

RESEARCH ARTICLE

Iron deficiency among primary school children in Mosul City /Northern Iraq, a cross-section study

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Abstract

Objective: To determine the prevalence of iron deficiency among primary school students in an urban setting.

Method: The descriptive, cross-sectional study was conducted from January to April 2019 in Mosul, Iraq, after approval from the ethics review committee of the College of Medicine, Nineveh University, Iraq, and comprised students aged 6-12 years who were part of the 2018-19 academic year at 4 public primary schools located along the two banks of Tigris River. Serum ferritin was measured in all the participants. Data was analysed using Minitab 20.

Results: Of the 827 subjects, 439(53%) were girls and 388(47%) were boys. The overall mean age was 8.5 ± 0.057 years, with 558(67.5%) aged <10 years. The mean serum ferritin level was 8.05 ± 6.43 ng/ml, and 173(20.92%) subjects were found to be iron-deficient. Among the iron-deficient students, 87(50.29%) had iron deficiency anaemia and 86(49.71%) had non-anaemic iron deficiency. Age and gender were significantly different between students with anaemic and non-anaemic iron deficiency ($p < 0.05$). Within boys, significant difference was also noted in terms of body mass index-for-age values ($p < 0.05$).

Conclusion: One-fifth of the students were found to have iron deficiency. Plans to control iron deficiency among young children are essential.

Key Words: Anaemia, Iron-Deficiency, Ferritins

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Introduction

Iron deficiency is the most common nutritional deficiency in both developed and developing countries, affecting >30% of the world's population.¹ Iron deficiency is common in children²⁻⁶. Varying prevalence of iron deficiency among children has been described.^{7,8} The prevalence of iron deficiency in Iraqi children aged from 6 months to 14 years ranged 50-70%.⁹ Iron deficiency anaemia (IDA) was the cause of anaemia in 94.01% of 234 anaemic children in Karbala, Iraq.¹⁰

Anaemia has adverse effects on the growth and development of children, while IDA affects children's cognitive, motor, socio-emotional, and neurophysiological development.¹¹

Ferritin is a good reflection of total iron storage, and is also the first laboratory index to decline with iron deficiency. Cut-off of serum ferritin (SF) <12 ng/ml defines iron deficiency^{1,12-14}, and its value may increase with infectious or inflammatory conditions because ferritin is also an acute-phase reactant.²) Haematocrit (Hct%) <35% in those aged 6-12 years in both genders signifies

anaemia.¹

The current study was planned to determine the prevalence of iron deficiency among public primary school children in an Iraqi city.

Subjects and Methods

The descriptive, cross-sectional study was conducted from January to April 2019 in Mosul, Iraq, after approval from the ethics review committee of the College of Medicine, Nineveh University, Iraq, and comprised students aged 6-12 years who were part of the 2018-19 academic year at 4 public primary schools located along the two banks of Tigris River. The schools, 2 each for boys and girls, were randomly selected from among the 638 public primary schools in Mosul city; 298 on the right bank, and 340 on the left. Multistage probability sampling technique was used which was suitable for random selection of schools. Geographical stratification was followed by gender stratification to select boys and girls' schools. Lot randomisation was performed to select schools on each side of the river. The four selected schools were Om Al-Darda (girls) and Al-Makarem (boys) on the left bank, and Alshaheed Salem Hussain (girls) and Sa'ad Ibn Abi Waqqas (boys) on the right bank of the river. Cluster sampling was then used to select one class from each grade of the selected school. All children in such classes were invited to participate after obtaining written parental consent.

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The sample size was estimated using the equation for prevalence studies: $n = D [Z\alpha/22 * p*(1-p) / MOE2]^{15}$. The sample size was inflated by 10% to cover got the presumed non-response rate.

After permission from the administration of each participating school as well as from the committee of health research of Nineveh Directorate of Health, a blood sample was obtained from each student for the estimation of SF, Hct, and C-reactive protein (CRP). As serum ferritin is one of the acute-phase reactants and to avoid documenting a false high SF value, a concomitant CRP was also analysed. Children with CRP ≥ 6 were excluded.¹⁶

SF estimation was done using VIDAS Ferritin (Biomerieux, France) kit based on enzyme-linked fluorescent assay (ELFA) technique. CRP was estimated using slide latex agglutination test (BioSystems S.A. Costa Brava, Barcelona, Spain).¹⁶

Weight of the subjects was measured using weighing scales (Seca, Germany) that were calibrated to 0.1kg. The measurement was done with minimum clothing, and the value was rounded off to the nearest 100g. Height was measured using a stadiometer (Seca 217, Germany), having a measuring range of 20-205cm, with digit counter readings precise to 1mm. The measurement was recorded to the last completed 0.1cm. Body mass index (BMI) was calculated as per the global standard in kg/m². Measurements for height, weight and BMI were plotted on age- and gender-appropriate growth charts¹⁷. Demographic data of the subjects' families was recorded using school records.

