who could not read or write English, the questionnaires were translated into their local language and administered to them.

About 4 mL of venous blood sample were drawn into vacutainer containing EDTA (Ethylene diamine tetra acetic acid) and red top and transported to the main laboratory for analysis. A complete blood count (CBC) was done using Huma Count 60 TS (Germany) for the determination of anemia. The hemoglobin results that were <11.0g/dl was considered as anemic.

Thin films were made from the collected EDTA venous blood, air dried, and stained using Giemsa stain and were examined microscopically for presence of Microcytic hypochromic red cells. Ferritin levels were determined from all the children under five years that were presenting with low Hemoglobin levels (<11g/dl), using an Immunochemistry machine (*Maglumi 800 Snibe*), IDA was characterized by serum ferritin levels of less than 12µg/L.

## Quality Control

Following the manufacturer's instructions, training of research assistants, pretest of questionnaire and use of standard operating procedures and quality control materials. Serum and blood samples were carefully collected, transported and analyzed using controls levels (L1, L2, and L3). Samples were thoroughly mixed to prevent clots. The Immunochemistry machine (*Maglumi 800 Snibe*) was calibrated and controlled for each reagent run before running serum ferritin levels.

## Data Analysis

The data obtained was entered into Excel spreadsheet using double entry technique cleansed and later exported into STATA software version 14 for analysis. Descriptive statistics like percentages, frequency, tables and pie chart were used to expressed prevalence and demographic characteristics. Association between determinants and iron deficiency anemia (IDA) was assessed using bivariate and multivariate logistic regression analysis. Determinants which were found associated with IDA and those that had p value <0.1 at bivariate logistic regression analysis were subjected to multivariate logistic regression analysis and level of significance was at $p \leq 0.05$.


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## Ethical Approval

This study was approved by the Faculty Research Committee (FRC), Faculty of Medicine, Mbarara University of Science and Technology, and the office of the hospital director, Luwero General Hospital (approval number MUST/MLS/030). Informed consent was obtained from the parents/guardians of the children, and they were assured of confidentiality. The methodology was complied with the 1975 Declaration of Helsinki's (1964) ethical standards. The purpose of the study was explained to them that their participation was free and voluntary and that they were free to withdraw from the study at any time and would not affect their access to medical attention.

# Results

In this study, a total of three hundred and eighty participants were recruited. The majority were aged 2–3 years old (27.9%), with males accounting for (50.5%). Most of their parents were aged 30–39 years (50%), with those that had attained primary education (38.7%), and those with low family income contributing (75.3%) of the study participants as shown in (Table 1).

**Table 1** Demographic Characteristics of Study Participants

| Variable | Frequency (n = 380) | Percentage (%) |
|---|---|---|
| **Child's age (years)** | | |
| 0-<6 months | 29 | 7.6 |
| 6 months-<1 year | 57 | 15.0 |
| 1-<2 years | 93 | 24.5 |
| 2 - <3 years | 106 | 27.9 |
| 3 - <4 years | 49 | 12.9 |
| 4-<5 years | 46 | 12.1 |
| **Child's gender** | | |
| Male | 192 | 50.5 |
| Female | 188 | 49.5 |
| **Child's weight (kg)** | | |
| <5 | 5 | 1.3 |
| 5-10 | 138 | 36.3 |
| 11-15 | 165 | 43.4 |
| Above 15 | 72 | 19.0 |
| **Parent's age (years)** | | |
| <20 | 18 | 4.7 |
| 20-29 | 101 | 26.6 |
| 30-39 | 190 | 50.0 |
| 40-49 | 59 | 15.5 |
| >50 | 12 | 3.2 |
| **Parent's education level** | | |
| No formal Education | 33 | 8.7 |
| Primary | 147 | 38.7 |
| Secondary | 146 | 38.4 |
| Tertiary | 54 | 14.2 |
| **Family Income (Ugx.)** | | |
| Low (<200,000/=) | 286 | 75.3 |
| Middle (200,000–500,000/=) | 75 | 19.7 |
| High (>500,000/=) | 19 | 5.0 |
| **Malaria** | | |
| Positive | 75 | 19.7 |
| Negative | 305 | 80.3 |

