Research Article

Comparison of Dietary Sources of Iron, Nutritional Status and Family Factors Between Anemic and Non-anemic Children in Sorong, West Papua Province, Indonesia.

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Abstract:

Background

Prevalence of anemia among children is still high. Negative impacts of anemia on child health needs the understanding of related factors for improvements, especially in Sorong, West Papua, where malnutrition, illnesses such as malaria and helminthic diseases as well as insufficient dietary sources of iron are prominent.

Methods

We conducted a cross sectional study involving 65 children aged 6-59 months who admitted to Sele Be Solu Hospital, Sorong from January to April 2018. We compared proportion of dietary sources of iron, nutritional status, family factors and illnesses between anemic and non-anemic children using chi-square test.

Results

The prevalence of anemia was 65%. Compared to anemic children, non-anemic children consumed significantly more liver (moderate intake 83% vs 17%, P=0.02), egg (good intake 67% vs 33%, P=0.009), and tempeh (good intake 67% vs 33%, moderate intake 52% vs 48%, P=0.031). Anemia in children was significantly related to factors such as antenatal care, iron supplementation during pregnancy, family income, and stunting status of the children. We found only two cases with P. vivax malaria and trichuriasis in anemic children respectively.

Conclusions

Most of anemic children are stunting, born to mothers without antenatal care as well as iron supplementation during pregnancy, and from family with lower income; whereas non-anemic children eat more dietary sources of iron i.e. liver, egg, and tempeh. Government assistance to the families with limited resources are needed to reduce the prevalence of anemia among children.

Keywords: anemia, dietary sources of iron, family factors, stunting

Introduction

Anemia in children aged 6-59 months refers to hemoglobin levels less than 11.5 g/dl.[1] Global prevalence of anemia in low and medium income countries is still high i.e. 42.6%.[2] High prevalence of childhood anemia are found in Asian countries i.e. China (54.3%)[3]; India (75.3%)[4]; Bangladesh (51.9%)[5], Nepal (46,4%)[6]; dan Pakistan (62,5%)[6]; whereas its prevalence among children in African countries is lower than the earlier, for example 37.3% and 25% in Ethiopia[7] and Kenya[8] respectively. The lowest prevalence of childhood anemia in Latin America and Carribean countries is in Chile and Costa Rica i.e. 4%; whereas the highest prevalence are in Guatemala, Haiti and Bolivia range 47,7%-61,3%. Other countries in that region indicate prevalence between 20,1%-37,3%.[9]

The prevalence of anemia among 12-59 months old children in Indonesia is 28,1%.[10] Researchers reported that 38.2% of infants aged 4-12 months in Jakarta in 2004 were anemic[11], whereas a study on infants 0-12 months in South Kalimantan in 2006-2008 reported a prevalence of iron deficiency anemia of 47.4%.[12] Among children aged 1 month until 18 years old in South Sorong Regency in 2015, close to our study site, 66.7% were anemic.[13]

Infant and childhood anemia impacts on future child health and mortality, as well as child development.[14] Animal study revealed that iron deficient rats demonstrated decreased spontaneous physical activity and change of pattern of diurnal physical activity that became normal after iron supplementation. In human, the first two years is vulnerable time for iron deficiency due to rapid neuron multiplication when the peak of iron deficiency occurs. [15]

We aim to compare the intake of dietary sources of iron, nutritional status and family factors of anemic and non-anemic children who come to the Sele Be Solu General Hospital, Sorong, West Papua Province, Indonesia where malnutrition, illnesses such as malaria and helminthic diseases as well as insufficient dietary sources of iron are prominent.

Methods

Design, site, period and population of the study

We conducted a prospective study with a cross sectional design at the Sele Be Solu General Hospital, Sorong, West Papua Province, Indonesia from January to April 2018. Study population was sick children aged 5-59 months who attended to the hospital.

Sample

Subjects who fulfilled inclusion and exclusion criteria were eligible for the study. Inclusion criteria were children aged 5-59 months and parents or legal guardians consented to participate in the study. Exclusion criteria were children with hemolytic diseases such as thalassemia, or malignancies and bleeding tendencies those could cause anemia. Therefore, using the criteria we expected to include children with anemia due to iron deficiency, the most prevalence anemia among children in our population. Our hospital had limited facilities to measure iron panel.

Variables

The outcome was anemia, whereas the determinants were quality of dietary source of iron from animal and plant food, nutritional status, family factors including family income, number of children, antenatal care, maternal supplementation during pregnancy, maternal anemia, birth weight and iron supplementation of the children.

We assessed anemia based on clinical appearance as palmar paleness combined with hemoglobin level <11,0 g/l.[1]

Quality of dietary sources of iron from animal and plant foods was classified as good if a child consumed at least once a day based on food frequency questionnaire; moderate if the consumption was once a week and poor if the consumption was once a month or never.

