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A Study on Iron Deficiency Anemia Among Urban Children in Baghdad: Prevalence and Risk Determinants

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Abstract: Background: Iron deficiency anemia (IDA) is an important global public health issue and a significant problem for children in many lower- and middle-income countries. After years of conflict and economic instability, little information exists to show the prevalence of IDA among children living in urban Baghdad.

Objectives: To determine the prevalence of iron deficiency anemia and assess the associated risk indicators.

Methods: A cross-sectional study was conducted during the study period (March to August 2024) among 1,247 children aged 6–12 months, selected randomly from households in five different districts of Baghdad. Findings included: demographic information identifying socioeconomic status, dietary intake, and laboratory testing (CBC, ferritin, transferrin saturation, total iron binding capacity).

Results: The overall prevalence of iron deficiency anemia was found to be 34.7% (95% CI: 32.1–37.4%). The highest prevalence was found in infants aged 6–24 months (47.8%). The percentage of IDA decreased as age increased. Significant risk factors for IDA included: pocketbook costs of dietary intake (OR=2.34, 95% CI: 1.78–3.08) <1.9% a day (040), maternal anemia (OR=2.67, 95% CI: 2.05–3.48), and low pocketbook cost of dietary intake (1.89 <1.41 <2.47).

Conclusion: Iron deficiency anemia is a major problem affecting more than one-third of children in urban Baghdad, with the highest burden in infants and toddlers. There is a great need for interventions both directly regarding the issue of clan and economic support.

Keywords: Iron deficiency anemia, children, prevalence, risk factors, Baghdad, Iraq.

Introduction

Iron deficiency anemia is among the most common nutritional disorders in the world and is estimated to affect about 1.62 billion people worldwide, with children bearing the brunt of the disease (1). The World Health Organization estimates the prevalence of iron deficiency anemia adds to around 47.4% of preschool aged children worldwide, with the rates being highest in developing nations where multiple factors coexist to make these economies susceptible to iron deficiency (2). Iron deficiency anemia has a broad range of implications beyond the primary hematological effects including potential detriments to cognitive function, immune response, and general grown-and-development trajectories in children .

In the Middle Eastern region, iron deficiency anemia has become a significant public health problem where rates of prevalence have a large variability in rates between countries and across population samples. Reports from neighbouring countries have noted concerning rates of iron deficiency anemia in specific segments of the population between 25% and 60% prevalence depending on the population studied and diagnostic criteria used (3,4). These will provide for potential variations and emphasis of the necessity to examine region-specific studies established to understand the epidemiology in that region in order to guide focused intervention strategies.

Iraq and in particular Baghdad has a distinct epidemiological context from other reports owing to many years of war, economic sanctions, and political instability. This has had a considerable impact on health care systems, food security, and overall living conditions to create a complex environment that shapes the risk factors and rates of iron deficiency anemia amongst children (5).Extended periods of conflict have disrupted healthcare systems, disrupted access to growing/delicious food, and disrupted maternal and child health programs, which are all important contributors to iron status in children .

The pathophysiology of iron deficiency anemia involve a convergence of inadequate iron intake, poor iron absorption, higher iron needs during periods of rapid growth, and iron losses from other processes. Iron needs are particularly high in infancy and in early childhood due to rapid growth and the expanding blood volume, making this susceptible to iron deficiency (6). The transition from exclusive breastfeeding to complementary feeding is a pivotal transition when many children are at risk for iron deficiency, particularly in circumstances where iron-rich complementary foods are scarce or not culturally acceptable .

Dietary factors are the primary determinants of iron deficiency anemia among children. Iron bioavailability differs greatly between heme iron (found mostly in meat) vs. non-heme iron (plant-based foods). The bioavailability of non-heme iron is affected by a multitude of dietary factors, with enhancers (like vitamin C) and inhibitors (phytates, tannins, calcium) (7). When the population is mostly plant-based dieters or limited access to iron-rich foods, the burden of iron deficiency anemia skyrockets .