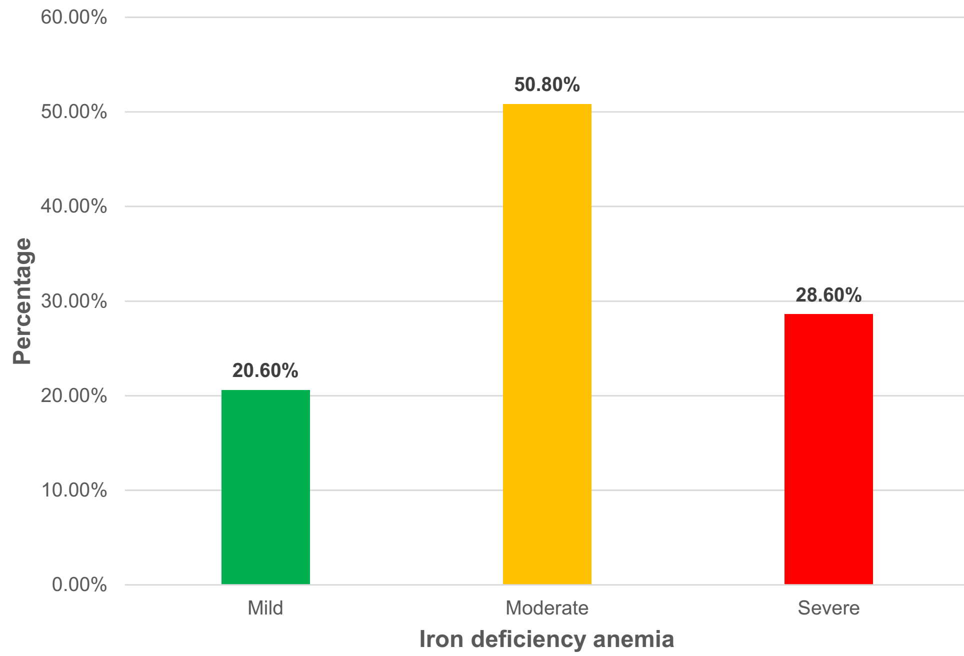


**Figure 1** A bar graph showing the severity of iron deficiency anemia among children under 5 years.

## Prevalence of Iron Deficiency Anemia Among Children Under 5 Years

Anemia was observed in 38.4% (146/380) of study participants. The overall prevalence of iron deficiency anemia was 16.6% (63/380) (95% CI: 0.13–20.7) and other forms of anemia was 21.8% (83/380).

## Severity of Iron Deficiency Anemia Among Children Under 5 Years

The majority of the children with iron deficiency anemia (IDA) had moderate IDA 32/63 (50.8%) followed by severe IDA 18/63 (28.6%) and mild IDA 13/63 (20.6%) as shown in (Figure 1). Mild, moderate and severe IDA were defined by serum ferritin levels 10–11.9µg/L, 5–9.9µg/L and <5µg/L, respectively (Figure 1).

## Determinants of Iron Deficiency Anemia Among Children Under 5 Years

Several factors were examined for association with iron deficiency anemia. At bivariate logistic regression analysis, male gender was at greater risk of IDA than female gender ($p = 0.012$), parent's age; 20–29 years ($p = 0.015$) and 30–39 years ($p = 0.06$) were at less risk of IDA than the parent's age <20 years. Also if the child had suffered infection in past 3 months, means they were at greater risk than children who had not suffered from infection ($p < 0.000$) were significant predictors of iron deficiency anemia (Table 2).

**Table 2** Bivariate Logistic Regression Analysis of Determinants of Iron Deficiency Anemia Among Children Under 5 Years

| Variable | Crude Odds Ratio (95% CI) | P-value |
|---|---|---|
| **Child's age** | | |
| 0-<6 months | Ref | |
| 6 months-<1 year | 2.7 (0.71–10.27) | 0.142 |
| 1-<2 years | 3.08 (0.83–11.42) | 0.093 |
| 2 - <3 years | 0.48 (0.07–3.61) | 0.484 |
| 3 - <4 years | 0.19 (0.02–1.84) | 0.152 |
| 4-<5 years | 0.13 (0.01–1.47) | 0.099 |

(*Continued*)


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**Table 2** (Continued).

| Variable | Crude Odds Ratio (95% CI) | P-value |
|---|---|---|
| **Child's gender** | | |
| Female | Ref | |
| Male | 2.26 (1.18–4.32) | 0.014* |
| **Parent's age (years)** | | |
| <20 | Ref | |
| 20-29 | 0.21 (0.06–0.74) | 0.015* |
| 30-39 | 0.17 (0.05–0.61) | 0.006* |
| 40-49 | 0.29 (0.07–1.24) | 0.095 |
| >50 | 0.52 (0.04–7.12) | 0.624 |
| **Education level** | | |
| No formal education | Ref | |
| Primary | 2.07 (0.55–7.75) | 0.279 |
| Secondary | 1.58 (0.40–6.15) | 0.513 |
| Tertiary | 4.33 (0.83–22.64) | 0.082 |
| **Income level (Ugx.)** | | |
| Low (<200,000/=) | Ref | |
| Middle (200,000/= – 500,000/=) | 0.40 (0.14–1.15) | 0.090 |
| High (>500,000/=) | 0.23 (0.02–3.18) | 0.271 |
| **Anemia history** | | |
| No | Ref | |
| Yes | 0.88 (0.35–2.17) | 0.776 |
| **Is the child breast feeding** | | |
| Yes | Ref | |
| No | 3.76 (0.83–17.06) | 0.086 |
| **Has child had any infections in past 3 months?** | | |
| No | Ref | |
| Yes | 5.88 (2.48–13.91) | <0.000* |
| **Malaria** | | |
| Negative | Ref | |
| Positive | 1.08 (0.44–2.64) | 0.864 |

