ORIGINAL ARTICLE

The Effectiveness of a Reminder-Based Intervention for the Prevention of Iron Deficiency Anemia in Infants Aged 6 to 12 Months: A Randomized Controlled Clinical Trial

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Objective: To evaluate the effectiveness of nutritional education combined with nutrition and iron supplementation reminders compared with standard iron supplementation over a 3-month period in preventing iron deficiency anemia among infants aged 6 to 12 months.

Materials and Methods: A randomized controlled trial was conducted with 49 infants aged 6 to 12 months at Naresuan University Hospital. Participants were randomized into three groups: nutritional reminder for iron-rich food, iron supplements reminder, and standard therapy. All groups received a weekly ferrous sulfate 12.5 mg. Data collected included general information, caregiver, family background, nutritional habits prior to the study, adherence to iron-rich food, and iron supplementation. Complete blood count (CBC) results were compared before and after the study.

Results: The nutritional reminder group for iron-rich foods had a mean daily elemental iron intake from food of 1.88±0.99 mg/day, which was higher than the other groups but not statistically significant. Comparing blood test results among subgroups revealed that children consuming iron-rich food daily and adhering to prescribed iron supplementation showed increased post-study hemoglobin and hematocrit levels. Specifically, the nutritional reminder for iron-rich food groups showed a statistically significant increase in hemoglobin levels by 0.47±0.78 g/dL.

Conclusion: The outcome of the nutritional reminder for iron-rich food and the iron supplements reminder on iron deficiency anemia for prevention in infants is not superior compared to standard treatment in children aged 6 to 12 months. The nutritional reminder for iron-rich food groups showed a statistically significant increase in hemoglobin level. Therefore, nutritional education with prophylactic iron supplementation remains essential in preventing iron deficiency anemia.

Keywords: Iron deficiency anemia; Prevent iron deficiency anemia; Infant; Nutritional reminder for iron-rich food; Iron supplements reminder

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Anemia is a major global public health concern, with the World Health Organization (WHO) reporting a 43% prevalence among children aged 6 to 59 months in 2011, of which 42% was attributable to iron deficiency[1]. Furthermore, the Southeast Asia Nutrition Survey (SEANUTS) reported a higher prevalence of anemia among Thai children aged 6 months to 2.9 years in rural areas (41.7%) compared to urban settings (26%)[2].

Children aged 6 months to 2 years are particularly vulnerable to iron deficiency anemia due to physiological depletion of iron storage by approximately 6 months of age, following a decline in erythropoiesis after birth. Insufficient dietary iron intake during this period may lead to clinical manifestations such as fatigue, pallor, growth retardation, cognitive impairment, and other systemic complications. The Royal College of Pediatricians of Thailand recommends anemia screening for infants at 9 months of age during child health supervision visits (2021)[3]. Recognizing the critical importance of iron in early neurodevelopment, the Ministry of Public Health in Thailand has instituted a prophylactic iron supplementation program targeting children aged 6 to 24 months. Under this initiative, infants attending well-child clinics receive a prophylactic weekly dose of 12.5 mg elemental iron[4].

Iron supplementation has been demonstrated to significantly reduce the prevalence of iron deficiency anemia. A study conducted by Autthawee & Phongphetdit (2020) at Health Promotion Hospital Center 5, Ratchaburi Province, reported a decrease

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in anemia prevalence among infants from 16.9% at 6 months of age to 13.4% at 9 months, and further to 6.7% at 12 months following therapeutic iron supplementation. Similarly, among infants diagnosed with anemia at 9 months, which was 23.3%, iron supplementation reduced the prevalence to 18.5%. These findings underscore the importance of early initiation of iron supplementation at age 6 months to achieve better outcomes[5]. This evidence is in concordance with the findings of Silva Neto et al. (2019) and Parkin et al. (2021), who reported that iron supplementation in non-anemic children led to significant increases in hemoglobin (3.19 g/dL)[6] and serum ferritin (16.9 μg/L)[7], respectively. Daily iron supplementation has been shown to be superior to weekly dosing for anemia prevention. Pattrakornkul et al. (2021) found that daily iron supplementation was more effective in increasing iron storage and hemoglobin levels in non-anemic infants aged 6 to 12 months. Consequently, a daily intake of 10 mg elemental iron is recommended to optimize iron status and prevent anemia, particularly for exclusively breastfed infants[8].

