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Determinants and prevalence of Iron Deficiency Anemia in Baghdad among Children under five years- A cross sectional study of a large pediatric referral center

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ABSTRACT
Iron deficient anemia (IDA) is the most common nutritional condition among children worldwide and the implication of this condition cannot be underestimated in relation to cognitive development and body maturation. This was a cross-sectional study to establish the prevalence and risk factors of IDA in the five year old children who were attending Central Child Teaching Hospital in Baghdad. A systematic random sampling was used to enroll (320 children) marshmallow children. CBC, serum ferritin (divided by CRP), serum iron, TIBC and saturation of transferrin were done. Demographic data, feeding practices and socioeconomic aspect data were gathered through use of structured questionnaires. The findings showed that general prevalence rate of anemia was 48.1 according to the IDA prevalence is 88.3 of all anemia prevalence in it with 42.5 prevalence of the IDA prevalence (n=136). The exclusive bottle feeding (aOR=2.86, p= 0.001), late introduction of complementary foods (aOR=2.34, p=0.002), low maternal education (aOR=1.98, p=0.008) and low socioeconomic status (aOR=2.12, p=0.004) were found to be significant risk factors. The mean hemoglobin of children with IDA was found to be 9.8+-1.4 g /dl as compared to 12.2+-1.1 g /dl in children without IDA ($p < 0.001$). This conclusion means that a sense of urgency exists in massive nutrition intervention programmes which focus on early childhood nutrition and maternal education in Iraq.

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1. INTRODUCTION

Iron deficiency anemia (IDA) is the most prevalent nutritional deficiency disorder in the world and it is known to afflict about 2 billion individuals across the world. Infants who are below the age of five years are especially vulnerable owing to the high levels of growth and development that at the age demand high levels of iron (1). WHO estimates that 42 percent of children below five years old in the developing nations are anaemic and that in most instances, the cause of anemia is iron deficiency (2).

The effects of IDA during early childhood go way beyond the hematological effects. Iron plays an important role in brain development and a lack of iron at critical stages may cause irreversible intellectual damage, behavioral disorders, and poor results at school. Moreover, IDA suppresses the immune system, exposing the body to the risks of infection, and impacts physical development and locomotor activities (3).

Childhood anemia has been on the increase in Iraq even after the healthcare infrastructure has been improved. Some of the causes of this burden are poor dietary intake, poor feeding habits, frequent infections and socioeconomic difficulties. The problem has been worsened by the nutritional shift taking place in the cities, which is defined by the higher intake of processed foods that lack iron bioavailability. In addition, the cultural food culture in Baghdad including excessive intake of tea during meals (inhibition of the uptake of iron) and low intake of

food enriched with iron, also plays a major role in the high prevalence of IDA (4).

The purpose of the study was to establish the prevalence of IDA among children younger than five years in the Central Child Teaching Hospital in Baghdad and the identification of the key modifiable risk factors related to this condition, which would be crucial in the design of specific intervention strategies to eliminate anemia among children in Iraq (5).

2-MATERIALS AND METHODS

Study Design and Setting

The proposed cross-sectional analytical study will be carried out at Central Child Teaching Hospital, which is among the biggest pediatric referral centers in Baghdad, between April and September 2024. The children served by the hospital are those in Baghdad and other governorates around, and the hospital offers an all-round care service to children.

Sample Size Calculation

The minimum sample size was computed through the formula to estimate one proportion where an approximate prevalence of 40% of IDA had been estimated in a study done in the region before and a 95% confidence level (Za=1.96) and margin of error of 5.5%. This gave a minimum sample of 304 participants. In order to consider the potential incompleteness of the data and non-response, 320 children were ultimately recruited.

Sampling Method and Population of the Study.

A systematic random sampling method was used and all children that enrolled in the outpatient department during the study period but every third were called upon to take part. There were 320 children between 6 months and 5 years. Inclusion criteria were age (6-60 months), the absence of acute illness at the time of the enrolment and parental consent. The exclusion criteria were known hemoglobinopathy (confirmed by hemoglobin electrophoresis where suspected) and chronic conditions that influence iron metabolism, recent blood transfusion (within 3 months), iron supplementation and children with evidence of acute infection (CRP >10 mg/L).

Table 1: The instruments in this study.

