**Journal of Pioneering Medical Sciences**
Received: January 24, 2026 | Accepted: May 31, 2026 | Published: June 05, 2026
Volume 15, Issue 05, Pages 01-10

*DOI https://doi.org/10.47310/jpms2026150501*




# Assessment of Knowledge and Feeding Performance of Caregivers Regarding Iron Deficiency Anaemia Among Children Aged 12–59 Months: A Cross-Sectional Study in Erbil, Iraq

**Amanj Yassin Hamad Amin[1*] and Nazar Ramadhan Othman[2]**
[1,2]Department of Nursing, Hawler Medical University, Kurdistan Region, Iraq

Author Designation: [1]Assistant Lecturer, [2]Assistant Professor

*Corresponding author: Amanj Yassin Hamad Amin (e-mail: amanj.amin@hmu.edu.krd).

©2026 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0

**Abstract:** **Background:** Iron deficiency anaemia (IDA) is the most common nutritional deficiency among children under five years globally. Caregiver knowledge and feeding practices are critical modifiable determinants of childhood IDA, yet data from the Kurdistan Region of Iraq remain limited. **Objectives:** To assess caregiver knowledge and feeding performance regarding IDA and examine their association with children's haematological parameters. **Methods:** A cross-sectional descriptive study was conducted among 180 caregiver–child pairs (children aged 12–59 months with moderate IDA) at Rapareen Paediatric Teaching Hospital, Erbil, from February to June 2025. Caregiver knowledge and feeding performance were assessed using purpose-developed, internally validated instruments. Haemoglobin, serum ferritin, and serum iron were measured. Spearman's correlation was used to assess associations. **Results:** Poor caregiver knowledge (71.1%, n = 128) and poor feeding performance (71.7%, n = 129) predominated, with mean scores of 11.81±2.80 and 5.71±5.49, respectively. Only 0.6% (n = 1) of caregivers demonstrated good knowledge, and none achieved good feeding performance. Significant IDA risk factors included family history of anaemia (27.8%), intestinal parasitic infections (26.7%), recurrent diarrhoea (24.4%), and pica (24.4%) (all $p<0.001$). No statistically significant correlations were found between caregiver knowledge or feeding performance and haematological parameters (all $p>0.05$ after Bonferroni correction). One unadjusted association between feeding performance and serum iron in the nutritional education subgroup ($\rho = -0.254$, $p = 0.049$) did not survive multiple-comparison correction and is considered exploratory. **Conclusions:** Caregiver knowledge and feeding performance regarding IDA are critically inadequate. Structured, skill-based nutritional education programmes should be integrated into routine paediatric care to improve feeding practices and reduce IDA burden.

**Key Words:** Iron Deficiency Anemia, Caregivers, Feeding Behavior, Child, Preschool, Cross-Sectional Studies

## INTRODUCTION

Iron deficiency anaemia (IDA) is the most prevalent nutritional deficiency worldwide, disproportionately affecting young children in low- and middle-income countries (LMICs). Globally, IDA affects an estimated 1.6 billion individuals, and children aged 12–59 months represent one of the highest-risk populations, owing to rapid growth, expanded blood volume, increased erythropoietic demand, and depletion of prenatal iron stores [1,2]. IDA in this age group is associated with impaired neurodevelopment, behavioural disturbances, and reduced cognitive performance — sequelae that may persist even after haematological recovery [3,4].

In Iraq, childhood anaemia prevalence ranges from 30% to 45% among children under five [5,6]. In the Kurdistan Region, including Erbil Governorate, persistently high IDA rates have been documented despite improvements in healthcare access [5,7]. Regional dietary patterns compound this burden: cereal-based diets high in phytates and the culturally widespread habit of serving tea with meals introduce potent inhibitors of non-haem iron absorption [1,8].

Caregiver knowledge regarding IDA — encompassing recognition of iron-rich foods, absorption enhancers, and absorption inhibitors — is one of the most important modifiable determinants of dietary iron adequacy in young children [9,10]. Caregivers are the primary gatekeepers of child nutrition; their understanding of IDA and appropriate complementary feeding practices directly shapes the child's dietary iron intake. Several studies from LMICs report that

poor caregiver knowledge and inappropriate feeding practices are independently associated with higher IDA prevalence and severity [9,11,12].

Feeding performance the practical translation of knowledge into feeding behaviour, including dietary diversity, meal frequency, and avoidance of absorption inhibitors — is a distinct but related construct. Evidence consistently shows that knowledge alone does not guarantee behaviour change; skill-based educational programmes that target feeding practice produce greater improvements in dietary iron adequacy than knowledge-transfer approaches alone [10,13]. Understanding the current level of caregiver knowledge and the gap between knowledge and practice is therefore essential for designing effective public health programmes.

Despite the recognised importance of these modifiable determinants, validated, population-level data on caregiver knowledge and feeding performance regarding IDA remain entirely absent from the published literature for Erbil Governorate and the broader Kurdistan Region of Iraq. This evidence gap is particularly consequential given the region's persistently high IDA burden [6, 8] and the absence of locally tailored nutritional education guidelines. The present cross-sectional study was designed to address this gap directly. The primary objectives were: (i) to assess the level of caregiver knowledge regarding IDA; (ii) to assess child feeding performance as practised by caregivers; and (iii) to examine the association between caregiver knowledge, feeding performance, and children's haematological parameters.

## METHODS

### Study Design and Setting

This cross-sectional descriptive study was conducted at Rapareen Paediatric Teaching Hospital over a five-month period from 1 February to 30 June 2025. The study aimed to assess caregiver knowledge and feeding performance regarding iron deficiency anaemia (IDA) and to examine their association with children's haematological parameters among children aged 12–59 months with confirmed moderate IDA.

The hospital is the main paediatric referral centre in Erbil Governorate, serving urban, suburban, and rural populations across the Kurdistan Region of Iraq, ensuring access to a diverse and representative clinical sample.

### Participants and Eligibility

participants were classified for descriptive purposes into three routine clinical management groups based on physician treatment decisions at enrolment.