Despite the proven benefits, adherence remains a significant challenge. Inconsistent iron intake was observed in 38.9% of infants aged 6 to 9 months and 26.9% of those aged 9 to 12 months at Health Promotion Hospital Center 5[5]. To address this issue, a study conducted in China demonstrated that reminder messaging improved adherence rates and reduced anemia prevalence. The adherence rate increased from 40.4% to 44.9% overall, and among anemic infants, adherence improved from 36.7% to 45.3%. Additionally, the intervention contributed to a 7% reduction in anemia prevalence. These findings suggest that digital reminders or caregiver education programs could be effective strategies for improving iron supplementation adherence and reducing the burden of iron deficiency anemia[9].

Research by Gera et al. (2012) demonstrated that an iron-rich diet effectively increases iron stores and hemoglobin levels in both children and adults. In children, combining an iron-rich diet with iron supplementation resulted in a greater hemoglobin increase of 0.53 g/dL compared to diet alone[10]. This finding aligned with a meta-analysis by Athe et al. (2013), which indicated that an iron-rich diet could increase hemoglobin levels by 0.474 g/dL in children under 10 years of age[11].

This randomized controlled trial study aimed to evaluate the effectiveness of nutritional education combined with nutrition reminders and iron supplementation reminders compared with standard iron supplementation over a 3-month period in preventing iron deficiency anemia among infants aged 6 to 12 months at Naresuan University Hospital. The secondary objectives were to assess the effects of nutritional reminder services on adherence to iron-rich food consumption and the amount of iron intake, as well as to evaluate the effects of iron supplementation reminders on adherence to iron administration. To enhance parental awareness of the consequences of iron deficiency and emphasize the importance of incorporating iron-rich foods alongside consistent iron supplementation to prevent iron deficiency anemia.

Materials and Methods

Ethical approval statement

The present study protocol was reviewed and approved by the Naresuan University Institutional Review Board (NU-IRB) (No. P3-0012/2566). Informed consent was obtained from their parents prior to study enrollment. All data was collected exclusively for statistical analysis, and confidentiality of personal information was strictly maintained.

Recruitment

This randomized controlled trial enrolled infants aged 6 to 12 months who presented for routine vaccinations at the Well Baby Clinic, Department of Pediatrics, Naresuan University Hospital, between May 1, 2023, and September 30, 2024.

Inclusion criteria required participants to have a hemoglobin concentration of at least 10.5 g/dL. Their parents possessed electronic devices enabling access to the LINE platform and were able to listen, speak, and read in the Thai language.

Preterm birth, postnatal complications necessitating resuscitation or blood transfusion, chronic illnesses (e.g., anemia, cardiac disorders, pulmonary disorders, hepatic disorders, neurological disorders, developmental delays, and malnutrition), thalassemia disease, and prior received iron supplementation were excluded from the study.

Sample size calculation

The sample size determination was based on a pilot study. Sample size calculation was performed using Stata software. The assumptions included a mean hemoglobin level of 11.0±0.5 g/dL in the standard care group and 11.5±0.5 g/dL in both reminder groups (delta hemoglobin 0.5 g/dL). A two-sided test with a significance level of 0.05 and a

power of 0.80 was applied. The calculated sample size was 48 participants, with an allocation ratio of 1:1:1 among the nutritional education and reminder for iron-rich food group, the iron supplements reminder-only group, and the standard therapy groups, based on a randomized controlled trial design.

Data collection

Participants were randomly assigned to three study groups using block randomization with a block size of six. Randomization was performed using a computer-generated program, and participants were allocated sequentially based on the order in which their parents provided written informed consent.

