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Prevalence of Iron-Deficiency Anemia in Infants Living in Rural Areas and the Factors that Influence it in the Pandemic COVID-19 Era

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Abstract

BACKGROUND: Iron-deficiency anemia (IDA) is caused by inadequate intake of iron or impaired erythrocyte formation due to chronic blood loss.

AIM: This study aimed to obtain data on the prevalence of iron deficiency and IDA in the pandemic COVID-19 era and to investigate the relationship of infant nutritional status, maternal education, maternal occupation, maternal parity, and family income with the prevalence of iron deficiency and IDA in infants 9–12 months at the Cempaka Banjarbaru Community Health Center.

METHODS: A cross-sectional analytic descriptive approach was used with a consecutive sampling technique to conduct this study. The sample consisted of 50 infants between 9 and 12 months old that had completed blood count and peripheral blood smear at measles immunization in May–September 2020 at the Cempaka Banjarbaru Community Health Center.

RESULTS: The results showed that the prevalence of iron deficiency, IDA, and hemolytic anemia was 16%, 28%, and 22%, respectively. Meanwhile, the data analysis was conducted using Chi-square and Fisher's exact test. The results showed a significant relationship between family income factors and the prevalence of iron deficiency and IDA ($p = 0.023$).

CONCLUSION: Infants at the age of 9–12 months need to have a complete blood count examination to detect an earlier iron deficiency and IDA.

Introduction

Iron deficiency is the most common nutritional deficiency in children, and the global prevalence of anemia in 2010 was 32.9%. It was the most severe burden for children <5 years of age [1] and it is a challenging problem for resource-limited nations [2]. In most of Africa, Latin America, and Southeast Asia, the prevalence ranges from 45% to 65% in children [3] and about one-third to one-half of this complication is attributed to iron deficiency, depending on the region [1], [2]. In Indonesia, iron-deficiency anemia (IDA) is also one of the leading nutritional health problems, consisting of 40–45% in infants aged 6–12 months [4]. Furthermore, a study (2016) was conducted in Banjarbaru City, South Kalimantan, using 211 newborns that were followed in a cohort until the age of 12 months. In this study, 24 babies (11.4%) suffered from iron depletion, 16 (7.6%) suffered from iron deficiency, and 100 (47.4%) suffered from IDA. Meanwhile, three of the infants aged 6 months to 5 years were very susceptible to anemia [5].

According to the Central Statistics Agency (BPS), the city of Banjarbaru had an impoverished population of 10,750 people (4.01%) as of March 2020 [6], [7]. Therefore, it is crucial to conduct a study on the prevalence of iron deficiency and IDA in infants aged 9–12 months. Furthermore, factors such as infant nutritional status and mother's education, mother's job, mother's parity, and family income should also be discussed.

Methods

A cross-sectional analytic descriptive approach was used with a consecutive sampling technique. The subjects were all infants aged 9–12 months who met the inclusion and exclusion criteria during a measles vaccination in May–September 2020 at the Cempaka Banjarbaru Community Health Center. The inclusion criteria were that parents allowed their babies to participate. Meanwhile, the exclusion criteria were:

1. Suffering from a hematologic-oncological disease at the time of measles immunization
2. Suffering from major congenital abnormalities
3. Incomplete family entry data.

The independent variables studied were infant nutritional status, mother's education, maternal occupation, maternal parity, and family income, while the dependent variables were iron deficiency and IDA. The IDA Criteria were [5], [8]:

1. Hemoglobin (Hb) levels <11 g/dL
2. Review of peripheral blood smear: Hypochromic and microcytic
3. Red cell distribution width (RDW)> 14%
4. RDW index> 220, where the RDW index = Mean corpuscular volume (MCV) RBC × RDW
5. Mentzer index> 13, where the Mentzer index = (MCV)/RBC.

It is called IDA when it meets criteria numbers (1) and (2); and at least 1 of 3 criteria numbers (3), (4), and (5).

Iron deficiency criteria: (1) Hb level ≥11 g/dL, (2) Review of peripheral blood smear: Hypochromic and/or microcytic, (3) RDW> 14%, (4) RDW index> 220, where the RDW index = (MCV)/RBC × RDW, and (5) Mentzer index> 13, where the Mentzer index = (MCV)/RBC. It is an iron deficiency when it meets criterion numbers (1) and (2); and at least 1 of 3 criteria numbers (3), (4), and (5) [5], [8].

