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Iron status in breast-fed infants

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ABSTRACT Ninety infants were selected stratified proportionally random sampling and they met the inclusion criteria. Iron status was determined by the serum ferritin level concentration. The nutritional status was determined by the body weight to age based on the standard criteria of WHO NCHS. The quality of food was defined by asking the parents to keep a diary of consumed in the last 7 days minimally for three days. Out of the 90 infants, 50.4 % of them were males and 45.6 % of them were females. Most of them (93.7%) had normal nourished and 8.3 % had undernourished. The prevalence status of low iron was 18.9%. The low iron status began to occur at the age of 4 – 6 months old (6%) and the highest at the age of 9 – 12 months old (65%). Statistically significant differences were found between the iron status and the quality of food supplements over age group. The low quality of food is a risk factor influence the status of low iron. It is suggested that the iron supplements be given to breast-fed infant at the age of 4 – 6 months old. **[Paediatr Indones 2001; 41:191-196]**

Keywords: *iron status, breast feeding, food supplementation, infants.*

IRON DEFICIENCY IS THE MOST COMMON NUTRITIONAL deficiency. At least one million people are estimated to suffer from iron deficiency. Most physicians diagnose this deficiency only after the anemia is found. [1]

Infants are sensitive to iron deficiency because of the increasing need of iron for growth. The normal newborn baby has iron supply sufficiently for its growth. This supply can last them until 4 -5 months of age. However, low birth weight infants only have sufficient iron for 2 -3 months. [1-3] The source of iron comes from the diet. The source of iron in the infant's diet is usually from human milk or from cow's milk/formula and its derivative. Although the content of iron in human milk and cow's are equally low (0.2 - 0.4 mg/l), the bioavailability of iron from human milk is far better than cow milk. As a result infants consuming human milk rarely suffer from iron deficiency before the age of six months. [4] Recent study shows a high incidence of iron deficiency (30% in the West) in 6 months old infants consuming human milk. The situation is worse in the developing countries, which generally have a lower socio-economic status; the intake of animal protein is lower. Furthermore there are foods with low iron bioavailability such as cereal, tubers, and vegetables with low content of vitamin C or food, which inhibit iron absorption such as corn, soybean, and tea. [4-7]

The symptoms of iron deficiency can be corrected by giving of the iron supplementation. If chronic iron deficiency reaches a chronic stage and occurs in infants up to 2 years of age, it will cause delayed mental development that cannot be corrected by iron supplementation, although it will correct the anemia. It is because of the rapid growth of the brain that occurs at this age. [2-4]

Although the physiology of ferritin is unknown, it is clinically important because its concentration reflects the supply of iron in the body. It is estimated

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that there are 8 mgs of iron in every 1 microgram feritin per liter serum. In iron deficiency, the concentration of serum ferritin is lower 10 mg/L, higher than 1000 mg/L indicated iron overload.[4]

The early diagnosis of iron deficiency is needed. The aim of this study is to identify the iron status in infants aged minimally 3 - 12 months consuming human milk, based on the level of serum ferritin. By knowing at what age serum ferritin is lower, than it can be confirmed when iron supplement (Fe) should be given as an effort to prevent iron deficiency. Similarly, by examining the role of iron status and the quality of food supplement, it was hoped that the problem of iron deficiency can be handled and reduced as minimum as possible.

Methods

This cross sectional study examined the serum ferritin of infants aged 3 - 12 months at the village of Buduk, sub-district of Mengwi, the regency of Badung. Buduk village was chosen because the village is easy to access and most of the infants there are breastfed.

The subject of thus study were all infants aged 3 - 12 months old with the inclusion criteria: the infant weight over 2500 grams, the full term (37 - 41 weeks), singleton birth, only fed with human milk without milk formula. The exclusion criteria were the presence of congenital defects prenatal complication, born by means of caesarean surgery or other complications of child birth, intake of fresh cow milk, iron therapy, iron-fortified formula/cereal, suffering from an infectious disease or other chronic illness. The parents were given informed consent and were allowed to refuse blood examination of their infants.

