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The Effect of Combination Alkaline Water and Iron Tablets on Improving Hemoglobin Level among Adolescent

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Abstract. Anemia is one of the health problems in Indonesia. It was due to the suboptimal absorption of Fe and increased body acidity. Alkaline water is an alternative to improve hemoglobin levels since it can maximize the absorption of iron and balance the body's acid-base. The study aimed to examine the combination of alkaline water and iron tablets on Increasing the hemoglobin levels. A quasi-experimental study method with pre-test and post-test study with control group design. Forty-two samples were assigned to the intervention group and the control group. The intervention group received a combination of alkaline water with a pH of 9.5 as much as 1 liter and 60 mg iron tablets for 14 days. The control group received 60 mg of iron tablets. The assessment of hemoglobin levels was conducted before and after treatment. The results showed that the combination of alkaline water and iron tablets positively affected the Hb level among adolescents. The results showed that the variety of alkaline water and iron tablets positively affected adolescents' Hb levels. The alkaline water can be proposed as an innovation to increase hemoglobin levels. Further studies are expected to control the socio-cultural factor and food factor. Future researchers can develop studies related to alkaline water by adding other variables, namely blood pH and Malondialdehyde (MDA).

Keyword: alkaline water, iron tablets, hemoglobin levels, adolescent

INTRODUCTION

One indicator for the degree of public health was the maternal mortality rate (MMR). Due to its sensitivity to health services improvement and accessibility and quality. According to statistics from the World Health Organization (WHO), in 2015, the global MMR reached 216/100,000 live births, where the Sustainable Development Goals (SDGs) target was <70 per 100,000 live births (1). The 2015 Intercensal Population Survey (SUPAS) showed that MMR in Indonesia reached 305 per 100,000 live births, while MMR in Central Java in 2016 reached 109.65 per 100,000 live births, and 30.37% of maternal deaths were caused by bleeding. Anemia is one of the indirect causes of the most bleeding among women in labor (2-3). This is due to anemia during pregnancy, and one of the contributing factors is prolonged anemia since the adolescent period (4).

Anemia is a condition where the number of red blood cells is inadequate to meet the body's physiological needs, which is clinically characterized by hemoglobin levels that are less than 12 g/dL in non-pregnant adult women (5). Anemia can be caused by an inadequate number of red blood cells, lack of oxygen-carrying capacity, increased blood acidity, insufficient iron or ferritin levels in the blood (6-7). The sub-optimal absorption of iron can be due to increased body acidity during iron absorption in the body. Iron binds with transferrin, which is then distributed to all body tissues that need iron. Iron and transferrin bonds will be broken in alkaline pH. Iron will be removed by itself when the pH is acidic, leading to iron deficiency in the body cells included in the bone marrow so that the production of red blood cells is reduced. There is also a decrease in hemoglobin formation in the blood, and anemia occurs (8). The most common cause of anemia among adolescent girls is iron anemia, caused by iron deficiency due to menstruation and lack of nutritional intake (9).

Basic Health Research Data showed that anemia among adolescent girls in 2013 was 37.1%, and in 2018 it increased to 48.9% (10). WHO (2011) recommends daily consumption of 60 mg of Fe tablets per day to women and adolescent girls, with a target prevalence of anemia of 20% (11). The government has a routine program related to the distribution of Iron (Fe Tablets) for adolescents as a strategic effort to break the cycle of nutrition problems (12). Although national and international efforts have implemented interventions and distributed iron tablet (Fe) supplements or iron-fortified foods, the global prevalence of iron deficiency anemia has not been resolved (13).

Various attempts to reduce the prevalence of anemia have been carried out. Studies related to anemia were focused on providing nutrition, but the reduction in anemia prevalence has not yet reached the target. One factor which causes anemia is increased body acidity (14). However, at this time, no researcher has conducted a study related to anemia due to increased body acidity. One that can affect the edge of the body is nutrient intake. One intake that can affect the body acidity is alkaline water.

The Japanese Ministry of Health, Labor, and Welfare in 1960 determined that alkaline water was suitable for consumption and beneficial for the human body. Alkaline water is a pH (Power of Hydrogen) with an alkaline nature. This water molecule is a micro-cluster so that it is very easily absorbed and enters into the cells hydrate intracellular. ORP value (Oxidation Reduction Potential) is very Negative. The more negative the ORP value indicates high antioxidant and has high dissolved hydrogen capable of protecting and preventing oxidative damage (15). Therefore, to maximize the Fe absorption. Based on the above background, the researchers are interested in avoiding anemia among adolescent girls in Islamic boarding schools by administering alkaline water and Fe tablets.

OBJECTIVE

This study examines the combination of alkaline water and iron tablets on Hemoglobin levels changed among adolescent groups.

METHOD

A quasi-experimental study, pre-test, and post-test design with a non-equivalent control group were applied in this study. This study was conducted at Semarang Islamic boarding school from April to May 2019.