Baseline characteristics, including sex, age, birth weight, birth length, weight, length, underlying disease, current medication, family and caregiver history, and dietary intake, were obtained. All participants underwent a complete blood count (CBC). All eligible participants were advised to provide iron-rich complementary diets to their infants and received prophylactic ferrous sulfate drops at a dose of 12.5 mg orally once a week, according to Ministry of Public Health guidelines. Parents assigned to the nutritional reminder for iron-rich foods group and the iron supplement reminder group were added to a LINE messaging group, which allowed two-way communication, and received weekly reminder messages in text and picture format every Friday at 8:00 AM for three months. Parents in the nutritional reminder for iron-rich foods group received nutritional education on the types and portions of iron-rich foods, combined with nutritional reminders and education on iron deficiency anemia. Parents in the iron supplement reminder group received iron supplement reminders in text format and education on iron deficiency anemia.

At the three-month follow-up, coinciding with scheduled vaccinations, a post-study CBC was performed. Additional data collected included adherence to iron supplementation, iron-rich dietary consistency, and estimated elemental iron intake. Adherence to iron supplements was assessed by questioning parents and verifying the amount of medication remaining. Parents recorded all foods and portion sizes consumed at each meal, and dietary iron intake was calculated from these records.

Statistical analysis

For continuous data, descriptive statistics were applied. If the data followed a normal distribution, results were presented as mean and standard deviation. For categorical data, frequency distribution and percentage were used to summarize the findings. To compare differences among groups, statistical analyses were conducted. Continuous data were analyzed using ANOVA, while categorical data were analyzed using the chi-square test. A significance level of 0.05 was set for statistical analysis. Data analyses were carried out using Stata, version 12 (StataCorp LP, College Station, TX, USA).

Results

The present study initially enrolled 76 participants. Based on blood test results, 20 individuals (26.3%) were excluded due to anemia, leaving 56 eligible participants. These participants were allocated into three groups: 18 participants (32.2%) in the nutritional reminder for iron-rich food group, 19 (33.9%) in the iron supplements reminder group, and 19 (33.9%) in the standard therapy group. Following the second appointment, seven participants withdrew from the study. Forty-nine participants completed the follow-up visits as scheduled (Figure 1). These participants were allocated into three groups: 14 (28.6%) in the nutritional reminder for iron-rich food group, 19 (38.8%) in the iron supplements reminder group, and 16 (32.6%) in the standard therapy group.

The baseline characteristics of the participants are summarized in Table 1. The study population included 25 males (51.0%) and 24 females (49.0%), with a mean age of 8 months, a mean birth weight of 3,050.1 g, and a mean birth length of 50.5 cm. Prior to study enrollment, the participants had a mean body weight of 8,384.0 grams and a mean body length of 70.7 cm. Baseline characteristics were comparable across all three groups in terms of age, weight, length, family information, and pre-study nutrition, with no statistically significant differences except for gender distribution ($p=0.033$).

Adherence to the daily consumption of age-appropriate iron-rich complementary foods was highest in the nutritional reminder for iron-rich food groups, with nine participants (64.3%). The mean daily elemental iron intake from food in these groups was also the highest at 1.88±0.99 mg/day. However, the difference among groups was not statistically significant (Table 2).

In the iron supplements reminder groups, 11 participants (57.9%) adhered to the prescribed iron supplement regimen (Table 3). Additionally, 14 participants (77.8%) in this group administered the supplement more than one hour apart from milk feeding, which was higher than the other

