**Iron Deficiency Anemia in Infants**

**فقر الدم نوع عوز الحديد في الاطفال الرضع**

Dr. Mohammed Abdulla Grmt Al-Fawaz. MB.CHB. FICMS(hema)

Dr. Alaa Saed Abass. MB.CHB. FICMS(hema)

Dr. Abdul razaq Wehab Abdalla. MB.CHB. M.Sc.(hema)

*Mhmdabdalla2@yahoo.com*

**الخلاصة:**

يعد فقر الدم عوز الحديد من اكثر المشاكل الناتجة من العوز الغذائي في العالم، ان الاطفال الرضع بين سني التاسعة والثانية عشر شهرا والاطفال في عمر المدرسة والنساء الحوامل من اكثر المجموعات المعرضة لفقر الدم عوز الحديد، ان عواقب فقر الدم عوز الحديد على الاطفال الصغار ممكن ان تنعكس سلبا على مجمل وضائف اعضاء الجسم المختلفة مما يقتضي منا الوقوف على مسببات هذا الفقر بالدم ومحاولة ايجاد بعض الحلول له.

**هدف الدراسة:**

ان هدف الدراسة الحالية هو محاولة التعرف على نسبه فقر الدم نوع عوز الحديد في اطفال الرضاعة الطبيعية مقارنة باطفال الرضاعة الاصطناعية بالإضافة الى محاولة التعرف على مسببات هذا النوع من فقر الدم.

**المواد والطرق:**

امتدت هذه الدراسة حوالي 6 اشهر من بداية شهر تموز الى نهاية شهر كانون الاول عام2014 وشملت 100 طفل رضيع كامل اشهر الحمل وتتراوح اعمارهم ما بين التاسعة والثانية عشر شهرا اثناء مراجعتهم مستشفى الزهراء التعليمي.

تم اخذ عينات دم وريدي ثم تم تحليلها لمعرفة معايير الدم المهمة ذات العلاقة بحالة فقر الدم مثل (تركيز الهيموكلوبين (Hb) وحجم الخلايا المكدسة ((PCV وصوره الدم وقياس تركيز الفيريتين في مصل الدم).

**النتائج:**

اظهرت نتائج التحليل الاحصائي ان مستوى تركيز الهيموكلوبين وحجم الخلايا المكدسة والفيريتين في اطفال الرضاعة الطبيعية (2±105 : 0.17±4.32 : 1± 15.18 ) على التوالي والتي كانت اقل وبشكل معنوي (P<0.05) من اطفال الرضاعة الصناعية (2±111 : 0.6±9.33 : 2± 34) على التوالي وان نسبة فقر دم عوز الحديد موجودة في 24 حالة من اطفال الرضاعة الطبيعية (48%) مقارنه مع 11 حالة لدى اطفال الرضاعة الصناعية (22%).

وان نسبة فقر الدم عوز الحديد عند اطفال الرضاعة الطبيعية بلغت 34% هي اعلى من نسبتها عند اطفال الرضاعة الصناعية (10%) حيث (P<0.001)، وان هناك علاقة بين وزن الولادة دون الطبيعي والرضاعة الطبيعية وعدم كفاية التغذية وهبوط مستوى التعليم لدى الام والمستوى المعاشي الاجتماعي المتدني وزياده نسبه الإصابة بفقر الدم عوز الحديد.

**الاستنتاج :**

اظهرت الدراسة ان فقر الدم نوع عوز الحديد اكثر انتشارا في اطفال الرضاعة الطبيعية وان عوامل الخطورة هي وزن الولادة دون الطبيعي، والرضاعة الطبيعية وعدم كفاية التغذية المكملة للرضاعة وهبوط مستوى التعليم لدى الام والمستوى المعاشي الاجتماعي المتدني للأسرة .

