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Comparative Study of Iron Deficiency Anemia between Breast Feeding Children and Bottle Feeding Children

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Original Article

Abstract

Background: *Exclusive breastfeeding for up to six months without the addition of iron supplementation may compromise the hematologic status of children, leading to iron deficiency anemia and the consequences of this condition. The issue that naturally follows from this is whether or not exclusively breast feeding protects newborns from developing anemia in their first six months of life.*

Objective: *To determine the incidence of anemia in infants who had received only breast milk between the ages of three and six months.*

Patients and Methods: *A comparative hospital based cross sectional study conducted at Raparin teaching hospital in Erbil city during the period from the July, 1st 2022 December,30th , 2022., A total of 150 children aged six months to three years were included and randomly assigned into three equal groups according to feeding practices; breast feeding, bottle feeding and mixed feeding. Data on iron status were collected. After measuring serum iron of the three groups, the children classified into iron deficiency anemia (IDA) or normal children. Statistical Package for Social Sciences (SPSS) version 28 used in statistical analysis.at a statistical significance level of ≤ 0.05*

Results: *Females contributed for (58.7%) of the studied group, most of children, (70%), were term infants, the vast majority (99%) of cases breastfed for > 6 months excluding breast feeding group. 34% of cases had iron deficiency anemia and most (66%) of them were normal.*

Conclusions: *The risk of iron deficiency anemia was several times higher in breastfed children than bottle-fed children. The risk was more pronounced in the first six months of life.*

Keywords: *Breast feeding, Bottle Feeding, Iron deficiency anemia, Risk*

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1. INTRODUCTION

Iron deficiency is among the most prevalent dietary limitations, is a serious worldwide health issue in both industrialized and growing nations (1). ID causes anemia because iron is required to hemoglobin, the primary component of red blood cells (2, 3). This condition, known as iron deficiency anemia (IDA), has adverse effects on several body systems and organs throughout the body (4). Behaviors, cognition, and psychomotor skills are among the most significant adverse consequences of IDA in children. Several earlier research has shown a relationship between ID in babies and neurodevelopmental disorders (5, 6). Breastfeeding is a distinctive unique procedure shared by all mammalian creatures. It is the outcome of evolutionary pressures molding an effective food transport platform, which involves mothers providing their children with all required nutrients in suitable proportions (7). Breast milk is without a doubt the {gold standard} dietary supplier for newborn in the early few months after birth. At least six months of breastfeeding alone would be required for a baby to be considered exclusively lactation, depending on both the World Health Organization (WHO) and the American Academy of Pediatrics (AAP) (8). Breastfeeding has important and significant effects on cognitive, behavior, and psychological health of children and moms in addition to being an essential source of food for the infant, according to study in the previous year's (9). The iron storage of a full-term newborn is adequate until four to six months of age at birth. During the first six months of life, the iron status of a newborn is determined more by the iron stores present at birth than by iron consumption from lactation. The human milk contains iron in low concentration and declines with time. However, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) support lactation as a worldwide public health policy since milk is regarded the greatest food for newborns throughout the first year of life, particularly during early six months (10). It is crucial to establish links between ID and nursing for more than six months in a variety of situations. In addition to nutritionally suitable and safe supplementary meals, the World Health Organization (WHO) advises continuous lactation for a minimum of two years. needs for iron are greatest during the second six months of life, hence the 6- to 24-month age range correlates to the highest incidence of ID (11). However, there is discussion about breastfed toddlers' iron requirements (12-14) and the dangers of iron supplementation in iron-sufficient newborns (15).

Male sex, fast growing, financial difficulties, and other family dysfunction all raise a patient's chance of getting ID in infancy (16) Breastfeeding throughout the second six months of life otherwise babies in good health can be another health concern, according to growing evidence. Toddlers breastfed for 6 months or longer in the USA were observed to be at greater danger of ID than babies who were not (14). Other international investigations (17-20) Breastfeeding has been associated with decreased iron levels for as long as the second half of a year after birth, according to several studies. A study in Bangladesh (21). Nevertheless, no connection between six-month breastfeeding and anemia was discovered. Researches limited to exclusively breastfed children do not answer the problem, however they illustrate the considerable variation in the frequency of ID or IDA among breastfed newborns in various settings (22-25).