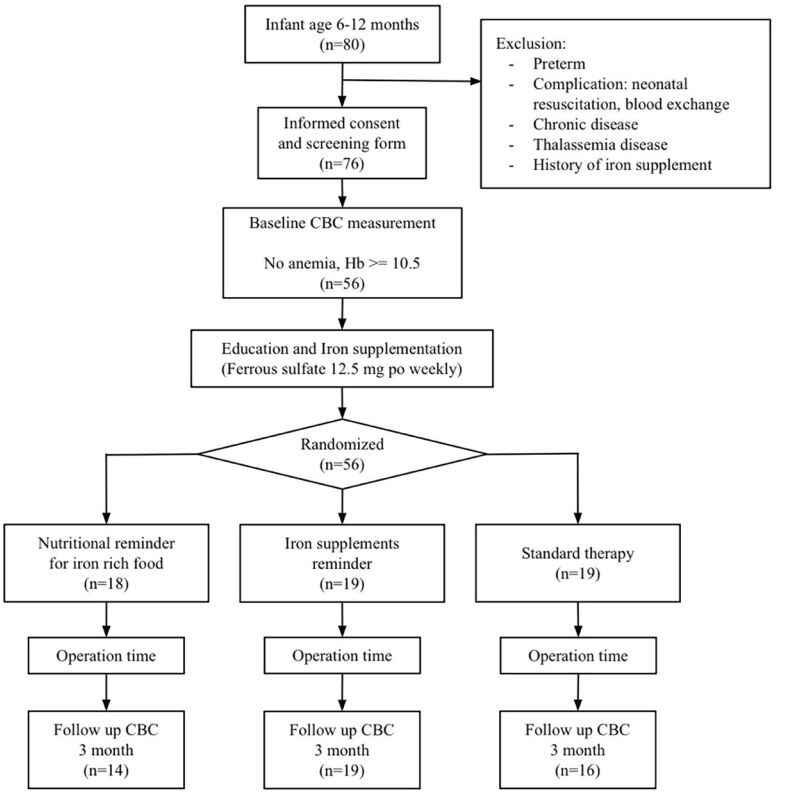

Figure 1. Flow diagram of participant enrollment.

Table 1. Comparison of baseline characteristics between studied groups

Demographic features	Nutritional reminder for iron-rich food group (n=14)	Iron supplements reminder group (n=19)	Standard therapy group (n=16)	p-value
General information				
Sex; n (%)				0.033
• Male	8 (57.0)	13 (68.0)	4 (25.0)	
• Female	6 (43.0)	6 (32.0)	12 (75.0)	
Age (months); mean±SD	8.3±1.2	7.9±1.6	7.9±1.4	0.679
Pre-study weight (g); mean±SD	8,283.6±821.6	8,607.6±1,172.2	8,206.3±1,110.8	0.499
Pre-study length (cm); mean±SD	70.1±3.4	71.7±4.5	69.9±3.1	0.349
Post-study weight (g); mean±SD	8,986.8±803.8	9,572.1±1,301.9	9,168.7±1,372.0	0.363
Post-study length (cm); mean±SD	74.2±3.8	75.1±3.1	73.9±3.2	0.582
Underlying disease; n (%)	1 (7.0)	2 (11.0)	1 (6.0)	0.887
Family information				
Maternal anemia; n (%)	1 (7.0)	0 (0.0)	0 (0.0)	0.279
Daycare; n (%)	2 (14.0)	0 (0.0)	2 (12.5)	0.248
Pre-study nutritional information				
Nutrition n (%)				0.652
• Breast milk only	0 (0.0)	1 (5.0)	1 (6.0)	
• Breast milk with formula	0 (0.0)	0 (0.0)	0 (0.0)	
• Complementary food	14 (100)	18 (95.0)	15 (94.0)	

SD=standard deviation

Table 2. Comparison of adherence to iron-rich foods between studied groups

Variables	Nutritional reminder for iron-rich food group (n=14)	Iron supplements reminder group (n=19)	Standard therapy group (n=16)	p-value
Adherence information for iron-rich food				
Frequency of iron-rich complementary food intake; n (%)				0.642
• No Iron-rich food intake	1 (7.1)	1 (5.3)	1 (6.2)	
• Iron-rich food for 1-3 days/week	0 (0.0)	1 (5.3)	3 (18.8)	
• Iron-rich food for 3-4 days/week	2 (14.3)	2 (10.5)	1 (6.2)	
• Iron-rich food for 5-6 days/week	2 (14.3)	5 (26.3)	5 (31.3)	
• Iron-rich food daily	9 (64.3)	10 (52.6)	6 (37.5)	
Estimated elemental iron-rich food intake in past 3 months				
Elemental iron (mg/day); mean±SD	1.88±0.99	1.38±0.91	1.51±1.46	0.459