Participants were recruited consecutively from caregiver–child pairs attending the paediatric outpatient clinic for anaemia assessment or management. Recruitment was conducted on all clinic days during the study period, and all eligible pairs were invited to participate.

Children were eligible if they were aged 12–59 months and had confirmed moderate IDA according to WHO criteria (haemoglobin 7.0–10.0 g/dL, serum ferritin <12 ng/mL, serum iron <50 µg/dL) [8]. Inclusion also required attendance with the primary caregiver, written informed consent, and residence within the hospital catchment area.

Exclusion criteria included anaemia of non–iron deficiency origin (e.g., thalassaemia, sickle-cell disease), elevated C-reactive protein (>5 mg/L), prior iron supplementation, or acute/severe illness.

A total of 198 caregivers–child pairs were assessed for eligibility. of these, 18 were excluded (7 non–iron deficiency anaemia, 6 elevated CRP, 5 prior supplementation). The remaining 180 eligible pairs were enrolled and completed all assessments, yielding a final sample of 180 participants (Figure 1). No losses occurred after enrolment due to single-visit cross-sectional data collection.

Sample size was calculated using $n = z^2p(1-p)/d^2$ based on an expected prevalence of poor caregiver knowledge of 60% from LMIC literature [9,11,12], 95% confidence level, and 7.3% margin of error. The minimum required sample was 172; therefore, the final sample of 180 ensured adequate statistical power.

Participants were classified into three routine clinical management groups: Group 1 (oral iron therapy, n = 60), Group 2 (nutritional education programme, n = 60), and Group 3 (combined therapy and education, n = 60). These categories were used for descriptive subgroup analysis only and were not randomized. Baseline comparability was confirmed using chi-square testing ($p>0.05$).

### Instruments and Data Collection

Data were collected through structured face-to-face interviews and review of clinical records. Content validity of the instruments was established through external evaluation by a panel of 10 experts in paediatrics, who reviewed the items for relevance, clarity, and cultural appropriateness prior to data collection. Caregiver knowledge was assessed using a 28-item validated questionnaire (Cronbach's $\alpha$ = 0.82) covering IDA causes, symptoms, dietary iron sources, enhancers, and inhibitors. Scores ranged from 0–28 and were categorised as poor (<14), fair (14–21), and good (≥ 22).

Feeding performance was assessed using a 20-item validated checklist (Cronbach's $\alpha = 0.78$) evaluating dietary diversity, meal frequency, iron-rich food intake, use of enhancers, and avoidance of inhibitors. Scores ranged from 0–20 and were categorised as poor (<11), fair (11–16), and good (≥17).

Both tools were pilot tested on 20 caregiver–child pairs (excluded from final analysis), and minor revisions were made to improve clarity and feasibility.

### Haematological Measurements

Venous blood samples (3 mL) were collected under aseptic conditions. Haemoglobin was measured using an automated haematology analyser, serum ferritin by immunoassay, and serum iron by colorimetric methods in an accredited laboratory.

### Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Hawler Medical University (Approval No.

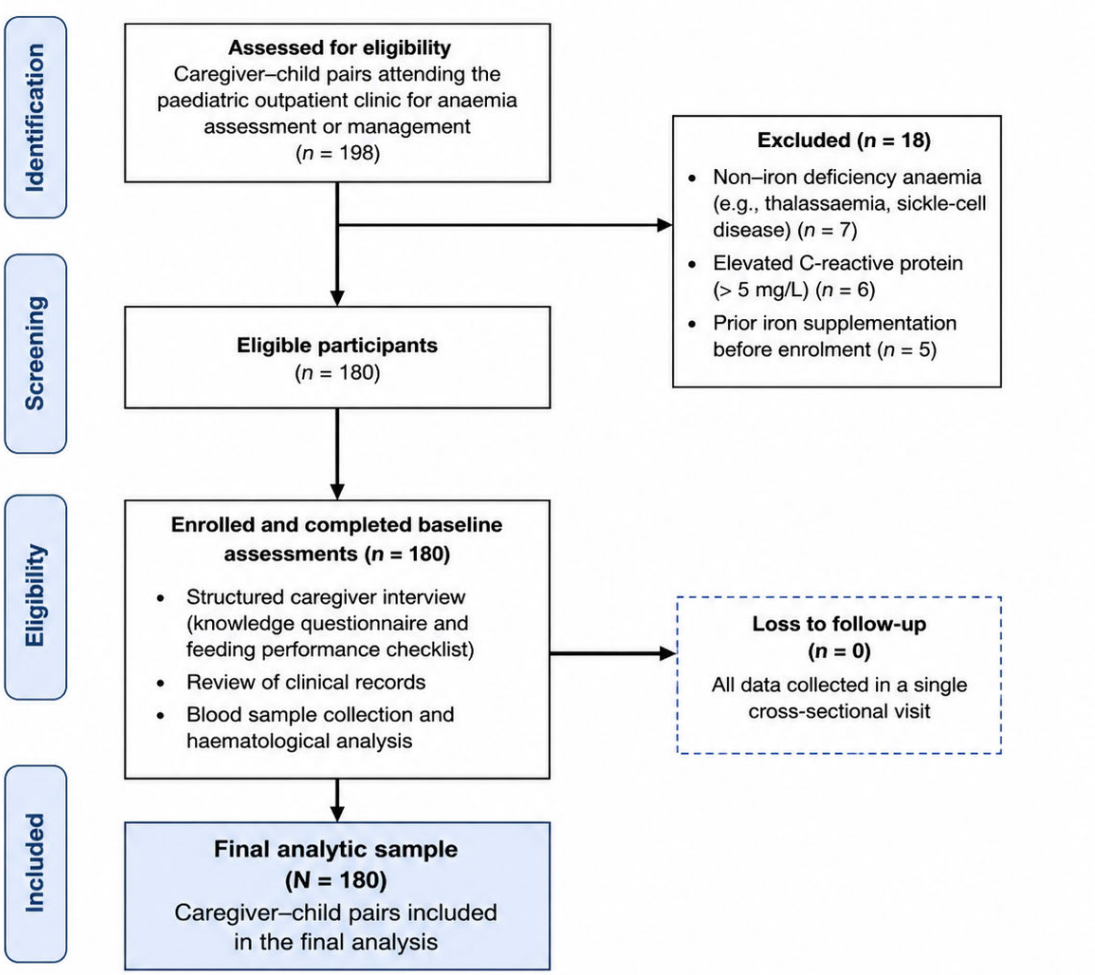



**Figure 1.** Flow of participants through the study.

*Note:* Children aged 12–59 months with confirmed moderate iron deficiency anaemia were included. Exclusion criteria: non–iron deficiency anaemia, C-reactive protein > 5 mg/L, prior iron supplementation. Final sample size = 180.

