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Comparison study of growth status and Hb. Level in Iraqi breast and Artificial fed babies during infancy

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Abstract
A randomizes study has been done on 200 healthy breast artificial fed infants aged between 3-12 months with male to female ratio (1: 1) at Central Teaching Hospital for Children for period between 2nd Jan. to 2nd Jun. 1998 coming to the hospital for vaccination to assess the growth status and hematocrit level in term of weight for age percentile, head circumference age percentile and hematocrit values on venous samples. The result has shown a significant retardation in weight for length for age in artificially fed infant at ages of (7-9) months and (10-12) months, and significant low hematocrit level for breast fed babies at age (10-12) months. No significant relationship between growth and anemia. Also no significant relationship in growth and hematocrit in relation to sex. In conclusion breast milk is enough for optimal growth for infant below 1 year, but not for preventing the development of anemia.

Keywords: Infant, anemia, hematocrit

Introduction
Iron, folic acid and vitamin B12 play important role in the production of red blood cells. Iron is constituent of hemoglobin, which accounts for about 75% of this element in the body [1]. During the last weeks of pregnancy the baby gets an iron store, so a woman needs more of these minerals during pregnancy and lactation, but directly increasing iron in lactating mother's diet does not seem to increase the amount in milk, possibly because of the way the body controls their absorption and blood levels. Thus is difficult to give effective supplements of iron during lactation, it is probably better for women to build up good stores for iron during early pregnancy so that she has what is necessary for the milk in advance [2]. It has long been recognized (Schmidt 1931) experimental iron deficiency in rodent, has a marked retarding effect on body growth as a whole. Iron acts dramatically restoring the rate of body growth and under this experimental condition, the upswing of the growth curve, give iron the characteristic of growth factor. The effect of iron deficiency on growth in man is not so easily observed in 6 to 36 months old infant, when iron deficiency is common especially among those on largely milk diet, iron deficient children although they may appear to be fat are on the contrary often underweight. A study in 1966 Judisch *et al* has shown that this type underweight is reversed by iron therapy, another study in 1974 by Burman shown an accelerated rate of growth in male infant with iron deficiency anemia after repletion with iron.

Review of literatures
Does prolonged breast feeding impair growth: There are several studies found a relationship between prolonged breast feeding and malnutrition. Many studies have shown a negative association between prolonged breast feeding and growth, but there is a little reason to expect the association to be causal. Human breast milk is a notoriously balanced and hygienic food source for infants [3, 4]. Its nutritional composition is constant and provides available source of protein, fat, Ca. and vitamins for growing toddler [5]. Yet some evidence suggests that child who is breast fed beyond their 1st birthday is more likely to be malnourished than those who are completely weaned before this time.

Confounding Factors: Health care and poverty: To insure that the association is not spurious, the possibility that some external factor caused both malnutritionand prolonged breast feeding must be explored. Malnutrition may be the result of inadequate resources in the house hold, appropriate food may be expensive or difficult to be obtained or family may be poorly educated about adequate nutrition. Prolonged breast feeding is typically more prevalent among poorer less educated women. Consequently poverty may cause both malnutrition and prolonged breast feeding and thus produce a spurious correlation.

Association with childhood illness: The positive association between illness and malnutrition and the negative association between illness and breast feeding would tend to mask any real association between prolonged breast feeding and malnutrition.

Revers causality: In addition to external causes, mother may delay weaning if her child shows sign of malnutrition or poor development. One study by Brakohipa [6] report that sickly, malnourished Ghanaian children were weaned later than children Who are able to walk or talk on the other hand, women may also stop breast feeding because they are dissatisfied with their child`s growth. In this case, selection would operate in the opposite direction-poorly nourished children would be weaned earlier.