ان منع فقر الدم نوع عوز الحديد يجب ان يتم من خلال التغذية المكملة للرضاعة والغنية بماده الحديد وكذلك فحص الهيموكلوبين او ال PCV بين اعمار التاسعة والثانية عشر شهرا لدى الاطفال الرضع الاكثر عرضه لعوامل الخطورة المؤدية لزياده نسبه الإصابة بفقر الدم نوع عوز الحديد .

**Background:**

Iron deficiency anemia consider one of the most nutritional problem in world, the infants aged from 9-12 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.

**Aim of the study**:

To compare the frequency of iron deficiency anemia (IDA) between breast-fed (BF) and formula fed (FF) infants and to identify the risk factors of IDA in these infants.

**Subject and methods:**

During period of six months from July to the end of December 2014 a total of 100 full term infants from aged 9-12 months were studied in vaccination unit in Al-Zahra teaching hospital.

A venous blood samples taken and were analyzed for hemoglobin(Hb), PCV, blood film and serum ferritin.

**Results:**

The mean values of Hb, PCV, and serum ferritin of breast fed 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±2g/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 &low socioeconomic status (adjusted RR: 4.7,3.4,2.8,5.3,1.9 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 &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 high risk infants.

**Introduction:**

The term anemia generally can be defined as a reduction below normal in the concentration of hemoglobin or red blood cells in the blood, and the lower limits of the normal range depend on the age & sex of the subjects . (1)

More than 500 million people have iron deficiency anemia . (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) Due to relatively rich iron stores at birth, iron deficiency is rarely observed during the first few months of infancy unless the infants were born with very low birth weight. (5)However, by 2 to 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)

**Objectives:** To assess the frequency of iron deficiency in infants aged between 9-12 months and to identify the risk factors in these infants.

**Methodology:**

Over a period of six months from July to the end of December 2014. one hundred infants (55 girls) and (45 boys) whose age were between 9 – 12 months were included in this study.

They were collected when they attended Al-Zahra teaching hospital.

The inclusion criteria were :

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 :

1. Preterm infants that is because they had less iron storage so they were more susceptible for iron deficiency anemia .
2. Mixed fed infants because this will interact with the results .
3. Infants or mothers who had a chronic illness or need some medications on regular basis .
4. Infants with congenital anomalies .

The infants were categorize into 4 groups according to their age (9 months,10 months,11 months and 12months), according to the adequacy of diet into (adequate diet and inadequate diet), to the low birth weight into (absent or present), to maternal education into (primary, secondary and college education), to social status into (low, middle and high social status), 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 & 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 Haemoglobin concentrations less than 110 g / l were consider to have anemia, and if the serum ferritin concentrations of these infants were less than 12 microgram /dl , these infants were consider to have iron deficiency anemia these values were according to the definitions of anaemia and IDA by the W.H.O. (10).

**Methods:**

From each infant about 2ml of venous blood were withdrawn by a sterile disposable syringe at time between 9-11 am to avoid diurnal variations. (11)

Blood samples were divided into 2 parts:

A)1 ml of blood were added to a tube containing EDTA as anticoagulant for haematological investigations (Hb,PCV,Blood film,Retic count).

B)1 ml of blood were collected in a clean plain plastic tube & was allowed to clot for about 30 min, before centrifugation , the serum obtained used for estimation of ferritin concentration .

**Haematological investigations**:

It were done on the same day of collection of each patch of samples using standard methods that described by (Dacie & lewis) .(11)

The tests done were:

1-Haemoglobin concentration by 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 minutes and reading using a reading device, the centrifuge used was manfacture by Griffin company and put in speed 12000g.

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 upright to dry, then read by using microscope.

4- Reticulocytes count by brilliant crystal blue stain by deliver 2 or 3 drops of the dye solution into a 75 × 10mm 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. Resuspend the red cells by gentle mixing, and make films on glass slides in the usual way.

1. 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 quntitive determination of circulating ferritin concentration by microplate immunoenzymatic assay using kit manufactured by Monobind Inc. company(CAT.No.92630).