Socioeconomic factors are another important aspect in the epidemiology of iron deficiency anemia.Poverty, food insecurity, and restricted access to health services create a cascade of risk factors that predispose children to iron deficiency. Families that are resource-poor may have limited access to food sources that are high in iron and especially animal protein sources, which are costly compared to plant-based foods (8). Overcrowded housing, poor sanitation, and other limitations to access clean water may place children at risk for infections, which can result in iron deficiency through causes such as inflammation, blood loss, and impaired iron absorption.

Maternal risk factors may also influence the iron status of children beginning in utero and extending during breastfeeding and weaning. Maternal iron deficiency anemia during pregnancy can lead to reduced iron stores in newborns, which can contribute to early iron deficiency (9). Knowledge and practices from mothers regarding infant feeding, including the timely introduction of complementary foods and the provision of animal protein rich foods, are also very important predictors of iron status in the child.

The health system's capacity for the identification, management, and prevention of iron deficiency anemia is another key determinant of burden and impact. In health systems with strong capacity development, routine screening, iron supplementation, and nutrition education programs provide opportunities for children to avoid iron deficiency anemia. However, in parts of the world with weaker health system capacity or conflict, these preventive measures and the management of anemia are limited or not provided (10). Environmental factors, such as exposure to lead and other heavy metals, can disrupt iron metabolism and be a positive contributor in the risk of anemia. Children in urban settings, particularly areas with industry or some environmental contamination, are at risk of exposure and it may further heighten the risk of iron deficiency anemia (11). Parasitic infections (more prevalent with poor sanitation) that cause chronic blood loss, are an additional risk for iron deficiency.

In children, iron deficiency anemia diagnosis requires more than just baseline hemoglobin levels. Even though hemoglobin remains a key indicator for determining if anemia exists, hemoglobin levels do not clinically identify if iron deficiency is a reason. To achieve a true diagnosis of iron deficiency will require a number of lab parameters (serum ferritin, transferrin saturation and total iron-binding capacity) in order to demonstrate iron deficiency and also, rule out other causes of anemia (12). All of these lab tests will have variable results during concomitant infections or inflammation states which can change the iron metabolism in the body and cloud diagnosis as well .

Signs of iron deficiency anemia are broader than pallor or fatigue. Additional issues for children with iron deficiency anemia may be cognitive delay, impaired psychomotor development, dysfunctional immune processes, and increased rates of infections (13); all of which may have long lasting negative effects on education, social development, and life in general. Iron deficiency anemia screening and treatment needs to be conducted as early as possible in minimizing above negative outcomes and promote positive child development .

Iron deficiency anemia prevention acknowledge the many risk factors and determinants as outlined in the populations. These include iron supplementation program, food fortification program, family nutrition education, improvement of socioeconomic conditions; and enhancement of the health care system to have an impact on iron deficiency anemia incidence and prevalence (14). It is important to coordinate and tailor strategies with the focus of each locality as it relates to the epidemiology and resources available.

In terms of implementation in Baghdad, one of the goals is understanding the current child iron deficiency anemia prevalence and risk factors so we can develop strategies related to public health. Baghdad has a special historical, socioeconomic, and health care context. We need a comprehensive review to inform evidence based policy and program implementation, while past educational studies in Iraq have had small samples, were subset geographically, or are antiquated, all make a need for us to undertake an integrated and timely area review toward public health action.

Methodology

This cross-sectional study was conducted between March 2024 and August 2024 to assess the prevalence and risk factors of iron deficiency anemia among children in urban Baghdad. The study was designed to provide representative data on iron deficiency anemia across different age groups and socioeconomic strata within the urban population of Baghdad.

Study Setting and Population

The study was conducted in Baghdad, the capital city of Iraq, which has an estimated population of approximately 7.7 million inhabitants. Baghdad is divided into nine administrative districts, and for this study, five districts were randomly selected to ensure geographic representation: Al-Karkh, Al-Rusafa, Sadr City, Al-Kadhimiya, and New Baghdad. These districts represent diverse socioeconomic conditions and population densities, providing a comprehensive view of the urban population.