Human breast milk is unique and better for feeding infants. Even from the fact that human milk has a lower concentration of iron but its bioavailability is higher than that in formula milk, and it is regularly mentioned as 12-56% (26). The WHO (27), and UNICEF,(17) recommend that breast milk feed as an ideal feeding way for babies while early six months of life. However, after six months age the human milk might be not enough supplement of iron to the body (28). Infants get most of their iron via food, thus feeding methods have a big influence on the amount of iron newborns have. During the first six months of life, there are many different infant feeding strategies. Several newborns are completely breastfeeding, while others are fed formula or a mix of formula and breast milk. Complementary meals may also be introduced to certain babies before six months' age. Although Thai health agencies do not support supplementation with iron for breastfeed newborns, as indicated in the AAP recommendation, some clinicians and researchers in Thailand do since iron supplement may have a preventative impact on ID in entirely or partly breastfeed children (29). Past investigations on iron levels in babies have demonstrated that anemia and IDA seem to be more prevalent in lactated babies than in formula-fed infants (30). A cross-sectional investigation of iron level in breastfeeding babies aged three to five months found that five months old infants had a greater incidence of ID and IDA than 3-month-old infants (31). A research study comparing the iron status of normal breastfed babies at 4 and 6 months of age revealed a rise in the incidence of iron deficiency anemia (ID) 5.7% to 26.1% and iron deficiency anemia (IDA) 3.4% to 23.9% among children at 4 months rather than those at 6 months (32). These results call into doubt the

iron sufficiency of breastfed newborns throughout the first 4–6 month lactating children get 1 mg/kg/day iron supplementation beyond 4 months to avoid iron deficiency anemia (IDA) (28)However, the drawbacks and advantages of this treatment are still uncertain. At early several months of life, Hb levels fall from a relatively excellent level at birth to their lowest point between six and ten weeks of age (33). This reduction is termed as "physiological anemia of the infant." After Hb approaches its minimum value at 2 months of age, it gradually rises and stabilizes between 6 and 9 months of age (34). So it is believed that full-term newborns have enough iron storage until six months of age and that exclusive breastfeeding protects full-term infants against anemia, particularly IDA (35). Before the age of 6 months, only preterm newborns and infants with low birth weight (<2500 g) are at risk for iron deficiency anemia and are recommended iron supplements due to their low iron levels (36). This is one explanation for the lack of frequency statistics as well as the lack of sufficient cut-off values for babies less than six months. Thus, the American Academy of Pediatrics (AAP) has decided that anemia should be universally screened for with measurement of Hb concentration at about one years old, and that universal screening for anemia in infants is not recommended (37). In Western Europe and the United States, probability of occurrence of manemia in healthy term babies 6–18 months of life range from 2–6 percent (38, 39), a lack of iron in certain developing countries, anemia affects more than half of all infants (40). In Mexico, 27% of infants ,5 years old are anemic (41). In a nationwide statistical study of Mexican children, anemia prevalence was shown to range from 13% at 6–11 months of age to 49% at 12–24 months of age(42). Infants with varying degrees of anemia have worse cognitive results (43, 44). Anemia identified in children between the ages 8 or 9 months has been related to considerably poorer performance results in second grade babies (45) and impaired muscle development at 18 months (46). Mental retardation was also shown to be substantially related with iron deficient anemia (47), reduced activity, increasing wariness or hesitation, while staying close to caregivers (48). In this investigation, the connection between newborn feeding habits and iron status and hematologic markers was studied. Historical data of patients examined have been used. We focused on the relation between breast feeding and bottle feeding infants with IDA. We also concentrated to see which type of feeding in much better than the other type

2. PATIENTS and METHODS

Study design and setting: The current study design was comparative hospital based cross sectional study, in which 150 children were randomly categorized into three equal groups each of 50 according to feeding practices either breast feeding, bottle feeding and mixed feeding children in Raparin teaching hospital, Erbil city from the beginning of July 2022 till the end of December 2022. This study obtained data on iron status of the whole sample size (infants and toddlers) aged between six months to three years. After measuring serum iron of both groups, the children classified into iron deficiency anemia (IDA) or normal children.

