Research Article

Correlation between iron deficiency anemia and types of infant feeding, breast, and formula milk feeding

Mohammad Abdulla Grmt[1], Alaa Saed Abass[1], Maitham Ghaly Yousif[2]*, Abdul razaqWehab Abdulla[1]

ABSTRACT

Background: Iron deficiency anemia (IDA) consider one of the most nutritional problems in world, the infants aged from 9 to 12 months, school-age children, and pregnant women are the most frequent risk group, the consequences of iron deficiency on the small children include weakness in immune system, growth defect, and neurological system disturbance. **Materials and Methods:** During period of 5 months of 6 months from July to the end of December 2014, a total of 100 full-term infants from aged 9 to 12 months were studied in vaccination unit in Al-Zahra Teaching Hospital. A venous blood samples were taken and were analyzed for hemoglobin (Hb), packed cell volume (PCV), blood film, and serum ferritin. **Results:** The mean values of Hb, PCV, and serum ferritin of breastfed infants were 105 ± 2 g/l, 32.4 ± 0.17%, and 15.18 ± 1 µg/l, respectively, which were significantly lower than those of formula fed (FF) infants (111 ± 2 g/l, 33.9 ± 0.6%, and 34 ± 2 µg/ml, $P < 0.05$). Anemia was found in 24 BF infants (48%) compared with 11 FF infants (22%). The proportion of IDA in BF infants was significantly higher than FF infants (34% vs. 10%, $P < 0.001$). Risk factors of IDA included low weight, breastfeeding, inadequate complementary food, low maternal education, and low socioeconomic status (adjusted RR: 4.7, 3.4, 2.8, 5.3, and 1.9, respectively). **Conclusion:** IDA is more prevalent in BF than FF infants. Risk factors of IDA are low birth weight, breastfeeding, inadequate complementary food, low maternal education, and low socioeconomic status. Prevention of IDA in infants should be achieved through adequate iron-rich complementary food and screening for Hb or PCV at 9–12 months of age in the high-risk infants.

KEY WORDS: Breastfeeding, Formula feeding, Iron deficiency anemia

INTRODUCTION

The term anemia generally can be defined as a reduction below normal in the concentration of hemoglobin (Hb) or red blood cells (RBC) in the blood, and the lower limits of the normal range depend on the age and sex of the subjects.[1] More than 500 million people have iron deficiency anemia (IDA).[2] Iron deficiency is a result of the amount of dietary iron absorbed being insufficient to meet iron requirements.[3] This situation is more common when iron requirements increase during pregnancy and growth, when iron is lost in menses or through some parasitic infections, and when food constituents impair iron absorption.[4] Furthermore, during breast infection by *Staphylococcus aureus* may lead to in suffusion milk feeding.[5] However, by 2–6 months, infants iron stores are depleted and they become increasingly dependent on an external iron supply. Important sources of iron supply for infants are breast milk and cow's milk.[6] Therefore, the most critical period in terms of adequacy of iron stores starts with weaning (usually 6 months of age) and lasts throughout the period of rapid growth (usually up to 24 months of age).[7]

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MATERIALS AND METHODS

Over a period of 6 months from July to the end of December 2014, a total of 100 infants (55 girls and 45 boys) whose age was between 9 and 12 months were included in this study. They were collected when they attended Al-Zahra Teaching Hospital. The inclusion criteria were as follows:

1. Born at 37–42 weeks of gestation (full-term baby).
2. Mothers planned to feed their infants either breast milk or formula milk. The exclusion criteria were as follows:
   - Preterm infants that is because they had less iron storage so they were more susceptible for IDA
   - Mixed fed infants because this will interact with the results

[1]Department of Haematology, Al-sadder medical City, Najaf Health Directorate, Najaf, Iraq, [2]Department of Biology, College of Science, University of Al-Qadisiyah, Al Diwaniyah, Iraq

***Corresponding author:** Maitham Ghaly Yousif, Department of Biology, College of Science, University of Al-Qadisiyah, Al Diwaniyah, Iraq. E-mail: matham.yousif@qu.edu.iq

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- Infants or mothers who had a chronic illness or need some medications on regular basis
- Infants with congenital anomalies.

