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ORIGINAL ARTICLE

Prevalence of iron deficiency in infants aged 6–12 months and its relationship with socioeconomic level and iron prophylaxis use

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ABSTRACT

Objective: Iron deficiency anemia is a widespread public health issue globally, with adverse effects across multiple systems. However, it can be prevented through simple recommendations and prophylactic supplementation. This study aimed to assess the prevalence of iron deficiency anemia, the impact of prophylactic iron supplementation, and the effect of socioeconomic status on the development of iron deficiency and anemia.

Material and Methods: The study encompassed 198 children aged 6–12 months (103 male and 95 female). Hematological parameters were evaluated in relation to the history of nutrition, prophylactic iron supplementation, and the families' socioeconomic status.

Results: The prevalence of iron deficiency was 55.4%, while iron deficiency anemia was observed in 17.9% of cases. Iron supplementation positively influenced hemoglobin and iron levels. Infants fed with formula exhibited higher levels of iron, serum ferritin, and transferrin saturation compared to those who were breastfed. Higher levels of iron, ferritin, and transferrin saturation were significantly associated with a higher monthly income. A greater proportion of mothers with only primary school education was observed in the group with iron deficiency anemia.

Conclusion: Iron deficiency remains highly prevalent in our country. Key strategies for addressing iron deficiency should focus on nutritional improvement and maternal education. Iron supplementation is also advisable.

Keywords: Anemia, iron deficiency, iron supplementation, socioeconomic condition.

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INTRODUCTION

Iron deficiency anemia (IDA) is a significant global health issue, particularly in developing countries. The World Health Organization (WHO) reported that in 2019, nearly 30% of women aged 15–49 years and 39.8% of children aged 6–59 months were affected by anemia. Anemia is most prevalent among children aged 6–59 months.[1] Recent studies indicate that the prevalence of anemia in children ranges from 7% to 24% in Türkiye.[2–4]

Nutritional deficiency due to a diet low in iron is the primary cause of iron deficiency (ID). Other risk factors for ID include low birth weight, periods of rapid growth such as infancy, early introduction of cow's milk and solid foods, breastfeeding beyond six months without iron supplementation, the mother's low education level, and low socioeconomic status.[5,6] Iron deficiency anemia can impact various systems (immune, gastrointestinal, cardiovascular), growth and development, and behavioral/mental functions.[5]

The most effective prevention strategy for anemia is prophylactic iron therapy. Research on iron prophylaxis suggests that iron supplementation should continue for eight months.[7] Organizations such as the WHO, United Nations International Children's Emergency Fund (UNICEF), Micronutrient Forum, and the International Nutritional Anemia Consultative Group (INACG) recommend routine iron supplementation for infants starting at four months of age in countries where the prevalence of IDA exceeds 5%.[8] Against this backdrop, the "Iron Like Turkey Project" was initiated across Türkiye in 2004 by the Ministry of Health, offering free iron supplements for prophylactic use to all infants aged 4–12 months and recommending iron treatment for anemic infants aged 13–24 months.[9]

This study aimed to assess the prevalence of IDA, the impact of prophylactic iron recommended during infancy, and the influence of the family's socioeconomic status on the development of ID and anemia in children.

MATERIAL AND METHODS

This prospective study included 198 pediatric patients aged between 6 and 12 months who were admitted to the University of Health Sciences, Zeynep Kamil Maternity, and Children's Hospital outpatient clinics from July 2014 to February 2015. Exclusion criteria were premature infants, babies with low birth weight, those with chronic diseases that could lead to anemia, patients with signs of infectious diseases, and children whose parents did not consent to participate.

Approval for the study was granted by the local ethics committee of the University of Health Sciences, Zeynep Kamil Maternity, and Children's Diseases Hospital (date: 04.07.2014, number: 107). Written informed consent was obtained from all participants' parents. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

A face-to-face survey was conducted with the families, gathering general information about the child (date of birth, gender, birth weight, current weight, and height), maternal details (education level, anemia treatment during pregnancy, and income level), and the child's nutrition and iron prophylaxis usage from 0 to 6 months.

Blood samples were collected in the morning after at least four hours of fasting and in the absence of clinical infection signs, to assess complete blood count and biochemical parameters.