Method of data collection:

Data was collected using pre-tested self-administered structured questionnaire designed to collect information on children's age that including infants and toddlers from 6 months to 3 years, mothers gestational age in weeks reported as well as term and preterm pregnancy, they were asked about their babies in terms of weight at birth in kilograms, weight and length at diagnosis, some mothers used breast feeding technique and some bottle feeding while the rest was mixed of both breast and bottle feeding according to duration of feeding some of them took >6months while the rest was <6months, the date included the question if the breast feeding was exclusive two answers were yes or no, also provided questions such as if the breast feeding mother was on iron treatment or not, and the age she started weaning of baby, in addition referred to drug weather the mother or child took drugs or having drug history, about family how many siblings the infant or toddler had, also collect information on how socioeconomic state affected the life of the baby and the mother with answering to upper, upper middle, lower middle, upper lower and lower, and the study showed if iron deficiency anemia ran in their family or not, answering question like that makes flexibility in diagnosis, numbers of questionnaires calculated in a dwelling and the dwelling size called crowding index, and information about clinical sign, investigation reported, questionnaire involved the question about CBC, RBC, HB, MCV, MCH test and finally iron study with two options s. iron and s. ferritin was provided in the questionnaire. The aim of the study is to dedicate the level of iron deficiency anemia among bottle feeding or breast feeding children.

Data management and statistical analysis:

The data recorded on a specially designed questionnaire, collected and entered in the computer via Microsoft Excel worksheet (Excel 2016) and then analyzed using appropriate data system which is called Statistical Package for Social Sciences (SPSS) version 28 and the results were compared between patients with different variables, with a statistical significance level of $\leq$ 0.05. The results presented as rates, ratio, frequencies, percentages in tables and figures and analyzed using t-test, and Chi square tests.

Inclusion criteria:

Inclusion criteria used for subjects' selection included families willing to participate in the study, children between six months to three years of age, not having diseases like anemia, not on medications. Control group was selected by using the following inclusion criteria children not fulfilling any of the above mentioned criteria of IDA children with no history of chronic blood loss or recent acute blood loss children with no history of chronic illness, acute or chronic infection at the time of the study children with no clinical features of malnutrition children with serum albumin $\geq$3.5 g/dl children with CRP <0.6 mg/dl, children with no history of taking immunosuppressant drugs, radiotherapy or chemotherapy.

Exclusion criteria:

We excluded children aged less than six months, those older than three years, having sickle-cell anemia or currently consumed multivitamin and/or mineral supplements on a regular basis, on iron treatment, children having any hematological abnormalities like leukemia, lymphoma, or anemia due to other causes rather than iron deficiency, having sickle-cell anemia, or the family rejected participation in the study.