Nutritional status was classified as stunting if HAZ <- 2 SD, wasting or severe wasting if WHZ <- 2 SD based on The WHO Child Growth Standard 2006 and otherwise was normal.

Family income was classified as same or more and less than local "Minimal Regional Salary" (IDR 2,677,000).

Family was grouped to had 1-2, 3-5, or 5-8 children. Mother was classified as with or lacked of antenatal care, iron supplementation, and maternal anemia.

Birth weight <2,5 kg was classified as low birth weight, and children were classified as iron supplemented or never.

Statistical analysis

Characteristics of study subject including gender, age, father's education, mother's education, father's occupation, mother's occupation, and number of children were presented in percent (%). Chi-square test was performed to test the significance of proportion between anemic and non-anemic children according to quality of dietary sources of iron, nutritional status, and family factors. A P value less than 0.005 was considered as statistical significance. Statistical analysis was done using a computer software (SPSS ver 20, SPSS Inc., Chicago, IL, USA).

Ethical consideration

The study protocol was approved by the Ethical Committee for Research and Health of the Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada and Dr. Sardjito General Hospital, Yogyakarta, Indonesia.

Results

Characteristics of study subject

Out of 65 children, 42 (65%) children were anemic. Most of the children were male (35 or 54%); aged 13-36 months (29 or 45%); fathers and mothers were graduated from senior high school (44 atau 67% and 29 or 43% respectively); father's occupation was merchant (36 or 54%), mother was housewife (41 atau 63%), and number of children was 1-2 (46 or 70%) **(Table 1)**.

Intake of animal and plant foods

Table 2 and **3** showed that compared to anemic children, non anemic children consumed more liver (moderate intake 83% vs 17%, P=0.02), egg (good intake 67% vs 33%, P=0.009), and tempeh (good intake 67% vs 33%, moderate intake 42% vs 48%, P=0.031). Other intakes were not statistically significant.

Table 1. Basic characteristics of study subject

Subject characteristics	Anemia		Non- anemia		Total	
	n	%	n	%	n	%
Gender						
Male	23	66	12	34	35	54
Female	19	63	11	37	30	46
Age, months						
6-12	19	76	6	24	25	38
13-36	15	52	14	48	29	45
37-59	8	73	3	27	11	17
Father's education						
Primary school	4	80	1	20	5	8
Junior high school	3	60	2	40	5	8
Senior high school	29	66	15	34	44	67
Bachelor's degree	1	50	1	50	2	3
Undergraduate	5	56	4	44	9	14
Mother's education						
Iliterate	1	100	0	0	1	2
Primary school	4	80	1	20	5	8
Junior high school	7	100	0	0	7	11
Senior high school	18	62	11	38	29	43
Bachelor's degree	0	0	3	100	3	5
Undergraduate	11	61	7	39	18	28
Post graduate	1	50	1	50	2	3
Father's occupation						
Army	0	0	3	100	3	5
Merchant	25	69	11	31	36	54
Farmer	3	75	1	25	4	6
Civil servant	2	29	5	71	7	11
Labor	4	67	2	33	6	9
Student	3	100	0	0	3	5
Unemployment	2	67	1	33	3	5
Fisherman	3	100	0	0	3	5
Mother's occupation						
Teacher	0	0	1	100	1	2
Housewife	27	66	14	34	41	63
Farmer	2	100	0	0	2	3
Civil servant	5	63	3	37	8	12

Labor	1	100	0	0	1	2
Student	3	75	1	25	4	6
Merchant	4	50	4	50	8	12
Number of children in family						
1-2	28	61	18	39	46	70
3-5	13	72	5	28	18	28
6-8	1	100	0	0	1	2

Table 2. Quality of dietary source of animal protein of children aged 6-59 months in Sorong, West Papua Province, Indonesia

Kind of food	Anemia*		Non anemia		P
	n	%	n	%	
Fish					
Good[a]	8	53	7	47	0,61
Moderate[b]	18	67	9	33	
Poor[c]	15	68	7	32	
Meat					
Moderate	2	50	2	50	0.61#
Poor	39	65	21	35	
Chicken					
Good	0	0	1	100	0.26
Moderate	12	57	9	43	
Poor	29	69	13	31	
Liver					
Moderate	1	17	5	83	0.02#$
Poor	40	67	18	33	
Egg					
Good	3	33	6	67	0.009$
Moderate	16	55	13	45	
Poor	22	85	4	15	
Pork					
Moderate	1	100	0	0	1.00#
Poor	41	64	23	36	

* Hemoglobin levels <11.0 g/l

Fisher exact test

$ Significant

[a] At least once a day (based on food frequency questionnaire)

[b] Once a week (based on food frequency questionnaire)

[c] Once a month or never (based on food frequency questionnaire)