Extent of supplementation: If the relationship between prolonged breast feeding and poor growth is truly causal the association must operate through some biologic determinant of malnutrition – increased infection or inappropriate nutrient intake. Many studies have shown that breast feeding is protective against diarrheal dis [7, 8] and other infections. Thus an increased risk of infection from prolonged breast feeding dose not seem likely. Yet breast-fed children who do not receive adequate supplementation as their nutritional needs increase, are at risk of malnutrition. Breast milk is probably not sufficient for optional growth after 6 months of age [9, 10]. In adequate supplementation is the most likely mechanism through which prolonged breast-feeding could impair growth.

Why breast-fed children do receive insufficient supplements?

Do mothers offer supplements in too little quantity or wrong time, or does breast milk reduce the child`s appetite for other foods? In the former case, the mothers need to be educated about proper supplementation, in the latter case earlier weaning may called for. Some investigation has observed that breast-fed children seem to have reduced appetite for added food A study in Mali, noted that most children maintain a sufficient diet of both breast milk and supplement, but some refuse any solid foods as long as they are nursing. Another study found those children's nutritional requirements [11].

Measurement of nutritional status: The includes Height for age, weight for age head circumference for age and height for weight. Mid upper arm circumference and triceps skin fold thickness feeding pattern may effect these measurements differently for example Height for age is affected by infant feeding over along period of time, whereas weight for height is an indicator of sudden dietary changes or acute illness. A study in Indonesia by Boedman *et al.* [5] found that the incidence of severe malnutrition is low among children who are breast fed for at least 1 year, the author claimed that breast feeding protects children from severe malnutrition which seem among bottle fed infant, so the author claimed a positive association with growth. Many other study showing a negative association with growth in which found adverse relationship between prolonged breast-feeding and child nutrition and the authors concluded that the mothers rely heavily on breast milk when their children should receive supplementary food. A study in Egypt generated similar finding [12] the incidence of chronic under nutrition is lowest among children weaned during their third of fifth months and is highest among children breast fed for more than 1 year. Many other studies show a mixed association between infections and mortality.

Hemoglobin and haematocrit: For infant (2-24) months of age, hemoglobin of 11 gm. / 1 is the cutoff point between anemia and normal, it's the lower limit of 99% range of normal, since this the most readily measured essential iron compounds, therefore decreasing its concentration can be regarded as presumptive evidence of iron deficiency. Iron deficiency is the commonest etiological factor in anemia its especially common in infancy for the following reasons

1. Both breast and cow's milk do not provide the baby with iron
2. Poor iron stores in premature babies predispose to further deficiency at about the third month which is the time for proximal physiologic reduction of hemoglobin.
3. Iron requirement in infancy are high because iron is needed not only for hemoglobin formation and tissue replacement but also for growth which is maximal in infancy and adolescence [13].
4. Basal metabolism in infancy is higher than in later childhood and adult.
5. The form of iron in the diet is more important than the amount and there is variation in iron absorption from less than 1% with some vegetable and food to 10-25% with meat [14].
6. In infancy there is almost non hemeform iron in the diet during period when milk is the major source of calories the relatively small amount of iron in milk is primarily in the nonheme form [13] however in breast milk, the unusually high bioavailability of the iron to some degree compensates for the low concentration and an average of 49% of the iron in breast milk is absorbed, while 12% from unfortified cow's milk or cow's milk formula, these finding help to explain the observation that prolonged breast feeding confers partial protection against the development of iron deficiency. The cause of excellent absorption of iron from breast milk is not known, it has been found that in the presence of iron depletion, The amount of iron absorbed from the milk can be expected to increase. Solid food that are feed near the time of breast feeding can substantially inhibit the absorption of iron from the breast milk feeding, this seem to favor feeding solid foods as a separate meal from milk [15].