SD=standard deviation

Table 3. Comparison of adherence to iron supplementation between studied groups

Variables	Nutritional reminder for iron-rich food group (n=14) n (%)	Iron supplements reminder group (n=19) n (%)	Standard therapy group (n=16) n (%)	p-value
Frequency of iron supplementation consumption				0.099
No consumption	4 (28.6)	1 (5.3)	7 (43.8)	
Missed dose 3 times/month	2 (14.3)	1 (5.3)	2 (12.5)	
Missed dose 2 times/month	4 (28.6)	3 (15.8)	2 (12.5)	
Missed dose 1 time/month	0 (0.0)	3 (15.8)	2 (12.5)	
As prescribed regimen	4 (28.6)	11 (57.9)	3 (18.8)	

Table 4. Comparison of iron supplementation consumption and adverse effect between studied groups

Variables	Nutritional reminder for iron-rich food group who consumed iron supplement (n=10) n (%)	Iron supplements reminder group who consumed iron supplement (n=18) n (%)	Standard therapy group who consumed iron supplement (n=9) n (%)	p-value
Timing of iron supplementation consumption				0.937
Immediately before or after meals	2 (20.0)	4 (22.2)	3 (33.3)	
>1 hour apart from milk	8 (80.0)	14 (77.8)	6 (66.7)	
Adverse effects	0.137			
Nausea and vomiting	0 (0.0)	1 (5.6)	2 (22.2)	
Diarrhea	0 (0.0)	0 (0.0)	1 (11.1)	

two groups. However, these differences were not statistically significant (Table 4). Reported adverse effects included nausea and vomiting in three participants (6.1%) and diarrhea in one (2.0%), with no statistically significant differences in adverse event rates across groups.

A comparison of CBC parameters before and after the study revealed no statistically significant differences among the three groups in hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW) (Table 5). Notably, the highest post-study hemoglobin level (11.83±0.78 g/dL) and hematocrit level (35.06±1.83%) were observed in the iron supplements reminder group.

Subgroup analysis based on the frequency of iron-rich complementary food intake showed that, among participants in the nutritional reminder for iron-rich food group, those who consumed iron-rich complementary foods daily exhibited a statistically significant increase in post-study hemoglobin levels of 0.47±0.78 g/dL compared to those who consumed such iron-rich complementary foods six days per week or less (Table 6).

Subgroup analysis of iron supplementation adherence revealed that participants across all three groups who adhered strictly to iron supplementation

Table 5. Comparison of pre-study and post-study blood test between studied groups

Variables	Nutritional reminder for iron-rich food group (n=14) Mean±SD	Iron supplements reminder group (n=19) Mean±SD	Standard therapy group (n=16) Mean±SD	p-value
Pre-study and post-study blood test				
Hemoglobin (g/dL)				
• Pre-study	11.69±1.30	11.85±0.86	11.62±0.87	0.787
• Post-study	11.59±0.94	11.83±0.78	11.54±0.70	0.526
• Difference	−0.10±1.44	−0.02±0.80	−0.08±0.93	0.974
Hematocrit (%)				
• Pre-study	35.31±4.17	35.17±2.32	34.69±2.83	0.843
• Post-study	34.63±2.51	35.06±1.83	34.52±1.89	0.716
• Difference	−0.68±4.64	−0.11±2.62	−0.17±2.99	0.881
MCV (fL)				
• Pre-study	71.05±5.97	70.75±5.63	72.97±3.77	0.421
• Post-study	71.07±4.90	70.59±6.21	72.80±3.97	0.441
• Difference	0.02±2.61	−0.16±2.06	−0.17±1.85	0.964
MCH (pg)				
• Pre-study	23.55±2.40	23.84±2.66	24.48±1.56	0.521
• Post-study	23.80±1.91	23.88±2.93	24.34±1.72	0.778
• Difference	0.25±0.78	0.04±0.97	−0.13±0.61	0.447
MCHC (g/dL)				
• Pre-study	33.09±0.93	33.67±1.28	33.51±0.99	0.322
• Post-study	33.44±0.82	33.73±1.56	33.43±1.10	0.718
• Difference	0.34±0.71	0.05±0.83	−0.09±0.81	0.326
RDW (%)				
• Pre-study	14.31±1.69	13.58±1.56	13.20±0.91	0.107
• Post-study	14.52±2.38	13.79±1.99	13.49±1.04	0.314
• Difference	0.21±1.92	0.22±1.37	0.29±0.94	0.985