Table 3. Quality of dietary source of plant protein of children aged 6-59 months in Sorong, West Papua Province, Indonesia

Kind of food	Anemia*		Non anemia		P
	n	%	n	%	
Tofu					
Good[a]	1	50	1	50	0.077
Moderate[b]	12	48	13	52	
Poor[c]	28	76	9	24	
Nuts					
Moderate	9	56	7	44	0.551#
Poor	32	67	16	33	
Soybean					
Moderate	2	50	2	50	0.614#
Poor	39	65	21	35	
Tempeh					
Good	1	33	2	67	0.031$
Moderate	12	48	13	52	
Poor	28	61	18	39	

* Hemoglobin levels <11.0 g/l

Fisher exact test

$ Significant

[a] At leat once a day (based on food frequency questionnaire)

[b] Once a week (based on food frequency questionnaire)

[c] Once a month or never (based on food frequency questionnaire)

Family factors

Compared to mothers of non anemic children, all mothers of the anemic children had no antenatal care (0% vs 100%, P=0.039) as well as never consumed iron supplements (0% vs 100%, P=0.045). More family of non anemic children received monthly salary above local Minimum Regional Salary than anemic children (54% vs 46%, P=0.03) **(Table 4)**.

Table 4. Family factors related to the anemia of children aged 6-59 months in Sorong, West Papua Province, Indonesia

Family factors	Anemia		Non anemia		P
	n	%	n	%	
Monthly income of family					
< local Minimum Regional Salary@	31	76	10	24	0.030#$
≥ local Minimum Regional Salary§	11	46	13	54	
Antenatal care					
No	7	100	0	0	0.039#$
Yes	35	60	23	40	
Supplementation during pregnancy					
No	7	100	0	0	0.045#$
Yes	35	60	23	40	
Maternal anemia					
No	13	48	14	52	0.051#
Yes	6	67	3	33	
Unknown	23	79	6	21	
Birth weight					
Normal	30	61	19	39	0.380#
Low¶	12	75	4	25	
Iron supplementation of children					
No	1	50	1	50	1.000#
Yes	41	65	22	35	

* Hemoglobin level <11.0 g/l

@ < IDR 2,667,000

§ ≥ IDR 2,667,000

Fisher exact test

$ Significant

¶ <2500 g

Nutritional status

Table 5 demonstrated that stunting was more frequent among children with anemia compared to whom without anemia (88% vs 12%, P=0.02).

Table 5. Nutritional status according to anemic status of children aged 6-59 months in Sorong, West Papua Province, Indonesia

Nutritional status	Anemia		Non-anemia		P
	n	%	n	%	
HAZ					
Stunting[ƒ]	15	88	2	12	0.020[$]
Non stunting	27	56	21	44	
WHZ					
Wasting[§] dan severe wasting[†]	14	82	3	18	0.087
Non wasting or severe wasting	28	58	20	42	

[ƒ] HAZ < - 2 SD based on The WHO Child Growth Standard 2006

[§] WHZ < - 2 SD and > - 3 SD based on The WHO Child Growth Standard 2006

[†] WHZ < - 3 SD based on The WHO Child Growth Standard 2006

Illness

We only found one case of vivax malaria and trichuriasis on different children with anemia. Therefore there was no co-infection between malaria and helminthic disease. Main diagnosis of children were shown in **Table 6**.

Table 6. Main diagnosis (ICD X) of children aged 6-59 months at Sele Be Solu Hospital, Sorong, West Papua Province, Indonesia

Diagnosis	n	%
Acute bronchitis, unspecified (J20.9)	10	15.4
Acute pharyngitis, unspecified (J02.9)	6	9.2
Bacterial infection, unspecified (A49.9)	1	1.5
Bronchopneumonia, unspecified organism (J18.0)	7	10.8
Dengue fever (A90)	1	1.5
Dengue hemorrhagic fever (A91)	3	4.6
Functional diarrhea (K59.1)	27	41.5
Functional dyspepsia (K30)	1	1.5
HIV disease (B20)	1	1.5
Mucopurulent conjunctivitis (H10.0)	1	1.5
Nutritional marasmus (E41)	1	1.5
Plasmodium vivax malaria (B51)	1	1.5
Urinary tract infection, site not specified (N39.0)	5	7.7
Total	65	100