**Abbreviations:** IDA, iron deficiency anaemia; CRP, C-reactive protein.

Figure 1: Flow of Participants through the Study

2724). The study adhered to the Declaration of Helsinki. Written informed consent was obtained from all caregivers. Data confidentiality was ensured using coded identifiers and password-protected files.

**Statistical Analysis**

Data were analysed using IBM SPSS Statistics. Descriptive statistics were used to summarise participant characteristics and study variables. Continuous variables were presented as means±standard deviations (SD), while categorical variables were reported as frequencies and percentages.

For inferential analysis, Pearson chi-square test or Fisher's exact test (where appropriate) was used to examine differences in categorical variables between groups. Associations between caregiver knowledge, feeding performance, and haematological parameters (haemoglobin, serum ferritin, and serum iron) were assessed using Spearman's rank correlation coefficient (ρ), given the ordinal nature and non-normal distribution of the study scores.

To control for type I error arising from multiple comparisons, Bonferroni correction was applied, with a revised significance threshold of $p<0.003$. Unadjusted p-values are also reported for transparency.

All analyses were conducted using complete-case analysis due to minimal missing data. Missing data were minimal and were assessed as missing completely at random (MCAR). As the proportion of missing data was negligible, no imputation procedures were performed, and complete-case analysis was applied.

Subgroup comparisons among the three clinically defined management groups (oral iron therapy, nutritional education, and combined intervention) were performed for descriptive and contextual purposes only, as the groups were not randomly assigned. These comparisons were included to explore baseline comparability and to provide clinical context for interpreting caregiver knowledge and feeding performance across routine care pathways, rather than to infer causal effects of interventions.

## RESULTS

### Sociodemographic and Child Characteristics

A total of 180 caregivers–child pairs completed the cross-sectional assessment. Table 1 presents sociodemographic and child characteristics across subgroups. The majority of caregivers were aged 24–29 years (32.8%), employed or unemployed (35.6% each), and resided in suburban areas (46.7%). The largest socioeconomic stratum was low (38.3%). Among children, the most common age group was 12–23 months (28.9%), male sex predominated (56.7%), and second-born children were most frequent (45.0%). Pearson chi-square ([a]) and Fisher's exact ([b]) tests confirmed no statistically significant inter-group differences in any variable (all p>0.05), supporting cross-sectional comparability.

### Iron Deficiency Risk Factors

Table 2 presents iron deficiency risk factors across subgroups. Formula feeding with complementary foods was the most common feeding method (33.3%), and three meals per day was the most frequent feeding frequency (34.4%). Four risk factors showed statistically significant between-group differences: family history of anaemia (total 27.8%;

Table 1: Sociodemographic Characteristics of Caregiver–Child Pairs (N = 180)

| Variable | G1 n (%) | G2 n (%) | G3 n (%) | Total (N=180) n (%) | p |
|---|---|---|---|---|---|
| A. Caregiver Characteristics | | | | | |
| Age group (years) | | | | | |
| 18–23 | 12 (20.0) | 12 (20.0) | 14 (23.3) | 38 (21.1) | 0.104[a] |
| 24–29 | 24 (40.0) | 15 (25.0) | 20 (33.3) | 59 (32.8) | |
| 30–35 | 20 (33.3) | 17 (28.3) | 18 (30.0) | 55 (30.6) | |
| 36–40 | 4 (6.7) | 16 (26.7) | 8 (13.3) | 28 (15.6) | |
| Occupation | | | | | |
| Housewife | 18 (30.0) | 23 (38.3) | 11 (18.3) | 52 (28.9) | 0.073[a] |
| Unemployed | 17 (28.3) | 22 (36.7) | 25 (41.7) | 64 (35.6) | |
| Employed | 25 (41.7) | 15 (25.0) | 24 (40.0) | 64 (35.6) | |
| Socioeconomic Status | | | | | |
| Low | 26 (43.3) | 23 (38.3) | 20 (33.3) | 69 (38.3) | 0.812[a] |
| Medium | 20 (33.3) | 20 (33.3) | 24 (40.0) | 64 (35.6) | |
| High | 14 (23.3) | 17 (28.3) | 16 (26.7) | 47 (26.1) | |
| B. Child Characteristics | | | | | |
| Child age group (months) | | | | | |
| 12–23 | 23 (38.3) | 13 (21.7) | 16 (26.7) | 52 (28.9) | 0.162[a] |
| 24–35 | 16 (26.7) | 11 (18.3) | 14 (23.3) | 41 (22.8) | |
| 36–47 | 10 (16.7) | 17 (28.3) | 18 (30.0) | 45 (25.0) | |
| 48–59 | 11 (18.3) | 19 (31.7) | 12 (20.0) | 42 (23.3) | |
| Child sex | | | | | |
| Male | 35 (58.3) | 32 (53.3) | 35 (58.3) | 102 (56.7) | 0.816[a] |
| Female | 25 (41.7) | 28 (46.7) | 25 (41.7) | 78 (43.3) | |

G1 = Oral iron therapy (n = 60); G2 = Nutritional education programme (n = 60); G3 = Combined (n = 60). [a]Pearson chi-square; [b]Fisher's exact test. All p>0.05

Table 2: Prevalence of Iron Deficiency Anaemia Risk Factors by Clinical Management Group (N = 180).