The infants were categorize into four groups according to their age (9 months, 10 months, 11 months, and 12 months), according to the adequacy of diet into adequate diet and inadequate diet, to the low birth weight (LOW) into absent or present, to maternal education into primary, secondary, and college education, to social status into low, middle, and high social status, and to the parity of the mother into para 1, 2, 3, 4, and 5 or more. Solid foods were introduced after 4 months of age in these infants, adequate complementary food was a consumed a variety of food from various food groups (rice, grain, vegetables, fruits, milk, eggs, meat, and fat), which had adequate amount of nutrient.[8] The socioeconomic status made up of many variables and it is difficult to quantify, in this study, we included the family income and education of the parents (e.g., the high income and high education regarded as high socioeconomic status).[9] By the age of 9–12 months, and because of the rapid growth of the infants the anemia at this age will become more apparently.

In this study, infants who had hemoglobin concentrations <110 g/l were consider to have anemia, and if the serum ferritin concentrations of these infants were <12 mg/dl, these infants were considered to have IDA these values were according to the definitions of anemia and IDA by the W.H.O.[10]

Methods

From each infant about 2 ml of venous blood was withdrawn by a sterile disposable syringe at time between 9 and 11 am to avoid diurnal variations.[11]

Blood samples were divided into two parts:

1. One ml of blood was added to a tube containing EDTA as anticoagulant for hematological investigations (Hb, packed cell volume [PCV], blood film, and Retic count)
2. One ml of blood was collected in a clean plain plastic tube and was allowed to clot for about 30 min, before centrifugation, the serum obtained used for the estimation of ferritin concentration.

Hematological Investigations

It was done on the same day of collection of each patch of samples using standard methods described by Dacie and Lewis.[11]

Table 1: Descriptive characteristics of the FF and BF infants

Parameter	Formula fed		Breastfed		Sig. value
	n	%	*n*	%	
Sex					
Girl	27	54.0	28	56.0	-
Boy	23	46.0	22	44.0	
Age groups (months)					
9	9	18.0	6	12.0	0.639
10	17	34.0	14	28.0	
11	14	28.0	16	32.0	
12	10	20.0	14	28.0	
Diet					
Adequate diet	11	22.0	15	30.0	0.362
Inadequate diet	39	78.0	35	70.0	
Low birth weight					
Absent	43	86.0	42	84.0	0.779
Present	7	14.0	8	16.0	
Maternal education					
Primary	20	40.0	19	38.0	0.914
Secondary	22	44.0	24	48.0	
College	8	16.0	7	14.0	
Social status					
Low	16	32.0	22	44.0	0.414
Middle	25	50.0	19	38.0	
High	9	18.0	9	18.0	
Parity					
1	12	24.0	17	34.0	0.806
2	12	24.0	9	18.0	
3	12	24.0	10	20.0	
4	7	14.0	6	12.0	
5 or more	7	14.0	8	16.0	

*Significant difference using independent Student's *t*-test at level of 0.05. FF: Formula fed, BF: Breastfed

Table 2: Comparison of hematological data between breastfed and formula

Test	Formula fed	Breastfed	Sig. value
Hemoglobin (g/l)	111.60±2.14 (75.00–130.00)	105.54±2.13 (76.00–130.00)	0.03*
PCV %	33.90±0.62 (23.00–40.00)	32.48±0.17 (24.00–40.00)	0.021*
MCHC (g/l)	330.38±1.75 (300.00–360.00)	323.74±1.53 (300.00–346.00)	0.005*
Retic count	1.57±0.13 (0.50–5.00)	1.38±0.12 (0.50–3.40)	0.285
Serum ferritin (ng/ml)	34.02±2.01 (7.00–75.00)	15.18±1.18 (4.00–42.00)	0.0001*

*Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration

Table 3: Blood film finding in formula fed and breastfed infants

Blood film finding	Formula fed		Breastfed		Sig. value
	n	%	*n*	%	
Hypochromic microcytic	6	12.0	17	34.0	0.06
Macrocytosis	3	6.0	4	8.0	
Normochromic normocytic	38	76.0	26	52.0	
Anisocytosis	2	4.0	3	6.0	
Spherocytosis	1	2.0	-	-	

