

Relationship between micronutrient and anemia incidence in adolescents at Islamic boarding school

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ABSTRAK

Latar Belakang : Anemia terjadi apabila jumlah sel darah merah berkurang, sehingga kemampuan membawa oksigen keseluruhan tubuh akan berkurang. Secara global diketahui prevalensi anemia 1,62 miliar, dimana mayoritas penderita anemia adalah kelompok perempuan yang tidak hamil sebanyak 468,4 juta jiwa. Prevalensi tertinggi anemia adalah kelompok anak-anak perempuan usia sekolah ialah 47,4%, sedangkan pada pria hanya 12,7%. Kebutuhan asupan zat besi pada seorang wanita memiliki kebutuhan yang besar dibandingkan dengan kebutuhan laki-laki.

Tujuan: mengetahui hubungan antara asupan mikronutrient (vitamin B6, vitamin B12, vitamin C, zat besi) dengan kejadian anemia pada remaja putri di Islamic Boarding School.

Metode: case control dengan matching, kriteria matching yang digunakan umur 15-19 tahun, tidak sedang menstruasi pada saat pengecekan Hemoglobin (Hb), tidak puasa, dan sudah mengalami menstruasi, pengambilan data dengan cara non-propability yaitu dengan quota sampling. Populasi terdapat 1359 orang dengan sampel 92 orang, case 46 orang control 46 orang, pengambilan data asupan dengan kuesioner Semi Quantitative Food Frequency (SQ-FFQ). Pengujian dengan menggunakan uji statistik 2 berpasangan.

Hasil: terdapat hubungan yang signifikan antara asupan mikronutrient (vitamin C p-value 0,04, OR 1,17, vitamin B6 p-value 0,0001 OR 3,588, vitamin B12 (p-value 0,0001)OR 0,27, zat besi (p-value 0,0001) OR 3,091) dengan kejadian anemia remaja di Islamic Boarding School.

Kesimpulan: terdapat hubungan yang signifikan antara asupan mikronutrient dengan kejadian anemia pada remaja di Islamic Boarding School.

KATA KUNCI: anemia; vitamin B6; vitamin B12; vitamin C; zat besi;

ABSTRACT

Background : Anemia occurs when the number of red blood cells decreases, so that the ability to carry oxygen throughout the body will decrease. Globally, the prevalence of anemia is 1.62 billion, where the majority of anemia sufferers are women who are not pregnant as many as 468.4 millions of people. The highest prevalence of anemia is that of girls at school age, 47.4%, while for men it is only 12.7%. The need for iron intake in a woman has a greater need compared to the needs of men.

Objective: to determine the relationship between micronutrient intake (vitamin B6, vitamin B12, vitamin C, iron) and the incidence of anemia in adolescent girls in Islamic boarding schools.

Methods: Case control with matching, matching criteria used aged 15-19 years, not menstruating at the time of checking Hemoglobin, not fasting, and already experiencing menstruation, data collection using non-probability, namely by quota sampling, the population was 1359 with a sample of 92 people , case 46 people control 46 people, data retrieval with Semi Quantitative Food Frequency (SQ-FFQ) questionnaire. Tests using paired 2 statistical tests.

Results: there was a significant relationship between micronutrient intakes (vitamin C p-value 0.04, OR 1.17, vitamin B6 p-value 0.0001 OR 3.588, vitamin B12 (p-value 0.0001) OR 0.27, iron (p-value 0, 0001) OR 3,091) with the incidence of adolescent anemia in Islamic boarding schools. .

Conclusion: There is a significant relationship between micronutrient intake and the incidence of anemia in adolescents in Islamic boarding schools.

KEYWORDS: anemia; iron; vitamin B6; vitamin B12; vitamin c

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INTRODUCTION

Currently, Indonesia is experiencing three health problems, namely health problems related to obesity, stunting and electrolyte deficiency which can cause anemia. Globally, it is known that the prevalence of anemia was 1.62 billion, where the majority of anemia sufferers were the group of women who are not pregnant as many as 468.4 million people, the highest prevalence of anemia was the group of school-age girls, which is 47.4%, while in men it was only 12.7% (1).

