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Iron Deficiency Risk Factors in Undernourished Children Aged 6-23 Months in Aceh, Indonesia

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ABSTRACT

The study aimed to analyse both the prevalence and risk factors for iron deficiency in undernourished children aged 6-23 months in Aceh. A cross-sectional study design was applied on 154 underweight children selected through a cluster sampling. Ferritin serum was analysed using the the enzyme-linked immunosorbent assay (ELISA), haemoglobin level using the cyanmethaemoglobin, socio-demographic and food frequency data were collected by interviews. Data on iron intake, dietary diversity and nutrient density were assesed by the repeated 24 hours recall method for three days. The results showed that 27.3% of children suffered from iron deficiency (ID), 50.7% was anaemic and 19.7% suffered from iron deficiency anaemia (IDA). Only 37.7% of children had received exclusive breast milk, 45.5% were given timely introduction of complementary feeding, 33.1% met the minimum meal frequency, 28.6% met dietary diversity, and 23.4% met the criteria for acceptable diet, 33.1% had iron intake from complementary feeding >40% RDA and 24.7% had enough iron density. Age, breastfeeding status and mother's occupation were significantly associated with the occurrence of ID where children aged 12-23 months were at lower risk than those aged 6-11 months (OR=0.28; 95%CI:0.09-0.83), while children who were not breastfed had 11.33 times higher risk of suffering from ID (OR=11.33; 95%CI:1.38-93.39). Working mothers had 8.29 higher risk of having children with ID (OR=8.29; 95%CI:1.71-40.08). The prevalence of ID in undernourished children was very high, thus it is necessary to improve the quality of breastfeeding and complementary feeding practicess as well as other interventions integrated into reducing malnutrition and iron deficiency to accelerate prevention of malnutrition in children.

Keyword: anaemia, breastfeeding, iron deficiency, underweight, young children

INTRODUCTION

Haemoglobin is one of the main factors leading to anaemia. It is estimated that 20 million people, about 30% of the world population, suffer from anaemia caused by iron deficiency. Iron deficiency also contributes to 50% of all anaemia cases occurring in non-pregnant and pregnant women as well as 42 % in toddlers (WHO 2017[b]).

The results of the Nasional Basic Health Research (*Riskesdas*) showed that 28.1% (namely 23.9% of girls and 18.4% of boys) of children under five in Indonesia suffered from anaemia (MoH 2013). The results from the South East Asian nutrition survey (SEANUT) study in 48 district in Indonesian revealed a 56.4% prevalence of anaemia in children aged 6-23 months where 60% of them had a low iron intake (<100% RDA) (Sumedi & Sandjaja 2015). Another study on children aged 0-12 months by Ringoringo (2009) in the city of Banjar Baru, South Kalimantan, found that 11.4% of toddlers had iron depletion, 7.6% had iron deficiency and 47.4% suffered from iron deficiency anaemia. The study by Ahmad *et al.* (2014) on iron deficiency and anaemia in children aged 6-23 months in Aceh Besar district showed high prevalence of iron deficiency (36.2%), iron deficiency anaemia (26.5%) and anaemia (46.7%). Another study by Wibowo *et al.* (2012) in city of Merauke also showed very high prevalence of anaemia in children aged 6-23 months, i.e., 90.7% in children aged 6-11 months and 78.8% in children aged 12-23 months.

Iron deficiency occurred in the first two years of life has negative impacts on both the growth rate and cognitive development as well as endurance due to the disruption of the immunity and nervous system and impaired regulation of energy metabolism. This conditions will have a long-term impact on the quality and productivity of their live as they grow into adulthood (WHO 2016). In general, iron deficiency is caused by a

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lack of iron intake, especially in early childhood due to the increased needs and a gap between the needs and the nutritional intake. Higher iron is needed in the first two years of life thus children in this age group require adequate feeding practicess to ensure optimal growth and development (WHO 2017[b]).

The World Health Organization (WHO) has established eight main indicators of the breast milk (BM) and complementary feeding (CF) practices to ensure the feeding quality of children aged 6-23 months. These indicators are as follows: early breastfeeding initiation (EBI), exclusive breastfeeding (EBF), continuation of breastfeeding (BF) until the age of 1 and 2 years, begin giving food at the age of 6 months, minimum dietary diversity (MDD) and sufficient minimum meal frequency (MMF), and meet the minimum acceptable diet (MAD) criteria and the consumption of iron-rich and fortified foods (PAHO/WHO/UNICEF 2013).