The population of interest was comprised of children aged between 6 months to 12 years old residing in households within selected districts for at least six months prior to study initiation. Children qualified for inclusion in study if they did not have known chronic diseases capable of altering iron metabolism, did not have iron supplementation in the past three months, and had caregivers who provided informed consent to participate.

Sample Size and Sampling Method

Sample size calculation was determined based on an expected rate of iron deficiency anemia prevalence of 35% in children with similar urban context in the Middle East region. A precision of 3%, a confidence level of 95%, and a non-response rate of 15% was used, yielding a sample size of 1,247 children.

A multistage cluster sampling method was utilized to select participants for the study. In stage one, firstly all residential neighborhoods were selected randomly from each of the five districts using probability proportional to size sampling method. In stage two, households were also selected systematically from the selected neighborhoods by taking every 5th household beginning from a random point. All eligible children from selected households were included as potential subjects maximizing sample size and efficiency of data collection.

Data Collection

Data was collected by the trained field teams of physicians, nurses, and laboratory technicians. Training for each team included extensive training on study procedures, ethics and data collection. Training included standardization of anthropometric measurement and blood collection techniques and interview techniques for within each study team in order to standardize data collection across teams.

Demographic and Socioeconomic Data

Demographic data was obtained from structured questionnaires administered to primary caregivers to obtain detailed information on several demographic characteristics, socioeconomic status, and household types and conditions. Demographic information included child age, sex, birth weight, gestational age at birth, and medical history related to the child. Maternal characteristics assessed included maternal age, education level, job title, and examination of medical history for anemic conditions during pregnancy.

Socioeconomic status was categorized using a composite index which combined household income, parental education, occupation types, household facilities, and asset ownership. The index was classified into tertiles of low, medium, and high socioeconomic status. Household food security was determined using the Household Food Insecurity Access Scale, with adjustments made for local utilization.

Dietary Assessment

Comprehensive dietary assessment was conducted using multiple methods to capture feeding patterns and nutrient intake. For children under 24 months, feeding practices were assessed including breastfeeding duration, timing of complementary food introduction, and types of complementary foods provided. For all children, a 24-hour dietary recall was conducted with primary caregivers to assess recent dietary intake.

Food frequency questionnaires specifically designed for the Iraqi context were used to assess usual dietary patterns over the preceding month. Special attention was paid to consumption of iron-rich foods including meat, poultry, fish, legumes, fortified cereals, and green leafy vegetables. Information was also collected on consumption of foods and beverages that may enhance or inhibit iron absorption.

Anthropometric Measurements

Standardized anthropometric measurements were conducted following WHO guidelines. Weight was measured using calibrated digital scales accurate to 100g, with children wearing minimal clothing. Length was measured for children under 24 months using infantometers, while height was measured for older children using stadiometers accurate to 1mm. Mid-upper arm circumference was measured using non-stretchable measuring tapes.

Z-scores for weight-for-age, height-for-age, and weight-for-height were calculated using WHO child growth standards. Stunting was defined as height-for-age z-score below -2, wasting as weight-for-height z-score below -2, and underweight as weight-for-age z-score below -2.

Laboratory Investigations

Blood samples were collected by trained phlebotomists using standardized procedures to minimize contamination and ensure sample quality. For children under 2 years, capillary blood samples were collected via heel prick or finger prick using sterile lancets. For older children, venous blood samples were collected using sterile techniques and appropriate pediatric collection tubes.

Laboratory analyses were conducted at certified laboratories using standardized protocols and quality control procedures. Complete blood count was performed using automated hematology analyzers, with hemoglobin concentration measured using the cyanmethemoglobin method. Serum ferritin levels were determined using chemiluminescent immunoassays, while serum iron, total iron-binding capacity, and transferrin saturation were measured using colorimetric methods.