3. RESULTS

A total of 150 children enrolled in our study, regarding the study group divided into three equal groups that each was 50 (33.3%) participants and took one third, more than half (58.7%) of them were female, most (70%) of children were term infants, the vast majority (99%) of cases breastfed for > 6 months excluding breast feeding group, more than one quarter (25.3%) of mothers were on iron treatment, most (60.7%) of families were in middle level and finally 23.3% of them were at low socioeconomic state see (**Table 1**). 20% of mothers took iron supplement followed by 3.3% of them took vitamin D3 capsule while only 2.7% of cases had oral hypoglycemic drugs, 22.7% of babies took vitamin D drop, 8.7% of infants took iron supplement and only 0.7% of them took lactulose syrup, more than one third (37.3%) of cases ran anemia in their family history, according to clinical signs 28.7% of them had pallor, 10% struggled from decreased oral intake, 4.7% of participants faced fatigue, 34% of cases had iron deficiency anemia and most (66%) of them were normal. All shown in (**Table 2 and Figure 1**). Mean age of infants was 16.993 months, average gravida of cases was 3.45 weeks, mean para of cases was 2.87, mean abortion of 0.47, average gestational age 36.84 weeks, mean weight at birth was 3.228 kg, the mean weight at diagnosis was 10.704 kg, mean length at diagnosis of infants 78.14 cm, mean weaning of baby was 5.970months, mean number of siblings was 1.67 sibling, average crowding index was 4.77, mean RBC was 3.751 million/mm3, mean Hb was 11.811 g/dl, average MCV was 75.09 µm3, mean MCH was 30.71 ± 8.455 per cell, mean serum iron was 74.18 µmol/L, finally the mean serum ferritin was 59.029 microgram per liter. As shown in (**Table 3**). There was a significant statistical association between study groups and iron deficiency anemia (IDA), nearly half (48%) of breast feeding group had IDA followed by 30% of mixed group and only 24% of bottle feeding group. Chi square test was significant and p-value was 0.031. As shown in (**Table 4**). There was significant statistical difference between study groups and hematological parameters including RBC, Hb, MCV, MCH, serum iron and ferritin. Generally, breast-feeding group had lowest mean regarding the hematological parameters in contrast the bottle-feeding had the highest mean. ANOVA test was performed to show differences between study groups in terms of hematological parameters, and p-values were highly significant (<0.01). As shown in (**Table 5 and Figure 2**).

Table 1. Background variables of participants.

Variables		Frequency	Percent
Study group	Breast feeding	50	33.3
	Bottle feeding	50	33.3
	Mixed feeding	50	33.3
Gender	Male	62	41.3
	Female	88	58.7
Term	Term	105	70
	Preterm	45	30
Duration of breast feeding	> 6 months	99	99
	< 6 months	1	1.0
Mother on iron treatment	Yes	38	25.3
	No	112	74.7
Socioeconomic state	Upper	24	16
	Middle	91	60.7
	Lower	35	23.3
Total		150	100

Table 2. Drug history and family history of iron deficiency anemia.

Variables		Frequency	Percent
Drug history of mother	None	99	66
	Antihypertensive	5	3.3
	Multivitamin capsule	5	3.3
	Vitamin D3 capsule	5	3.3
	Iron supplement	30	20
	Oral hypoglycemic drugs	4	2.7
Drug history of baby	Anti-epileptic	2	1.3
	None	102	68.0
	Vitamin D drop	34	22.7
	Iron supplement	13	8.7
	Lactulose syrup	1	0.7
Family history of iron deficiency anemia	Yes	56	37.3
	No	94	62.7
Clinical signs	No	83	55.3
	Pallor	43	28.7
	Decreased oral intake	15	10.0
	For follow up	1	0.7
	Fatigue	7	4.7
	Weight loss	1	0.7
Iron deficiency anemia	Yes	51	34.0
	None	99	66.0
Total		150	100