The parameters evaluated included Hemoglobin (Hb), Hematocrit (Hct), Red Blood Cell (RBC) count, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin Concentration (MCHC), Mean Corpuscular Hemoglobin (MCH), Red Cell Distribution Width (RDW), serum iron, Total Iron-Binding Capacity (TIBC), serum ferritin, and Transferrin Saturation (TS). Serum transferrin saturation was calculated as (%) by dividing the serum iron level by TIBC values.

The limit values adopted for this study, based on WHO recommendations, were 55 µg/dL for serum iron, 15% for transferrin saturation, and 10 µg/L for ferritin level.[10] Iron deficiency was determined when two or more of these parameters were below the limit values. Cases with ID and a hemoglobin value below 10.5 g/dL were classified as IDA.[11]

Patients' height and weight were classified using the percentile curves prepared for Turkish children by Olcay Neyzi et al.[12] Nutritional status from 0 to 6 months was scored with 100 for exclusive breastfeeding, 50 for mixed feeding, and 0 for exclusive formula feeding. This scale helped categorize the nutritional history of the cases on a scale from 0 to 100.

Statistical Analysis

The SPSS software (Version 15.0, IBM Company, SPSS Inc.) and MİNİTAB 17 were utilized for statistical analysis. Quantitative variables were presented as mean (±standard deviation) or median values, while qualitative variables were expressed as percentages. The Chi-square and Fisher's exact tests were employed for the analysis of categorical variables when comparing groups. For comparing means between two groups, the Student's T-test and Mann-Whitney U test were used; for averages among more than two groups, the Kruskal Wallis test (followed by Dunn's test for pairwise comparisons) and ANOVA (followed by post-hoc Bonferroni test for pairwise comparisons) were applied; the Pearson correlation test was also utilized for assessing correlations. The results were considered with a 95% confidence interval, with a significance level set at $p<0.05$.

RESULTS

In this study, 198 children aged between 6 and 12 months who visited the pediatric outpatient clinics of İstanbul Zeynep Kamil Women's and Children's Diseases Training and Research Hospital from July 2014 to February 2015 were evaluated. Of these, 103 (52%) were boys and 95 (48%) were girls, with a mean age of 8.85 (±1.96) months.

The mothers' education levels were distributed as follows: 28.8% (n=57) had primary school education, 27.3% (n=54) had high school education, 21.2% (n=42) had secondary school education, and 17.7% (n=35) were university graduates. Nine mothers (4.5%) were illiterate, and the educational status of one mother (0.5%) was unspecified.

Regarding birth weights, 28.3% (n=56) of the infants weighed between 2500–3000 g, 43.4% (n=86) weighed between 3000–3500 g, 22.2% (n=44) weighed between 3500–4000 g, and 6.1% (n=12) weighed between 4000–4500 g.

Table 1: Iron, TIBC, ferritin, and TS levels according to the characteristics of the patients

	Iron level			TIBC			Ferritin			TS		
	Mean	SD	p	Mean	SD	p	Mean	SD	p	Mean	SD	p
Gender			0.055			0.255			0.115			**0.038***
Male	47.74	19.93		358.08	59.31		25.14	21.15		13.77	6.35	
Female	55.22	24.91		348.38	59.19		32.89	32.17		16.38	7.99	
Breast milk			**0.029***			0.561			**0.011***			**0.022***
No	59.80	27.66		348.59	59.40		37.52	30.79		17.37	8.01	
Yes	49.10	20.75		354.69	59.40		26.54	25.78		14.40	6.98	
Iron use			**0.014***			**0.015***			0.467			0.310
Never	46.06	20.94		346.06	51.94		30.42	32.15		13.19	5.59	
Irregularly	46.43	19.53		340.61	63.88		29.46	23.98		14.18	6.22	
Regularly	55.54	24.30		363.27	55.74		28.22	28.57		15.90	8.08	
Anemia in pregnancy			0.137			**0.0001*****			0.072			**0.012***
No	53.98	23.77		338.18	56.05		31.02	27.82		16.49	7.84	
Yes	48.90	21.53		367.57	58.98		26.87	26.61		13.66	6.47	
Education level			0.061			0.051			0.070			**0.036***
Illiterate	44.56	22.25		322.00	62.24		39.38	45.42		14.19	7.24	
Primary	49.68	25.71		357.37	70.02		22.63	19.29		14.69	8.46	
Secondary	47.29	18.12		373.66	50.95		25.77	24.95		13.00	5.45	
High	52.44	22.06		346.06	53.33		35.12	33.94		15.46	7.22	
University	59.29	22.73		342.74	52.56		30.72	22.40		17.63	6.83	
Monthly income			**0.0005*****			**0.003****			**0.0001*****			**0.0001*****
<1000 TL	48.97	25.94		379.72	71.79		20.63	28.52		13.70	8.42	
1000–3000 TL	48.67	20.87		349.73	53.87		29.50	27.28		14.20	6.35	
>3000 TL	63.26	21.69		335.91	53.08		36.01	23.48		19.36	7.53	