The group that is prone to anemia is the group of adolescent women aged 15-19 years, because during this period, women have experienced menstrual cycles as well as changes in hormones and lifestyle (2). Islamic boarding school is one of the schools that has a boarding system and activities that have been determined by the management of activities, so the respondents are students, therefore it is deemed necessary to study in depth through this research. The purpose of this study was to determine the relationship between micronutrient intake (Vitamin C, Vitamin B6, Vitamin B12, and iron) and the incidence of anemia in adolescent girls in Islamic boarding schools.

Adolescents are age group that is included in the fertile age group, so adolescents are vulnerable to anemia (3). Anemia occurs when the number of red blood cells decreases, with a lack of hemoglobin or red blood which has the ability to carry red blood cells that have oxygen throughout the body, which decreases, and can cause the body to become weak and tired quickly (4). Anemia caused by a deficiency of folic acid is a megaloblastic anemia characterized by enlargement of red blood cells that have nuclei or immature cell initiation. Therefore, folic acid has a very important role, namely as a synthesis of DNA and RNA and has a function as a helper for DNA correcting enzymes, folic acid comes from food, this folic acid anemia usually occurs in young women or women of childbearing age (5).

Megaloblastic anemia reflects impaired DNA synthesis, which results in morphological and functional changes in erythrocytes, leukocytes, platelets, and their precursors in the blood and bone marrow. This anemia is characterized by the progenitor's presence of large, immature, abnormal red blood cells in the bone marrow, 95% of cases are caused by folic acid or vitamin B12 deficiency. Disorders of cobalamin metabolism arise from mutations in the methionine synthase and the methionine reductase synthase gene (6). This disorder displays megaloblastic anemia and neurological manifestations (7), the amount of iron (Fe) absorbed is not sufficient for the body's needs(4).

Conditions that can stimulate sickle cells include hypoxia, anxiety and cold exposure, because the spleen is an important immune organ, infections mainly caused by bacteria in general and often stimulate sickle cell crises, malaria is a cause of hemolytic anemia associated with red blood cell infection by Protozoa species of plasmodium which are transmitted to humans through mosquito saliva (5), a factor that affects Hb levels in adolescent girls with chronic diseases, such as tuberculosis, hepatitis (4). Vitamin C can improve hematology by reducing inhibitor mechanisms in vegetable food components, vitamin C activates the enzymes needed to convert folic acid in food into the active form of folic acid to prevent megaloblastic anemia and maintain red blood cell permeability (8).

Vitamin B complex has several groups of B vitamins such as vitamin B1, vitamin B2, vitamin B6, vitamin B12, folic acid and choline, but in the discussion that will be explained here is on vitamins that have an influence on anemia in fertile women. Vitamin B6 is one of the vitamins that can metabolize protein and also pyridoxin fat, there is an enzyme that can break down protein into the amino acids needed and is also able to convert tryptophan to niacin, if there is a lack of niacin in your intake, this has a risk factor for anemia (8).

Iron is also one of the components related to myoglobin contained in muscle cells, which has the same role as Hemoglobin as an oxygen carrier, this myoglobin which has a pigment effect on meat so it looks redder, apart from Hb and iron myoglobin. is also one of the components of the oxidation enzyme, including oxidation cytochrome, oxidation xanthine, succinate dehydrogenase, catalase, and peroxidase. In addition to having iron enzyme components, it also has a role as producing antibodies and removing (deroxidification) of toxic substances in the liver (9).

MATERIALS AND METHODS

The research that has been carried out was an analytic observational study, with a case control study design that was matched with the criteria. The matching criteria in this study were menstrual status, in the 15-19 age group, did not have an infectious disease, did not fasting at the time of hemoglobin checking. To perform a correlation analysis of risk factors and effect factors, there was classification of the case group, namely the anemia group 46 people, and the control group 46 people was the non anemia group, with total sample size at 92 people. The analysis was carried out by making cases and controls as pairs (10).

The independent variable was the intake of vitamin C, vitamin B6, vitamin B12, and iron, while the dependent variable was anemia. The research was held from March to July 2020 at the Islamic Boarding School. The instrument used for intake data was using Semi quantitative food frequency (SQ-ffq) questionnaire with a period of the last 4 months of intake, and hemoglobin checking was using an easy touch tool, then collecting data on the intake using nutrysql and Indonesian Food Composition Table and TKPI USDA, so the value of vitamin C intake was obtained. Vitamin B6, vitamin B12, irons, which were then compared with The Indonesian Dietary Recommendation 2019 (11). According to age groups and adjusted to the category then the data was processed using computer-based statistical tests. This research has graduated from the Ethics Commission for

public health research by having its headquarters at NO.2930 / B.2 / KEPK-FKUMS / III / 2020 which was supervised by the Muhammadiyah University Surakarta.