Significant difference using independent Student's *t*-test at level of 0.05

Table 4: Distribution of hematological parameter according to the sex of infants

Hematological data	Feeding	
	Formula fed	Breastfed
Hemoglobin (g/l)		
Girl	109.30±2.79	103.26±3.23
Boy	114.30±3.28	108.22±3.49
P value	0.247	0.302
PCV%		
Girl	33.19±0.85	31.81±0.89
Boy	34.74±0.89	33.26±1.00
P value	0.214	0.284
MCHC (g/l)		
Girl	331.85±2.61	323.52±2.49
Boy	328.65±2.28	324.00±1.66
P value	0.368	0.878
Retic count%		
Girl	1.51±0.19	1.51±0.16
Boy	1.64±0.18	1.24±0.16
P value	0.604	0.250
Serum ferritin (ng/ml)		
Girl	35.52±2.74	16.63±1.95
Boy	32.26±2.97	13.48±1.11
P value	0.424	0.187

*Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration

Table 5: Distribution hematological parameters according to the age of infants

n	Feeding	
	Formula fed (50)	Breastfed (50)
Hemoglobin (g/l)		
9 months–15	108.56±4.65	96.50±6.81
10 months–31	114.24±3.94	104.57±5.20
11 months–30	112.00±4.47	106.37±4.09
12 months–24	109.30±4.14	109.43±3.88
Sig. value	0.783	0.472
PCV%		
9 months–15	33.00±1.46	29.83±1.99
10 months–31	34.59±1.00	32.50±1.42
11 months–30	34.36±1.23	32.56±1.15
12 months–24	32.90±1.52	33.50±1.13
Sig. value	0.700	0.478
MCHC (g/l)		
9 months–15	328.78±1.98	322.67±4.44
10 months–31	331.12±3.00	321.21±2.85
11 months–30	325.79±3.58	325.81±2.80
12 months–24	337.00±4.35	324.36±3.01
Sig. value	0.173	0.707
Retic count		
9 months–15	1.96±0.43	1.43±0.39
10 months–31	1.26±0.12	1.55±0.18
11 months–30	1.67±0.28	1.24±0.20
12 months–24	1.60±0.26	1.36±0.25
Sig. value	0.302	0.781
Serum ferritin (ng/ml)		
9 months–15	34.44±4.66	10.00±1.69
10 months–31	34.88±4.29	15.50±1.54
11 months–30	34.71±3.36	14.69±2.03
12 months–24	31.20±3.58	17.64±3.02
Sig. value	0.924	0.315

*Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: MCHC: Mean corpuscular hemoglobin concentration

The Tests Done Were

1. Hemoglobin concentration using of Drabkin solution from crescent diagnostic company (CAT. No.301) and the standard from the same company (CAT.No.3400), the absorbance being read at 540 nm by spectrophotometer
2. PCV was done by capillary tubes methods that centrifuged for 5 min and reading using a reading device, the centrifuge used was manufactured by Griffin company and put in speed 12,000 g.
3. Blood smear stained with Lishman's stain for evaluate RBC morphology, by flood the slide with the stain, after 2 min, add double the volume of water and stain the film for 5–7 min. Then, wash it in a stream of buffered water until it has acquired a pinkish tinge (up to 2 min), set it up right to dry, then read using microscope.
4. Reticulocytes count by brilliant crystal blue stain by deliver 2 or 3 drops of the dye solution into a 75 mm × 10 mm plastic tube by means of a plastic Pasteur Pipette, then add 2–4 volumes of the patient's

EDTA-anticoagulated blood to the dye solution and mix, keep the mixture at 37°C for 15–20 min. Re-suspend the red cells by gentle mixing and make films on glass slides in the usual way.

- Serum ferritin, the serum obtained was stored in refrigerator for 3 days till the time of estimation of each batch of the collected samples. Serum ferritin test was quantitative determination of circulating ferritin concentration by microplate immunoenzymatic assay using kit manufactured by Monobind Inc. company (CAT.No.92630).

RESULTS

The studied sample was conducted on 100 apparently healthy infants aged between 9 and 12 months distributed as 50 breastfed (BF) and 50 formula fed (FF), girls were slightly more than boys, most infants had received inadequate diet, few of them had history of LBW, as shown in Table 1. This study showed that the Hb, PCV, and serum ferritin were significantly higher in FF infants than BF infants, but reticulocytes count shows no significance ($P = 0.28$), as shown in Table 2. Low serum ferritin (<12 ng/ml)was found in 5 cases of FF and 17 cases of BF. Low Hb (<110 g/l) was found in 11 cases of FF infants and[12] case of BF infants. The blood film study shows that most cases are normochromic normocytic and about 6 cases of FF had hypochromic microcytic compared with 17 cases of BF these cases are further assessed by serum ferritin to confirm the diagnosis of IDA. Other 6 cases in FF show macrocytosis with some hyper segmented neutrophils which supposed to be megaloblastic anemia, while in BF 7 cases show