Definition of Iron Deficiency Anemia

Iron deficiency anemia was defined using age-specific criteria combining hemoglobin levels and iron status indicators. Anemia was defined according to WHO criteria: hemoglobin <110 g/L for children aged 6-59 months, <115 g/L for children aged 5-11 years, and <120 g/L for children aged 12-14 years. Iron deficiency was defined as serum ferritin <12 μg/L for children under 5 years and <15 μg/L for children 5 years and older, or transferrin saturation <16%.

Children were classified as having iron deficiency anemia if they met criteria for both anemia and iron deficiency. Iron deficiency without anemia was defined as normal hemoglobin levels with evidence of iron deficiency based on ferritin or transferrin saturation criteria.

Experience and Training of Field Workers

The data collecting field workers all had experience as Ministry of Health community health workers, with some having received additional training as research assistants during another study. All field workers engaged in group and individual training opportunities related to the research and the study protocol.

Quality Control and Data Management

All quality control measures were strictly adhered to throughout the study. Laboratory equipment was calibrated periodically, with internal and external quality control samples assayed to ensure the laboratory procedures and results were accurate and precise. Data collection forms were reviewed daily to ensure completeness and consistency. Field teams received immediate feedback if answers on forms were inconsistent with the observational data.

Data were entered into a password-protected electronic database using double data entry to reduce transcription errors. The data entry system included range and consistency checks to detect potential errors during the initial entry process. Applying data cleaning procedures included examining records visually, more than 1 to 2 times, to identify any remaining inconsistencies or missing values.

Statistical Analysis

Statistical analysis was performed with SPSS version 28.0. Descriptive statistical results included frequencies (% of total) for categorical variables and means with standard deviations (or medians with interquartile ranges) for continuous variables. The prevalence of iron deficiency anemia was presented with a 95% confidence interval, overall and by selected demographic and socioeconomic characteristics.

Bivariate analyses employed Chi-square tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables as appropriate. multivariable logistic regression analysis was performed to identify independent risk factors for iron deficiency anemia, with results presented as adjusted odds ratios with 95% confidence intervals. Multivariable analysis included variables with p-values <0.20 in bivariate analyses**.**

Maintaining Ethical Standards

Written informed consent was obtained from the parents or legal guardians of the children participating in the study, and children 7 years and older provided assent. All participants were assured confidentiality, and personal identifiers were not included in the final dataset.

Children diagnosed with iron deficiency anemia were offered referrals to health facilities for further follow-up and care. Information sheets on iron-rich foods and feeding practices were provided to families in the study, regardless of the child's iron status.

Results

A total of 1,247 children were successfully enrolled in the study across the five districts of Baghdad, with a response rate of 89.3%. The study population included 647 males (51.9%) and 600 females (48.1%), with ages ranging from 6 months to 12 years. The mean age was 4.2 ± 3.1 years, and the distribution across age groups was relatively even.

Table 1: Demographic and Socioeconomic Characteristics of Study Population

Characteristic	n (%)
Age Groups	
6-23 months	298 (23.9)
24-59 months	387 (31.0)
5-8 years	341 (27.3)
9-12 years	221 (17.7)
Sex	
Male	647 (51.9)
Female	600 (48.1)
Socioeconomic Status	
Low	456 (36.6)
Medium	421 (33.8)
High	370 (29.7)
Maternal Education	
No formal education	287 (23.0)
Primary education	398 (31.9)
Secondary education	356 (28.5)
Higher education	206 (16.5)
Household Food Security	
Food secure	523 (41.9)
Mildly food insecure	394 (31.6)
Moderately food insecure	233 (18.7)
Severely food insecure	97 (7.8)

The overall prevalence of iron deficiency anemia was 34.7% (95% CI: 32.1-37.4%), affecting 433 children. The prevalence varied significantly by age group, with the highest rates observed among children aged 6-23 months (47.8%) and decreasing progressively with age. Among children aged 9-12 years, the prevalence was 18.1%.