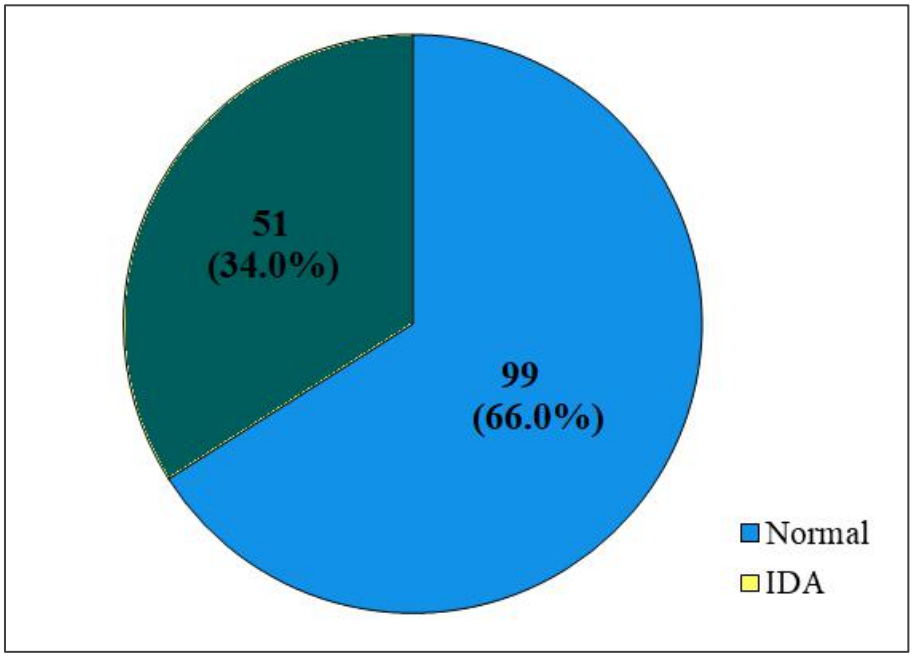

Figure 1. Frequency distribution of Iron deficiency anemia among the studied group

Table 3. Mean age, GPA, weight, length, serum and hematological parameters of participants (N=150)

Variables	Mean	SD	Range	Minimum	Maximum
Age (month)	16.99	8.10	29	6	35
Gravida	3.45	1.93	7	1	8
Para	2.87	1.65	6	1	7
Abortion	0.47	0.69	3	0	3
Gestational age (week)	36.84	2.84	12	29	41
Weight at birth (kg)	3.23	0.65	2.7	1.8	4.5
Weight at diagnosis (kg)	10.70	2.43	11	5	16
Length at diagnosis (cm)	78.14	9.30	65	35	100
Weaning of baby (month)	5.97	0.51	2.5	4.5	7
Number of siblings	1.67	1.63	6	0	6
Crowding index	4.77	1.76	9	0	9
RBC	3.75	0.82	3.1	2	5.1
HB	11.81	1.34	7.1	8.9	16
MCV	75.09	12.80	65	34	99
MCH	30.71	8.46	55	15	70
Serum iron	74.18	28.01	110	30	140
Serum ferritin	59.03	46.37	136	4	140
SD: standard deviation					

Table 4. Association between study groups and iron deficiency anemia (IDA).

Variable		Study group						P. value
		Breast feeding		Bottle feeding		Mixed feeding		
		No.	%	No.	%	No.	%	
Iron deficiency anemia	None	26	52	38	76	35	70	0.031
	IDA	24	48	12	24	15	30	
Total		50	100	50	100	50	100	

Table 5. Difference between study groups in the hematological parameters.

Parameter		N	Mean	Std. Deviation	P. value	ANOVA
RBC	Breast feeding	50	3.48	0.79	0.005	Highly significant
	Bottle feeding	50	4.00	0.73		
	Mixed feeding	50	3.76	0.83		
	Total	150	3.75	0.81		
HB	Breast feeding	50	11.44	1.39	0.007	Highly significant
	Bottle feeding	50	12.26	1.34		
	Mixed feeding	50	11.73	1.14		
	Total	150	11.81	1.33		
MCV	Breast feeding	50	71	13.68	0.015	Significant
	Bottle feeding	50	78.16	10.79		
	Mixed feeding	50	76.10	12.91		
	Total	150	75.09	12.80		
MCH	Breast feeding	50	27.98	7.92	0.007	Highly significant
	Bottle feeding	50	33.22	9.17		
	Mixed feeding	50	30.94	7.49		
	Total	150	30.71	8.45		
Serum iron	Breast feeding	50	58.90	18.67	0.001	Highly significant
	Bottle feeding	50	87.20	30.20		
	Mixed feeding	50	76.44	26.62		
	Total	150	74.18	28.01		
Serum ferritin	Breast feeding	50	41.72	37.63	0.003	Highly significant
	Bottle feeding	50	72.24	47.35		
	Mixed feeding	50	63.12	48.78		
	Total	150	59.02	46.37		