Discussion

The prevalence of anemia in our population i.e. 65% was higher compared to national prevalence for children aged 12-59 months (28.1%)[10] as well as global prevalence (42.6%).[2] However, our prevalence was comparable with the prevalence of anemia in other developing countries such as Pakistan (62.5%)[6], and Latin American countries i.e. Haiti (60.6%) and Bolivia (61.3%)[9], but lower than India (75.3%).[4] Data from Scholoo Keyen Hospital in South Sorong Regency, close to our population indicated comparable prevalence i.e. 66.7%.[13] This high prevalence of anemia in children should be followed-up by serious government policy, since anemia in children affects future health problem including mortality. Previous studies showed the relationship between anemia, especially iron deficiency anemia and child morbidity and mortality. [14] We did not properly diagnose iron deficiency anemia in this study, because of limited facilities in our hospital. Diagnosis of iron deficiency anemia was confirmed if it fulfills 2 out of 3 requirements as follows:

hemoglobin levels <11.0 g/dl, serum ferritin levels <10 μg/dl, zinc protophorphyrin >1,42 μmol/l erythrocytes, and transferin sturation <10%.[13] However, we argue that children in our population are likely iron deficient based on the fact that the prevalence of iron anemia among children in developing countries is high.[13] Moreover, we excluded other possible causes of anemia those were thalassemia, blood malignancies and bleeding tendencies.

Studies showed the impact of iron deficiency anemia on child mortality. A meta-analysis reported from 6 African countries involving 12,000 children aged 28 days to 12 years an Odds ratio 0.76 (95% CI 0.62-0.93) or in other words the incline of 1 g/dl hemoglobin levels will decline mortality rate of 24% or 1.8 million death.[14]

Soliman et al. reported that children presenting with iron deficiency anemia who were less than 4 years of age had lower length growth (HAZ -1.2 ± 1SD) compared to who were not anemic (HAZ 0,25 ± 0,2), had lower growth velocity (7,5 ± 2,2 cm/year vs 9,7 ± 1,2 cm/year), and had lower BMI (13,5 ± 1,2 kg/m^2 vs 15,3 ± 0,9 kg/m^2). After 6 month treatment there were improvement in growth parameters such as HAZ (–0,6 ± -0,9), growth velocity (13,2 ± 4,4 cm/year), and BMI (14,2 ± 1,1 kg/m^2).[17] The proportion of stunting, wasting and severe wasting among anemic children in our population were higher compared to non anemic children. Anemia decreases oxydative response, appetite and immune function. Infection as a consequence of decrease of immune function on the other hand increases the probability of malnutrition due to poor food intake.[18]

Poor intake of dietary sources of iron may cause iron deficiency anemia. Liver, egg and tempeh are important dietary source of iron in children in Sorong. Children who were not anemic consumed more such foods compared to who were anemic. Anemic children in Mexico were less likely to ate meat dan nuts[19]; as well as in Brazil where anemic children consumed less meat, nuts, and green vegetables.[20] Although families in our population could provide some foods containing sufficient iron and protein depending on their income, however a culture i.e. "makanan kosong" (literally "empty meal") meaning "eat only carbohydrate" is the main related protein and micronutrient deficiency in our population. Health providers and government have to motivate families and change this behavior to improve the quality of dietary intake.

Changing community behavior and culture needs sufficient time, moreover government policy sometimes could not accomodate community situation, for example an opnion which lets community to change their own behavior without any support from health providers and doing health education without monitor and evaluation of the progression or improvement. Other problem rises when health policy for a certain community merely is based on an expert opinion that could not accommodate unpredictable changing in the middle of progression of a health programme. Moreover, not entire people have similar ideas or sometimes are irrational. Without long term evaluation the outcome of health education is almost impossible satisfy.[21]

There were only two anemic children in our study who suffered from Plasmodium vivax malaria and only one with trichuriasis. One study from Scholoo Keyen Hospital, South Sorong Regency indicated 45 children who were took care in the hospital suffered from malaria, 15 of all the children suffered malaria tertiana and 30 children with malaria tropicana.[13] Different geographical factor might be the reason. Sorong is an urban area, whereas South Sorong is a rural area. Malaria causes anemia due to physiological disturbance of iron distribution and utilzation through hemolysis mechanism, heme release, dyserythropoiesis, iron deposition in macrophage, and inhibition of iron absorption in the gut. On the contrary, anemia decreases malaria prevalence, because Plasmodium requires iron for their proliferation in liver and erythrocytes. However, mechanism about how Plasmodium obtain iron from their host till now is unclear. Animal studies suggested that iron chelator can inhibit Plasmodium growth invitro.[22] Kenyan children with iron deficiency anemia were more rare suffered from malaria possibly caused by immunological factors and limited nutrients that essential for development of malaria parasites.[23] Co-infection could happen between malaria and helminthic disease. In Cameroon, out of 98.5% malaria cases, all of helminthiasis (11.9%) were co-infection. Ascaris lumbricoides (73,5%) is the most prevalence followed by ankylostomiasis (8.2%).[24] We did not find any co-infection in the two malaria cases.

Conclusion

Anemic children in our study are more stunted, born to mothers without any antenatal care as well as iron supplementation during pregnancy, and from lower income family. Non-anemic children more consume

liver, egg and tempeh. Government assistance is necessary for the incline of anemia prevalence in our children.

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