Table 2: Prevalence of Iron Deficiency Anemia by Demographic Characteristics

Variable	Total n	IDA Cases n (%)	95% CI	p-value
Overall	1,247	433 (34.7)	32.1-37.4	-
Age Groups				<0.001

6-23 months	298	142 (47.8)	42.0-53.6	
24-59 months	387	156 (40.3)	35.4-45.3	
5-8 years	341	95 (27.9)	23.1-33.1	
9-12 years	221	40 (18.1)	13.2-23.8	
Sex				0.092
Male	647	212 (32.8)	29.2-36.6	
Female	600	221 (36.8)	32.9-40.9	
Socioeconomic Status				<0.001
Low	456	198 (43.4)	38.8-48.1	
Medium	421	142 (33.7)	29.2-38.5	
High	370	93 (25.1)	20.7-30.0	

Laboratory parameters revealed significant variations in iron status indicators across the study population. Mean hemoglobin concentration was 107.2 ± 18.4 g/L, with 52.8% of children having hemoglobin levels below age-specific cut-off values. Serum ferritin levels were markedly low among children with iron deficiency anemia, with a mean value of 8.7 ± 4.2 μg/L compared to 28.4 ± 12.1 μg/L among children without anemia.

Table 3: Laboratory Parameters by Iron Deficiency Anemia Status

Parameter	IDA (n=433) Mean ± SD	No IDA (n=814) Mean ± SD	p-value
Hemoglobin (g/L)	89.3 ± 12.7	116.8 ± 14.2	<0.001
Hematocrit (%)	27.1 ± 4.8	35.2 ± 4.1	<0.001
MCV (fL)	68.4 ± 8.9	81.7 ± 6.3	<0.001
Serum Ferritin (μg/L)	8.7 ± 4.2	28.4 ± 12.1	<0.001
Transferrin Saturation (%)	11.2 ± 3.8	24.7 ± 6.9	<0.001
TIBC (μmol/L)	89.7 ± 15.4	58.3 ± 11.2	<0.001

Nutritional status assessment revealed that 23.7% of children were stunted, 11.4% were wasted, and 18.9% were underweight. Children with iron deficiency anemia had significantly higher rates of malnutrition across all anthropometric indicators compared to those without anemia.

Table 4: Risk Factors Associated with Iron Deficiency Anemia - Multivariable Analysis

Risk Factor	Adjusted OR	95% CI	p-value
Age 6-23 months	3.47	2.45-4.91	<0.001
Low socioeconomic status	1.89	1.45-2.47	<0.001
Exclusive breastfeeding >6 months	2.34	1.78-3.08	<0.001
Maternal anemia	2.67	2.05-3.48	<0.001
Food insecurity (severe)	2.12	1.32-3.41	0.002
Low birth weight (<2.5kg)	1.78	1.23-2.57	0.002
Stunting	1.65	1.24-2.19	<0.001
Poor sanitation	1.43	1.08-1.89	0.012

Discussion

The results of this study indicate that iron deficiency anemia is prevalent in more than one third of children (34.7%) in urban Baghdad, which suggests that iron deficiency anemia remains a significant public health issue in the capital of Iraq. The prevalence of iron deficiency anemia is substantially greater than prevalence rates reported in many developed countries; however, it is within the range of prevalence rates reported in other Middle Eastern and countries with similar economic development to Iraq, and is consistent with the interplay among socioeconomic, nutrition, and health factors that affect iron status in children.(15,16)

The pattern of the age-related prevalence of iron deficiency anemia from this study with the highest prevalence in the 6-23 month age group (47.8%) agrees with previously reported patterns of iron deficiency anemia prevalence around the world and suggests the susceptibility of this age group to iron deficiency. The 6-23 month age group is a time of rapid growth spurts, depletion of iron stores gained during fetal life, and the significant transition from exclusive breastfeeding to complementary food. Given the high prevalence in this age group, we can infer that iron intake from complementary foods is inadequate. Inadequate iron intake is likely due to delayed introduction of iron rich foods, iron-poor complementary foods, or feeding practices that do not promote absorption of iron.(17)