Recommended iron intake is 7 mg/day for children aged 6-11 months and 8 mg/day for children aged 1-3 years based on the recommended nutritional adequacy rate. The adequate administration of CF is expected to meet the nutrient gap between the intake and children's needs. Breastmilk is still a significant source of energy and nutrients in infants which provide around half of the energy needs of children until the age of one year. The contribution of energy and nutrients from breastmilk, after six months, is 35% with 55% protein and only 5% iron, while vitamin A (± 80%) could still be fulfilled mainly by the breastmilk (WHO 2004). Toddlers born at term with adequate iron reserves will be able to meet their iron needs in the first six months. Afterward, most of the required iron must be provided through the CF (WHO 2004).

Iron deficiency can lead to various health issues in children such as susceptible to infection, nervous system disorders and regulation of energy metabolism. The children will also face difficulties in growing optimally (WHO 2016). The indicators used to assess the growth disturbances include high underweight prevalence, wasting and stunting in children. The underweight prevalence in Indonesia tends to increase, from 17.9% in 2010 to 19.65% in 2013. Aceh is a province in Indonesia with a very high prevalence of malnutrition compared to the national average. The prevalence of malnutrition in Aceh increased from 23.7% to 26.3% (MoH 2013). Nutrition improvement programs (interventions) have been carried out, but the decline in the underweight indicator is difficult because the prevalence of stunting is still remain high.

Several studies revealed a strong link between underweight, anaemia and iron deficiency. The results of the study conducted by Sumarmi *et al.* (2016) in Probolinggo, East Java, on young female children showed that anaemia prevalence was higher in underweight children (48.1%) compared to normal children (28.4%), while iron depletion and iron deficiency erythropoiesis were higher in underweight children (37% and 48.1%, respectively) compared to normal weight children (9% and 17%). Santos *et al.* (2011) stated that there was a strong relationship between low weight and the occurrence of anaemia with a prevalence ratio (PR) of 1.39; 95%CI:1.18-1.64), with younger children had a higher risk of anaemia (PR=2.01; 95%CI:1.57-2.56).

To date, there is not enough data on the prevalence of iron deficiency in children aged 6-23 months, especially in those suffering from malnutrition. Thus, the intervention is more focused on macronutrient interventions through the provision of additional foods with a certain energy and protein content to increase body weight. However, the handling of undernourished children with a comprehensive approach through micronutrient interventions has not been widely explored. Hence, this study aimed to analyse the prevalence of iron deficiency and the determinant factors related to feeding practicess and socio-economic and demographic factors that affected children aged 6-23 months who suffer from malnutrition in Aceh, Indonesia. The results can be used as a basis for preventing both iron deficiency and nutritional status in undernourished children.

METHODS

Design, location, and time

This research used a crossectional design and was carried out in four sub-districts in Aceh Besar district from October to November 2016. The subjects of the research were children aged 6-24 months who suffered from malnutrition. The following inclusion criteria determined the subjects are, (1) suffering from malnutrition (weight for age Z-scores [WAZ] <-2 SD), (2) not suffering from congenital diseases and pathological abnormalities, and (3) mother/parents willing to participate in the study (informed consent).

Sampling

The sample size for the study was determined by Lemeshow formula (1990) with the prevalence of undernourished children in Aceh Besar district of 26.7% (Aceh Health Office 2015), a 10% precision with $Z(1-\alpha/2)=1.96$ at a 95% confidence level. This resulted in 75 children, then multiplied by 2 (design effect), bringing the number of subjects to a minimum of 150. The number of subjects in this study were 154 children from 166 children (baseline), only subjects with complete data from serum ferritin examination were used in this research. The research was conducted through the cluster sampling method, where *Posyandu* (maternal and child health center services in the village level) as clusters (65 clusters). The selection of *Posyandu* was based on underweight prevalence criteria of less than 10%, and each subject was taken proportionally based on the number of undeweight children.

This study has received the ethical approval from the University of Indonesia's Ethics Committee of the Faculty of Medicine: 452/UN.2.F1/ETIK/2016. At the time of data collection, each mother confirmed her wil-lingness to fill out an informed consent form.

Data collection

Socio-demographic, age, gender, birth weight, birth order family, education, the occupation of both mother and father, family income, number of family members data were collected through interviews. Serum ferritin (SF) was measured by the ELISA method with the IMMULITE 2000 tool, while haemoglobin (Hb) level was measured by the cyanmethaemoglobin method.