Table 6: Relations between hematological parameters and diet adequacy

n	Feeding	
	Formula fed	**Breastfed**
Hemoglobin (g/l)		
Inadequate–74	101.82±4.86	95.33±3.94
Adequate–26	114.36±2.21	109.91±2.64
Sig. value	0.014*	0.004*
PCV%		
Inadequate–74	31.36±1.32	29.80±1.04
Adequate–26	34.62±.67	33.63±.77
Sig. value	0.028*	0.007*
MCHC (g/l)		
Inadequate–74	325.09±3.31	321.13±3.10
Adequate–26	331.87±2.00	324.86±1.74
Sig. value	0.110	0.270
Retic count		
Inadequate–74	2.25±0.39	1.12±0.17
Adequate–26	1.38±0.11	1.50±0.14
Sig. value	0.004*	0.135
Serum ferritin (ng/m)		
Inadequate–74	24.82±4.62	13.40±2.41
Adequate–26	36.62±2.07	15.94±1.34
Sig. value	0.013*	0.329

*Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration

Table 7: Relations between hematological parameters and birth weight of infants

n	Feeding	
	Formula fed	**Breastfed**
Hb (g/l)		
LBW (absent)–85	114.93±1.84	107.81±2.56
LBW (present)–15	91.14±6.32	93.63±4.52
Sig. value	0.0001*	0.027*
PCV%		
LBW (absent)–85	34.70±0.60	33.12±0.71
LBW (present)–15	29.00±1.51	29.13±1.37
Sig. value	0.001*	0.026*
MCHC (g/l)		
LBW (absent)–85	332.00±1.78	324.52±1.70
LBW (present)–15	320.43±4.91	319.63±3.31
Sig. value	0.020*	0.246
Retic count		
LBW (absent)–85	1.55±0.14	1.32±0.12
LBW (present)–15	1.67±0.30	1.71±0.38
Sig. value	0.755	0.217
Serum ferritin (ng/ml)		
LBW (absent)–85	35.37±2.03	16.55±1.29
LBW (present)–15	25.71±6.74	8.00±1.07
Sig. value	0.095	0.007*

*Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration, LBW: Low birth weight, Hb: Hemoglobin

Table 8: Relation between maternal education and hematological parameters

Haematological data	Feeding	
	Formula fed	**Breastfed**
Hemoglobin (g/l)		
Primary	104.75±3.70	98.00±3.62
Secondary	115.45±2.55	106.71±3.34
College	118.12±4.98	122.00±1.94
Sig. value	0.026#	0.003#
PCV%		
Primary	31.90±1.07	30.32±1.02
Secondary	35.00±.76	32.83±0.91
College	35.88±1.30	37.14±0.80
Sig. value	0.024#	0.003#
MCHC (g/l)		
Primary	331.00±2.95	322.00±2.89
Secondary	330.50±2.40	324.08±2.09
College	328.50±5.23	327.29±2.81
Sig. value	0.893	0.542
Retic count		
Primary	1.71±0.20	1.22±0.17
Secondary	1.44±0.21	1.62±0.17
College	1.58±0.25	1.03±0.26
Sig. value	0.643	0.124
Serum ferritin (ng/ml)		
Primary	28.70±3.15	11.42±1.46
Secondary	35.59±3.20	16.08±1.73
College	43.00±1.46	22.29±3.09
Sig. value	0.040#	0.008#

#Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration macrocytosis, as shown in Table 3. Two cases in FF and three cases in BF showed anisocytosis with some target cells. Spherocytosis seen in one cases of FF infants accompanied with increased retic count in this case, it supposed to have hemolytic anemia, as shown in Table 3. Table 4 shows that there was no significant difference between girls and boys in FF as well as BF infants. When the hematological parameters distributed according to the age of infants, it shows that Hb, PCV, mean corpuscular hemoglobin concentration, retic count, and serum ferritin level show no significant difference between the different age groups [Table 5]. Table 6 shows that there was significant difference between Hb, PCV, and serum ferritin in infants who were on adequate diet from those on inadequate diet in FF and BF infants. The Hb, PCV, and serum ferritin also have significant results among infants that have history of LOW, as shown in Table 7. Table 8 shows a significant relationship between maternal education and hematological parameters (Hb, PCV, and serum ferritin). Table 9 shows a significant relationship between socioeconomic status and Hb and PCV but not with retic and serum ferritin in BF and FF infants. Table 10 shows a significant correlation between Hb, PCV, and serum ferritin with increase parity of the mothers. Table 11 shows that anemia was found in 11 (22%) cases of FF infants with significantly lower than BF infants 24 (44%) cases. Table 12 shows IDA found in 5 cases of FF and 17 cases of BF it has a significant correlation with type of feeding (BF), diet inadequacy, history of LOW, low maternal education, low social status, and increased parity of the mother. When study the relative risk, we found that BF, diet inadequacy, history of LBW, low maternal education, and low social status had high relative risk, so those considered as a risk factor for IDA were the sex and parity have not been considered as risk factors [Table 13].

Table 9: Relation between socioeconomic status and hematological parameters

n	Feeding	
	Formula fed	Breastfed
Hemoglobin (g/l)		
Low–38	102.88±3.75	98.09±3.19
Middle–44	112.56±2.86	108.74±4.21
High–18	124.44±1.68	117.00±2.36
Sig. value	0.001[#]	0.007[#]
PCV%		
Low–38	31.25±1.07	30.32±0.89
Middle–44	34.28±0.82	33.32±1.15
High–18	37.56±0.63	36.00±0.76
Sig. value	0.001[#]	0.004[#]
MCHC (g/l)		
Low–38	334.38±4.22	321.45±2.68
Middle–44	327.52±1.70	326.42±2.23
High–18	331.22±3.85	323.67±2.58
Sig. value	0.223	0.350
Retic count %		
Low–38	1.65±0.18	1.42±0.19
Middle–44	1.72±0.21	1.35±0.18
High–18	1.02±0.18	1.38±0.25
Sig. value	0.134	0.963
Serum ferritin (ng/ml)		
Low–38	34.63±3.24	12.50±1.31
Middle–44	31.64±3.27	16.68±2.26
High–18	39.56±2.64	18.56±2.82
Sig. value	0.357	0.113

[#]Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration

DISCUSSION

Anemia is a common pediatric problem, in Western countries 5–8% of infants were reported to be anemic, while 38–82% in Asia, 22–68% in Latin America, and 17–90% in the Middle East countries were found to be

Table 10: Hematological parameters distributed according to the parity

n	Feeding	
	Formula fed	Breastfed
Hemoglobin (g/l)		
Parity 1–29	110.00±5.73	113.06±3.89
Parity 2–21	121.00±2.01	112.33±4.65
Parity 3–22	117.17±1.30	101.10±5.21
Parity 4–13	98.29±5.93	103.33±6.37
5 or more–15	102.00±5.56	89.13±3.50
Sig. value	0.003[#]	0.006[#]
PCV%		
Parity 1–29	33.92±1.65	34.41±1.12
Parity 2–21	36.00±0.80	34.00±1.38
Parity 3–22	35.50±0.60	31.80±1.52
Parity 4–13	29.86±1.64	31.50±1.88
5 or more–15	31.57±1.53	28.25±1.03
Sig. value	0.010[#]	0.023[#]
MCHC (g/l)		
Parity 1–29	328.17±3.79	326.12±2.49
Parity 2–21	335.50±2.95	330.11±2.05
Parity 3–22	330.08±3.23	317.30±3.20
Parity 4–13	328.71±7.28	325.50±3.91
5 or more–15	327.57±3.24	318.25±4.73
Sig. value	0.587	0.039[#]
Retic count%		
Parity 1–29	1.75±0.37	1.24±0.20
Parity 2–21	1.24±0.18	1.14±0.20
Parity 3–22	1.43±0.19	1.33±0.20
Parity 4–13	1.69±0.32	1.37±0.25
5 or more–15	1.94±0.39	2.04±0.40
Sig. value	0.480	0.162
Serum ferritin (ng/ml)		
Parity 1–29	31.08±5.40	20.00±2.62
Parity 2–21	41.92±3.05	16.33±0.83
Parity 3–22	32.92±3.24	12.20±1.71
Parity 4–13	34.57±4.72	13.67±2.64
5 or more–15	26.86±5.44	8.50±1.71
Sig. value	0.192	0.009[#]