How important is iron: Its used to be that you should give supplementary foods at four months age when a baby's iron stores are depleted. This aspect is no longer thought to be so important, since although there is little iron in breast milk, its very well adsorbed (Mcmillar Landaw, and Dski 1976, Saaninen and Siimes 1979, Picciano 1980). Its possible that supplementary vegetable foods inhibit the iron absorption, especially from breast milk, the question of iron supplementation of breast-fed infants is not yet resolved.At any rate is more likely to be a bottle fed baby's problem**,** because iron from cow's milk is poorly absorbed**.** Move over it has not been demonstrated that a temporary slight iron deficiency anemia is not physiological or that has any adverse effect upon an infant, on the other hand, giving too much iron may lower a child's resistance to certain infection, for instance by gram negative bacteria (Bullen, Rogers and Leigh 1972). This paradox occurs because the supplementary iron saturates the iron binding protein (Lactoferrin) in the milk, making free iron available to the bacteria, so that they can more easily get the iron they need for growth.

Physiology: Essential iron and storage iron: In 1912 Ashby identified the liver as the dragon that has the most to do with the storage ……. of iron. When the iron is needed, it is given by the liver into the blood …… and used to make new hemoglobin and red blood corpuscles. He also found that concentration of the liver iron was higher at birth than in the adult but it declined rapidly during early infancy (Lancet 1912; 2: 150-3) [1]. Iron containing compounds fall into two categories: The essential compounds that serve metabolic or enzymatic functions and compounds associated with iron storage [16, 17]. The first category functions in the transport and utilization of oxygen for the production of cellular energy and includes hemoglobin, myoglobin, the cytochrome, and iron sulfur proteins. The storage compound, ferritin and hemosiderin are involved in the maintenance of iron hemostasis. When the supply of dietary iron become inadequate, iron is mobilized from the storage, compounds to maintain the production of hemoglobin and other essential iron compounds not until the production of essential iron compounds restricted. The term of iron deficiency is used to refer to iron lack of sufficient severity to restrict the production of hemoglobin. Iron deficiency anemia occurs when the hemoglobin has fallen sufficiently due to iron lake to fulfill the laboratory definition of anemia, namely when is below 95% reference range for age [18].

Iron balance: The amount of body iron is regulated primarily through modulation of iron absorption over more than 20 fold range [19, 20]. Iron absorption depend on the foods and on the combination of foods in the diet, it increases as storage iron become decreased. Iron excretion occurs mainly by loss with desquamation of the intestinal mucosa, the amount of iron lost in this manner varies only over a fourfold rang, decreasing in iron deficiency and increasing in iron overload [16]. Consequently, the major determination factor in maintaining iron hemostasis is absorption. The average one year old infant derives less than 70% of red cell iron from senescent red cells and requires about 30% from the diet to meet the needs imposed by rapid growth, in contrast to adult in whom about 95% of iron required for the production of red blood cells is recycled from the breakdown of senescent red cells and only 5% comes from dietary sources, as result the amount of iron absorbed must be several times greater than iron losses. This difference helps to explain the high prevalence of iron deficiency in late infancy.

Absorption of Iron from Food: There are two broad categories of iron in food, heme iron which is present in hemoglobin and myoglobin is supplied mainly by meat and rarely accounts for more than a quarter of the iron ingested in most diet. Heme ir on relatively well absorbed and its absorption is little influenced by other constitute of the diet. Most of the remaining iron is present in the form of salts and is called No heme iron. Since infant diet contains little meat, the vast preponderance of iron is the non-heme form. The absorption of non-heme iron depends on how soluble it become in the intestine, and this in turn is determined by the composition of foods that are consumed in a meat [18, 19]. Absorption of small amount of iron in breast milk is high 50% in contrast to 10% of iron from unfortified cow milk formula, and 4% form iron fortified cow milk formula [21-23], also about 4% of the iron from iron fortified cereals is absorbed [22]. Absorption of non-heme iron from a mixed meal is about four time greater when the major protein source is meal, fish, or chicken in comparison to the diary product milk, cheese, or egg. The beverage consumed with the meal plays an equally important role, compared with water orange juice will double the absorption of non-heme iron from the entire meal whereas tea will decrease by 75% and milk will decrease it to a lesser degree. The most important enhancers of non-heme iron absorption is ascorbic acid and meat, fish and poultry. Major inhibitors are bran, polyphenol including tenants in tea and phosphate. The basis for the excellent absorption of iron from human milk is not known, the lower phosphate and protein content of human milk compared to cow milk, and the high concentration of the iron binding protein (Lacto ferrin) have been postulated to play a role, but can not explain this phenomenon entirely. There is some evidence that ingestion of human milk per se may influence the intestinal mucosa in manner that facilitates iron absorption [24]