Data on the practicess of complementary feeding used eight indicators recommended by WHO regarding infant and young child feeding (IYCF); early breastfeeding initiation (EBI), administration of colostrum, exclusive breastfeeding and the first feeding age of pureed, semi-solid and solid complementary feedings were collected with feeding history questionnaire for children at the age of 0-5 months. In addition, current breastfeeding status were collected through an interview (WHO 2012 & PAHO/WHO/UNICEF 2013). The minimum dietary diversity (MDD) data was collected with a repeated 24 hours recall method for three days. The determination of the level of dietary diversity was based on standards which varied if the child consumes 4 or more than seven food groups, namely 1) cereals and tubers, 2) legumes and nuts, 3) dairy products (milk, yogurt, and cheese), 4) flesh foods (meat, fish, poultry, and liver/organ meats), 5) eggs, 6) fruits and vegetables that are rich in pro vitamins A, and 7) other fruits and vegetables (WHO 2012; PAHO/WHO/UNICEF 2013 & FAO 2013). The minimum meal frequency (MMF) data were collected by interviewing the frequency of eating staples and daily snacks with the recommended frequency standard. Minimum acceptable diet (MAD) is the proportion of children who received dietary diversity and frequency of daily eating according to the minimum standards. Consumption of iron-rich or iron-fortified foods data was collected through the interview method using a structured questionnaire (WHO 2012; PAHO/WHO/UNICEF 2013 & FAO 2013). Iron intake from complementary feedings was collected by the repeated 24 hours recall method for three days (Gibson 2005). Iron nutrient density data were collected by repeated 24 hours recall method for three days (FAO 2013).

Nutritional status data were collected by anthropometric measurement of body weight and length. Body weight was measured using digital scales (Tanita digital scale) with an accuracy of 0.1 grams. The body length was measured in a recumbent position using a baby length board with an accuracy of 0.1 cm. The index used was weight for age Z-score (WAZ) (WHO 2005). Children health status: data on the event of fever, runny nose and diarrhea were collected by interview method using a structured questionnaire measuring the incidence and duration of each type of ilness.

Data analysis

Data processing is carried out through four stages, namely editing and coding, entry and data analysis, input data into the excel format and then transfer to the IBM SPSS 21 program for the analysis. The iron deficiency was determined based on ferritin serum level <12µg/l and anaemia was determined based on Hb<11 mg%. Iron deficiency anaemia occurs if the SF<12 µg and Hb<11mg% (WHO 2011 & WHO 2017[b]). The dietary diversity score was taken from the average score of the three days recall. It was considered as poor in dietary diversity if the score <4 and good dietary diversity if the score is ≥4.

The MMF for breastfed babies aged 6-8 months was 2 times/day or more and for ages 9-23 months was 3 times/day or more, while for infants 6- 23 months who were not breastfed was at least 4 times/day or more (WHO 2012 PAHO/WHO/UNICEF 2013 & FAO 2013). The analysis of the nutrient intake using *Nutrisurvey* software was classified based on the average percentage of RDA. The nutrient density is calculated by divid-

ing the amount of nutrient intake by the total energy intake multiplied by 1,000 kcal, then compared with the FAO standard which is <7 mg/1,000 kcal (low) and 7-40 mg/1,000 kcal (enough) (Drenewski 2005). Whereas, the nutritional status was determined by analyzing the Z-score using the *WHO Anthrop-plus 2007* software (WHO 2007), while the incidence of ilness was analysed based on the number of incidents and the duration in the last 1 month, grouped into; never, 1-2 days, 3-4 days, and ≥5 days.

The univariate analysis was carried out to analyse the distribution of frequency, average, standard deviation and minimum and maximum values of variables, while the Odds Ratio (OR) was obtained from logistic regression statistical test. Risk factor analysis was carried out through 3 stages, i.e., the bivariate analysis to determine the relationship between independent variables and iron status; the second stage i.e., multivariate analysis by entering all variables with $p<0.25$ from the results of the bivariate analysis; then the third stage i.e., the multivariate analysis by analyzing variables with a value of $p<0.05$ and including all variables with $p>0.05$ from the results of multivariate test (stage 2) until there were no more variables that had a value of $p>0.05$. To find out if there is a correlation between independent variables or predictors, the regression modelling was carried out by multicollinearity test based on the tolerance value and variance inflating factor (VIF) using tolerance limit >0.01 and VIF value <10. All tests were carried out at a 95% confidence level ($\alpha=0.05$).