**Note**: * Significant.

In the multivariate logistic regression analysis, Male gender ((aOR: 2.29, 95% CI: 1.20–4.35, p = 0.012), and history of infection in the past 3 months aOR: 5.62, 95% CI: 2.94–10.74, p < 0.000) remained significant predictors of iron deficiency anemia while parental age; 20–29 years (aOR: 0.21, 95% CI: 0.06–0.73, p = 0.014), 30–39 years (aOR: 0.17; 95% CI: 0.05–0.59; p = 0.005) were independently associated with a reduced odds of developing anemia (Table 3).

**Table 3** Multivariate Logistic Regression Analysis of Determinants of Iron Deficiency Anemia Among Children Under 5 Years

| Variable | Adjusted Odds Ratio (95% CI) | P-value |
|---|---|---|
| **Child's age** | | |
| 0-<6 months | Ref | |
| 6 months-<1 year | 2.69 (0.71–10.10) | 0.144 |
| 1-<2 years | 3.13 (0.85–11.50) | 0.086 |
| 2 - <3 years | 0.48 (0.07–3.52) | 0.470 |
| 3 - <4 years | 0.19 (0.02–1.80) | 0.147 |
| 4-<5 years | 0.13 (0.01–1.44) | 0.096 |

(*Continued*)

**Table 3** (Continued).

| Variable | Adjusted Odds Ratio (95% CI) | P-value |
|---|---|---|
| **Child's gender** | | |
| Female | Ref | |
| Male | 2.29 (1.20–4.35) | 0.012* |
| **Parent's age (years)** | | |
| <20 | Ref | |
| 20-29 | 0.21 (0.06–0.73) | 0.014* |
| 30-39 | 0.17 (0.05–0.59) | 0.005* |
| 40-49 | 0.28 (0.07–1.19) | 0.086 |
| >50 | 0.51 (0.04–7.02) | 0.617 |
| **Education level** | | |
| No formal education | Ref | |
| Primary | 2.08 (0.56–7.71) | 0.271 |
| Secondary | 1.57 (0.41–6.10) | 0.511 |
| Tertiary | 4.32 (0.83–22.33) | 0.081 |
| **Income level (Ugx.)** | | |
| Low (<200,000/=) | Ref | |
| Middle (200,000/= – 500,000/=) | 0.39 (0.14–1.15) | 0.087 |
| High (>500,000/=) | 0.23 (0.02–3.19) | 0.272 |
| **Is the child breast feeding** | | |
| Yes | Ref | |
| No | 3.85 (0.86–17.21) | 0.077 |
| **Has child had any infections in past 3 months?** | | |
| No | Ref | |
| Yes | 5.62 (2.94–10.74) | <0.000* |

**Note**: * Significant.

## Discussion

This study found that the prevalence of iron deficiency anemia (IDA) among children under 5 years was 16.6% at Luwero General Hospital. This finding correlates with the reported prevalence from a systematic and meta-analysis study where the pooled prevalence of iron deficiency anemia was found to be 16.42%. This same study also reported the highest prevalence in Asia 23.37% and Africa 16.4%.[19] It also aligns with a study conducted in Congo among preschool children, which found a 16.2% prevalence of iron deficiency anemia.[20]

The finding of this present study is lower than a population-based study conducted in Brazil (Minas Gerais state) between February 2007 and July 2008 in 725 male and female aged less than 60 months where the prevalence was 37.4%.[21] This study disagrees with findings from a study conducted about iron deficiency anemia on 331 randomly selected children 2–5 years in southern Ethiopia where the prevalence was 25%[22] and also not comparable with a study conducted in Sudan that reported 49.4% prevalence of anemia in children below 5 years old.[23]

A study conducted in south western Uganda on 364 children 6–23 months at Ishaka Adventist Hospital and Kampala International University teaching hospital where consecutive counselling was used, the prevalence of iron deficiency anemia, 41.5% was higher than that of the present study.[18]

In this study, moderate anemia was the most common, affecting 50.8% of the participants, followed by severe anemia at 28.6% and mild anemia at 20.6%.