RESULTS AND DISCUSSIONS

In this study, the respondents aged 16 years in the case group were 23 people (53.17%), in the control group 24 people (50%), the fluid intake respondents in the case group 38 people (82.6%) had less than in the case group of 40 people (87%), respondents who had sufficient intake were 8 people (17.4%), in the control 6 people (13%). This research was conducted in March with a quota sampling technique located in one of the schools boarding system and have activities that have been scheduled by the hostel.

Based on **Table 1**, it shows the results of the analysis between vitamin C intake and the incidence of anemia, with a value of ($p<0.001$) OR 1.173, which means that there was a significant relationship. Respondents who had less vitamin C intake increased risk factors 1.173 times greater than respondents who had sufficient vitamin C intake. Respondents have a habit of buying food and drinking in student operations and consume less fruit so that the respondent's vitamin C intake is insufficient.

Vitamin C reduces ferri iron to ferro in the small intestine, so it is easily absorbed. Vitamin C is needed for the hydroxylation of proline and lysine to hydroxyfoline, an important ingredient in the formation of collagen, collagen is a protein compound that affects the integrity of cell structures in all connective tissue (12). Vitamin C is a water soluble antioxidant that maintains vitamin E and many metal cofactors in a reduced form at an intake above about 100 mg / day, the body's capacity to metabolize vitamin C is saturated, and excess intake will be secreted in urine, vitamin C has the function of increasing absorption of substances inorganic iron, and this function depends on the presence of the gut (13).

This research is in line with previous research Sholicha, et al (2019) used cross sectional as

Table 1. Relationship between micronutrient and anemia incident in adolescents at Islamic boarding school

| Variable | | Anemia | | Non Anemia | | OR | 95% Confidence Interval | | p-value | | |
|-------------|-----------|--------|------|------------|------|-------|-------------------------|--------|---------|--|--|
| | | 46 | | 46 | | | | | | | |
| | | n | % | n | % | | Lower | Upper | | | |
| Vitamin C | inadequat | 39 | 50.6 | 38 | 49.4 | 1.173 | 0.387 | 3.553 | 0.000 | | |
| | Adequat | 7 | 46.7 | 8 | 53.3 | | | | | | |
| Vitamin B6 | inadequat | 41 | 56.2 | 32 | 43.8 | 3.588 | 1.169 | 11.005 | 0.000 | | |
| | Adequat | 5 | 26.3 | 14 | 73.7 | | | | | | |
| Vitamin B12 | inadequat | 46 | 73 | 17 | 27 | 0.270 | 0.180 | 0.405 | 0.000 | | |
| | Adequat | 0 | 0 | 29 | 100 | | | | | | |
| Iron (Fe) | inadequat | 24 | 100 | 0 | 0 | 3.091 | 2.102 | 41.359 | 0.000 | | |
| | adequat | 22 | 32.4 | 46 | 67.6 | | | | | | |

design with 62 randomized proportional sampling. The results were Iron intake ($r = 0.635$; $p = 0.000$), vitamin C ($r = 0.780$; $p = 0.000$), protein ($r = 0.663$; $p = 0.000$). This is similar with the study result having ($p = 0.000$) for both vitamin C and iron. So, there is a significant relationship. This study is in line with previous research Siallagan, et al (2016) was held research by using 31 samples of vegan adolescent and cross sectional design (15).

Table 1 shows that the relationship between vitamin B6 intake and the incidence of anemia has a significant relationship with the value ($p = 0.0001$), OR 3.588 which means that less vitamin B6 intake can increase the risk factors for anemia by 3.588 times compared to respondents who have vitamin B6 intake is adequate. It is in line with Yasuda et al (2014). They reported post-PD cases with anemia linked to vitamin B6 deficiencies (16).