RESULTS AND DISCUSSION

Characteristics of the family and subject

The results showed that the majorities of the subjects were aged 12-23 months (72.7%), female (50.6%), were the second child (33.1%) and had low birth weight (LBW) about 12.3%. Most respondents (mothers) were housewives (85.1%) with high school education (51.9%) and had low family income (50.6%) (<Rp. 1.9 million). The incidence and duration of the illness in the past month was 26.0% for children suffering from fever (1-2 times/month) with the longest being 3-4 days (24.0%). In addition, 14.3% children had suffered from cough (1-2 times/month) lasting for more 5 days (19.5%), 2.6% of the children had diarrhea (1-2 times) lasting up to 3-4 days (7.1%) and 16.9% had cold (1-2 times) with the most extended period i.e., 3-4 days (22.7%) (Table 1).

The feeding practices and iron intake and density.

The results of the study (Table 2), referring to the eight infant and young child feeding indicators recommended by the WHO, revealed that 73% of children were subjected to early breastfeeding, 37.7% were given EBF, and 87.0% were given BM. Almost three quarters (66.9%) had met the standard MMF. However, the MDD was still very low at only 28.6%, and the majority (76.6 %) did not fulfill the MAD standard. The results also showed that some of the children were given green and orange vegetables (72.7%) and 66.9% were given plant based protein sources (nuts and other processed products), 80.5% were provided with animal protein (fish, eggs, meat, and others) and 76.2% were given fruits; 91.6% of children were given fortified manufactured food, and 11.0% were given multivitamin supplement.

The average % RDA of iron intake was 41.8±45.1%, while the average iron density of the CF was 6.86±10.92 mg. The levels of iron intake from the CF of most of the subjects were still low, i.e., 66.9% of children iron intake representing <40% RDA. The iron density of the daily consumed food was still low, i.e., 75.3% of subjects had the iron density from food that was less than 7 mg per 1 000 kcal.

Iron status in undernourished children aged 6-23 months

The results of 154 subjects completing the serum ferritin assesment demonstrated that the average SF level was 34.8±39.8 µg/L with an iron deficiency prevalence was 27.3%. Iron deficiency mostly occurred in children aged 12-23 months (33.0%) compared to the 6-11 months age group (11.9%). In addition, it was slightly higher for male (28.9%) than female (25.6%). Meanwhile, the average haemoglobin level was 10.8±1.06 g/dl, with an anaemia prevalence was 50.7%. Meanwhile, the results of SF and Hb combination analysis in 142 children aged 6-23 months revealed that 8.5% was suffering from iron deficiency, 31% suffered from anaemia, and 19.7% was suffering from iron deficiency anaemia (Figure 1).

The high prevalence of iron deficiency is strongly influenced by biological factors such as low iron intake from food and other nutritional deficiencies, growth, physiological level, gender, age, and race. Other factors include infection and inflammation, genetic development disorder, social and behavioral factors as well as environmental factors (WHO 2017[b]). The results of this

Table 1. Family socio-demography and characteristics of undernourished children aged 6-23 months