The number of samples in this study was 90 infants. Infants were identified by using the infant register obtained at the Health Center of Mengwi II, at the Buduk village. The number of infants aged 3 - 12 months was 137. Those infants were then grouped based on their age: 3 - 4 months (24 infants); 4 - 6 months (32 infants); 6 - 9 months (41 infants); and 9 - 12 months (40 infants). Then the sample was chosen proportionally from each of the age group. So the number of each age group was: 3 - 4 months (16); 4 - 6 months (21); 6 - 9 months (27); 9 - 12 months (26). Iron status was determined by examining the level of serum ferritin and was divided into two level: low iron status (iron deficiency) if the level of serum ferritin < 10 mg/L and iron status is normal when the level of serum ferritin is ^{3} 10 mg/L.

Nutritional status of these infants were based on the age (month(s)) and body weight (kg), using standard classification by WHO NCHS:[8] Under nourished when under 3rd centiles, normal nourished when over 3rd-50th centiles.

The quality of food was identified by asking history of the infant food consumed. The criteria of the quality of food for infants of 3 - 4 months was[9] considered that it was good quality if the infant is only fed human milk, while it was considering poor quality if besides human milk, solid food has already been given (banana, fruit, rice, etc.)

The criteria of food quality for infants of 4 -6 months[8] that it was good if they consumed at least 2 kinds of food for 3 of the last 7 days basic food (rice, tuber) as well as animal and vegetable protein. It was considered poor quality if the food consumed is only 1 kind, basic food only.

The criteria of food quality for infants of 6 - 12 months is determined by asking the kind of infant food consumed for the last 7 days (meat, fish, egg, legumes, tofu, tempe, green vegetable/ fresh fruit). It was good quality: if for 3 of the last 7 days they consume at least 4 kinds of food mentioned above. It was poor quality if they consumed 4 or less kinds of food mentioned above.[10]

A 3 ml sample of blood was taken from every infant fulfilled the inclusion criteria, it was sent to the Department of Clinical Pathology, Sanglah Hospital to have the examination of serum ferritin using the Feritin Magic Lite Kit, Ciba Corning and read with a Magic Lite type MLA I NR 1589 photometer.

The prevalence of low iron status in infants was determined. The relationship between the variables of sex, iron status, nutrition status and the quality of food supplements with age group, it was tested by using Chi-square with the significance level of $p < 0.05$. The risk of the incidence low iron status with nutrition status and the quality of food supplements, it was determined by the prevalence ratio. Confidence interval were determined by using the method of statistical program for social science (SPSS – 6.0).[11]

Results

From the results of the study, it was found out that the subjects were 54.4 % males and the remaining 45.6 % females. Most of them (93.3%) had normal nourished status and 6.7 % were found

TABLE 1. DATA OF STUDY BASED ON AGE GROUP

	Age group (months)					
	3 - 4 n (%)	4 - 6 n (%)	6 -9 n (%)	9 -12 n (%)	Total n (%)	*p*
No. of subjaxts	16 (17.8)	21 (23.3)	27 (30.0)	26 (28.9)	90 (100)	0.829
Male	8 (16.3)	10 (20.4)	16 (32.7)	15 (30.6)	49 (100)	
Female	8 (19.6)	11 (26.8)	11 (26.8)	11 (268)	41 (100)	
Mean ferritin (µg/L)	196.0931	122.2286	18.5822	17.9827	74.1507	
SD	65.9069	68.9612	11.4874	31.1131	84.7838	
Minimum (µg/L)	25.730	9.080	6.780	6.580	6.580	
Maximum (µg/L)	278.680	198.170	48.560	167.050	278.680	
Iron status						
Normal	16 (21.9)	20 (27.4)	22 (30.1)	15 (20.6)	73 (100)	0.00126
Low	-	1 (5.8)	5 (29.4)	11 (64.8)	17 (100)	
Nutritional status						
Normal	16 (19.1)	18 (21.3)	25 (29.8)	25 (29.8)	84 (100)	0.3262
Undernourished	-	3 (50.0)	2 (33.3)	1 (16.7)	6 (100)	
Food quality						
Good	11 (26.8)	14 (34.2)	9 (21.9)	7 (17.1)	41 (100)	0.00894
Poor	5 (10.2)	7 (14.3)	18 (36.7)	19 (38.8)	49 (100)	