TIBC: Total iron-binding capacity; TS: Transferrin saturation; SD: Standard deviation; *: P<0.05; **: P<0.005; ***: P<0.0005.

The nutritional status of the cases, scored out of 100, averaged 81.4±28.9. No statistically significant association was found between the mothers' education levels and the duration or rate of breastfeeding, or the feeding scale (p>0.05).

Regarding iron supplementation, 8.6% (n=17) of the children never used iron supplements, 36.4% (n=72) used iron irregularly, and 55.1% (n=109) used iron regularly. There was no statistically significant correlation between the mothers' education levels and iron usage (p>0.05).

While 48% (n=95) of the mothers did not experience anemia during pregnancy, 52% (n=103) did. The family's monthly income was below 1000 Turkish Liras (TL) for 20.2% (n=40), between 1000–3000 TL for 62.1% (n=123), and over 3000 TL for 17.7% (n=35).

The mean and standard deviations for Hb, Hct, RBC, MCV, MCH, MCHC, and RDW values were 11.15±1.05 g/dl, 33.68±2.74%, 4.39±0.39 M/Ul, 76.48±5.31 fL, 25.23±2.09 pg, 33.32±0.98 g/dl, and 15.99±1.76, respectively.

No significant effect of gender, presence or absence of anemia during pregnancy, and monthly income on the mean Hb values was observed (p=0.086, p=0.123, p=0.364, respectively). Significant effects of nutrition, use of iron prophylaxis, and education were found on the mean Hb values. The mean Hb level was 11.3 g/dl for regular iron prophylaxis users, 11.2 g/dl for irregular users, and 10.6 g/dl for non-users (p=0.023). The mean Hb value was significantly higher in the formula-fed group compared to the breastfed group (p=0.008). Considering education levels, the mean Hb value was 11.2 g/dl for children of university graduate mothers, 11.03 g/dl for high school graduates, 11.07 g/dl for secondary school graduates, 10.53 g/dl for primary school graduates, and 11.4 g/dl for children of illiterate mothers (p=0.004).

No significant correlation was found between serum iron level and gender, maternal anemia history during pregnancy, and maternal education level (p=0.052, p=0.856, p=0.964). The mean serum iron level was 58.7 µg/dl for regular iron prophylaxis users, 48.6 µg/dl for irregular users, and 48.1 µg/dl for non-users. The mean iron level for monthly incomes of 0–1000 TL was 47.8 µg/dl, for 1000–3000 TL was 46.1 µg/dl, and for over 3000 TL was 61.5 µg/dl. Significant differences were found between serum iron levels, iron prophylaxis usage, and monthly income (p=0.006 for both).

The mean iron level was 51.35±22.72 (median: 48, range: 11–150), mean TIBC was 353.41±59.30 (range: 178–539), mean ferritin was 28.86±27.20 (median: 20, range: 1–198), and mean TS was 15.03±7.29 (median: 13.30, range: 2.20–47.30).

No statistically significant difference in TIBC was found between those who received breast milk and those who did not (p>0.05). Iron, ferritin, and TS levels were significantly lower in those who received breast milk compared to those who did not (p<0.05). The impacts of various factors on iron, TIBC, ferritin, and TS levels are summarized in Table 1.

Iron deficiency was identified in 55.4% (n=108) of the patients, and IDA in 17.9% (n=35). The values for 43.9% (n=87) of the patients were within normal ranges. Three patients were excluded from this classification due to missing parameters. There was no statistically significant difference between the normal, ID, and IDA groups in terms of gender, breast milk use, and iron use (p>0.05). In the IDA group, the rate of maternal anemia during pregnancy, the rate of mothers who were primary school graduates, and those with monthly incomes below 1000 TL were significantly higher than in the other two groups (Table 2).