No.	Instrument	Company	Origin
1	Automated Hematology Analyzer (Sysmex XN-1000)	Sysmex	Japan
2	Chemistry Analyzer (Cobas c501)	Roche	Germany
3	ELISA Reader (for Ferritin)	BioTek	USA
4	Digital Infant Scale	Seca	Germany
5	Infantometer/Stadiometer	Seca	Germany
6	Centrifuge	Eppendorf	Germany

Data Collection

The structured questionnaire issued to mothers/caregivers was used to get: (1) demographic variables including: age of child, sex, birth order and gestational age at birth; (2) feeding practices including: length of time breastfeeding child, age at which to start complementary feeding (under 6 months, 6-8 months and more than 8 months), and score of dietary diversity; (3) recurrent infections history (more than three cases of diarrhea and/or respiratory infections per year); (4) deworming status within the last

Anthropometric Assessment

The weight, length/height measurements and mid-upper arm circumference (MUAC) measurements were standardized. The z-scores of weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ) z-scores were calculated using WHO Anthro software (version 3.2.2). Underweight was taken as WAZ below 2 SD, stunting as HAZ below 2 SD and wasting as WHZ below 2 SD.

Laboratory Analysis

The venous blood samples (3 mL) of each child were taken. They were measured using Sysmex XN-1000 in assessing complete blood count (CBC) with hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and red cell distribution width (RDW). Serum ferritin was measured in ELISA. The serum iron and total iron-binding capacity (TIBC) was determined using colorimetric methods on Cobas c501; transferrin saturation (TSAT) was as (serum iron/TIBC) x 100. C-reactive protein (CRP) was determined by immunoturbidimetric assay to determine subclinical inflammation.

Definitions

WHO standards were used to define anemia: Hb below 11 g/dl in children under the age of 6-59 months. In the remainder of the sample (not

including the values above 10mg/L) IDA was considered as anemia with:(a) Serum ferritin less than 12 ng/mL in the cases where the CRP was below 5mg/L, or (b) serum ferritin less than 30 ng/mL when CRP was between 5-10 mg/L and/or saturation of transferrin less than 16%. This approach relies on WHO recommendations of changing the interpretation of ferritin in an already infected burden.

Statistical Analysis

Data were analyzed using the SPSS 26. The continuous variables have been represented in means +- SD and compared as independent t-test after verifying that the normality has been verified with Shapiro-Wilk test. The categorical variables were presented in the form of frequencies and percentages and compared using chi-square test. Multivariate logistic regression was done to come up with independent risk factors of IDA where the entering variables included the variables that had $p<0.1$ in the univariate analysis. Model fit was tested using Hosmer-Lemeshow test. The p-value under 0.05 was considered significant.

Ethical Considerations

The study protocol was reviewed and approved by the IRB of Central Child Teaching Hospital, Baghdad (Approval No.: CCH-2024-IDA-008). Informed consent among parents/guardians of all the children through signing written consent was obtained before the enrollment. Every single process was performed based on principles of ethics proclaimed in Helsinki declaration. The data used were very confidential and anonymous during the study.

3-RESULTS

The sample size was 320 children with an average age of the children being 28.4+-14.6 months. The male populations were 54.1 (n=173). Anemia was 48.1%(n=154) in prevalence. Worthwhile, the etiology of anemia among the age group in question is still identified to be Iron deficiency, as 88.3 percent of the overall anemia (n=136 of 154) was caused by IDA. This provided a total IDA prevalence of 42.5%. The most common of IDA was observed in the 6-24 months age group (52.3%). Table 2 shows the demographic characteristics, anthropometric characteristics, hematological characteristics, and iron indices of the study population.

Table 2: Demographic, Anthropetric, Hematological and Iron Indices Characteristics.

Variable	IDA (n=136)	Non-IDA (n=184)	P-value
Age (months)	24.6 ± 12.8	31.2 ± 15.4	<0.001
Male n (%)	78 (57.4)	95 (51.6)	0.312
WAZ (Z-score)	-1.42 ± 1.18	-0.68 ± 0.94	<0.001
HAZ (Z-score)	-1.28 ± 1.24	-0.52 ± 0.98	<0.001
Hemoglobin (g/dL)	9.8 ± 1.4	12.2 ± 1.1	<0.001
MCV (fL)	64.8 ± 6.4	78.4 ± 5.2	<0.001
Serum Ferritin (ng/mL)*	8.4 ± 4.2	42.6 ± 18.4	<0.001
Serum Iron (µg/dL)	32.4 ± 12.6	78.6 ± 24.8	<0.001
TIBC (µg/dL)	412.8 ± 68.4	328.6 ± 52.4	<0.001
Transferrin Saturation (%)	8.2 ± 3.4	24.6 ± 8.2	<0.001

**Interpreted according to CRP levels as per WHO recommendations*

The multivariate logistic regression analysis of risk factors of IDA is indicated in Table 3. Exclusive bottle feeding, late complementary foods (>8 months), low maternal education and low socioeconomic status were all important independent predictors of IDA. Hosmer-Lemeshow test showed that there is a good model fit (kh2=6.84, p=0.554).

Table 3: Multivariate Logistic Regression Analysis of the Risk Factor in IDA.