**Result:** The studied sample was conducted on 100 apparently healthy infants aged between 9-12 months distributed as 50 breast fed and 50 formula fed, girls were slightly more than boys, most infants had received inadequate diet, few of them had history of low birth weight ( **LBW**) as shown in table (1)

**Table (1) Descriptive characteristics of the FF and BF infants.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Formula fed** | | **Breast fed** | | **P value** |
| **No** | **%** | **No** | **%** |
| **Sex**  **Girl** | **27** | **54.0** | **28** | **56.0** | **-** |
| **Boy** | **23** | **46.0** | **22** | **44.0** |
| **Age groups (months)**  **9 months** | **9** | **18.0** | **6** | **12.0** | **0.639** |
| **10 months** | **17** | **34.0** | **14** | **28.0** |
| **11 months** | **14** | **28.0** | **16** | **32.0** |
| **12 months** | **10** | **20.0** | **14** | **28.0** |
| **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** |

This study showed that the Hb , PCVand serum ferritin were significantly higher in formula fed(**FF**) infants than breast fed(**BF**) infants, but reticolocytes count shows no significancy (P value = 0.28)as shown in table (2).

**Table (2) Comparison of haematological data between breast fed and formula fed.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Formula fed | Breast fed | P value |
| Haemoglobin (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 t-test at level of 0.05.

Mean ± SEM

Low serum ferritin(less than 12 ng/ml)was found in 5 cases of FF & 17 cases of BF. Low Hb (less than 110 g/l) was found in 11 cases of formula fed infants and (24) case of BF infants .

The blood film study shows that most cases are normochromic normocytic and about 6 cases of formula fed had hypochromic microcytic compared with 17 cases of breast fed these cases are further assessed by serum ferritin to confirm the diagnosis of IDA.

Other 6 cases in formula fed show macrocytosis with some hyper segmented neutrophils which supposed to be megaloblastic anaemia. While in breast fed 7 cases shows macrocytosis. as shown in table(3) .

**Table(3) Blood film finding in formula fed and breast fed infants**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Blood film finding* | Formula fed | | Breast fed | | P value |
| No | % | No | % |
| 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 t-test at level of 0.05

two cases in formula fed and three cases in breast fed showed anisocytosis with some target cells .Spherocytosis seen in one cases of formula fed infants accompanied with increased retic count in this case ,it supposed to have haemolytic anaemia as shown in table(3) .

Table (4) show that there was no significant difference between girls & boys in formula fed as will as breast fed infants.

**Table (4) Distribution of haematological parameter according to the sex of infants.**

|  |  |  |  |
| --- | --- | --- | --- |
| *Haematological Data* | | Feeding | |
| Formula fed | Breast fed |
| Haemoglobin (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 t-test at level of 0.05.

Mean ± SEM

When the hematological parameters distributed according to the age of infants, it show that Hb,PCV, MCHC, Retic count and Serum ferritin level show no significant difference between the different age groups.

**Table(5) Distribution hematological parameters according to the age of infants**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | | **Feeding** | |
| **Formula fed(50)** | **Breast fed(50)** |
| **Haemoglobin (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** |
| **P 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** |
| **P 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** |
| **P 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** |
| **P 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** |
| **P value** | **0.924** | **0.315** |

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.

**Table(6) Relations between hematological parameters & and diet adequacy**

|  |  |  |  |
| --- | --- | --- | --- |
| No. | | Feeding | |
| Formula fed | Breast fed |
| Haemoglobin (g/l) | Inadequate 74 | 101.82±4.86 | 95.33±3.94 |
| Adequate 26 | 114.36±2.21 | 109.91±2.64 |
| P value | 0.014\* | 0.004\* |
| PCV% | Inadequate 74 | 31.36±1.32 | 29.80±1.04 |
| Adequate 26 | 34.62±.67 | 33.63±.77 |
| P 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 |
| P 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 |
| P 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 |
| P value | 0.013\* | 0.329 |

\*Significant difference using independent-student t-test at level of 0.05.