SD=standard deviation; MCV=mean corpuscular volume; MCH=mean corpuscular hemoglobin; MCHC=mean corpuscular hemoglobin concentration; RDW=red cell distribution width

Table 6. Comparison of adherence to iron-rich foods with blood test between subgroups

Variables	Nutritional reminder for iron-rich food group			Iron supplements reminder group			Standard therapy group		
	Consumed iron-rich food daily (n=9) Mean±SD	Consumed iron-rich food ≤6 days/week (n=5) Mean±SD	p-value	Consumed iron-rich food daily (n=10) Mean±SD	Consumed iron-rich food ≤6 days/week (n=9) Mean±SD	p-value	Consumed iron-rich food daily (n=6) Mean±SD	Consumed iron-rich food ≤6 days/week (n=10) Mean±SD	p-value
Pre-study and post-study blood test									
Hemoglobin (g/dL)									
• Pre-study	11.17±0.70	12.62±1.66	0.038*	11.83±0.71	11.87±1.04	0.929	11.67±0.56	11.59±1.04	0.871
• Post-study	11.63±1.08	11.5±0.71	0.810	12.02±0.83	11.61±0.72	0.268	11.67±0.60	11.46±0.77	0.585
• Difference	0.47±0.78	−1.12±1.87	0.042*	0.19±0.83	−0.26±0.74	0.236	0.00±0.80	−0.13±1.04	0.797
Hematocrit (%)									
• Pre-study	33.74±1.88	38.12±5.83	0.056	34.61±1.46	35.79±2.98	0.281	34.53±2.06	34.78±3.31	0.873
• Post-study	34.89±2.71	34.16±2.30	0.622	35.04±2.00	35.08±1.73	0.966	34.93±1.26	34.27±2.21	0.516
Difference	1.14±1.89	−3.96±6.48	0.154	0.43±2.40	−0.71±2.86	0.358	0.40±2.54	−0.51±3.31	0.574
MCV (fL)									
• Pre-study	69.59±5.57	73.68±6.33	0.233	72.04±6.11	69.32±4.99	0.306	72.70±4.47	73.13±3.53	0.834
• Post-study	69.86±4.34	73.26±5.58	0.227	71.55±7.04	69.53±5.34	0.495	73.10±3.84	72.62±4.23	0.824
• Difference	0.27±2.63	−0.42±2.80	0.655	−0.49±2.02	0.21±2.15	0.474	0.40±1.89	−0.51±1.83	0.358

SD=standard deviation; MCV=mean corpuscular volume

Table 7. Comparison of adherence to iron supplementation with blood test between subgroups

Variables	Nutritional reminder for iron-rich food group			Iron supplements reminder group			Standard therapy group		
	Consumed iron supplement as prescribed regimen (n=4) Mean±SD	Consumed iron supplement ≤3 weeks/month (n=10) Mean±SD	p-value	Consumed iron supplement as prescribed regimen (n=10) Mean±SD	Consumed iron supplement ≤3 weeks/month (n=8) Mean±SD	p-value	Consumed iron supplement as prescribed regimen (n=3) Mean±SD	Consumed iron supplement ≤3 weeks/month (n=13) Mean±SD	p-value
Pre-study and post-study blood test									
Hemoglobin (g/dL)									
• Pre-study	11.03±0.30	11.95±1.46	0.083	11.74±0.63	12.00±1.13	0.523	11.77±0.76	11.58±0.92	0.756
• Post-study	11.75±0.65	11.52±1.05	0.695	11.99±0.8	11.60±0.75	0.296	12.07±0.31	11.42±0.71	0.152
• Difference	0.73±0.46	−0.43±1.58	0.185	0.25±0.77	−0.40±0.72	0.077	0.30±0.95	−0.17±0.94	0.450
Hematocrit (%)									
• Pre-study	33.13±0.87	36.18±4.68	0.229	34.60±1.46	35.95±3.09	0.220	34.93±2.38	34.63±3.01	0.874
• Post-study	34.80±1.19	34.56±2.93	0.879	35.15±1.88	34.93±1.87	0.795	35.87±0.23	34.21±1.98	0.179
• Difference	1.68±1.39	−1.62±5.20	0.245	0.55±2.24	−1.03±2.97	0.203	0.93±2.35	−0.42±3.14	0.498
MCV (fL)									
• Pre-study	69.73±7.24	71.58±5.73	0.619	70.74±5.84	70.78±5.71	0.989	73.57±4.81	72.83±3.71	0.772
• Post-study	69.50±4.36	71.70±5.18	0.470	70.31±6.54	70.99±6.13	0.822	73.63±4.70	72.61±3.97	0.701
• Difference	−0.23±3.18	0.12±2.53	0.833	−0.43±1.92	0.21±2.31	0.519	0.07±0.40	−0.22±2.05	0.645