| Risk Factor | Response | G1 n (%) | G2 n (%) | G3 n (%) | Total n (%) | p |
|---|---|---|---|---|---|---|
| Feeding method | Breastfeeding only | 4 (6.7) | 6 (10.0) | 6 (10.0) | 16 (8.9) | |
| | BF + complementary | 17 (28.3) | 13 (21.7) | 11 (18.3) | 41 (22.8) | 0.719 |
| | Formula only | 8 (13.3) | 11 (18.3) | 12 (20.0) | 31 (17.2) | |
| | Formula + complementary | 23 (38.3) | 20 (33.3) | 17 (28.3) | 60 (33.3) | |
| | Mixed + complementary | 8 (13.3) | 10 (16.7) | 14 (23.3) | 32 (17.8) | |
| Meal frequency/day | Once | 17 (28.3) | 20 (33.3) | 16 (26.7) | 53 (29.4) | 0.395 |
| | Twice | 10 (16.7) | 12 (20.0) | 11 (18.3) | 33 (18.3) | |
| | Three times | 25 (41.7) | 20 (33.3) | 17 (28.3) | 62 (34.4) | |
| | Four times + | 8 (13.3) | 8 (13.3) | 16 (26.7) | 32 (17.8) | |
| Family history of anaemia | No | 58 (96.7) | 27 (45.0) | 45 (75.0) | 130 (72.2) | <0.001* |
| | Yes | 2 (3.3) | 33 (55.0) | 15 (25.0) | 50 (27.8) | |
| Intestinal infection (amoeba / giardia) | No | 55 (91.7) | 32 (53.3) | 45 (75.0) | 132 (73.3) | <0.001* |
| | Yes | 5 (8.3) | 28 (46.7) | 15 (25.0) | 48 (26.7) | |
| Recurrent diarrhoea | No | 55 (91.7) | 37 (61.7) | 44 (73.3) | 136 (75.6) | <0.001* |
| | Yes | 5 (8.3) | 23 (38.3) | 16 (26.7) | 44 (24.4) | |
| Pica | No | 58 (96.7) | 32 (53.3) | 46 (76.7) | 136 (75.6) | <0.001* |
| | Yes | 2 (3.3) | 28 (46.7) | 14 (23.3) | 44 (24.4) | |

G1 = Oral iron therapy; G2 = Nutritional education programme; G3 = Combined. *p<0.001 by Pearson chi-square. BF = breastfeeding; GI = gastrointestinal

Table 3: Distribution of Caregiver IDA Knowledge Scores by Clinical Management Group at baseline (N = 180).

| Knowledge Level | G1 (n=60) n (%) | G2 (n=60) n (%) | G3 (n=60) n (%) | Total (N=180) n (%) |
|---|---|---|---|---|
| Poor (score<14) | 54 (90.0) | 39 (65.0) | 35 (58.3) | 128 (71.1) |
| Fair (score 14–21) | 6 (10.0) | 20 (33.3) | 25 (41.7) | 51 (28.3) |
| Good (score ≥ 22) | 0 (0.0) | 1 (1.7) | 0 (0.0) | 1 (0.6) |
| Mean±SD | 10.13±2.49 | 12.55±2.76 | 12.75±2.58 | 11.81±2.80 |
| Overall Assessment | Poor | Poor | Poor | Poor |

Poor: score<14 (<50% correct); Fair: 14–21 (50–74%); Good: ≥ 22 (≥ 75%). G1 = Oral iron therapy; G2 = NEP; G3 = Combined

Table 4. Distribution of Child Feeding Performance Scores by Clinical Management Group at baseline (N = 180)

| Feeding Performance Level | G1 (n=60) n (%) | G2 (n=60) n (%) | G3 (n=60) n (%) | Total (N=180) n (%) |
|---|---|---|---|---|
| Poor (score<11) | 56 (93.3) | 29 (48.3) | 44 (73.3) | 129 (71.7) |
| Fair (score 11–16) | 4 (6.7) | 31 (51.7) | 16 (26.7) | 51 (28.3) |
| Good (score ≥ 17) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Mean±SD | 1.12±3.44 | 10.87±2.51 | 5.15±5.98 | 5.71±5.49 |
| Overall Assessment | Poor | Poor | Poor | Poor |

Poor: score<11 (<50%); Fair: 11–16 (50–74%); Good: ≥ 17 (≥ 75%). G1 = Oral iron therapy; G2 = NEP; G3 = Combined

Table 5: Spearman Correlation between Caregiver Knowledge, Feeding Performance, and Haematological Parameters (Hb, ferritin, Serum Iron)

| Parameters | | Haemoglobin (g/dL) | | Serum Ferritin (ng/mL) | | Serum Iron (µg/dL) | |
|---|---|---|---|---|---|---|---|
| Subgroup | Measure | ρ | p-value | ρ | p-value | ρ | p-value |
| G1 — Oral iron therapy subgroup (n = 60) | | | | | | | |
| Knowledge score | | 0.149 | 0.255 | 0.004 | 0.975 | 0.020 | 0.881 |
| Feeding performance score | | -0.106 | 0.421 | -0.159 | 0.224 | -0.036 | 0.784 |
| G2 — Nutritional education programme subgroup (n = 60) | | | | | | | |
| Knowledge score | | -0.034 | 0.799 | -0.201 | 0.124 | 0.000 | 0.999 |
| Feeding performance score | | -0.057 | 0.668 | -0.134 | 0.307 | -0.254* | 0.049 |
| G3 — Combined therapy subgroup (n = 60) | | | | | | | |
| Knowledge score | | -0.064 | 0.628 | -0.025 | 0.847 | -0.032 | 0.809 |
| Feeding performance score | | -0.115 | 0.384 | -0.022 | 0.867 | -0.034 | 0.795 |

ρ = Spearman's rank correlation coefficient. *Significant at p<0.05. All other correlations non-significant (p>0.05). G1 = Oral iron therapy; G2 = NEP; G3 = Combined

p<0.001), intestinal infection with amoeba or giardia (26.7%; p<0.001), recurrent diarrhoea (24.4%; p<0.001), and pica (24.4%; p<0.001). Subgroup G2 had markedly higher rates of all four significant risk factors compared to G1 and G3. No child in any subgroup had a history of gastrointestinal surgery.