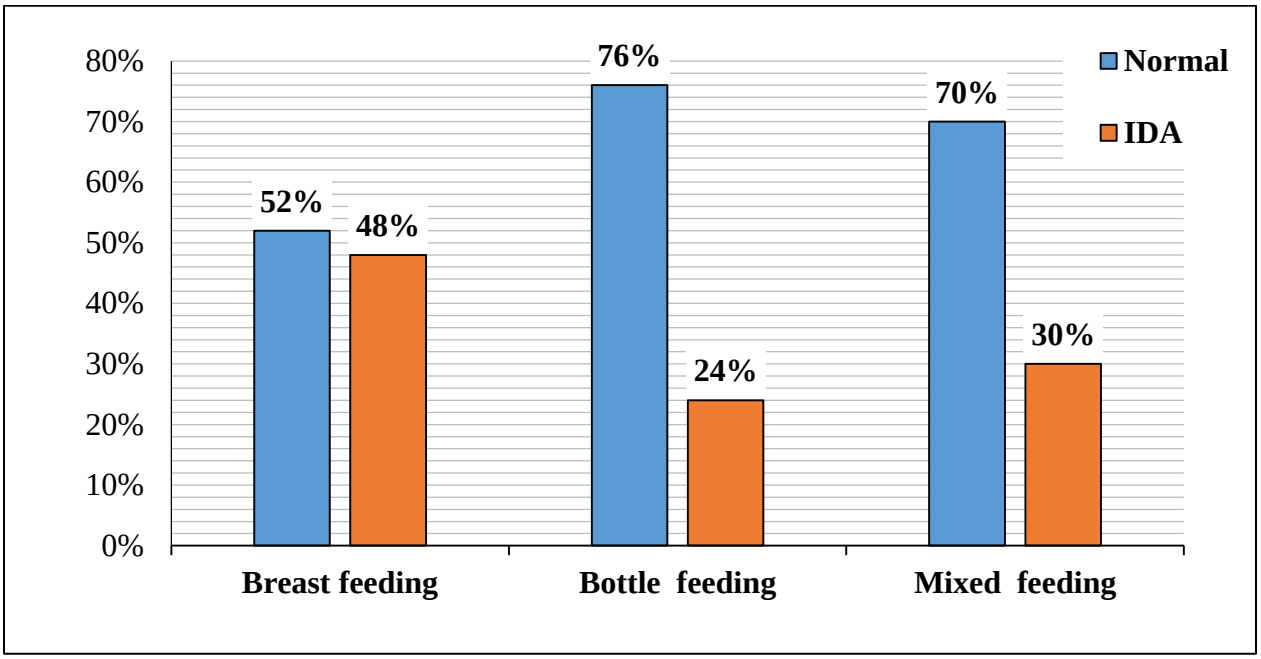

Figure 2. Iron deficiency anemia among the study groups.

4. DISCUSSION

Anemia is a global problem that affects children of all ages, but especially infants and young children. Worldwide, the prevalence of anemia in children under five years of age is estimated to be 36% (49). This is a major public health concern as anemia can lead to poor cognitive development, reduced quality of life, increased risk of death, and increased health care costs (50).Various studies have compared the prevalence of anemia between breast-fed and bottle-fed children. However, the results of these studies have been inconsistent and conflicting. The goal of this study is to conduct a meta-analysis of existing research on the comparative effectiveness of breastfeeding versus bottle-feeding for preventing anemia in children. By identifying gaps in the research and providing guidance to healthcare providers, the results of this study will improve the treatment of anemia and improve public health outcomes. This article will present the study methods and results and discuss the implications of these findings for public health. The high prevalence of anemia in this study population reflects the estimated prevalence in Kurdistan regain- Iraq. In Egypt, the long-term effects of anemia on Nigeria's