SD=standard deviation; MCV=mean corpuscular volume

demonstrated increased post-study hemoglobin and hematocrit levels compared to those who consumed an iron supplement for three weeks per month or less. However, these differences were not statistically significant (Table 7).

At the three-month follow-up, five participants (10.2%) were found to have anemia (hemoglobin of less than 10.5 g/dL). Among these, two were from the nutritional reminder for iron-rich food groups, two from the iron supplements reminder groups, and one from the standard therapy group. The participant in the standard therapy group had neither consumed iron-rich foods nor iron supplementation. In contrast, participants in the nutritional reminder for iron-rich food groups demonstrated consistent daily intake of iron-rich complementary foods, but their average elemental iron intake was only 0.95 mg/day, with poor adherence to iron supplementation. Participants in the iron supplements reminder groups exhibited consistent adherence to both iron-rich diet and iron supplementation; however, their average elemental iron intake remained low at 1.15 mg/day, which was below the recommended daily intake.

Discussion

The present study was conducted among children aged 6 to 12 months attending a well-baby clinic for routine vaccinations. Twenty participants (26.3%) were excluded due to anemia, consistent with national data from Thailand in 2011, which reported anemia prevalence of 41.7% in rural areas and 26% in urban areas among children aged 6 months to 2.9 years[2]. Similarly, the Global Health Observatory data from the WHO in 2021 reported a 24.9% prevalence of anemia in Thai children under five years of age[12].

After three months of follow-up with prophylactic iron supplementation in non-anemic infants, anemia was found in five participants (10.2%). This finding aligns with studies by Chueasuwanchai (2022) and Obmalee (2022), which reported anemia prevalence of 10.24%[13] and 12%[14], respectively, in infants receiving 12.5 mg of prophylactic iron once weekly for one month. However, it was lower than the prevalence reported by Aphikulchatkit (2020), which was 35.29%[15] in a similar age group.

The present study found that the nutritional reminder for the iron-rich food group and the iron supplements reminder group did not significantly outperform the standard therapy group in preventing iron deficiency anemia. This contrasts with the findings of Ismail et al. (2022), who reported a 40% reduction in anemia among children aged one to three years after three months of nutritional counseling[16], and Zhou et al. (2016), who reported a 7% reduction in anemia among children aged 6 to 12 months receiving reminders for iron supplement intake over six months[9]. One explanation is that these prior studies focused on children already diagnosed with anemia, which may have increased parental adherence, whereas the present study enrolled only non-anemic participants. Additionally, standard care included iron supplementation, which was also prescribed to the other two groups. This may have influenced the finding that hemoglobin levels did not

differ among the three groups. Another limitation of the present study is that baseline CBC measurements were not obtained at the same age, ranging from 6 to 12 months, which may have affected the findings, particularly with respect to anemia screening at nine months of age.