**Baseline Caregiver Knowledge Assessment**

Table 3 presents the distribution of caregiver knowledge levels at the time of cross-sectional assessment. Overall, 71.1% of caregivers (128/180) scored in the poor knowledge category, 28.3% in the fair category, and only one caregiver (0.6%) achieved good knowledge. G1 demonstrated the lowest knowledge levels (90.0% poor; mean 10.13±2.49), followed by G2 (65.0% poor; mean 12.55±2.76) and G3 (58.3% poor; mean 12.75±2.58). Across all subgroups, the overall assessment level was poor. Not a single caregiver in G1 or G3 achieved the good knowledge threshold, underscoring the profound deficit in IDA-related nutritional literacy in this population.

**Baseline Child Feeding Performance Assessment**

Table 4 presents the distribution of child feeding performance levels at baseline. Overall, 71.7% of caregivers (129/180) demonstrated poor feeding performance and 28.3% were at the fair level. No caregiver in any subgroup achieved good feeding performance at the time of assessment. G1 had the lowest performance (93.3% poor; mean 1.12±3.44). G2 showed the highest baseline performance yet was still predominantly poor (48.3% poor; mean 10.87±2.51). G3 was intermediate (73.3% poor; mean 5.15±5.98). The universal absence of good feeding performance confirms that iron-focused feeding practices are not being implemented by caregivers of IDA-affected children in this clinical population.

**Associations Between Knowledge, Feeding Performance, and Haematological Parameters**

Table 5 presents Spearman's correlation coefficients between baseline caregiver knowledge and feeding performance scores and haematological parameters across all three subgroups. In G1, no significant correlations were found between either knowledge or feeding performance and any haematological parameter (all p>0.05). In G2, knowledge scores showed no significant association with any biomarker at baseline; however, a statistically significant negative correlation was identified between feeding performance and serum iron ($\rho = -0.254$; $p = 0.049$), indicating that caregivers with poorer baseline feeding practices were associated with lower serum iron in their children. In G3, no significant correlations were found between either measure and any haematological parameter at baseline (all p>0.05). Overall, baseline caregiver knowledge was not significantly associated with children's haematological status across any subgroup, and feeding performance showed only a single marginal association with serum iron in G2.

## DISCUSSION

This cross-sectional study provides one of the first systematic, validated assessments, validated assessment of caregiver knowledge and child feeding performance regarding IDA in Erbil, Kurdistan Region of Iraq. The principal finding is that poor IDA-related knowledge (71.1%) and poor feeding performance (71.7%) are near-universal among caregivers of IDA-affected children aged 12–59 months in this clinical population. These levels are substantially low and indicative of poor nutritional literacy in LMIC contextsand are consistent with comparable assessments from LMICs, which typically report correct response rates of 40–60% among caregivers in the absence of structured educational input [9,11,12].

The particularly low knowledge scores in G1 (90.0% poor; mean 10.13) are clinically significant. may reflect routine outpatient management where pharmacological iron supplementation is provided without structured nutritional counselling — a pattern common in resource-constrained outpatient settings where consultation time is limited [13,14]. Without concurrent improvement in caregiver knowledge and feeding practices, the dietary and behavioural determinants of IDA remain unaddressed even as the acute haematological deficit is being treated pharmacologically. may contribute to persistent risk of recurrence if dietary determinants remain unaddressed, as depleted iron stores cannot be maintained in the normal range without sustained improvements in dietary iron intake [8].

Between-group variation in baseline feeding performance (G1 mean 1.12; G2 mean 10.87; G3 mean 5.15) likely reflects baseline differences in clinical and nutritional status between groups, particularly in G2, which had substantially higher rates of intestinal infections (46.7%), pica (46.7%), and recurrent diarrhoea (38.3%) — conditions that may have independently prompted caregivers to seek dietary guidance prior to enrolment. The single nominally significant correlation observed (G2 feeding performance vs serum iron: $\rho = -0.254$, unadjusted $p = 0.049$) is biologically plausible but did not survive Bonferroni correction and should be regarded as exploratory. With 18 tests conducted simultaneously, one spurious significant result at $p<0.05$ is statistically expected by chance alone. Cross-subgroup comparisons of knowledge and feeding scores should accordingly be interpreted as descriptive observations contextualised by differing disease burden profiles, rather than as evidence of differential educational or treatment effects.

The absence of significant correlations between baseline knowledge scores and haematological parameters across all subgroups is consistent with the widely documented knowledge–practice gap in nutrition education research [10,13]. Caregiver knowledge — as assessed by a questionnaire at a single time point — does not straightforwardly translate into feeding behaviour or haematological outcomes. Mediating factors include caregiver self-efficacy, household food security, cultural dietary norms, socioeconomic constraints, and child food acceptance [9,10]. Educational programme design must therefore target practical feeding skill acquisition and behaviour change, not merely information transfer [10,13].

The high prevalence of compound IDA risk factors — intestinal infections (26.7%), pica (24.4%), and recurrent diarrhoea (24.4%) — highlights the multifactorial aetiology of childhood IDA in this population. Intestinal parasites, particularly Giardia lamblia and Entamoeba histolytica, compete for luminal iron, damage absorptive enterocytes, and upregulate hepcidin-mediated iron sequestration [15]. Pica introduces chelating substances that bind luminal iron and reduce net absorption [3]. Recurrent diarrhoea accelerates intestinal transit and causes direct enteral iron losses [3,15]. These biomedical risk factors co-exist with dietary deficiencies and low caregiver knowledge, creating a compounded vulnerability that pharmacological treatment alone cannot resolve. From a public health standpoint, these findings underscore the necessity of integrated paediatric IDA management protocols that combine iron supplementation, routine parasitological screening, and structured caregiver nutritional education — a model that is currently absent from standard clinical practice in the Kurdistan Region.