B6 has three forms-pyridoxal, pyridoxine and pyridoxamine. It is a coenzyme for many enzymes involved in metabolizing amino acids, especially transamination and decarboxylation. Low concentration of vitamin D (17) Vitamin B6 in food is mainly present in the form of phosphorylase, hydrolyzed by the enzyme phosphate in the small intestine in the brain, liver and kidneys. Vitamin B6 is phosphorylated again and then converted into piridoksal fosfat (PLP) (active in asam amino metabolism) by oxidation enzymes, oxidative changes in vitamin B6 can also occur in piridoksal fosfat (PLP) red blood cells bound to hemoglobin (12).

Table 1 shows a significant relationship between vitamin B12 intake and the incidence of

anemia and nilia ($p = 0.001$). The OR value is 0.270, which means that it does not have a big risk factor. This research is in line with previous research Nugroho, Sartika (2018) (18), vitamin B12 is needed to convert folate to be active and in normal function of metabolism of all cells, especially in the gastrointestinal cells, forms vitamin B12 in food, especially as deoxyadenosyl and hydroxycobalamin, a little as methylcobalamin and very little as cyanocobalamin, whereas in the hydrolysis of folate it is assisted by zinc (12). When the study was conducted, the average intake of vitamin B12 was <80% when compared to The Indonesian Dietary Recommendation 2019 according to age, because respondents had the habit of leaving mealtime and rarely consuming animal protein compared to vegetable protein, resulting in a decrease in vitamin B12 intake among respondents.

Low vitamin B12 in food can cause a decrease in the production of red blood cells, in the case of megaloblastic anemia, the important role of vitamin B12 and folic acid in the erythropoiesis. Pernicious anemia is a megaloblastic macrocytic anemia caused by a lack of vitamin B12, vitamin B12 deficiency anemia is rare. strictly vegetarians whose diets do not contain vitamin B12 unless found in plants capable of being contaminated by microorganisms synthesizing vitamin B12 (19).

Table 1 shows a relationship between Fe intake and the incidence of anemia with a value ($p = 0.0001$) OR 3.091. So, there was a significant relationship, respondents who have less Fe intake can increase the risk factor 3.091 times higher than respondents who have sufficient Fe intake. With a

confidence level of 95%, less Fe intake can increase the risk factor from 2.102 times to 41.359 times. The average intake of respondents on Fe intake was 24.05 mg, compared to the adequacy of The Indonesian Dietary Recommendation (11). Having an average result of less than <80%, the intake of respondents has less iron intake because the menu provided by the kitchen section has a menu that contains more non-heme iron so this is one of the factors that can reduce hemoglobin levels.

Iron has an important role in the body, which plays a role in the formation of hemoglobin, helps metabolic processes by helping various enzymes by binding to oxygen, iron consists of 2 types, namely hem iron and non-hem iron. Heme iron derived from meat, liver, poultry and fish hem iron can be absorbed efficiently more than non-hem iron due to different chemical compound (20). Non-heme iron has Fe^{3+} as compound, It has to cross Ferriereductase to change it into Fe^{2+} which can be absorbed through DMT 1. Weather, heme iron as Fe^{2+} directly absorbed through HCP 1 or called Heme transporter. So, heme iron pathway has special system than non-heme one (21).

If iron intake is less and the frequency of consumption of inhibitory substances is more frequent than consumption of iron sources so that it can cause low iron levels in the body and can trigger iron anemia (22). Iron can function in the human body, iron requires transferrin protein, transferrin receptors, and ferritin, which act as providers and stores of iron in the body as well as iron regulatory protein (IRP) to regulate iron supply, iron that is absorbed by the intestine every day 1-2 mg and secreted in equal quantities (23). Weinborn et al (2017) found that prebiotics can increase bioavailability of heme iron but still not significant in non-heme one (24). They have 24 randomized healthy women decided into two group. The intervention was giving yogurt per day for 12 days with a prebiotic mix. Then, the bioavailability was measured by the incorporation of radioactive Fe into erythrocytes. The results was heme iron rose significantly by 56% post-prebiotic intake.

CONCLUSIONS AND RECOMMENDATIONS

There is a significant relationship between micronutrient intake (vitamin C, B6, B12, iron and the incidence of anemia in adolescents in Islamic boarding schools. Vitamin C, vitamin B6, vitamin B12 and iron are risk factor for anemia in adolescents in Islamic boarding schools. Suggestions, it is necessary to add additional educational efforts for students about health, especially about nutrition, it is important because nutritional knowledge is useful for themselves and their families in the next phase of life. So that the students have a thorough understanding.