Available food

Iron in breast milk: It appears that the concentration of iron in breast milk decline slightly during the course of lactation, but not everyone has observed this change [27]. The concentration of iron in pooled breast milk is in the region of (40 mg / 100 ml) and in colostrum (45 mg / 100 ml) [27] about 30% of the iron in milk is association with the lipid fraction and36% is bound to unidentified low molecular weight protein < 15000 [27]. Lactoferrin is the principle iron binding protein in milk (3.3 ± 1.9 g/l) [27] and though it contains 24% of the iron in human milk, it's only 1.4 % saturated. This very high unsaturated iron binding capacity enables lacto- ferrin to inhibit bacterial growth by complexing free iron [28, 29]. It should be noted however, that lactoferrin is also found in bile, pancreatic and intestinal secretions. It coats the luminal surface of the intestine and may be have the additional function of binding dietary iron to donating it do surface receptors on the duodenal brush border [30].

Iron in formulas: Some have added iron (generally in the form of ferrous formulate) and others do not [31]. The amount added to most full term formulas aims to provide between 1.0 - 2.0 mg/kg per day at an intake of 150 L/kg/d. For example one LBW formula (8 Kcal / 100 ml) without added iron contain 0.2 mg iron/100ml while the same formula with iron contain 1.4 mg / 100 ml [32]. The formula with added iron would there provide just over 2.0 mg iron/kg/d when fed at 120 kcal/kg/d [150 ml/kg/d].

Material and Method: Our study conducted at Central Teaching Hospital for children. They were 200 infant taking in the study during their visit to the hospital for vaccination their ages ranged (3-12 months) for the period between 2nd

January 1998 to2nd June 1998.

The following question are asked: Name, age, type and feeding (When started, duration, frequency) we exclude mixed feeding from study).

- Additional food (cereal, eggs, soups, vegetable, rice, fruit, juice, meat) if started and when.
- History of acute illness like gastroenteritis, upper respiratory tract infection and other acute illness were excluded.
- Social history taking - mother and father age, occupation and state of education.

Also infant undergo full examination and following sign is recorded and exclude the infant from the study if having (Pallor, rickets, hepatosplenomegaly). Growth parameters include: weight, length, head circumference and plotted on the percentile chart of growth (wt./age, length/age, HC/age, wt./length). Hb. And PCV% is done by aspiration of venous sample. We do comparison between breast and artificial fed infant in relation to growth parameter (wt./age, length/age, HC/age, wt./length) and divide into 4 groups (A, B, C, D) from (0-3, 4-6, 7-9, 10-12) (excluding the neonatal period). Half of each group were artificial and the other half were breast fed, and each group were 50% male and 50% female (resp.) We regard Hb. Level of 11 gm./dl is the cut point between anemia and not anemic pat. And for the growth percentiles we regard those below 5th percentile for weight, length, head circumference as retarded growth.

Results

Table (1, 2) Show difference in growth parameter (weight / length) between breast and artificial fed babies, as shown in table, the growth retardation are more in artificial than breast fed babies in group C and D.

Table No. (3) There is no difference in growth parameter (weight / length) in relation to sex.

Table (4, 5) Show negative association between growth parameter (weight / length) and hematocrit level as growth retardation more in non- anemic than anemic baby.

Table (6) The relation between type of feeding and hematocrit level, the anemia more encountered in breast fed babies than artificial fed baby in group D while no difference in age group (A, B, C).