Data was coded and analysed using Microsoft Excel 2010 and Minitab 20. Student's t-test was employed in comparing measurable parameters. Analysis of variance (ANOVA) F-test with Tukey's pair-wise comparisons was used evaluating mean SF differences among the age groups. Chi-square test of independence was used for categorical parameters. $P \leq 0.05$ was considered statistically significant.

Results

827 pupils participated in the study and constituted 2.51 % of the total public primary schools' pupils (330 045) Of the 827 subjects, 439(53%) were girls and 388(47%) were boys. The overall mean age was 8.5 ± 0.057 years, with 558(67.5%) aged <10 years. The mean serum ferritin level was 8.05 ± 6.43 ng/ml, and 173(20.92%) subjects were found to iron-deficient. There was no significant association of iron deficiency with age, gender, and parental education ($p < 0.05$). Children of schools on the

Table-1: Demographic characteristics.

Items	No.[n = 827]	Serum ferritin (ng/ml)		p-value
		Mean	SD	
Age groups				
6 - < 7	106	25.95	18.12	0.716
7 - < 8	164	28.08	17.81	
8 - < 9	177	26.71	19.81	
9 - < 10	111	27.03	21.45	
10 - < 11	139	26.46	20.83	
11 - < 12	130	24.13	24.49	
BMI percentiles for age in boys (n = 388)				
< 5th	15	22.0 B	9.32	0.029
5th – 95th	337	24.9 B	15.90	
> 95th	36	32.6 A	28.76	
BMI percentiles for age in girls (n = 439)				
< 5th	26	28.9	19.30	0.704
5th – 95th	372	27.2	22.74	
> 95th	41	26.7	24.89	
Paternal education level				
Illiterate	39	27.5	17.14	0.085
Primary school	512	26.3	21.68	
Intermediate schools	200	27.6	19.38	
University and post graduate	76	24.3	24.3	
Maternal education level				
Illiterate	71	30.4	20.24	0.152
Primary school	549	26.5	21.82	
Intermediate and secondary schools	182	24.5	15.06	
University and post graduate		25	30.2	
Site of the school				
Left bank of Mosul city	400	24.3	17.20	0.002
Right bank of Mosul city	427	28.6	22.80	

SD: Standard deviation, BMI: Body mass index.

One-way ANOVA-test with Tukey's Pair wise comparisons was used.

Means that do not share a letter (A, B) are significantly different.

Table-2: Comparison between iron-deficient and iron-sufficient groups.

Parameters	Iron deficiency Serum ferritin <12 ng/ml [n = 173]		Iron sufficient Serum ferritin ≥12 ng/ml[n = 654]		p-value
	No.	%	No.	%	
Age groups (years)					
6 - < 7	23	21.70	83	78.30	0.417
7 - < 8	24	14.63	140	85.37	
8 - < 9	40	22.60	137	77.40	
9 - < 10	26	23.42	85	76.58	
10 - < 11	31	22.30	108	77.70	
11 - < 12	29	22.31	101	77.69	
Gender					
Boys [n = 388]	75	19.33	313	80.67	0.291
Girls [n = 439]	98	22.32	150	77.68	
BMI percentiles for age in boys (n = 388)					
< 5th	3	20.00	12	80.00	0.423

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5th – 95th	68	20.20	269	79.80	
> 95th	4	11.10	32	88.90	
BMI percentiles for age in girls (n = 439)					
< 5th	2	7.70	24	92.30	0.113
5th – 95th	84	22.60	288	77.40	
> 95th	12	29.30	29	70.70	
Paternal education level					
Illiterate	5	12.80	34	87.20	0.128
Primary school	104	20.30	408	79.70	
Intermediate schools	41	20.50	159	79.50	
University and post graduate	23	30.30	53	69.70	
Maternal education level					
Illiterate	14	19.72	57	80.28	0.736
Primary school	110	20.00	439	80.00	
Intermediate schools	43	23.60	139	76.40	
University and post graduate	6	24.00	19	76.00	

BMI: Body mass index.

Table-3: Comparison between iron-deficient students with and without anaemia.

Parameters	Pupils with iron deficiency				p-value
	With anaemia		Without Anaemia		
	PCV< 35% [n = 87]		PCV ≥ 35% [n = 86]		
	No.	%	No.	%	
Age groups (years)					
6 - < 7	17	73.91	6	26.09	0.001
7 - < 8	16	66.67	8	33.33	
8 - < 9	24	60.00	16	40.00	
9 - < 10	13	50.00	13	50.00	
10 - < 11	9	29.00	22	71.00	
11 - < 12	8	27.59	21	72.41	
Gender					
Boys [n = 388]	45	60.00	30	40.00	0.025
Girls [n = 439]	42	42.86	56	58.14	
Percentiles (BMI-for-age BOYS) n = 75					
< 5th	0	0.00	3	100.00	0.028
5th – 95th	44	64.70	24	35.3	
> 95th	1	25.00	3	75.00	
Percentiles (BMI-for-age GIRLS) n = 98					
< 5th	1	50.00	1	50.00	**
5th – 95th	36	42.50	48	57.50	
> 95th	5	41.67	7	58.33	
Paternal education level					
Illiterate	3	60.00	2	40.00	0.920
Primary school	51	49.00	53	51.00	
Intermediate schools	22	53.66	19	46.34	
University +	11	47.83	12	52.17	
Maternal education level					
Illiterate	7	50.00	7	50.00	0.847
Primary school	56	50.90	54	49.10	
Intermediate schools	22	51.16	21	48.84	
Unversity +	2	33.33	4	66.67	

PCV: Packed cell volume, BMI: Body mass index.