undernourished. From the analysis of the food quality, it was found that 45.5 % were good quality food and 55.5% were poor quality of food. From the examination of the sample of serum ferritin, 81.1 % were normal (> 10.00 mg/L) and 18.9% had a low serum ferritin (< 10.00 mg/L). In table 1, infants at 4 –6 months of age began to demonstrate low status of iron (6%), also the age group of 6 – 9 months (29%) and the age group of 9 – 12 months (65%). Infants with age group of 3 – 4 months had the highest average of serum ferritin (196.0931 mg/L) while in infants with age group of 9 – 12 months had the lowest average of serum ferritin (17.9827 mg/L). There was a statistically significant difference between iron status and the quality food supplements with age group. There were no differences found between gender and nutritional status at the different age group.

In Table 2, there were 6 infants with undernourished, 2 of them with low status of iron. There were 84 infants with normal nourished, 15 of them with low iron status. The status of undernourished was not a significant risk factor for low iron status.

TABLE 2. IRON STATUS BASED ON NUTRITIONAL STATUS IN INFANTS

	Iron Status		
	Low	Normal	Total
Nutritional Status			
Under nourished	2	4	6
Normal nourished	15	69	84
Total	17	73	90

In Table 3, there were 48 infants with poor quality of food, 15 of them with low iron status. There were 42 infants with good quality of food, 2 of them with low iron status. The quality of food is a significant risk factor for low iron status.

TABLE 3. IRON STATUS BASED ON QUALITY OF SUPPLEMENTARY FOOD

	Iron Status		
	Low	Normal	Total
Food quality			
Poor	15 (31.2%)	33 (68.8%)	48 (100%)
Good	2 (4.8%)	40 (95.2%)	42 (100%)
Total	17	73	90

Prevalence ratio: 6.5 (95% confidence interval 1.94- 42.65)

Discussion

Iron deficiency is a common cause of health problem in infants, especially in developing countries such as Indonesia. The need for iron is increased in infants because of their rapid growth of tissue.[8] Because of the increased need for iron and the supply of iron in infants gradually decreases between the ages of 2 until 6 months. If the intake of iron through the diet does not meet the physiological needs, the deficiency of iron in the body will manifest.[12] Study in the United States in infants of 6 – 20 months fed human milk showed, 9 % with iron deficiency.[13] Study in Chile (1991) examined the status of iron in 854 infants at the age of 9 months, iron deficiency was found 26.5% in infants with human milk and 37.5 % with milk formula.[14] A study in Argentina found the prevalence of iron deficiency in infants fed human milk exclusively for 6 months at 4% (with the level of serum ferritin < 10 mg/L).[15] A study in Finland did not find any iron deficiency in infants with human milk at the age of 6 months and a very small percentage at the age of 9 months.[16] Study in Japan (1993) found the level of serum ferritin < 10 mg/L in 20 – 30% in infants fed exclusively with human milk for 4 – 5 months.[17] In infants in Italy (1995) fed human milk for only an average of 5.5 months. At the age of 12 months the serum ferritin level decreased as much as 66.5% and 30% developed anemia because of the iron deficiency.[18] Most of the studies above, the decrease of serum ferritin begins to occur at the age of 6 months. In this study, the prevalence of low iron status in breastfed infants from the age 3 – 12 months was 18.9 %.The decrease of serum ferritin first occurs in infants with the age group of 4 – 6 months (6%). There was a statistically significant difference between low iron status and the poor quality of food with the increasing age of the infant. Nine to twelve month old infants had the highest low iron status (65%) and the quality of food supplements was poor (38.8%). In infants fed human milk, the iron ingested has high bioavailability (49%) so that it is easily absorbed. Neucleotides in human milk, particularly inosin, is assumed to play a role in facilitating the absorption of iron in the intestine.[19] However, the iron content in the human milk is low and after the first two weeks, decreases progressively from 0.6 mg/L to 0.3 mg/L. After 6 months with the addition of solid foods, there will be a decrease in total human milk consumption. With age, the need for iron increases. Approximately 0.8 mg of iron a day is absorbed from diet, where 0.6 mg is needed for growth and 0.2 mg for the substitute of iron loss. It is recommended that the intake of iron in food is at least 4.3 mg/day at the age of 4 – 6 months and 7.8 mg/day at the age of 7 – 12 months.[20]