Table (7) No difference in hematocrit level between male and female as shown in table [7].

Table 1: Growth percentile (wt. / l) between breast and artificial.

	Artificial									
AGE	**< 5**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**>95**	**Total**
A	0	1	2	2	2	1	0	2	0	10
B	0	3	1	5	4	11	2	3	1	30
C	6	6	0	3	5	7	0	2	1	30
D	9	3	4	6	5	3	0	0	0	30
Total	15	13	7	16	16	22	2	7	2	100

	Breast									
AGE	**< 5**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**>95**	**Total**
A	0	1	2	1	2	3	1	0	0	10
B	1	4	2	9	7	4	2	1	0	30
C	3	2	5	4	5	3	2	3	3	30
D	1	2	4	10	7	4	1	0	1	30
Total	5	9	13	24	21	14	6	4	4	100

Artificial
Chi Square 37.24
P-value = 0.04

Breast
Chi Square 20.68
P-value = 0.6

Table 2: Growth Condition (wt. / l) in relation to type of feeding

	A			B			
Age	**N**	**O**	**R**	**N**	**O**	**R**	**Total**
A	8	2	0	10	0	0	20
B	26	4	0	28	1	1	60
C	21	3	6	21	6	3	60
D	21	0	9	28	1	1	60
Total	76	9	15	87	8	5	200

A
Chi Square 14.23
P-value = 0.02

B
Chi Square 9.91
P-value = 0.12

N = Normal
O = Obese
R = Retarded

Table 3: Difference in growth (wt. / l) between Male and Female

	Male				Female			
Age	**N**	**O**	**R**	**Total**	**N**	**O**	**R**	**Total**
A	8	2	0	20	8	0	2	10
B	26	2	2	30	21	3	6	30
C	19	7	4	30	15	2	13	30
D	23	1	6	30	21	0	9	30
Total	76	12	12	100	65	5	30	100

Male
Chi Square 10.99
P-value = 0.08

Female
Chi Square 8.39
P-value = 0.21

N = Normal
O = Obese
R = Retarded

Table 4: Difference in Growth parameter (wt. / l) between anemic and non anemic

	Anemic									
AGE	**< 5**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**>95**	**Total**
A	0	1	0	2	1	1	0	0	0	5
B	1	4	2	8	3	3	4	2	0	27
C	3	5	2	2	5	4	0	2	0	23
D	1	2	5	7	8	4	1	0	0	28
Total	5	12	9	19	17	12	5	4	0	83

	Non Anemic									
AGE	**< 5**	**5**	**10**	**25**	**50**	**75**	**90**	**95**	**>95**	**Total**
A	0	1	4	1	3	3	1	2	0	15
B	0	3	1	6	8	12	0	2	1	33
C	6	3	3	5	5	6	2	3	4	37
D	9	3	3	9	4	3	0	0	1	32
Total	15	10	11	21	20	24	3	7	6	117

Chi Square 41.05
P-value = 0.0006

Table 5: Growth percentile (wt. / l) Difference between Anemic and Not Anemic infant

	Anemic				Not Anemic			
Age	**N**	**O**	**R**	**Total**	**N**	**O**	**R**	**Total**
A	5	0	0	5	13	2	0	15
B	24	2	1	27	30	3	0	33
C	18	2	3	23	24	7	6	37
D	27	0	1	28	22	1	9	32
Total	74	4	5	83	89	13	15	117

P-VALUE = 0.22 P-VALUE = 0.02
N = Normal
O = Obese
R = Retarded

Table 6: Difference between artificial and breast feeding in relation to the number of anemic infants.

Age	Artificial	Breast	Total
A	1	4	5
B	14	13	27
C	10	13	23
D	9	19	28
Total	34	49	83

Chi square 6.670
P-value = 0.009

Table 7: Difference between Male and Female in relation to the number of anemic (Y) and not anemic infant (N).