These findings are somewhat consistent with a study by Kajoba et al (2024) conducted in Ishaka, southwestern Uganda, which examined the prevalence and contributing factors of iron deficiency anemia in children aged 6–24 months. The study reported that most participants, 51.7% (78 individuals), had moderate iron deficiency anemia, followed by 37.7% with mild anemia and 10.6% with severe anemia.[18]

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In a case-control study examining the association between serum status, iron deficiency, and severe early childhood anemia, the prevalence of mild anemia was 29.5%, which is greater than the 20.6% reported in this study.[24]

In the current study, severe anemia was more prevalent than in a study conducted in Bangladesh, where 265 children were enrolled at birth and followed up at 7, 15, and 24 months. In that study, the prevalence of mild, moderate, and severe anemia was 43%, 21%, and 0% at 7 months; 12%, 34%, and 2% at 15 months; and 18%, 23%, and 0% at 24 months, respectively.[25]

The findings of this study were also higher compared to a study conducted in rural Hunan Province, China, where the overall prevalence of anemia was 8.8%, with mild, moderate, and severe anemia occurring at rates of 6.3%, 2.5%, and 0.1%, respectively.[26]

This current study found that male gender had significantly higher odds of iron deficiency anemia compared to females. The study findings are consistent with a study that reported males had higher risk of iron deficiency anemia compared to female counterparts due to the possibility that males have lower iron stores compared to females.[27] In addition, male infants exhibit, on average, a greater birth weight and an accelerated growth trajectory during the first year of life. This heightened growth velocity necessitates substantially increased iron utilization to facilitate the expansion of circulating hemoglobin mass and support myogenesis.

Furthermore, this study findings affirms with another conducted on 4853 children between 0 and 8 years from Kenya, Uganda, Burkina Faso, South Africa and Gambia where the prevalence of iron deficiency anemia was highest among the male children.[28] Also, a study conducted in Tanzania on children 6–59 months revealed that being male had higher odds of iron deficiency anemia compared to being female and was in line with this current study.[29] However, findings from a study conducted in Peru found no significant association between iron deficient anemia and sex.[30]

Parental age was a significant factor, with children of parents aged 20–29 and 30–39 demonstrating significantly lower odds of iron deficiency anemia compared to those with parents under 20 years of age. This indicates that parental age is a key determinant of IDA risk in children. One plausible explanation is that increased age may be associated with greater parental knowledge and more optimal child feeding practices, thereby mitigating nutritional risk.

Children with a history of recent infections had higher odds of iron deficiency anemia. This is similar to a study conducted by[28] which revealed that children who had infections had higher odds of iron deficiency anemia.[28] A possible explanation for this finding is that infections can increase the body's demand for iron, leading to a depletion of iron stores and an increased risk of iron deficiency anemia. The study findings are consistent with a study conducted in Bugando M C, Mwanza Tanzania among under 5 years where children who had malaria and those that had sickle cell disease had higher odds of iron deficiency anemia compared to those that did not.[31] The finding still were similar to those from a study conducted in Burao city Somalia 2020 where children who had parasites in stool had increased odds of iron deficiency anemia compared to their counter parts.[32] A study conducted in Tanzania on children 6–59 months revealed that children with fever and stunted growth had higher odds for iron deficiency anaemia.[29]

## Limitation of the Study

Serum ferritin is widely used to diagnose iron deficiency anemia (IDA), but it has notable drawbacks. As an acute-phase reactant, its levels can rise due to inflammation, infections, liver disorders, or malignancies, potentially leading to falsely normal or elevated readings that obscure underlying iron deficiency. Additionally, because ferritin mainly indicates iron storage, its levels may stay within the normal range during the initial stages of iron depletion, making it an unreliable early indicator of iron deficiency.

## Conclusion

The prevalence of iron deficiency anemia (IDA) among children under five years reported in this study is high, 16.6%. The analysis identified male gender and a recent history of infection as significant risk factors for iron deficiency anemia (IDA). In contrast, higher parental age was associated with a protective effect.

To address these findings, we recommend a targeted intervention strategy. This should include routine screening for IDA in all anemic children, coupled with iron supplementation for those diagnosed, with a particular focus on high-risk groups such as male children and those with recent infections.

Furthermore, tailored nutritional education programs for younger parents, specifically those under 20 years of age, are essential to improve child-feeding practices and reduce the overall disease burden.

## Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Disclosure

The authors report no conflicts of interest in this work.

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