Risk Factor	aOR	95% CI	P-value
Exclusive bottle feeding	2.86	1.78 - 4.58	<0.001
Late complementary feeding (>8 mo)	2.34	1.42 - 3.86	0.002
Low maternal education (<secondary)	1.98	1.19 - 3.28	0.008
Low socioeconomic status	2.12	1.28 - 3.52	0.004
Recurrent infections (>3/year)	1.76	1.06 - 2.92	0.028

aOR = adjusted Odds Ratio; Model adjusted for age and sex

4-DISCUSSION

The research indicates a high level of IDA (42.5) in children below the age of five years in a large children referral center in Baghdad. This offers current hospital-based statistics on the scale of this population health issue in Iraq. The rates are comparable to the ones found in other developing nations and demonstrate the high levels of IDA among young Iraqi children (6).

Of special interest, the incidence of iron deficiency was found to explain 88.3 percent of all cases of anemia in our cohort, which proved as iron deficiency anemia (IDA) is still the leading etiology of anemia in this age group. This observation highlights the need to use iron-based nutritional interventions instead of generic anemia programs. The other 11.7% of anemic children probably contained other etiologies such as thalassemia trait, anemia of chronic disease or some other nutritional deficiencies and should be further explored in this population.

The close relationship between exclusive bottle feeding and IDA (aOR=2.86) identifies the paramount significance of breastfeeding promotion. Although the relative content of iron is very low, breast milk gives iron high bioavailability (approximately 50% absorption rate versus 10% in cow milk). On the contrary, milk-derived formulas can impair the absorption of iron and result in occult intestinal hemorrhage in newborns. Moreover, cow's milk is usually introduced early in Iraqi families, and this factor could also cause high levels of IDA (7).

This high-ranking correlation between late the use of complementary foods and IDA (aOR=2.34) portrays the relevance of timely dietary diversification. Store of iron supplied at birth is depleted by the age of 4-6 months of age and therefore there is a need to introduce iron-rich complementary foods. WHO suggests the use of complementary foods at the age of 6 months of age with continued breastfeeding. Late introduction causes a poor consumption of iron during this critical period of high growth and brain development (8).

The childhood nutrition is socially determined through the associations made with maternal education and socioeconomic status. The educated mothers have higher chances of engaging in proper infant feeding habits, seeking health care and adopting preventive mechanisms. The availability of varied and iron-rich foods and the provision of health care is restricted by socioeconomic factors, which makes the problem of malnutrition end in a cycle. These results go well with the evidence worldwide that poverty is associated with the problem of anemia in children (9).

A major strength of the study as a methodology is that the CRP is measured to correct ferritin interpretation in order to overcome the well-known weakness of ferritin as an acute-phase reactant. Children having acute infection (CRP >10 mg/L) were not included and among the rest of the participants, ferritin cut-offs were set according to CRP levels. This is a recommended approach of diagnosing IDA in the settings with infection burden as suggested by WHO. The overwhelming adverse effects of IDA on parameters (WAZ and HAZ) of growth illustrated in our study support the urgency of early intervention.

Study Limitations

There are a number of limitations of this study. First, its cross-sectional nature does not allow the causal relationship between the risk factors and IDA. Second, the sample at the hospital can fail to provide a fair depiction of the general pediatric population in Baghdad and can over-represent the prevalence of IDA because of the selection of sicker children who visited as a tertiary care unit. Third, nutritional evaluation was based on maternal recollection which can be affected by the error of recall. Fourth, we failed to conduct stool test on the presence of intestinal parasites, which is a major contributor of IDA among children. Fifth, the CRP was quantified, but other more sensitive inflammatory markers like a-1 acid glycoprotein (AGP) were not done. Lastly, not measured was infection of the Helicobacter pylori that could lead to iron malabsorption.

Nevertheless, hematological and biochemical characterization of IDA in a large group of young children in Baghdad has been well established in the study, though adequate correction of inflammation was made in the interpretation of ferritin.

CONCLUSION

The present research reveals that the prevalence of IDA in children under five years of age in Baghdad is high with the percentage of iron deficiency being a whopping 88.3 of all cases of anemia in children. The modifiable risk factors were feeding practices, maternal education, and socioeconomic factors. These results indicate that there is a great need to have comprehensive intervention programs with the following attributes: (1) exclusive breastfeeding 6 months and proper complementary feeding; (2) iron supplementation programs aimed at high-risk infants; (3) nutritional education programs aimed at mothers, especially those who are less educated; (4) food fortification

policies; and (5) addressing socioeconomic determinants of child health through intersectoral collaboration. Such iron-targeted and evidence-based programs should be implemented in order to decrease the impact of childhood anemia and its long-term effects on cognitive development and productivity in Iraq.

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