Nutritional and social economic often influence the status of iron in infants. In some studies in Indonesia, the prevalence of iron deficiency in infants of 6 months – 5 years with well-nourished was found 38 – 73 %, light protein deficiency 83% and heavy malnourished 85 – 100%.[21] Untario found the prevalence of iron deficiency in infants with under nourished 43.3% because of blood loss from hookworm infestation and low intake of iron.[22] The study conducted by Sutejo and Samsudin in Indonesia found the prevalence of iron deficiency in infants with well nourished as large as 76.5%, 79.4% in undernourished and 100% in malnourished infants.[23] In our study the prevalence of iron deficiency was 17.8 % in infants with normal nourished and 33.3% in infants with undernourished.

In our study we found the status of infant nutrition was less significant as the risk factor for iron status. This was probably caused by the number of infant sample with undernourished which was so small (7%) and 93% of the infants had normal nourished. Another possibility is that the nutritional status in this study was not a significant risk factor for the iron deficiency to occur in infants of 3 – 12 months. Iron deficiency in infants can happen in those children with normal nourished, when the food quality con-

sumed by infants, contains low content of iron or other food substances that can inhibit the absorption of iron. Further cohort study needs to be conducted which analyzes the relationship between the rapid infant's growth and the incidence of iron deficiency.

The kind of infant food can influence the incidence of iron deficiency. The absorption ability of food from animals is bigger than those from vegetables. Average percentage of iron absorption from animals foods are 15% or more for liver, fish and meat. For absorption in vegetables are the highest for wheat and soybean (10%) and the lowest is for rice (around 1%). The amount of iron absorbed by the body is largely depending on iron found in food. [22] In our study, the quality of food serves as risk factor for low status of iron to occur. The composition of infant food in our study containing iron with low bioavailability, less variation and low vitamin C and contain more substances that can inhibit iron absorption. [13,23] In addition there was socio-cultural factor in Bali where certain food (beef) is not consumed.

In our study, the quantity of food consumed by infants may be sufficient but may low of iron. This may caused by the lack of knowledge in the parents about food for the infants as well as the lack of ability to buy food rich in iron such as meat and egg. For this purpose, more education is needed for mothers about eating nutritious food and the result of food lacking iron in infants.

The results of our study shows that the prevalence of low iron status in infants of 3 – 12 months is 18.9%. Sixty-five percent occurred in infants with the age group of 9 – 12 months, 29% occurred in infants with the age of 6 – 9 months and 6% occurred in infants with the age group of 4 – 6 months. Although it only occurred 6% in the age group of 4 – 6 months, thus age group there is the lowering of iron stores. If there is no intervention the status of low iron will increase with age of the infants. To prevent the decreasing of the iron stores in the infants at an early age, the following intervention can be done: (a) encouraging the consumption of human milk and giving iron-added food, (b) the consumption of iron-fortified food and rich in vitamin C after the solid food is given at the age of 4 – 6 months, and (c) giving weaning food containing more iron easily absorbed like meat, fish and liver.

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