DISCUSSION

Iron deficiency is the most common nutritional deficiency globally.[13] Its prevalence varies by age, gender, socioeconomic status, and geographical regions but is notably higher in developing countries.[14]

The World Health Organization estimated that in 2019, the global prevalence of anemia in children aged 6–59 months was 39.8%, affecting nearly 269 million children. The highest prevalence of anemia in children under five was observed in the African Region at 60.2%. Since 2000, there has been a gradual decrease in the global prevalence of anemia in children under five, from 48.0% to 39.8%.[1] In various studies across different regions of Türkiye, the prevalence of iron deficiency in children has been reported as high as 28.7–30%, while anemia prevalence ranged from 7.3% to 24.3%.[2–4]

In our study, which included 198 cases from İstanbul aged between 6 and 12 months, iron deficiency was identified in 55.4% of the children, and iron deficiency anemia in 17.9%. Differences in the frequency of iron deficiency and anemia across studies can be attributed to variations in age groups, geographical regions, socioeconomic status, and the definitions of anemia used. However, consistent with numerous studies, the prevalence of iron deficiency remains high.

Iron supplementation is frequently used to control ID in developing countries. It is applied by giving high doses of micronutrients to a specific target group (pregnant women, infants).[15] In countries where the prevalence of anemia is more than 40% or where iron-enriched foods are unavailable, 2 mg/kg/day iron supplementation is recommended by WHO for all children aged 6–23 months.[8]

In the study conducted by Vatandaş et al.[16] with 117 cases in 2007, the average Hg, MCV, RDW, and ferritin values were significantly higher in the group given 1 mg/kg/day iron prophylaxis starting from the fourth month compared to the control group. Their study determined ID or IDA in 22.2% of the prophylaxis group and 55.5% of the control group.

In a study conducted in Brazil in 2013 to demonstrate the effectiveness of iron supplementation in preventing anemia seen in infancy, the patients were divided into three groups. The first group received 25 mg elemental iron once a week, the second group received 12.5 mg elemental iron daily, and the third group received no iron supplementation. Iron deficiency and IDA were significantly lower in the first two groups receiving iron supplements.[17]

In our study, the use of iron prophylaxis was questioned retrospectively. A significant relationship was found between iron prophylaxis and Hg level. The mean Hg value of those who used iron prophylaxis regularly was 11.3 g/dl, while the mean Hg level of those who never used it was 10.6 g/dl.

Iron levels were also higher in those who received iron supplements regularly compared to the other group. The mean serum iron level of the cases who used the recommended iron prophylaxis regularly was 58.7 µg/dl, the mean serum iron level of the patients who used it irregularly was 48.6 µg/dl, and the mean serum iron level of the patients who never used it was 48.1 µg/dl.

There was no statistically significant difference in iron usage between normal, ID, and IDA groups. Although iron supplementation increases iron and Hg levels, it is thought to be due to its inability to prevent ID because it cannot meet the increased need seen in children.

Although the iron content of breast milk is not very high, the absorption of available iron is very good. Many studies show that breastfed babies will not have IDA for the first six months. In the study by Duncan et al.[18] IDA was not observed in any of the 33 babies who were exclusively breastfed for six months. Also, in the study by Pisacane et al.[19] in Italy, although anemia was not observed in babies exclusively breastfed for seven months, a decrease in hemoglobin was detected in most of those who started complementary feeding before the seventh month. They thought exclusive breastfeeding for the first six months would protect against IDA. Although in our study, there was no significant difference between those fed with breast milk or formula in terms of the development of ID and IDA, iron and ferritin levels were lower in those who were breastfed than those who were not. Similar to our study, studies show an increase in the risk of iron insufficiency in the breastfed group.[2,20] As the amount of iron in breast milk depends on the mother's nutritional status and Hb level, we did not evaluate the current anemia status of the mothers in our study.