** Invalid Chi-square test because small frequency of two expected cells.

right bank of the river had significantly higher levels of

serum ferritin 28.6 ± 22.80 ng/ml than those on the left bank 24.3 ± 17.20 ng/ml ($p < 0.05$). Also, boys with body mass index (BMI) >95th percentile for age had significantly higher serum ferritin levels

(32.6 ± 28.76 ng/ml) than the rest of the boys, but no such difference was found in serum ferritin in association with BMI for girls (Table 1). Children of schools on the right bank of the river had significantly higher levels of serum ferritin 28.6 ± 22.80 ng/ml than those in the left bank (24.3 ± 17.20 ng/ml).

There were no significant differences when comparing iron-deficient group with iron-sufficient group (Table 2). Among the iron-deficient students, 87(50.29%) had iron deficiency anaemia and 86(49.71%) had non-anaemic iron deficiency. Age and gender were significantly different between students with anaemic and non-anaemic iron deficiency ($p < 0.05$). Within boys, significant difference was also noted in terms of BMI-for-age values (Table 3).

Discussion

Iron deficiency, with or without IDA, affects populations across the world.¹³ Approximately, 20% of the current students in Mosul city were found to have iron deficiency, which is in line with earlier findings.^{3,4,18} In two studies from Saudi Arabia and Pakistan, the prevalence of iron deficiency in children ranged 35-37%.^{18,19}

There was no significant association of SF level with either age or gender in the current study. There was no significant difference in SF level with respect to gender in other studies.²⁰

The area on the right bank of Tigris River in Mosul city is generally inhabited by people having low socioeconomic status (SES),²¹ and the consumption of home-made food might explain the significantly higher ($p = 0.002$) SF level (28.6 ± 22.80 ng/ml) than those living on the left bank of the river (24.3 ± 17.20 ng/ml).

Boys having BMI above the 95th percentile for age had significantly higher SF level than the rest, while no such difference was found among girls. In the eastern culture, boys usually receive more attention and care than girls.^{22, 23}

There was no significant differences between iron-deficient and iron-sufficient groups in relation to BMI percentiles in both genders in the current study. Nevertheless, iron-deficient boys were more frequently anaemic than girls, probably because boys have less

restriction on buying iron-deficient junk food from the local markets. Iron-deficient boys with normal BMI were more frequently anaemic, suggesting that iron deficiency was more severe than is often believed, or a small sample size of the compared groups may have been the reason for the finding. Boys with extreme BMI values were more iron-deficient than anaemic that is more difficult to discover without SF estimation as iron deficiency manifests with few visible symptoms.⁶ This emphasises the need for nutritional education regarding iron supplementation.

Among the studied 173 iron-deficient students, non-anaemic iron deficiency (NAID) was as frequent as IDA in children, with a ratio of about 1:1. In Africa, studies presented comparable results.¹³ The IDA: NAID ratio was 2:1 or higher in other studies,¹⁸ denoting that iron deficiency in primary school children of Mosul city was severe, and that the studied children had passed to the late degree of iron deficiency without being noticed.

Among the 173 iron-deficient subjects, there was a significant difference in age ($p=0.001$) while comparing IDA to those with NAID. IDA was more frequent than NAID in children aged 6-9 years than in the older group, highlighting the importance of giving more nutritional and educational consideration to this vulnerable age group. A study found that the prevalence of anaemia was significantly higher among children aged ≤ 10 years than children aged > 10 years.⁷

Although several studies have shown significant relationship between low levels of mothers' education and anaemia in children,²⁴⁻²⁶ parental education did not have significant effect on the difference of SF level.

It is important to have a proper way of preventing IDA by utilising the World Health Organisation (WHO) recommendations. After 4-6 months of age, supplemental iron is needed by full-term infants, and use of iron-containing foods should be initiated. At any age, after the introduction of solid foods, iron-rich or fortified foods should be encouraged. In regions where iron deficiency is widespread, its prevention may necessitate iron therapy.⁵

In the light of the current findings, it is recommended that health education and awareness plans must be initiated. Further studies are needed to evaluate the causes of iron deficiency among primary school children.

Conclusion

One-fifth of the students were found to have iron deficiency. Plans to control iron deficiency among young children are essential.

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