Socio-demography and characteristics	Frequency (n)	Percentage (%)	Socio-demography and characteristics	Frequency (n)	Percentage (%)
Age of children (months)			Number of children		
6 - 11	42	27.3	1-2	89	57.8
12 - 23	112	72.7	3-4	56	36.4
Gender			≥ 5	9	5.8
Female	78	50.6	Frequency of fever (times)		
Male	76	49.4	Never	105	68.2
Birth order			1-2	40	26.0
1st Child	38	24.7	3-4	9	5.8
2nd Child	51	33.1	Duration of fever (days)		
3rd Child	36	23.4	Never	73	47.4
4th Child or more	29	18.8	1-2	22	14.3
Body weight at birth (kg)			3-4	37	24.0
<2.5	19	12.3	≥ 5	22	14.3
2.5-2.69	17	11.0	Frequency of cough (times)		
2.7-3.5	103	66.9	Never	122	79.2
≥3.6	15	9.7	1-2	22	14.3
Low birth weight status			3-4	10	6.5
LBW (< 2 500 g)	19	12.3	Duration cough (days)		
Normal (≥ 2 500 g)	135	87.7	Never	89	57.8
Nutritional status			1-2	9	5.8
Stunting (<-2 SD)	79	51.3	3-4	26	16.9
Normal (≥-2SD)	75	48.7	≥5	30	19.5
Age of the mother (years)			Frequency of cold (times)		
< 25	22	14.3	Never	122	79.2
25-35	96	62.3	1-2	26	16.9
≥35	36	23.4	3-4	6	3.9
Occupation of the mother			Duration of cold (days)		
Housewife	131	85.1	Never	80	51.9
Work	23	14.9	1-2	10	6.5
Education of the mother			3-4	35	22.7
Not graduated ES	6	3.9	≥5	29	18.8
Elementary school	13	8.4	Frequency of diarrhea (times)		
Junior high school	27	17.5	Never	148	96.1
Senior high school	80	51.9	1-2	4	2.6
Graduate and above	28	18.2	3-4	2	1.3
Family members			Durration diarrhea (days)		
3-4	35	22.7	Never	132	85.7
5-6	111	72.1	1-2	10	6.5
≥ 7	8	5.2	3-4	11	7.1
Family income per month[1]			≥5	1	0.6
< 1.9 million	78	50.6			
1.9-3.5 million	67	43.5			
> 3.5 million	9	5.8			

[1]IDR: Indonesian Rupiah; HAZ: height for age Z-score; LBW: low birth weight; ES: elementary school

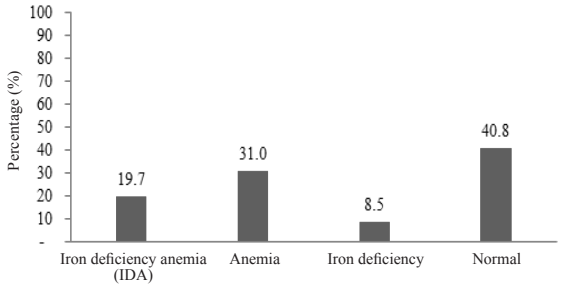

Figure 1. Prevalence of iron deficiency, anemia and iron deficiency anemia in undernourished children aged 6-24 months

study showed (Table 2) that iron intake from the CF only had an average of 41.8% RDA and most iron intake was below 40% RDA.

The prevalence of iron deficiency in this study was lower than the study conducted on children aged 6-23 months by Ahmad *et al.* (2014) in different areas in Aceh Besar where 36.2% suffered from iron deficiency, 46.7% from anaemia and 26.5% from iron deficiency anaemia. However, this condition indicated that iron deficiency is still a public health problem in Aceh, especially in Aceh Besar. The results of this study are similar to those by Laillou *et al.* (2012) in Vietnam on children aged 6-75 months where 12.9% suffered from iron deficiency. Likewise, the results of the study by Sailaja *et al.* (2017) in India, showed that 53.1% of children aged 6-23 months suffering from anaemia experienced iron deficiency. Also, the results of the study conducted by Lozoff *et al.* (2006) on 12 months old children resulted in 34.9% ID. The prevalence of iron deficiency was also very high in African countries, namely 51% in Algeria, 27% in Egypt, 51% in Ivory Coast , 21% in Kenya, 30% in Morocco and 11% in South Africa (Mwangi *et al.* 2017).

Table 2. The breastfeeding and complementary feeding practice of undernourished children aged 6-23 months

BF and CF practice	Frequency	Percentage (%)	BF and CF practice	Frequency	Percentage (%)
Early breastfeeding initiation			Provision of nuts		
No	41	26.6	Yes	103	66.9
Yes	113	73.4	No	51	33.1
Exclusive breast feeding			Animal side dishes		
Exclusive breast milk	58	37.7	Yes	124	80.5
Not exclusive breast milk	96	62.3	No	30	19.5
Breastfeeding Status			Provision of fruits		
Yes	134	87.0	Yes	117	76.0
No	20	13.0	No	37	24.0
Timely introduction of CF			Consumption of fortified food		
Birth- 5 months	84	54.5	Yes	141	91.6
≥ six months	70	45.5	No	13	8.4
Minimum meal frequency			Consumption of multivitamin		
Not suitable	51	33.1	Yes	17	11.0
Suitable	103	66.9	No	137	89.0
Minimum dietary diversity			Iron intake fron compelementary feeding		
Poor (<4 food group)	110	71.4	<40% RDA	103	66.9
Good (≥4 food group)	44	28.6	≥40% RDA	51	33.1
Minimum acceptable diet			Iron density of complementary feeding (mg)		
Poor	118	76.6	<7	116	75.3
Good	36	23.4	7-40	38	24.7
Provision of vegetables					
Yes	112	72.7			
No	42	27.2			

BF: breast feeding; CF: complementary feeding; RDA: recommended dietary allowance

The results of the study by Chandyo *et al.* (2016) in Bhaktapur, Nepal, revealed that the prevalence of iron deficiency is also very high, namely 17% in children aged ≤6 months and 30% in children aged 7-12 months.