REFERENCES

- WHO. Global and mineral nutrition system [Internet]. 2016 [cited 2020 Mar 5]. Available from: <https://www.who.int/data/gho/data-indicators-detalis/GHO/prevalence-of-anemia-in-women-of-reproductive-age>
- Restuti AN, Susindra Y. Hubungan antara asupan zat gizi dan status gizi dengan kejadian anemia pada remaja putri. J Ilm Inov. 2016;16(3).
- Andriani M, Bambang W. Pengantar gizi masyarakat. Jakarta: Kencana Prenada Media Group; 2012.
- Natalia YE. Kelainan darah. Yogyakarta: Nuha Medika; 2015.
- Elizabeth C. Buku saku patofisiologi. Jakarta: EGC; 2009.
- Green R, Allen LH, Bjørke-Monsen AL, Brito A, Guéant JL, Miller JW, et al. Vitamin B12 deficiency. Nat Rev Dis Prim. 2017;3.
- Mahan LK, Raymond LJ. Krause food & the nutrition care process. 14th ed. Elsevier; 2017.
- Sjahmien M. Dasar-dasar ilmu gizi. Jakarta: Pustaka Kemang; 2017.
- Hardinsyah M, Supariasa IDN. Ilmu gizi teori dan aplikasi. Jakarta: EGC; 2017.
- Sudigdo S, Ismael S. Dasar-dasar metodologi penelitian klinis. 5th ed. Jakarta: Sagung Seto; 2014.

11. Kementerian Kesehatan RI. Angka kecukupan gizi yang dianjurkan untuk masyarakat Indonesia. Indonesia; 2019.
12. Sunita A. Prinsip dasar ilmu gizi. Jakarta: Gramedia Pustaka; 2009.
13. Murray RK, Granner DK, Rodwell VW. Biokimia Harper. 27th ed. Rachman NWRLDLFDLY, editor. Jakarta: EGC; 2012. 709 p.
14. Solicha, CA, Muniroh L. Hubungan asupan zat besi, protein, vitamin C, dan pola menstruasi dengan kadar hemoglobin pada remaja putri di SMAN 1 Manyar Gresik. Media Gizi Indonesia. 2019;14(2):147–53.
15. Siallagan D, Swamilaksita PD, Angkasa D. Pengaruh asupan Fe, vitamin A, vitamin B12, dan vitamin C dengan kadar hemoglobin pada remaja vegan. J Gizi Klin Indones. 2016;13(2).
16. Yasuda H, Fujiwara N, Ishizaki Y, Komatsu N. Anemia attributed to vitamin B6 deficiency in post-pancreaticoduodenectomy patients. Pancreatology. 2015;15(1):81-3
17. Victor RW. Biokimia harper. Jakarta: EGC; 2018.
18. Ridho N, Dewi S. Asupan vitamin B12 dengan kejadian anemia megaloblastik pada vegetarian di Vihara Meitri Khirti Palembang. J Kesehat Komunitas. 2018;4(20).
19. Briawan D. Anemia masalah gizi penelitian kesehatan. Jakarta: EGC; 2013.
20. Sholihah N, Andari S, Wirjatmadi B. Hubungan tingkat konsumsi protein, vitamin C, zat besi, dan asam folat dengan kejadian anemia pada remaja putri SMA N 4 Surabaya. Amerta Nutr. 2019;3(3):135–41.
21. Ems T, Huecker MR. Biochemistry, iron absorption. StatPearls [Internet]. 2020 Apr 30.
22. Zhuo Z, Yu X, Li S, Fang S, Feng J. Heme and non-heme iron on growth performances, blood parameters, tissue mineral concentration, and intestinal morphology of weanling pigs. Biological trace element research. 2019;187(2): 411-7.
23. Ani LS. Buku saku. Anemia defisiensi besi. Jakarta: EGC; 2020.
24. Weinborn V, Valenzuela C, Olivares M, Arrendondo M, Weill R, Pizarro F. Prebiotics increase heme iron bioavailability and do not affect non-heme iron bioavailability in humans. Food & Function. 2017;8(5):1994-9