Validated assessment of caregiver knowledge and child feeding performance regarding IDA in Erbil, Kurdistan Region of Iraq. The principal finding is that poor IDA-related knowledge (71.1%) and poor feeding performance (71.7%) are near-universal among caregivers of IDA-affected children aged 12–59 months in this clinical population. These levels are substantially below the WHO-recommended nutritional literacy threshold and are consistent with comparable assessments from LMICs, which typically report correct response rates of 40–60% among caregivers in the absence of structured educational input [9,11,12].

The particularly low knowledge scores in G1 (90.0% poor; mean 10.13) are clinically significant. These caregivers were receiving pharmacological iron supplementation for their children without any structured educational component — a pattern common in resource-constrained outpatient settings where consultation time is limited [13,14]. Without concurrent improvement in caregiver knowledge and feeding practices, the dietary and behavioural determinants of IDA remain unaddressed even as the acute haematological deficit is being treated pharmacologically. This creates a revolving-door dynamic of treatment and recurrence, as depleted iron stores cannot be maintained in the normal range without sustained improvements in dietary iron intake [3].

Between-group variation in baseline feeding performance (G1 mean 1.12; G2 mean 10.87; G3 mean 5.15) most plausibly reflects pre-existing differences in the clinical and dietary contexts of the three management groups, particularly in G2, which had substantially higher rates of intestinal infections (46.7%), pica (46.7%), and recurrent diarrhoea (38.3%) — conditions that may have

independently prompted caregivers to seek dietary guidance prior to enrolment. The single nominally significant correlation observed (G2 feeding performance vs serum iron: $\rho = -0.254$, unadjusted $p = 0.049$) is biologically plausible but did not survive Bonferroni correction and should be regarded as exploratory. With 18 tests conducted simultaneously, with 18 comparisons performed, approximately one nominally significant result at $p<0.05$ would be expected by chance. Cross-subgroup comparisons of knowledge and feeding scores should accordingly be interpreted as descriptive observations contextualised by differing disease burden profiles, rather than as evidence of differential educational or treatment effects.

The absence of significant correlations between baseline knowledge scores and haematological parameters across all subgroups is consistent with the widely documented knowledge–practice gap in nutrition education research [10,13]. Caregiver knowledge — as assessed by a questionnaire at a single time point — does not straightforwardly translate into feeding behaviour or haematological outcomes. Mediating factors include caregiver self-efficacy, household food security, cultural dietary norms, socioeconomic constraints, and child food acceptance [9,10]. Educational programme design must therefore target practical feeding skill acquisition and behaviour change, not merely information transfer [10,13].

The high prevalence of compound IDA risk factors — intestinal infections (26.7%), pica (24.4%), and recurrent diarrhoea (24.4%) — highlights the multifactorial aetiology of childhood IDA in this population. Intestinal parasites, particularly Giardia lamblia and Entamoeba histolytica, compete for luminal iron, damage absorptive enterocytes, and upregulate hepcidin-mediated iron sequestration [15]. Pica introduces chelating substances that bind luminal iron and reduce net absorption [8]. Recurrent diarrhoea accelerates intestinal transit and causes direct enteral iron losses [8,15]. These biomedical risk factors co-exist with dietary deficiencies and low caregiver knowledge, creating a compounded vulnerability that pharmacological treatment alone cannot resolve. From a public health standpoint, these findings underscore the necessity of integrated paediatric IDA management protocols that combine iron supplementation, routine parasitological screening, and structured caregiver nutritional education — a model that is currently absent from standard clinical practice in the Kurdistan Region. Validated assessment of caregiver knowledge and child feeding performance regarding IDA in Erbil, Kurdistan Region of Iraq. The principal finding is that poor IDA-related knowledge (71.1%) and poor feeding performance (71.7%) are near-universal among caregivers of IDA-affected children aged 12–59 months in this clinical population. These levels are substantially below the WHO-recommended nutritional literacy threshold and are consistent with comparable assessments from LMICs, which typically report correct response rates of 40–60% among caregivers in the absence of structured educational input [9,11,12].

The particularly low knowledge scores in G1 (90.0% poor; mean 10.13) are clinically significant. These caregivers were receiving pharmacological iron supplementation for their children without any structured educational component — a pattern common in resource-constrained outpatient settings where consultation time is limited [13,14]. Without concurrent improvement in caregiver knowledge and feeding practices, the dietary and behavioural determinants of IDA remain unaddressed even as the acute haematological deficit is being treated pharmacologically. This creates a revolving-door dynamic of treatment and recurrence, as depleted iron stores cannot be maintained in the normal range without sustained improvements in dietary iron intake [8].

Between-group variation in baseline feeding performance (G1 mean 1.12; G2 mean 10.87; G3 mean 5.15) most plausibly reflects pre-existing differences in the clinical and dietary contexts of the three management groups, particularly in G2, which had substantially higher rates of intestinal infections (46.7%), pica (46.7%), and recurrent diarrhoea (38.3%) — conditions that may have independently prompted caregivers to seek dietary guidance prior to enrolment. The single nominally significant correlation observed (G2 feeding performance vs serum iron: $\rho = -0.254$, unadjusted $p = 0.049$) is biologically plausible but did not survive Bonferroni correction and should be regarded as exploratory. With 18 tests conducted simultaneously, one spurious significant result at $p<0.05$ is statistically expected by chance alone. Cross-subgroup comparisons of knowledge and feeding scores should accordingly be interpreted as descriptive observations contextualised by differing disease burden profiles, rather than as evidence of differential educational or treatment effects.

The absence of significant correlations between baseline knowledge scores and haematological parameters across all subgroups is consistent with the widely documented knowledge–practice gap in nutrition education research [10,13]. Caregiver knowledge — as assessed by a questionnaire at a single time point — does not straightforwardly translate into feeding behaviour or haematological outcomes. Mediating factors include caregiver self-efficacy, household food security, cultural dietary norms, socioeconomic constraints, and child food acceptance [9,10]. Educational programme design must therefore target practical feeding skill acquisition and behaviour change, not merely information transfer [10,13].