[#]Significant difference using independent Student's *t*-test at level of 0.05. PCV: Packed cell volume, MCHC: Mean corpuscular hemoglobin concentration so.[13] The vast majority of cases were associated with iron deficiency.[14]

In this study found that mean values of Hb, PCV, and serum ferritin of BF infants were 105 ± 2 g/l, 32.4 ± 0.17%, and 15.18 ± 1 µg/l, respectively, which were significantly lower than those of FF infants (111 ± 2 g/l, 33.9 ± 0.6%, and 34 ± 2 ng/ml, $P < 0.05$), Table 2. Despite numerous benefits of breast milk, breastfed infants had IDA more than FF infants. This may be explained by the low iron content in breast milk; breast milk contains 0.3–0.5 mg/L of iron with 50% of iron absorption compared with 8–12 mg/L of iron content and 4–10% of absorption in iron-fortified formula.[15] Therefore, BF infants received iron from milk less than FF infants. This study revealed that anemia and IDA in infants still prevalent and the incidence of anemia in breastfed infants were higher than FF infants (48% vs. 22%); also, the incidence of IDA in breastfed infants was higher than FF infants (34% vs. 10%), these findings were in agreement with previous studies. Studies of the prevalence of anemia and IDA in Iraqi infants were limited, a study of anemia in infants by Al-Naamy in Mosul[16] found that BF was higher than FF infants (30% vs. 9%) which was in agreement with Pisacane *et al*.[17] In a study was done in Baghdad, by Arif and Al-Alwan,[18] IDA was present in 80% of Iraqi infants aged between 5 and 12 months, which was definitely exceeded this current study (63%) and this because most infants are on breastfeeding and most families being of low economic status. However, another study was done by Al-Mallah in Mosul which found that 83% of anemic infants had iron deficiency anemia.[19] Furthermore, a study was done by Yousif *et al*.[20] found that anemia was related to cervical cancer. Pizarro *et al*.[21] in Italy reported that IDA was found in 14.7% of breastfed compared with 0.6% of FF infants, whereas Calvo *et al*.[22] in Spain reported that the prevalence of anemia at 9 months of age in breastfed infants was 27.8% compared with 7.1% in FF infants and IDA was found in 27.8% of breastfed infants but none of FF infants, the low results of anemia and IDA compared with this current study are due to good nutritional habit of infants in these studies.

Table 11: The effects of risk factors on anemic infant

Parameter	Total	Anemia (Hb<110g/l)		Sig. value
		n	%	
Feeding				0.006*
Formula fed	50	11	22.0	
Breastfed	50	24	48.0	
Sex				0.644
Girl	54	20	37.0	
Boy	46	15	32.6	
Age groups (months)				
9	15	6	40.0	0.954
10	31	10	32.3	
11	30	11	36.7	
12	24	8	33.3	
Diet				
Adequate	74	18	24.3	0.0001*
Inadequate	26	17	65.4	
Birth weight				
≥2500 g	85	23	27.1	0.0001*
<2500 g	15	12	80.0	
Maternal education				
Primary	39	21	53.8	0.002*
Secondary	46	13	28.3	
College	15	1	6.7	
Social status				
Low	38	21	55.3	0.001*
Middle	44	13	29.5	
High	18	1	5.6	
Parity				
1	29	8	27.6	0.0001*
2	21	2	9.5	
3	22	6	27.3	
4	13	8	61.5	
5	15	11	73.3	

*Significant difference using independent Student's *t*-test at level of 0.05. Hb: Hemoglobin

Table 12: The effects of risk factors on IDA infants

Parameter	Total	IDA		Sig. value
		n	%	
Feeding				
Formula fed	50	5	10.0	0.004*
Breastfed	50	17	34.0	
Sex				
Girl	54	10	18.5	0.363
Boy	46	12	26.1	
Age groups (months)				
9	15	5	33.3	0.389
10	31	4	12.9	
11	30	8	26.7	
12	24	5	20.8	
Diet				
Adequate	74	11	14.9	0.004*
Inadequate	26	11	42.3	
Birth weight				
≥2500 g	85	12	14.1	0.0001*
<2500 g	15	10	66.7	
Maternal education				
Primary	39	17	43.6	0.0001*
Secondary	46	5	10.9	
College	15	-	-	
Social status				
Low	38	12	31.6	0.028*
Middle	44	10	22.7	
High	18	-	-	
Parity				
1	29	6	20.7	0.0001*
2	21	-	-	
3	22	5	22.7	
4	13	2	15.4	
5 and more	15	9	60.0	