population will likely persist into adulthood. The results from this study are largely in accord with other studies regarding the negative effects of breastfeeding without food or nutrient supplementation on anemia (51, 52). In the present study, 150 cases have been taken in which they are fed differently using breasts, bottles, and mixed feeding. The percentage of females is higher than the percentage of males. The duration of breastfeeding was more than six months for nearly 99% and less than 6 six months for only one present. Different factors like a mother on iron treatment, drug history of the mother, drug history of the baby, socioeconomic state, and family history of iron deficiency anemia. In general, we tried to show how all this factor can affect babies' health and their growing process. We identified (53) studies that examined the associations between breastfeeding for 6 months or more and infant iron status (54, 55). In all but 4 studies, (54, 56) iron status was assessed only by Hb or Hb combined with serum ferritin. Iron deficiency anemia (IDA) affect by several parameters like mean age IDA can affect individuals of all ages, but it is more common in infants, children, women of childbearing age, and elderly individuals (57). GPA, or grade point average, is not typically measured in the context of IDA. Weight and length these parameters are important for assessing growth and development in children with IDA. Children with IDA may have delayed growth and development, which can affect their weight and length. Several serum parameters may be measured in patients with IDA also hematological parameters refer to the blood cell count and morphology in IDA patients(58). This study shows an association between different feeding groups with IDA. The results were significant when we compared IDA for different groups of feedings infants. It was found that about half of the participants were anemic, and 34 percent of them had iron deficiency anemia based on hematological parameters. However, in third-world countries, 40 percent of 9 months infants were anemic. WHO publications estimated the prevalence of anemia in south American infants aged 6 to 9 months to 70 percent. Anemia in Kurdistan infants is a severe public health problem that needs effective intervention. According to WHO, more than 40% of anemia was mentioned in the severe public health category. According to previous investigations, iron deficiency anemia is estimated to be about half of the total anemia prevalence (59). When infants in the breastfeeding group show, the overall prevalence of anemia in 6-month-old infants was 48%, comparable to the prevalence previously reported in multiple studies among infants and

children in similar age groups in Thailand. A study by Suwannakeeree et al. found a 29.1% prevalence of anemia in 9-month-old infants , and Tantracheewathorn et al. found a 26.4% prevalence in 9–12 month-old infants. Rojroongwasinkul et al. reported a 26.0% prevalence in urban children aged between 0.5 to 2.9 years in the South East Asian Nutrition Survey (60). The overall prevalence of IDA among infants in our study was 48, 24, and 30 percent, respectively, for breastfeeding, bottle feeding, and mixed feeding , which was higher than the previously reported prevalence among 9–12 month-old infants in Thailand (14.3% by Tantracheewathorn et al. and 17.9% by Suwannakeeree et al. and prevalence among 6–12 month-old infants in other countries (6.6% in Taiwan and 6.9% in New Zealand). This difference in IDA prevalence was likely owing to differences in the ages of the study populations. The iron stored at birth is the source of iron utilization in infants until approximately 6 months. The risk of IDA among infants over 6 months old is increased unless appropriate complementary feeding is given (61, 62). Previous studies have revealed evidence linking exclusive breastfeeding during the first 6 months of life or longer to an increased risk of IDA among infants at 6–12 months of age (63). Current practice guidelines from the Ministry of Health of Thailand recommend weekly iron supplements (12.5 mg of elemental iron once a week) for infants at 6 months of age. This recommendation can ensure the iron status of infants older than 6 months, but the adequacy of iron for infants during the first 4–6 months of life remains unclear. (64) The difference between study groups in the hematological parameters was completely significant. When we compared RBC, HB, MCV, MCH, iron, and ferritin serum. The result obtained according to the present study it shows that. Babies with bottle feeding are at a lower risk of anima compared to breastfeeding and mixed feeding groups.

5. CONCLUSIONS

The type of child feeding has a significant impact on the risk of anemia, particularly iron deficiency anemia, in infants and young children. Bottle fed is associated with a lower risk of iron deficiency anemia compared to breast feeding and mixed feeding. According to the results obtained there was significant approach in hematological parameters. Since iron deficiency contributes for the vast majority of anemias in poor nations, any anemia in newborns should,

by default, be assumed to be IDA and has to be addressed as soon as possible to avoid the severe and permanent repercussions of IDA on infants' development and growth.

Ethical Clearance:

Ethical issues were taken from the research ethics committee. Informed consent was obtained from each participant. Data collection was in accordance with the World Medical Association (WMA) declaration of Helsinki for the Ethical Principles for Medical Research Involving Human Subjects, 2013 and all information and privacy of participants were kept confidentially.

Conflict of interest: Authors declared none

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