Iron deficiency risk factors in undernourished children aged 6-23 months in Aceh

The undernourished children aged 12-23 months had a lower risk of iron deficiency about 0.28 times than children aged 6-11 months (OR=0.28; 95%CI:0.09-0.839) and p<0.05. Working mothers had 8.29 times higher risk of having children with greater iron deficiency than housewife mothers where (OR=8.29; 95%CI:1.71-40.08) and p<0.01. Meanwhile, children who are no longer breastfed have a risk 11.35 times greater of iron deficiency than children who were still breastfed (OR=11.35; 95%CI: 1.38-93.39) and p<0.05 (Tabel 3). The results of the collinearity analysis showed that there was no multicollinearity problem in the analysis model of the relationship between predicting variables.

The results of this study determined risk factors for iron deficiency in undernourished children which were namely the age of children, working mothers and breastfeeding status. The results also showed that the child's age is significantly associated with the occurrence of iron deficiency where children aged 12-23 months are at lower risk (0.29 times) compared to children aged 6-11 months (OR=0.29; 95% CI:0.09-0.84). These results are in line with the study conducted by Laillou *et al.* (2012) where children at a younger age (6-17 months) had a higher risk of anaemia than those at an older age, and study of Woldie *et al.* (2015) in Northeast Ethiopia also showed children 9-11 months of age higher risk of anemia. However, the results were different to those of Fatima *et al.* (2013) where SF levels were higher in children aged 1 month than children aged over 1 month i.e., aged 1 month (200 ng/ml), 2 months (123 ng/ml), 3 months (82 ng/ml), 4 months (49 ng/ml), 5 months (37 ng/ml) and 6 months (37 ng/ml). Also, the result of this study differed to those of Chandyo *et al.* (2016) where the prevalence of iron deficiency was higher in children aged 7-12 months (30%) than younger children (6 months), about 17%. Different results were also observed in Soh *et al.* (2004) research that stated that iron prevalence was higher in children aged 12-24 months (23.3%) than those aged 6-11 months only about 8.3%, in study Ekwochi *et al.* (2018) in Enugu South East Nigeria, prevalence of iron deficiency anaemia was higher among age group 13-23 months..

The high prevalence of iron deficiency at 6-12 months of age can occur due to the practices of breastfeeding, i.e., exclusive breastfeeding and continued breastfeeding. Study by Burke *et al.* 2018 in Bolivian infant showed higher risk of ID in young children caused by inadequate breastfeeding practice, that are prolonged EBF, and study by Uyoga *et al.* (2016) in rural Kenya showed greater duration of EBF predict better iron status. The results study of Tsai *et al.* (2016) in showed prolonged breastfeeding and predominantly breastfed associated with IDA. The results of systematic review by Eussen *et al.* (2015), showed higher prevalence iron deficiency in infant aged 6-12 months caused by drinking dringking cow's milk as a main type of drink in the first year of life.

The results of this study (Table 2) showed that only 37.7% of children were breastfed exclusively and the proportion of children who were no longer breastfed was 13%. The early introduction to food (before six months of age) was

Table 3. The iron deficiency risk factors in undernourished children aged 6-24 months[§]

Determinant factors	Iron status		OR 95% (CI)	p
	Deficiency (0)	Normal (1)		
Age of the children (months)				
6-11	5 (11.9)	37 (88.1)	(1)	
12-23	37 (33.0)	75 (67.0)	0.28 (0.09-0.83)	0.022*
Occupation of the mother				
Housewife	40 (30.5)	91 (69.5)	(1)	
Worker	2 (8.7)	21 (91.3)	8.29 (1.71-53.40)	0.009**
Current breastfeeding status				
Yes	41 (30.6)	93 (69.4)	(1)	
No	1 (5.0)	19 (95.0)	11.35 (1.38-93.39)	0.024*