*Significant difference using independent Student's *t*-test at level of 0.05. IDA: Iron deficiency anemia

Pisacane *et al*.[17] in the USA reported that anemia and IDA are more common in breastfed than FF (25% vs. 12%), respectively. However, breastfeeding was not a risk factor of IDA in some studies Soh *et al*.[23] in New Zealand and Male *et al*.[24] in Germany. Inadequate dietary iron as a cause of anemia is unusual before 6 months of age because iron stores are adequate, but it becomes apparent in older infants when the iron stores depleted and infants cannot get optimal iron supplementations from regular diet.[14] This study showed that inadequate complementary diet is one of important risk factors this in developing IDA [Table 13], this result was in agreement with Chuansumrit *et al*.[12] and Dewey *et al*.[25] in the USA. Furthermore, this study showed that IDA was more in infants of low socioeconomic families and low education of the mothers, as shown in Table 12, and this was in agreement with Soh *et al*.[23] in New Zealand, Kilbride *et al*.[26] in Jordon, and Al-Mallah *et al*.[19] and Yousif *et al*.[20] in Mosul. The low socioeconomic families complained form negligibility and inadequate dietary habit and will reflect their effect on infant.

Seone and Pearson[27] in England agree that poor people developed IDA more than other people, but Jacob in the USA said that IDA had no exception and was common in infancy in all countries including Western societies.[28] This study showed that the LBW is also risk factors [Table 13] this was in agreement with Soh *et al*.[23] in New Zealand and Eden and Mir[29] in England. Families with more children means more neglect to the children by caregiver and usually IDA were more common in poor families with more children, this study showed that there was a significant relationship between the increase parity of the mother and number of iron deficiency anemic infants, as shown in Table 12, this result was in agreement with Al-Mallah *et al*.[19] and Seone and Pearson.[27] This study reveals that BF, diet inadequacy, history of LOW, low maternal education, and low socioeconomic status consider as a risk factor for IDA (adjusted RR: 4.7, 3.4, 2.8, 5.3, and 1.9, respectively) [Table 13]. On the other hand, the sex of infants and the increase parity of the mothers showed low relative risk (adjusted RR: 0.7 and 1.09, respectively), as shown in Table 13.

The retic count that was done in this current study showed insignificant correlation with all variables that were taken by this study. IDA in infants is important because of its association with adverse neurodevelopmental outcomes.[30] Longitudinal studies indicated that children who were anemic in early childhood continued to have poor cognitive development and school achievement in later life. The children who had IDA in infancy had developmental scores less than non-anemic control children, suggesting that IDA at a critical period of brain growth and differentiation may produce irreversible abnormalities.[31] Because of long-term consequences of IDA, it should be prevented in every child. Recent double-blinded, randomized-controlled trials of iron supplementation in breastfed infants and preschool children demonstrated that the supplemented group had iron status and psychomotor development better than the placebo group.[30]

Table 13: Effect of risk factors on iron deficiency anemic infants

Parameter	Total	Iron deficiency anemia		Sig. value	RR (95% CI)
		n	%		
Feeding					
Formula fed#	50	5	10.0	0.004*	3.40 (1.36–8.50)
Breastfed	50	17	34.0		
Sex					
Boy	46	12	26.1	0.363	0.71 (0.34–1.49)
Girl	54	10	18.5		
Diet					
Adequate#	74	11	14.9	0.004*	2.8 (1.1–0.7.1)
Inadequate	26	11	42.3		
Birth weight					
≥2500 g#	85	12	14.1	0.0001*	4.72 (2.50–8.91)
<2500 g	15	10	66.7		
Maternal education					
Secondary and college#	61	5	8.2	0.0001*	5.32 (2.14–13.25)
Primary	39	17	43.6		
Social status					
Middle and high#	62	10	16.1	0.070	1.96 (0.94–4.09)
Low	38	12	31.6		
Parity					
Primiparous#	29	6	20.7	0.840	1.09 (0.47–2.51)
Multiparous	71	16	22.5		

#Significant difference using independent Student's *t*-test at level of 0.05. RR: Relative risk, CI: Confidence interval

CONCLUSIONS

The most common cause of anemia is IDA where IDA constitutes among breastfeeding with risk factors of LOW.

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