Nutritional status is assessed based on body weight according to length, and it is divided into overnutrition, good nutrition, undernutrition, and poor nutrition [9]. In this study, overnutrition and good nutrition were categorized into a good nutritional status with a z-score of −2 SD to +3 SD. In contrast, undernutrition and poor malnutrition were categorized into undernutrition status with a z-score <−2 SD.

The education level of the mothers is considered low when they attend only elementary to junior high school. In contrast, the education level is classified as medium-high when she attended high school to tertiary education.

The classification of family income uses the poverty line. Family income is classified as low when it is below the poverty line. When the income is above the poverty line, it is called middle family income [6], [7].

The data form contains patient and family identity, mother's education, mother's occupation, maternal parity, family income, body weight, body length, immunization status, complete blood count results, and a review of the peripheral blood smear.

All of the patient's parents signed the informed consent, and ethical clearance was obtained from the Research Ethics Commission of Medical Faculty of University of Lambung Mangkurat No. 513/KEPK-FK ULM/EC/I/2021.

Blood sampling

Every infant who meets the inclusion and exclusion criteria will be taken a blood sample of 1 ml from the median cubital vein. The blood sample was put in a tube with EDTA anticoagulant, homogenized by turning it over, and stored in a storage box. Then, the blood sample was examined using the DIRUI BCC-3600 Hematology Analyzer at the Cempaka Banjarbaru Community Health Center.

Statistical analysis

IBM Statistical Product and Service Solutions (SPSS) software version 23.0. Furthermore, Chi-square and Fisher's exact tests were conducted with a confidence level of 95% and a significance value of $p < 0.05$.

Results

The subjects were 50 babies that met the study criteria, and Table 1 shows the characteristics of the babies. The diagnosis was divided into four: Normal, iron deficiency, IDA, and hemolytic anemia. Table 1 shows that iron deficiency and IDA prevalence were 16% and 28%, respectively, and the prevalence of hemolytic anemia was 22%.

Table 1: Characteristics of iron deficiency and iron-deficiency anemia in infants 9–12 months at the Cempaka Banjarbaru Community Health Center

Characteristics	Sum, n (%)
Age (months)	
9	30 (60)
10	11 (22)
11	6 (12)
12	3 (6)
Gender	
Male	29 (58)
Female	21 (42)
Diagnosis	
Normal	17 (34)
Iron deficiency	8 (16)
IDA	14 (28)
Hemolytic anemia	11 (22)
Nutritional status (BW/BL)	
Good nutrition	43 (86)
Undernutrition	7 (14)
Maternal education	
Low	27 (54)
Middle-high	23 (46)
Maternal occupation	
Employed	3 (6)
Unemployed	47 (94)
Maternal parity	
Primipara	23 (46)
Multipara	27 (54)
Family income	
Low	29 (58)
Middle	21 (42)

IDA: Iron-deficiency anemia, BL: Birth length, BW: Birth weight.

The diagnosis of iron deficiency and IDA was combined into one category because they can be treated with iron preparations.

Table 2 shows 20 infants (40%) with iron deficiency and IDA having good nutritional status. The result of Fisher's exact test was p = 0.444, meaning that there was no significant relationship between the nutritional status and the prevalence of iron deficiency and IDA.

Data from Table 2 show that the factors of maternal education, maternal occupation, and maternal parity have no significant relationship with the prevalence of iron deficiency and IDA (p > 0.05).

Table 2 shows that 29 babies (58%) were from families with low-income levels. Furthermore, the Chi-square test showed a value of p = 0.023 (p < 0.05), meaning that there was a significant relationship between family income and the prevalence of iron deficiency and IDA.

Discussion

The high prevalence of iron deficiency and IDA can be attributed to the data in Table 1, which shows that more women are from low-educated (54%), unemployed (94%), multiparous (54%), and low-income families (58%). Furthermore, there is a significant relationship between family income factors with the prevalence of iron deficiency and IDA (p < 0.05). The impact of the COVID-19 pandemic has affected family income so that the baby's needs are not optimally met because family income is much reduced. Family income is reduced due to restrictions in all lines of work, and most of the baby's parents work as laborers. Woldie *et al.*, Keikhaei *et al.*, and Wahtini stated that family income could be a risk factor for the prevalence of iron deficiency and IDA. This is because higher family income assists in buying food containing complete nutrition and is suitable for baby intake to reduce the chances of having iron deficiency and IDA. Meanwhile, socioeconomic factors and low income can influence diarrhea and respiratory infections, which increase the risk of iron deficiency and IDA. Previous studies also reported that iron deficiency was higher in low-income families [10], [11], [12].