	Male		Female		
Age	N	Y	N	Y	Total
A	8	2	7	3	20
B	14	16	19	11	60
C	17	13	20	15	65
D	14	16	18	12	60
Total	53	47	64	41	205

Discussion

Human breast milk is a nutriously balanced and is constant and provide available source of protein, fat and vitamin for growth [5]. Our study found a positive association between breast feeding and growth parameter (weight for length) in these infant age group C and D in comparison to artificial fed babies, while no significant difference in other age group. The explanation is that breast feeding protects children from the severe malnutrition typically seen among bottle fed infants, in addition other investigators have shown that breast milk has a high caloric and protein density that is comparable with or higher than that of commonly used weaning foods. Other studies have shown that breast feeding is protective against diarrheal disease [7, 8] and other infections, the result of our study is agreement with the study of Boedman *et al*. [5] in Indonesia that found the incidence of severe malnutrition is low among children who are breast fed for at least 1 year, of 120 children studied only 1 (0.8% was severely malnourished (weight/length) < 60%. Another study that show a negative association between prolonged breast feeding and growth by victor a *et al*. In Southern Brazil found that breast feeding beyond 6 month is association with growth retardation. Brakohiapa *et al*. [6] in 1988 found that children of 1 year old who admitted to hospital in China still being breast fed, more likely to wasted (weight/length) < 80% below national center for health statistic median. The explanation of these negative association, is that the mothers rely heavily on breast milk when their children should receive supplementary foods, other concluded that mothers delay weaning when their children are malnourished so the negative association may be attributable to revers causality. To insure that the association is not spurious, the possibility that some external factor caused both malnutrition and prolonged breast feeding must be explored for malnutrition may be the result of inadequate resources in the household-appropriate foods, may be expensive or difficult to obtain or family may be poorly educated about adequate nutrition. Prolonged breast feeding is typically more prevalent among poorer, less educated women for a variety of reasons including economic necessity and traditional norms. Inadequate supplementation is the most likely mechanism through which prolonged breast feeding could impair growth. Growth retardation more in artificial fed baby. The explanation is that because of the effect of economic sanction lead to inadequacy of artificial milk supply, enough sources of food and low family income that effect nutritional and hygienic status of the family in general. About the relation between breast feeding and low hematocrit level especially in age group (D) (10-12) months in comparison to artificially fed babies, it was claimed that iron store in the body is usually adequate until the infant birth weight doubled at 6 months, and the infant during this period consume the iron store in his body, our finding are in agreement with the study of Pizarroetal [33] that showed prevalence of anemia at growth of 9 months of age 22.5% in breast fed infants, 3.8% in infants fed iron fortified formula. After sixth months of life there is depletion of iron store within the boy, yet breast fed babies who do not receive adequate supplementation of iron rich diet in comparison to most artificially iron fortified formula, will develop anemia and this has encountered in our study also because the effect of economic sanction on our Iraqi children that result in adequate resource in the household appropriate foods.

Conclusion and Recommendation: Optimal growth can be achieved with breast feeding but won't prevent iron deficiency anemia.

- Women should be encouraged to continue breast feeding for as long as possible.
- Even if prolonged breast feeding is found to impair growth the protection that breast feeding provides against infection would
- Argue against any policy changes particularly where sanitary condition are poor.
- Any change in policy must also consider the beneficial impact of prolonged breast feeding on birth spacing, mother child interaction infection and mortality.
- Breast fed infants should be given supplemental iron from the fourth month of life, when iron reserves at birth are likely to be depleted.
- Complementary foods for breast fed infants should emphasize the use of appropriately iron fortified weaning foods.
- Infant fed breast milk or formula with no added iron should receive 2 – 2.5 mg iron salts/kg/day from not later than 8 weeks of age maximum15 mg/day [75].
- Iron supplementation should be continued until full mixed feeding providing adequate iron intake is established usually (12-15) months.

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