Mean ± SEM

The Hb ,PCV & serum ferritin also have significant results among infants that have history of low birth weight **,** as shown in table(7).

**Table(7) Relations between hematological parameters and birth weight of infants.**

|  |  |  |  |
| --- | --- | --- | --- |
| No. | | Feeding | |
| Formula fed | Breast fed |
| 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 |
| P 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 |
| P 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 |
| P 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 |
| P 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 |
| P value | 0.095 | 0.007\* |

\*Significant difference using independent-student t-test at level of 0.05.Mean ± SEM

In table (8) shows a significant relation between maternal education and hematological parameters(Hb,PCV and serum ferritin).

**Table(8) Relation between maternal education and hematological parameters**

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Feeding | |
| Formula fed | Breast fed |
| Haemoglobin (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 |
| P 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 |
| P 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 |
| P 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 |
| P 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 |
| P value | 0.040# | 0.008# |

Table( 9) shows a significant relation between socioeconomic status and Hb and PCV but not with retic and serum ferritin in BF and FF infants .

**Table (9) Relation between socioeconomic status and hematological parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| No. | | Feeding | |
| Formula fed | Breast fed |
| Haemoglobin (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 |
| P 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 |
| P 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 |
| P 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 |
| P 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 |
| Low 38 | 0.357 | 0.113 |

Table (10) shows a significant correlation between Hb, PCV & serum ferritin with increase parity of the mothers

**Table (10) haematological parameters distributed according to the parity**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | | **Feeding** | |
| **Formula fed** | **Breast fed** |
| **Haemoglobin (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** |
| **P 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** |
| **P 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** |
| **P 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** |
| **P 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** |
| **P value** | **0.192** | **0.009#** |

Table (11) shows that anemia was found in 11(22%) cases of formula fed infants with significantly lower than BF infants 24(44%)cases.

**Table (11) The effects of risk factors on anemic infant**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Total** | **Anemia(Hb<110g/l)** | | **P value** |
| **No** | **%** |
| **Feeding;**  **Formula fed** | **50** | **11** | **22.0** | **0.006\*** |
| **Breast fed** | **50** | **24** | **48.0** |
| **Sex;**  **Girl** | **54** | **20** | **37.0** | **0.644** |
| **Boy** | **46** | **15** | **32.6** |
| **Age groups (months);**  **9 months** | **15** | **6** | **40.0** | **0.954** |
| **10 months** | **31** | **10** | **32.3** |
| **11 months** | **30** | **11** | **36.7** |
| **12 months** | **24** | **8** | **33.3** |
| **Diet;**  **Adequate** | **74** | **18** | **24.3** | **0.0001\*** |
| **Inadequate** | **26** | **17** | **65.4** |
| **birth weight**  **=>2500 grams** | **85** | **23** | **27.1** | **0.0001\*** |
| **<2500 grams** | **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** |

Table (12) show iron deficiency anemia ( IDA) found in 5 cases of FF and 17 cases of BF it has a significant correlation with type of feeding (Breast fed), diet inadequacy, history of low birth weight , low maternal education , low social status, & increased parity of the mother.