The high prevalence of compound IDA risk factors — intestinal infections (26.7%), pica (24.4%), and recurrent diarrhoea (24.4%) — highlights the multifactorial aetiology of childhood IDA in this population. Intestinal parasites, particularly Giardia lamblia and Entamoeba histolytica, compete for luminal iron, damage absorptive enterocytes, and upregulate hepcidin-mediated iron sequestration [15]. Pica introduces chelating substances that bind luminal iron and reduce net absorption [8]. Recurrent diarrhoea accelerates intestinal transit and causes direct enteral iron

losses [8,15]. These biomedical risk factors co-exist with dietary deficiencies and low caregiver knowledge, creating a compounded vulnerability that pharmacological treatment alone cannot resolve. From a public health standpoint, these findings underscore the necessity of integrated paediatric IDA management protocols that combine iron supplementation, routine parasitological screening, and structured caregiver nutritional education — a model that is currently absent from standard clinical practice in the Kurdistan Region.

### Limitations

The following limitations should be acknowledged: (i) the cross-sectional design precludes causal inference between caregiver knowledge, feeding practices, and haematological status; (ii) subgroup allocation was non-random, resulting in significant baseline differences in disease burden that confound cross-subgroup comparisons; (iii) the 18 Spearman correlation tests conducted increase Type I error risk, and the single nominally significant result ($\rho = -0.254$, $p = 0.049$) did not survive Bonferroni correction; (iv) convenience sampling at a single tertiary centre may limit generalisability to primary care and rural settings; (v) social desirability bias in self-reported feeding practices cannot be fully excluded; (vi) the study instruments were purpose-developed for this population and, while demonstrating satisfactory internal consistency, have not been independently validated in external populations; (vii) caregiver educational level was not collected, limiting characterisation of knowledge determinants. Future studies should use population-representative sampling, randomised or longitudinal designs, and internationally standardised instruments.

## CONCLUSIONS

This cross-sectional study demonstrates that poor caregiver knowledge and poor feeding performance regarding iron deficiency anaemia (IDA) are highly prevalent among caregivers of affected children aged 12–59 months in Erbil, Iraq. At baseline, neither caregiver knowledge nor feeding performance showed significant associations with children's haematological parameters after correction for multiple comparisons, confirming a substantial knowledge–practice gap in this population.

These findings highlight that informational deficits alone are insufficient to explain feeding behaviours or biological outcomes, and they underscore the need for interventions that translate knowledge into practical caregiving skills. Accordingly, structured, skill-based nutritional education programmes should be integrated into routine paediatric care, with emphasis on hands-on feeding practices rather than knowledge transfer alone.

In addition, routine clinical screening for modifiable risk factors — particularly intestinal parasitic infections, recurrent diarrhoea, and pica — should be strengthened as part of comprehensive IDA management. Addressing these factors is essential to target the multifactorial aetiology of childhood IDA in the Kurdistan Region of Iraq.

From a policy perspective, healthcare planners should prioritise the development and resourcing of community-based nutritional education programmes for caregivers of young children. These programmes should focus on practical feeding skill acquisition and be embedded within existing primary healthcare services to improve prevention and long-term control of childhood IDA.

### Strengths of Study

This study has several notable strengths. It is the first validated, instrument-based assessment of caregiver knowledge and child feeding performance regarding IDA in Erbil and the Kurdistan Region of Iraq, addressing a critical evidence gap. The concurrent measurement of both knowledge and feeding practice dimensions alongside haematological biomarkers (haemoglobin, serum ferritin, serum iron) provides a multidimensional baseline profile not previously available for this population. Both instruments demonstrated satisfactory internal consistency (Cronbach's $\alpha = 0.82$ for knowledge; $\alpha = 0.78$ for feeding performance) and were subjected to a formal pilot phase prior to main data collection. The application of Bonferroni correction across 18 simultaneous correlation tests reduces the risk of spurious findings. The final analytic sample of 180 participants exceeded the calculated minimum of 172, ensuring adequate statistical power for all planned analyses.

### Limitations

The following limitations should be considered when interpreting the findings and their generalisability. (i) The cross-sectional design precludes any causal inference between caregiver knowledge, feeding practices, and haematological outcomes. (ii) Participants were recruited from a single tertiary paediatric referral centre using convenience sampling; therefore, the findings may not be fully representative of children with iron deficiency anaemia (IDA) in primary care, rural, or remote settings across the Kurdistan Region, and generalisation should be made with caution.

Subgroup classification was based on routine clinical management decisions rather than randomisation, introducing the possibility of baseline differences and limiting the interpretability of between-group comparisons. (iv) Multiple simultaneous statistical tests (18 Spearman correlations) increase the risk of type I error; the only nominally significant finding ($\rho = -0.254$, $p = 0.049$) did not remain significant after Bonferroni correction and should be interpreted as exploratory. (v) Self-reported feeding practices may be subject to social desirability bias, potentially leading to overestimation of appropriate behaviours.

These limitations should be considered when interpreting the results and highlight the need for future population-based, multi-centre, and longitudinal studies to improve generalisability and causal understanding in the Kurdistan Region.

### Innovation and Contribution

This study makes an original contribution to the regional and global literature by providing the first simultaneous,

validated assessment of caregiver IDA knowledge, child feeding performance, and haematological biomarkers in a clinically confirmed IDA population in the Kurdistan Region of Iraq. By linking caregiver-level educational and behavioural data with child-level biomarker profiles across three clinical management groups, this work generates a contextualised baseline that is directly actionable for the design and evaluation of structured nutritional education interventions in this and comparable LMIC settings.

### Implications for Practice

The critically inadequate levels of caregiver knowledge and feeding performance documented in this study have clear, immediate implications for clinical practice and health policy in the Kurdistan Region. First, structured, skill-based nutritional education should be formalised as a standard component of all paediatric IDA management encounters, delivered by trained healthcare workers alongside pharmacological treatment rather than as an optional add-on. Second, routine clinical screening for key modifiable risk factors — intestinal parasitic infections, recurrent diarrhoea, and pica — should be embedded in paediatric outpatient protocols to enable targeted, early intervention. Third, regional and national health authorities should invest in the development of community-based caregiver education programmes, prioritising practical feeding skill acquisition through demonstration and supported practice, in order to translate knowledge into sustained behavioural change and measurably reduce the childhood IDA burden across the Kurdistan Region of Iraq.