The nutritional reminder for iron-rich food groups showed improved consistency in consuming iron-rich foods and higher iron intake; however, the differences were not statistically significant. This contrasts with the study of Ismail et al. (2022), where dietary behavior in children aged one to three years improved markedly, from 35% to 84% consuming iron-rich foods after three months[16]. Most participants in the present study consumed insufficient dietary iron based on the Thai Ministry of Public Health's guidelines, which recommend 9.3 mg/day of elemental iron for children aged six months to two years[4]. The likely explanation is that children aged 6 to 12 months primarily rely on milk, which contains low iron. Therefore, iron supplementation remains critical. This contrasts with data from U.S. children of the same age in 2016, who consumed an average of 13.4±0.4 mg/day of iron[17].

The iron supplements reminder groups demonstrated better adherence, though the difference was not statistically significant. This finding contrasts with Zhou et al. (2016), who reported a 10% improvement in adherence among children with iron deficiency anemia[9]. Additionally, Sontakke et al. (2022) observed that the group receiving medication reminders exhibited a significant increase in consistent iron supplementation, rising from 48% to 93% compared to the control group[18]. As previously mentioned, caregivers of anemic children may be more motivated to comply with supplementation. In the present study, 31 participants (63.2%) were inconsistent with iron supplementation, including eight (25.8%) in the iron supplements reminder group, 10 (32.3%) in the nutritional reminder for iron-rich food group, and 13 (41.9%) in the standard therapy group. This is consistent with Obmalee (2022), which found 35% non-adherence due to caregivers forgetting to administer the supplement or children refusing the medication[14].

Subgroup analysis showed that daily consumption of iron-rich food and adherence to prescribed iron supplementation were associated with greater improvements in hemoglobin and hematocrit levels. Therefore, combining nutritional education with prophylactic iron supplementation plays a key role in preventing iron deficiency anemia in children.

Conclusion

The outcome of the nutritional reminder for iron-rich food and iron supplements reminder on iron deficiency anemia prevention in infants is not superior compared to standard treatment in children aged 6 to 12 months. The nutritional reminder for iron-rich food groups showed a statistically significant increase in hemoglobin level. Therefore, nutritional education with prophylactic iron supplementation remains essential in preventing iron deficiency anemia in children.

What is already known about this topic?

Iron deficiency anemia is among the most common nutritional deficiencies affecting infants aged 6 to 24 months. In Thailand, the Ministry of Public Health recommends a weekly prophylactic iron supplementation regimen, which has been shown to reduce the prevalence of anemia. However, adherence to supplementation and adequate dietary iron intake remains suboptimal.

What does this study add?

Among non-anemic Thai infants aged 6 to 12 months, nutritional education combined with reminders for iron-rich foods or iron supplementation did not demonstrate superior effectiveness compared with standard prophylactic supplementation in preventing iron deficiency anemia. Nevertheless, infants in the nutritional reminder group who consistently consumed iron-rich complementary foods achieved a significant increase in hemoglobin levels. These findings highlight the critical role of consistent adherence to both iron supplementation and iron-rich diets, reinforcing that nutritional education in conjunction with prophylactic supplementation remains essential for anemia prevention in early childhood.

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Authors' contributions

Conceptualization: NY and PP. Methodology: NY and PP. Data curation: PP. Formal analysis: NY and PP. Writing-original draft: PP. Writing-review & editing: NY. Supervision: NY. All authors have read and agreed to the published version of the manuscript.

Data availability statement

All data were collected exclusively for statistical analysis, and the confidentiality of personal information was strictly maintained. The de-identified dataset from this study is available from the corresponding author upon reasonable request and appropriate ethics approval. Public data sharing is restricted in accordance with the requirements of the Naresuan University Institutional Review Board Committee and due to concerns regarding the privacy of pediatric patients.

Ethics approval and consent to participate

This study protocol was reviewed and approved by the Naresuan University Institutional Review Board (NU-IRB) (No. P3-0012/2566). Informed consent was obtained from the parents of the participants prior to study enrollment. All data was collected exclusively for statistical analysis, and confidentiality of personal information was strictly maintained.

Clinical trial registration

This study was not registered as a clinical trial.

Use of artificial intelligence

This manuscript was prepared without the use of any artificial intelligence.

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Conflicts of interest

The authors have no conflicts of interest to disclose.

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