**Table (12) The effects of risk factors on IDA infants**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Total** | **IDA** | | **P value** |
| **No** | **%** |
| **Feeding**  **Formula fed** | **50** | **5** | **10.0** | **0.004\*** |
| **Breast fed** | **50** | **17** | **34.0** |
| **Sex**  **Girl** | **54** | **10** | **18.5** | **0.363** |
| **Boy** | **46** | **12** | **26.1** |
| **Age groups**  **9 months** | **15** | **5** | **33.3** | **0.389** |
| **10 months** | **31** | **4** | **12.9** |
| **11 months** | **30** | **8** | **26.7** |
| **12 months** | **24** | **5** | **20.8** |
| **Diet**  **Adequate** | **74** | **11** | **14.9** | **0.004\*** |
| **Inadequate** | **26** | **11** | **42.3** |
| **birth weight**  **=>2500 grams** | **85** | **12** | **14.1** | **0.0001\*** |
| **<2500 grams** | **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 & more** | **15** | **9** | **60.0** |

When study the relative risk we found that breast fed ,diet inadequacy , history of LBW, low maternal education and low social status had high relative risk , so those considered as a risk factor for iron deficiency anemia , were the sex & parity have not been considered as risk factors .

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Total** | **Iron Deficiency Anemia** | | **P value** | **RR (95% CI)** |
| **No** | **%** |
| **Feeding**  **Formula fed#** | **50** | **5** | **10.0** | **0.004\*** | **3.40 (1.36-8.50)** |
| **Breast fed** | **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-.7.1)** |
| **Inadequate** | **26** | **11** | **42.3** |
| **Birth weight;**  **=>2500 grams#** | **85** | **12** | **14.1** | **0.0001\*** | **4.72 (2.50-8.91)** |
| **<2500 grams** | **15** | **10** | **66.7** |
| **Maternal education Secondary&College#** | **61** | **5** | **8.2** | **0.0001\*** | **5.32 (2.14-13.25)** |
| **Primary** | **39** | **17** | **43.6** |
| **Social status**  **Middle & High#** | **62** | **10** | **16.1** | **0.070** | **1.96 (0.94-4.09)** |
| **Low** | **38** | **12** | **31.6** |
| **Parity**  **Primiparaous#** | **29** | **6** | **20.7** | **0.840** | **1.09 (0.47-2.51)** |
| **Multiparaous** | **71** | **16** | **22.5** |

**Table (13) Effect of risk factors on iron deficiency anemic infants.**

**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 &17-90% in Middle East countries were found to be so.(12)

The vast majority of cases were associated with iron deficiency.(13)

In this study found that mean values of Hb, PCV, and serum ferritin of breast fed 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 infants (111±2g/l, 33.9±0.6%, 34 ±2 ng/ml, p < 0.05),table 2.

Despite numerous benefits of breast milk, breastfed infants had iron deficiency anemia more than formula fed 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(14)

Therefore, breast fed infants received iron from milk less than formula fed infants.

This study revealed that anemia and iron deficiency anemia in infants still prevalent and the incidence of anemia in breastfed infants were higher than formula fed infants(48%v.s 22%),also the incidence of iron deficiency anemia in breastfedinfants were higher than formula fed infants (34%v.s10%),these findings were in agreement with previous studies.Studies of prevalence of anemia & iron deficiency anemia in Iraqi infants were limited, a study of anemia in infants by Asmaa Al-Nuaimy in Mousl(15) (1999) found that breast fed were higher than formula fed infants (30% vs. 9%)which was in agreement with Piscane A.et al(16).

In a study was done in Baghdad, by Arif H.S,Al-Alwan(17) iron deficiency anemia 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 breast feeding and most families being of low economic status. However, another study which was done by Bassam A.Al-Mallah in Mousl which found that 83% of anaemic infants had iron deficiency anaemia.(18)

Also a study done by Ban Ghazi (19) found that anemia was 53%in infants below one year and most cases (78%) are due to iron deficiency anemia.These result were in agreement with this study in that iron deficiency is the common type of anemia in infancy.

Pizzaro et al(20) in Italy reported that iron deficiency anemia was found in 14.7% of breastfed compared with 0.6% of formula fed infants, whereas Calvo et al(21)in spain reported the prevalence of anemia at 9 months of age in breastfed infants was 27.8% compared with 7.1% in formula fed infants and iron deficiency anemia was found in 27.8% of breastfed infants but none of formula fed infants ,the low results of anemia and IDA compared with this current study are due to good nutritional habit of infants in these studies.