WHO and UNICEF recommend exclusive breastfeeding for up to 6 months and continued breastfeeding for at least two years. Appropriate and timely initiation (at six months of age) of complementary feeding is necessary to prevent nutritional deficiencies.[21]

In a study by Male et al.[6] with 488 cases in 11 different European regions, a significant relationship was found between the educational status of the mother and the development of IDA. While the incidence of ID in children of university graduate mothers is 6.8%, the incidence of IDA is 0%. This rate is higher in children of mothers with lower education levels. In the study by Soylu et al.,[22] 166 cases aged between 5 and 36 months were evaluated, and ID was detected in 72.3% of the children. The cases were divided into four different

Table 2: Characteristics of the patients in the iron deficiency, iron deficiency anemia, and normal groups

	Normal (n=87)		ID (n=73)		IDA (n=35)		
	n	%	n	%	n	%	p
Gender							0.106
Male	39	44.8	39	53.4	23	65.7	
Female	48	55.2	34	46.6	12	34.3	
Weight percentile							–
<3 p	3	3.5	1	1.4	3	8.6	
3–10 p	5	5.9	9	12.7	2	5.7	
10–25 p	17	20.0	11	15.5	7	20.0	
25–50 p	19	22.4	16	22.5	11	31.4	
50–75 p	22	25.9	18	25.4	9	25.7	
75–90 p	7	8.2	13	18.3	3	8.6	
90–97 p	11	12.9	2	2.8	0	0.0	
>97 p	1	1.2	1	1.4	0	0.0	
Height percentile							–
<3 p	4	5.0	4	5.9	1	3.0	
3–10 p	8	10.0	8	11.8	3	9.1	
10–25 p	11	13.8	9	13.2	4	12.1	
25–50 p	20	25.0	13	19.1	13	39.4	
50–75 p	19	23.8	19	27.9	7	21.2	
75–90 p	11	13.8	7	10.3	4	12.1	
90–97 p	5	6.3	8	11.8	1	3.0	
>97 p	2	2.5	0	0.0	0	0.0	
Breastfeeding							0.090
No	23	26.4	15	20.5	3	8.6	
Yes	64	73.6	58	79.5	32	91.4	
Iron use							0.245
Never	4	4.6	7	9.6	6	17.1	
Irregularly	34	39.1	25	34.2	13	37.1	
Regularly	49	56.3	41	56.2	16	45.7	
Anemia in pregnancy							**0.013***
No	47	54.0	38	52.1	9	25.7	
Yes	40	46.0	25	47.9	26	74.3	
Education level							**0.0001****
Illiterate	3	3.4	5	6.9	1	2.9	
Primary	20	23.0	16	22.2	21	60.0	
Secondary	14	16.1	19	26.4	8	22.9	
High	27	31.0	20	27.8	5	14.3	
University	23	26.4	12	16.7	0	0.0	
Monthly income							**0.0001****
<1000 TL	11	12.6	13	17.8	16	45.7	
1000–3000 TL	50	57.5	52	71.2	18	51.4	
>3000 TL	26	29.9	8	11.0	1	2.9	

ID: Iron deficiency; IDA: Iron deficiency anemia; *: P<0.05; **: P<0.0005.

socioeconomic classes, but no relationship was found between the development of ID and gender, nutrition, and socioeconomic level.

In our study, the rate of those whose mothers were primary school graduates was statistically significantly higher in the IDA group. In addition, the proportion of those with a monthly income of less than 1000 TL was higher in the IDA group. In the group with a monthly income of 3,000 TL and above, iron, TIBC, ferritin, and TS levels were found to be significantly higher compared to the other groups. These findings suggest that the mother's high education and income levels protect against ID.

Our study is not a community-based study and reflects the local data of our hospital, so the results could not be generalized to the population. Since the hemoglobin level of the mothers and their current anemia status are unknown, it is not known whether this situation reflects the results of breastfed children.

CONCLUSION

Considering all these findings, it is observed that IDA still poses a serious public health problem for Türkiye. Children's use of iron prophylaxis should be supported, and mothers' knowledge level should be increased. Children should be evaluated for signs of ID at every doctor's examination, and hematological parameters should be reviewed between 9–12 months in places with high prevalence, as in our country.

Statement

Ethics Committee Approval: The Zeynep Kamil Maternity and Children's Diseases Health Training and Research Center Clinical Research Ethics Committee granted approval for this study (date: 04.07.2014, number: 107).

Author Contributions: Concept – MİN, ZAS; Design – MİN, ZAS; Supervision – MİN, ZAS; Resource – MİN, ZAS; Materials – MİN, ZAS; Data Collection and/or Processing – MİN, ZAS; Analysis and/or Interpretation – MİN, ZAS; Literature Search – MİN, ZAS; Writing – MİN, ZAS; Critical Reviews – ZAS.

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