[§] The logistic regression analysis; significant in *p<0.05; **p<0.01; 0=deficiency; 1=normal

54.5%. Early feeding causes breastfeeding to not be optimal regarding both the frequency and quantity of breast milk which causes the child not to get optimal iron from BM. Whereas, iron requirement in the first six months can be met from the reserves carried in the womb and breast milk (WHO 2004). Moreover, iron requirement for children aged 6-12 months is 9.3 mg/day which is higher than that of 12-23 months old children i.e., 5.8 mg (Dewey 2007) or 0.9-1.3 mg at 6-12 months of age and 0.5-0.8 mg per kilogram of children body weight per day for 12-23 months of age (Domellof *et al.* 2014).There is a huge gap of iron availability from breast milk which represents only 5% of the children's needs after the age of 6 months. Meanwhile, the availa-bility of iron in breast milk is very low and estimated at 0.2 mg/day. Thus, the amount needed from food is between 9-10 mg/day at 6-8 months of age and 5-7 mg/day at 12-24 months of (Dewey 2007). Thus, most of the required iron must be supplied by CF (WHO 2004).

On top of the low proportion of children who received EBF, the results of this study indicated that the average iron intake from CF is deficient at only 3.3 mg (2.8 mg in children aged 6-11 months and 3.7 mg in children aged 12-23 months) or an average of 41.8% RDA. Studies on lower socio-economic children in Indonesia are still deficient, and the results of a study by Sumedi *et al.* (2015) showed that the average iron intake of children aged 6-23 months is still below the requirement which is 4.6 mg or an average of 60.3% RDA. The low iron intake from the CF is influenced by inadequate feeding practicess. The results of this study (Table 2) demonstrated that 76.6% of children did not meet the MAD standard, 33.1% did not meet MMF and 71.4% did not meet MDD.

Breastfeeding status is significantly associated with iron deficiency, and children who are no longer breastfed are at risk of 11.33 times greater to suffer from iron deficiency than children who are still breastfed (AOR=11.33; 95%CI:1.38-93.39). This result was similar to study by Sailaja *et al*. (2017) stating that breastfeeding status is one of the protective factor for iron deficiency anaemia in children aged 6-23 months. Another study by Kang *et al.* (2015) in Seongnam, Korea, showed that the short duration of breastfeeding is a risk factor for iron deficiency in children who are breastfed (6.54 times) risk of suffering from iron deficiency. In addition, a study by Thorisdottir *et al.* (2011) also showed similar results where iron deficiency was higher (21%) among infants fed a diet of primarily cow milk, and the prevalence was very low in children who were still breastfed, only 2.6% compared to 1.4%.

However, several studies show that children who are given breastfeed only after the age of 6 months without complementary feeding, actually have a higher risk of suffering from deficiency. The results study of Clark *et al.* (2016) in China showed the odds of iron deficiency increased in breastfed and mixed fed infants than formula-fed infants at 9 months of age. So that the recommended iron-rich foods supplement to prevent iron deficiency (Qaseem *et al.* 2015), but the first four months of life iron deficiency and iron deficiency anemia can be prevented by exclusive breastfeeding (Marques *et al.* 2014)

Breastfeeding is one of the main sources of nutrition for children aged 0-6 months continuing until the child is two years old. After six months, breast milk can still meet 5% of the children's iron needs, although the iron contribution from BM is relatively small with a very good bioavailability value (WHO 2004). The results of a study conducted by Sumedi *et al.* (2015) showed that children who are no longer breastfed (weaned) are at (10.99 times) risk of having less iron intake than children who are still breastfeed. Children who are no longer given breast milk will generally switch to formula milk. Some studies showed that the prevalence of iron deficiency is higher in children who are no longer given breast milk, i.e., feeding on other food such as cow's milk. The results of the study by Qudsia *et al.* (2015) in 4-9 months children showed that children fed on both BM and fortified formulas had higher serum ferritin levels (109±71.7 µg and 137.7±90.6 µg) compared to children fed on cow's milk (24.0±22.8 µg). The results of this study also concluded that children who were breastfed did not require an iron supplement, folate, or iron fortification. The results of the study by Chandyo *et al.* (2016) revealed that breastfeeding and exclusive breastfeeding, child age, sex, and ferritin concentration of the mother are predictors for iron deficiency in children aged 0-12 months.