The overall trend of decreasing prevalence rates of iron deficiency anemia with increasing age until age 9-12 years (18.1%) is likely associated with expanded dietary variety, diminished growth plateaus, and possibly a survival bias whereby children with early-life severe iron deficiency anemia may persistently not thrive and their developmental delay may have precluded them from the 9-12 year old group.Despite slightly higher rates of iron deficiency in younger children, even the lowest observed prevalence for children at the oldest age category is still above the 15% marker as indicative of a moderate public health consequence, and thus, indicating that iron deficiency is an ongoing problem across all childhood age categories in this population.(18)

The socioeconomic gradient in prevalence of iron deficiency anemia, with children in the lowest socioeconomic status having nearly double the odds of developing anemia compared to children in the higher socioeconomic status families point to the basic influence of poverty and lack of resources and access to food on nutritional outcomes. Most probably, this occurs through various pathways, including food access for iron-rich foods, especially in animal protein sources which contain heme iron that is highly bioavailable, lower access to healthcare for preventive care and early recognition of anemia, and higher incidence of environmental exposures that may provoke iron deficiency including sanitation and other infectious diseases.(19)

Additionally, maternal anemia was robustly associated with childhood iron deficiency anemia where children of mothers with anemia had a 2.67 greater odds of anemic status. This shows the transmission of iron deficiency throughout generations, from pregnancy, where maternal iron deficiency could deplete fetal iron storage, along breastfeeding, where maternal iron status could affect the iron content of breast milk, and during early childhood due to maternal feeding behaviors and overall adolescent food security status. These findings indicate the importance of addressing maternal iron status to inform childhood anemia prevention programmingIdentifying exclusive breastfeeding beyond six months as a significant risk factor for iron deficiency anemia, with adjusted odds ratio of 2.34, reflects that breast milk alone is inadequate to meet iron needs after six months of age. As noted in the previous chapter, while breast milk is ideal in meeting nutritional needs in the first six months of life, after six months of age, breast milk cannot provide enough iron to makeup iron needs of growing infants. The need for early introduction of iron-containing complementary foods to prevent iron deficiency during the first year of life, along with continued breastfeeding starting at six months of age, is emphasized .(21)

The relationship between food insecurity and iron deficiency anemia, and in particular severe food insecurity (which increased anemia odds by 2.12 times), illustrate the direct effect inadequate food access has on nutritional status. Households experiencing food insecurity often prioritize food quantity over quality meaning their diets are calorically adequate, but micronutrient (including iron) deficient. Lastly, food insecurity is correlated with other areas of concern like housing challenges or poor healthcare etc. which can also affect iron deficiency risk and/or may act by other mechanisms altogether(22)

The association with low birth weight and increased risk of iron deficiency anemia, with affected children having 1.78 times the odds of developing anemia, is a long-term impact of suboptimal fetal growth and development.Low birth weight infants often have low iron stores at birth, generally because of shortened gestation or intrauterine growth restriction, and thus might face early depletion of iron stores. This leads to the implication of improved infant monitoring and perhaps altered feeding recommendations for low birth weight infants to prevent early childhood iron deficiency.(23)

While the connection between stunting and iron deficiency anemia, may be bi-directionally related, it reveals the relationships between types of malnutrition. Iron deficiency may be one factor leading to growth failure through effects on cellular metabolism and immune response and reasons for stunting, such as long-term undernutrition and recurrent infections, may also cause children to be at risk for iron deficiency. This reinforces the need for comprehensive nutrition interventions for children that will address more than one micronutrient deficiency.(24)

Sanitation was related to iron deficiency anemia, and poor sanitation increases the odds of anemia by 1.43; this raises the question of how infectious disease and environmental contamination affect iron status. Poor sanitation increases risk of gastrointestinal infections which can cause blood loss through bleeding,(5), causes GI inflammation which contributes to impaired iron uptake, and can increase iron requirements from the inflammatory state. Moreover, being exposed to environmental toxins, e.g., lead or other heavy metals that caused by resource deprived environments and inadequate sanitation, can impact iron metabolism and lead to anemia.(25)

The laboratory findings collected from the study show that children with iron deficiency anemia have serum ferritin levels that are lower than those of non-iron deficient infants and transferrin saturation reflects that same state of deficiency. That finding confirms that the anemia is due to iron deficiency, and supports this analytical framework. Specifically, an average serum ferritin level of 8.7 μg/L reflects a significant deficiency in iron heme iron structures and a transferrin saturation of 11.2% shows a deficient amount of iron needed for erythrogenesis. compared with dietary strategies only .