Iron deficiency and IDA have been linked to the consumption of iron-rich foods that are insufficient to meet one's daily needs. The dietary requirement is considerably higher than the net absorbed iron requirement because only a fraction of dietary iron is absorbed. This is dependent on the bioavailability of the iron in the food. Breast milk, for example, only contains 0.3–1.0 mg/l iron but has a high bioavailability (50%). In contrast, proprietary iron-containing formulas typically have 12 mg/L iron with low bioavailability (4–6%) [13]. The iron need absorbed by infants during the 1st year was 0.55–0.75 mg/day [14]. Therefore, after 6 months, breast milk alone will not meet the baby's nutritional requirements, especially iron needs.

The study by Ringoringo (2008) showed that the incidence of iron depletion, iron deficiency, and IDA in infants aged 6 months was 28.0%, 27.0%, and 40.8%, respectively. When the requirement is not met at the age of 6–12 months, iron deficiency and IDA's prevalence rate will increase [15].

Woldie *et al*. (2015) stated that mothers without formal education have a 2.6 times higher risk of anemia than those with formal education (middle-high education). Educated mothers will pay more attention to health care and will have better knowledge of exclusive breastfeeding and supplementary nutrition for their babies [10].

Choi *et al*. study showed that mothers with higher education know the types of foods consumed for nutritional fulfillment during complementary feedings, such as meat, fish, and poultry containing heme iron with higher bioavailability [16].

Alemayehu *et al*. stated that there is a relationship between maternal employment and the incidence of IDA because working mothers can support the amount of family income earned to fulfill the consumption of nutritious food [17]. In this study, most mothers did not work, therefore, the family income was

Table 2: Relationship between influencing factors and prevalence of iron deficiency and iron-deficiency anemia in infants 9–12 months at the Cempaka Banjarbaru Community Health Center

Influencing factors	Diagnosis			Sum, n (%)	p
	Normal, n (%)	Iron deficiency and IDA, n (%)	Hemolytic anemia, n (%)		
Nutritional status					
Good nutrition	15 (30)	20 (40)	8 (16)	43 (86)	0.444
Undernutrition	2 (4)	2 (4)	3 (6)	7 (14)	
Maternal education					
Low	10 (20	11 (22)	6 (12)	27 (54)	0.860
Middle-high	7 (14)	11 (22)	5 (10)	23 (46)	
Maternal occupation					
Employed	1 (2)	1 (2)	1 (2)	3 (6)	1.000
Unemployed	16 (32)	21 (42)	10 (20)	47 (94)	
Maternal parity					
Primipara	8 (16)	12 (24)	3 (6)	23 (46)	0.332
Multipara	9 (18)	10 (20)	8 (16)	27 (54)	
Family income					
Low	10 (20)	9 (18)	10 (20)	29 (58)	0.023
Middle	7 (14)	13 (26)	1 (2)	21 (42)	

IDA: Iron-deficiency anemia.

low, which resulted in an increase in iron deficiency and IDA incidence.

Opitasari and Andayasari stated that multiparous mothers have 1.7 times the risk of developing anemia than primiparous mothers [18]. Furthermore, Shukla *et al*. stated that babies born to mothers with anemia have lower Hb and ferritin levels than those born to mothers without anemia [19].

This study found 11 cases (22%) of hemolytic anemia characterized by Hb <11 g/dL, MCV <70 fL, Mentzer index <13, and the blood smear picture showed hemolytic signs. However, the etiology of hemolytic anemia is unknown. In most Southeast Asia countries, including Indonesia, the leading cause is thalassemia. In addition, the diagnosis of thalassemia can only be confirmed by Hb electrophoresis examination, which is conducted when the child is more than 1-year-old [20].

Conclusion

The prevalence of iron deficiency, IDA, and hemolytic anemia was 16%, 28%, and 22%, respectively. Meanwhile, the factor associated with the prevalence of iron deficiency and IDA in this study is family income. In terms of maternal occupation, there is a tendency that the babies of unemployed mothers are at risk of iron deficiency and IDA compared to those that are employed.

The recommendation related to this study is that infants at the age of 9–12 months should have a complete blood count examination to detect an earlier iron deficiency and IDA.

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