The socio-demographic conditions of the family are also associated with the occurrence of iron deficiency. The results of this study indicated the the father's age and the mother's occupation are risk factors for iron deficiency. Children with working mothers are at higher risk 8.29 times of suffering from iron deficiency than children with mothers working as housewives (OR=8.29; 95% CI:1.71-40.08). Based on the analysis of family income level (based on work, data not shown in the table), there was no significant difference

(p>0.05) concerning income level between working mothers and housewive. However, the proportion of mothers with low income (IDR<1.9 million/month) was higher in housewive (52.7%) than working mothers (39.1%).

The mother's work will affect childcare in that mothers who work have little time to directly take care of their children. Working mothers generally leave their children with helpers or parents (grandmothers) at home. Thus, the maid or caregiver will entirely and automatically care for children, including the practices of feeding, the results of study by Kabir *et al.* (2017) showed feeding practicess for infants and young children broadly determined by mothers. Study in urban slums of Davangere city, showed the prevalence of exclusive breast-feeding was carried out by 62% of at-home mothers however only 16% of working mothers. Among working mothers with children age 6-23 months only 11% were were giving minimum acceptable diet less than among at-home mothers 31% (Shuba *et al.* 2015).

Working mothers outside the home has a negative influence on feeding practices, study by Ryan *et al.* (2006) showed mothers who work outside the home, especially full-time, has a negative impact on duration of breastfeeding. Study of Attanasio *et al.* (2013) also showed, women employed full-time were less likely to fulfill their intention to exclusively breastfeed. Study Ogunba (2015) Southwestern Nigeria showed adoption of appropriate infant feeding practice positively influences by maternal place of work. The Study results of Chekol *et al.* (2017) in Gondar town, Northwest Ethiopia showed breastfeed practice higher in unemployed mothers breastfeed than employed mothers. Several other studies also showed that socio-demographic aspect of the family is related to micronutrient deficiencies. Liu (2011) showed that children living in rural areas, small homes and small families (≤3 people) have a higher prevalence of micronutrient deficiency.

The high prevalence of iron deficiency in children aged 6-23 months, especially in developing countries, is closely related to complementary feeding practices. Stewart *et al.* (2013) stated that malnutrition in the first two years is closely related to inadequate complementary feeding and improper breastfeeding. WHO (2015) stated that the quality of CF practices in children aged 6-23 months is still low, less than a quarter of children aged 6-23 months in developing countries meet the criteria of MDD and MMF. The results of this study (Table 2) showed that the CF practices was still inadequate where only 23.4% of the subjects had met MAD standard, as well as the standard of MDD, where only 28.6% with 33.1% that did not meet the MMF. The poor practices of providing complementary feeding will illustrate both the low quality and quantity of children food consumption.

Iron is one of major limiting nutrients in the complementary diets, The results study of Ferguson *et al.* (2016) in rural Kenyan children showed Zinc, iron and calcium are major limiting nutrients in the complementary feeding. The results of this study (Table 2) showed an average iron intake from CF of 6.86± 10.92 (mean% RDA 41.8±45.1). In addition, they also showed that 66.9% of children had an iron intake from CF less than 40% of RDA. Poor quality of CF significantly impact on iron status. Study of Reinbott *et al.* 2016 in Cambodian showed the consumption of animal source foods (ASF) and high nutrient density in complementary feeding index was significantly impacts on ferritin, sTfR and hemoglobin concentrations. Andersson & Hurrell (2010) state, increase iron content and bioavailability of the diet, and consumption of iron-fortified foods are needed to prevention of iron deficiency in older children. Kejo *et al.* (2018) state low or nonconsumption of iron-rich foods like meat, vegetables, and fruits were predictors of anemia among under-five children. Ray *et al.* (2018) state factors associated with nutritional anemia in children less than 5 years age are low iron intake, increasing birth order and symptoms of anemia in mother.

CONCLUSION

Iron deficiency in undernourished children aged 6-23 months is very high in that 1 out of 4 undernourished children suffer from iron deficiency, and 1 out of 2 children suffer from anaemia. Iron deficiency is still a public health problem in Aceh, especially in undernourished children. The children aged 12-23 months had a lower risk of iron deficiency, however iron deficiency higher risk in the working mothers and the children who are no longer breastfed. Increased nutrition education, especially the CF practices and interventions to overcome iron deficiency in children aged 6-23 months. This effort is pivotal to accelerate growth, especially in children who suffer from malnutrition.

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