The high overall rate of anemia in the study sample (52.8%) shows that iron deficiency is not the only cause of anemia in this population of children in Baghdad, however iron deficiency remains the predominant cause operationally in terms of being iron deficient. Other potential causes of anemia among the study population might include other micronutrient deficiencies, folate or B12 deficiency, chronic diseases, or hemoglobinopathies. The amount of children with some combination of possible causes of anemia highlights a pressing need for the diagnostic work-up and treatment plan.

From the perspective of public health, the main implication of this study highlights the need for a comprehensive plan to address iron deficiency anemia in children in Baghdad. These strategies should be implemented using a lifecycle approach that starts with improving the iron status of mothers during pregnancy, as well as appropriate feeding practices, iron supplementation programs, and food fortification programs during infancy and childhood. The overall high burden across all levels of socioecocomics indicates that both population-based strategies, as well as targeted strategies, would be important for generating meaningful population reductions in iron deficiency anemia burden.

The successful development and implementation of effective intervention strategies for iron deficiency anemia in Baghdad, capacity of health systems will need to be developed to treat, find, and prevent cases of iron deficiency anemia.Health system capacity should include training health care providers to use appropriate diagnostic methods, having iron supplements and therapeutic foods available, and monitoring efforts to evaluate effectiveness to reduce anemia prevalence. Community based interventions to address the underlying determinants of iron deficiency including poverty, low food security, and poor sanitation will also be necessary to ensure lasting change in iron status .

CONCLUSIONS

The present study illustrates compelling evidence that iron deficiency anemia remains an urgent public health concern impacting over one-third of children in urban Baghdad. The 34.7%

prevalence observed in this population far exceeds any of the WHO's definitions of moderate public health importance and requires immediate public health attention for focused interventions on this issue. Age-dependence of iron deficiency anemia is profound, with almost half of children aged, 6-23 months having iron deficiency anemia, revealing the at-risk stage of complementary feeding for infants and toddlers.

The complexity and multifactorial nature of iron deficiency anemia that we observed in this study, evidenced through the dependence of socioeconomic, nutritional, maternal, and environmental risk factors, calls for targeted, integrated intervention package aimed at addressing the immediate causes and underlying determinants of iron deficiency anemia. The relationships of poverty, food insecurity, maternal anemia, and poor feeding practices highlight how intertwined the issue is and justifies an integrated approach combining direct nutrition and more broad social and economic interventions .

Recommended prioritized interventions to reduce iron deficiency anemia prevalence in children should begin with improving maternal iron status when pregnant and lactating, the careful refined management of appropriate infant and young child feeding inputs, highlighting the importance of timely introduction of iron-fortified complementary foods, iron supplements for identified high risk groups in need if the population based efforts fall short, and food fortification as a means of population-based improvement in iron intake. Additionally, the recommendations to address the underlying determinants of poverty, food insecurity, and poor sanitation will also be extremely relevant to achieving sustainable reductions in iron deficiency anemia prevalence.

The results from this study certainly provide an advancement of the basis of evidence required to guide policy and program decision-making to address the iron deficiency anemia in pediatric population of Baghdad. Regular monitoring and evaluation of the intervention efforts are essential components of measuring outcomes and impact against the intervention strategies aimed at iron deficiency anemia. As far as future research, this study should stay focused on how to assess the comparative effectiveness of varied interventions and assess creative ways to address the complex determinants of iron deficiency anemia in this urban challenged environment.

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