Piscane A.et al(16) in USA reported that anemia and iron deficiency anemia is more common in breastfed than formula fed (25% vs. 12%)respectively.However, breastfeeding was not a risk factor of iron deficiency anemia in some studies Soh P. et al (22) in New Zealand and Male C,et al (23) in Germany.

Inadequate dietary iron as a cause of anemia is unusual before six 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.(13) This study showed that inadequate complementary diet is one of important risk factors this in developing iron deficiency anemia ( IDA) (table 13),this result was in agreement with Chuansumrit A. et al(24) and Dewey K.G.et al(25) in USA .

Also this study showed that iron deficiency anemia was more in infants of low socioeconomic families and low education of the mothers as seen in (table 12) and this was in agreement with Soh P. et al (22) ) in New Zealand , Kilbride J.et al (26) in Jordon,Bassam A.Al-Mallah et al(18) and Ban Ghazi et al(19) in Mousl. As infants of low socioeconomic families complained form negligibility and inadequate dietary habit.

Seone et al(27) in England agree that poor people developed iron deficiency anemia more than other people, but Jacob et al in USA said that iron deficiency anemia 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 P. et al (22) in New Zealand and Eden A.N et al(29)in England. Families with more children means more neglect to the children by caregiver and usually iron deficiency anemia was more common in poor families with more children , this study showed that there was a significant relation between the increase parity of the mother and number of iron deficiency anemic infants as seen in (table 12), this result was in agreement with Bassam A.Al-Mallah et al(18)and Seone et al(27).

This study reveal that breast fed ,diet inadequacy , history of low birth weight, low maternal education and low socioeconomic status consider as a risk factors for iron deficiency anemia (adjusted RR: 4.7,3.4,2.8,5.3,1.9 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, 1.09 respectively) as seen 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.

Iron deficiency anemia in infants is important because of its association with adverse neurodevelopmental outcome (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 iron deficiency anemia in infancy had developmental scores less than non-anemic control children, suggesting that iron deficiency anemia at a critical period of brain growth and differentiation may produce irreversible abnormalities( 31). Because of long term consequences of iron deficiency anemia, 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).

**Conclusions:**

1-Most common cause of anaemia is iron deficiency anemia ( IDA)where IDA constitutes about 63% of the anaemic infants.

2- IDA is more prevalent in BF than FF in 9-12 months aged infants.

3- Risk factors of IDA in infants are low birth weight, breastfeeding, inadequate complementary food, low education of the mother and low socioeconomic status.

4-Sex and parity are not considered as risk factors of IDA in this study.

**The Recommendations**

1- Parents and health care clinicians should be educated about the role of iron in infants growth and cognitive function.

2-Screening for anemia in high risk infants including low birth weight infants ,infants fed with non-fortified formula and breastfed infants who had inadequate iron from complementary food.

3-We should prevent IDA in infants by: a-If the infant remains breastfed beyond six months of age , an iron supplement should be given.

b- The infants who are not breastfed should be provided with an iron-fortified formula for the first 12 months of life.