### Recommendations for Future Research

- Employ population-representative, multi-centre sampling to improve generalisability across urban, rural, and primary care settings
- Use randomised or longitudinal study designs to establish causal relationships between caregiver knowledge, feeding practices, and haematological outcomes
- Develop and adopt standardised, externally validated instruments for assessing caregiver knowledge and feeding performance to enhance comparability across studies
- Include systematic assessment of caregiver educational level and broader socioeconomic determinants to better understand predictors of feeding behaviour and IDA risk
- Design and evaluate skill-based, behaviour-focused nutritional interventions rather than knowledge-only education to improve real-world feeding practices and child outcomes

## Author Contributions

Amanj Yassin Hamad Amin: Conceptualization, study design, data collection, statistical analysis, writing — original draft. Assist Prof. Dr. Nazar Ramadhan Othman: Study design, supervision, critical revision, institutional oversight. Both authors approved the final manuscript.

## Funding

This research received no external funding.

## Institutional Review Board Statement

Approved by the Research Ethics Committee of Hawler Medical University (Approval No. 2724, 2025). Conducted in accordance with the Declaration of Helsinki.

## Informed Consent Statement

Written informed consent was obtained from all participating caregivers. Data were fully de-identified prior to analysis.

## Data Availability Statement

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

## Acknowledgments

The authors thank the caregivers and children who participated, and the clinical staff of Rapareen Paediatric Teaching Hospital for their cooperation during data collection.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Reporting Standards

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies. A completed STROBE checklist is provided as Supplementary Material (Supplementary File S1).

## REFERENCES

[1] World Health Organization, United Nations Children's Fund and United Nations University. *Iron Deficiency Anaemia: Assessment, Prevention and Control — A Guide for Programme Managers*. WHO Press, 2001.

[2] Safiri, S. *et al.* "Burden of anemia and its underlying causes in 204 countries and territories, 1990–2019: results from the Global Burden of Disease Study 2019." *Journal of Hematology & Oncology*, vol. 14, no. 1, 2021, p. 185. https://doi.org/10.1186/s13045-021-01202-2.

[3] Lozoff, B. and Jimenez, E. "Long-term developmental outcome of infants with iron deficiency." *New England Journal of Medicine*, vol. 325, no. 10, 1991, pp. 687–694. https://doi.org/10.1056/NEJM199109053251004.

[4] Georgieff, M.K. "Nutrition and the developing brain: nutrient priorities and measurement." *American Journal of Clinical Nutrition*, vol. 85, no. 2, 2007, pp. 614S–620S. https://doi.org/10.1093/ajcn/85.2.614S.

[5] Abdulhussein, H.M. *et al.* "Prevalence of nutritional iron deficiency anemia among children under six years in Al Madinah, Basra, Iraq." *Annals of Tropical Medicine and Public Health*, vol. 24, no. 4, 2021, pp. 40–47. https://doi.org/10.36295/ASRO.2021.24418.

[6] Armishty, F.S. *et al.* "Prevalence of anemia and associated factors among children under 5 years in Zakho City, Kurdistan Region, Iraq." *Passer Journal*, vol. 5, no. 2, 2023, pp. 398–404. https://doi.org/10.24271/psr.2023.390463.1287.

[7] Ali, H.I. *et al.* "Prevalence of iron deficiency anemia among different age groups in Duhok City, Kurdistan Region, Iraq." *Technium BioChemMed*, vol. 8, 2024, pp. 39–47. https://doi.org/10.47577/biochemmed.v8i.10808.

[8] World Health Organization. *Guideline: Daily Iron Supplementation in Infants and Children*. WHO Press, 2016.

[9] Suryana, S. *et al.* "Nutritional education and maternal knowledge of iron intake among toddlers with anemia." *Open Access Macedonian Journal of Medical Sciences*, vol. 10, 2022, pp. 1434–1439. https://doi.org/10.3889/oamjms.2022.7017.

[10] Wiafe, M.A. and Apprey, C. "Nutrition education improves knowledge of iron and iron-rich food intake practices among young adolescents." *Journal of Nutrition and Metabolism*, vol. 2023, 2023, pp. 5461967. https://doi.org/10.1155/2023/1804763.

[11] Odili, V.U. *et al.* "Community preventive health education intervention for pediatric iron-deficiency anemia in rural southeast Nigeria." *Journal of Patient Experience*, vol. 9, 2022, pp. 23743735221136743. https://doi.org/10.1177/23743735221136743.

[12] Abu-Baker, N.N. *et al.* "The impact of nutrition education on knowledge, attitude, and practice regarding iron deficiency anemia among female adolescent students in Jordan." *Heliyon*, vol. 7, no. 2, 2021, p. e06348. https://doi.org/10.1016/j.heliyon.2021.e06348.

[13] Larijani, N.M. *et al.* "The effect of maternal education on preventive behaviors of iron deficiency anemia in children: a randomized controlled trial." *Research Square*, 2020. https://doi.org/10.21203/rs.3.rs-21420/v1.

[14] Pasricha, S.R. *et al.* "Iron deficiency." *The Lancet*, vol. 397, no. 10270, 2021, pp. 233–248. https://doi.org/10.1016/S0140-6736(20)32594-0.

[15] Elmehy, D.A. *et al.* "Predominance of *Giardia lamblia* assemblage A among iron deficiency anaemic pre-school Egyptian children." *Journal of Parasitic Diseases*, vol. 47, no. 1, 2023, pp. 82–92. https://doi.org/10.1007/s12639-022-01542-x.

[16] Thurnham, D.I. *et al.* "Adjusting plasma ferritin concentrations to remove the effects of subclinical inflammation in the assessment of iron deficiency: a meta-analysis." *American Journal of Clinical Nutrition*, vol. 92, no. 3, 2010, pp. 546–555. https://doi.org/10.3945/ajcn.2010.29284.