**References**

1. William Kern ch2 in PDQ Haematology 1st ed. London, Churchill Livings, 2010 P17-40
2. Beutler. G . The common anaemias : JAMA 1998 250:p 2433.
3. Rios E, Hunter R E , Cook J D, et al . The absorption of iron as supplements in infants cereal & infants formulas. Pediatrics 1985;55: 686-693.
4. Craig , W. J. , iron status of vegetarians . Am J clinical nutrition 1994 59: 1233-1237.
5. Hertampf E, Cayazzo M, Pizzaro F, Stekel A. Bioavailability of iron in Soy based formula & its effects on nutrition in infancy paediatrics 1986; 78. 640-645.
6. Mark Worwood and Victor Hoff brand : Iron metabolism , I .D and disorder
7. of heme synthesis. In : Victor Hoffbrand,Daniel Catovsky,Edward G.D.,
8. Postgraduate haematology, 5th ed.,Oxford, Black well publishing, 2015,p26-38.
9. Barbara J.Bain, ch 8 in practical guide of red cells, 4th ed. Oxford Blackwell Publishing,2006.p287.
10. Pochedly C. and May SL : iron deficiency anemia in children .Am fran physician 1987,35,195-200.
11. U.S Department of health and human services.Epidemiology program office Atlanta 2013
12. W.H.O./United Nations University/UNICEF. Iron deficiency anemia, assessment, prevention and control: A guide for programme managers. Geneva: WHO, 2011
13. Barbara J. Bain ,S. Mitchell Lewis: Basic haematological techniques .In: Dacie and Lewis practical haematology ,Churchill Livingstone Elsevier , 10 th ed.,2006 ,p 27-45
14. Center for disease control & prevention . recommendation to prevent & control iron deficiency in USA , MMWR 1998; 47: 1-29.
15. American Academy of Pediatrics, Work Group on Breastfeeding. Breastfeeding and the use of human milk. Pediatrics 1997; 100: 1035-9
16. Stekel A. : Iron nutrition in infancy & childhood. Nestle nutrition workshop series 1984 Vol. 4 , P 2-68.
17. Asmaa Al-Naamy , haematological profile in mothers & their infants , A Thesis for Iraqi scientific council of pathology , 1999 .
18. Piscane A.et al:iron status in breast fed infants.J.pediatr.1995.127:429.
19. Arif H.S,Al-Alwan S.H:iron status in group of Iraqi children.J.Al-Nahreen University ,1998,2.71-77.
20. Bassam A. AL-Mallah:iron deficiency anemia in children, a thesis for Iraqi scientific council of pediatrics .1997.
21. Ban Ghazi:types of anemia in children; a thesis for Iraqi scientific council of pediatrics 2006.
22. Pizzaro F, Yip, Dallman PR . Iron status with different infants feeding regimens : relevance to screening & prevention of Iron deficiency .J. paediatrics 1991; 118: 287-92.
23. Calvo EB, Galindo AC , Aspres NB . Iron status in exclusively breast fed infants. Paediatrics 1992:90:375-9.
24. Soh P.,Gibson RS.iron deficiency and risk factors in 6-24month old New Zealanders,Euro J.nutr.2012;58:71-9.
25. Male C, Persson LA, Freeman V, Guerra A, van’t Hof. MA, Haschke F and Euro-Growth Iron Study Group.Acta paediatric.2001.90:492.
26. Chuansumrit A, Arnutti P, Apivanich S. Iron status of one-year-old infants in a well baby clinic. J Med Assoc 2012; 85: p1081-8.
27. Dewey KG, Cohen RJ, Rivera LL , Brown KH. Effects of Age of introduction of food on iron status of breast fed infants . AM J clin. Nutr. 1998 : 67 878-84
28. Kilbride J, Baker TG, Khoury SA. Incidence of iron deficiency anemia in infants in a prospective study in Jordan. Haematol 2010.64:231
29. Seone PV.Pearson HA.disappaerance of iron deficiency anemia in a high risk infant given supplemental iron .NEJM.1985:313;1239.
30. Jacob A.disorders of iron metabolism ,Clini hematol.1982;11:259.
31. Eden AN, Mir MA Iron deficiency in 1 year old children, a pediatric failure? Arch Pediatr Adolesc Med,1997:151:986.
32. Lozoff B, Jimenz E, haymen J, et al. poorer behavioral & developmental outcome more than 10 years after treatment for iron deficiency in infancy . pediatric 2000 , 105-651.
33. Lozoff B, Jimenz E , wolf AW. Long term developmental outcome of infants with iron deficiency N Engl , J. Med 1991 : 325 : 687-694.