Forty-two samples were selected based on inclusion criteria and allocated into the experimental group (n=21) and control group (n=21). In this study, the inclusion criteria were adolescent girls aged 13-15 years, were not menstruating, were not taking drugs, and had hemoglobin levels of <12gr/dL. This study used two groups. The intervention group was given a combination of alkaline water and iron tablets for 14 days. The control group was assigned iron tablets for 14 days. The hemoglobin level, blood samples are examined using the cyanmethemoglobine method. Ethical feasibility in this study was conducted by explaining the research's purposes and objectives. The participation of respondents was voluntary and without coercion. The adolescent girl who was willing to be the respondents was asked to sign an informed consent.

The instruments used in this study included: 1) Characteristic questionnaire containing: Name, Age, Weight loss, height, and Body Mass Index (BMI), nutrition intake, 2) Measurement of hemoglobin levels using blood samples examined using cyanmethemoglobin methods, Tool used Spectrophotometer/photometer with 540-550 nm filter, the respondent anemia if the measurement of hemoglobin level is < 12.00 gr/dl 3) Observation sheet that was used to monitor the consumption of iron tablets and alkaline water.

Descriptive analysis was used to describe each variable's characteristics in the percentage of age, as well as the mean and standard deviation of the frequency of weight loss, height-body, Body Mass Index, and nutrition intake. Test the normality of the data as a monitor of bivariate parameters used the Shapiro Wilk test, analyzing hemoglobin levels pre-test, and post-test between the intervention groups was compared with the control group using the paired t-test. The researcher used the independent t-test to measure the mean between the experimental group and the control group.

This study was conducted after obtaining an Ethical Clearance Test provided by the Health Study Ethics Commission of Dr. Moewardi District General Hospital Number: 406/III/HREC/2019.

RESULTS

Characteristic of respondents

Table 1 showed the results of the characteristics of respondents among the experimental group and the control group. The mean age among the experimental group was 13.81±0.75, and the control group was 13.67 ± 0.79.

Regarding the weigh of respondents, the experimental was 43.19±0.73, and the control group 43.33±0.74. The respondents' height in the experimental group was 147.09±1.1, while the control group was 146.8± 0.92. Regardless of the body mass index status, the respondents in the experimental group were 20.04±0.29. Whereas among the control group was 20.06±0.37.

The mean daily nutritional intake among the intervention group showed a protein intake of 34.1 grams/day, and the control group was 34.8 ±2.62. The mean iron intake was 12.65

mg/day, and the control group was 12.46 ± 2.24. Furthermore, Vitamin C intake was 22 mg/day, and the control group was 22.19 ±1.66. All characteristic variables were not a significant difference between the experimental group and the control group with p-value>.005

Table 1. Characteristic of respondents

Characteristics of respondents	Frequency (%) or Mean ±SD		$\rho - value$ [a]
	Control group (n=21)	Intervention group (n=21)	
Age (years)	13.67 ±0.79	13.81 ±0.75	0.486 *
13 Years Old	11 (52,4)	8 (38.1)	
14 Years Old	6 (28.6)	9 (42.9)	
15 Years Old	4 (19.5)	4 (19)	
Weight	43.19±0.73	43.33±0.74	0.892 *
Height	146.8± 0.92	147.09±1.1	0.850 *
BMI	20.06±0.37	20.04±0.29	0.962 *
Nutrition intake			
Protein	34.8 ±2.62	34.1 ±2.18	0.928*
Fee	12.46 ± 2.24	12.65 ± 2.46	0. 470*
Vitamin C	22.19 ±1.66	22 ±1.2	0.176*

Mean difference of hemoglobin level within-group before and after receiving the intervention

Table 2 showed the mean difference of hemoglobin level within-group before and after receiving the intervention. The mean hemoglobin level before treatment (pre-test) in the intervention group was 9.97 gr/dL and after treatment (post-test) was 10.35 gr/dL. The significant level was p-value<0.05. Meanwhile, the mean hemoglobin level before treatment (pre-test) in the control group was 9.80 gr/dL, and after treatment (post-test), it also increased to 9.91 gr/dL. The significant level was p-value <0.05.

Table 2. Mean difference of hemoglobin level within-group before and after receiving the intervention

Hemoglobin Levels	**Group**		***p-value***
	Intervention (n:21)	**Control (n:21)**	
Pre-test			
Mean ± SD	9.97± 0.611	9.80± 0.508	0.815*
Post-test			
Mean ± SD	10.35± 0.637	9.91± 0.420	0.013*

DISCUSSION

The potential of alkaline water on the changes in hemoglobin levels showed that the administration of alkaline water with a pH of 9.5 as much as 1 liter per day could increase hemoglobin levels. The independent t-test indicated a significant difference in the effect between the administration of iron tablets in the control group and the administration of alkaline water and iron tablets in the intervention group with a ρ-value of 0.013 (<0.05). It was indicated that there was a significant difference in hemoglobin levels between the control and intervention groups.

The potential of alkaline water in increasing hemoglobin levels is alkaline water has a high oxidative reduction potential (ORP), which can neutralize free radicals and increase normal hemoglobin derivatives and reduce the shape of abnormal hemoglobin, thereby improving overall hemoglobin health. The study finding is in line with Bassem's study in 2016, which showed that administration of alkaline water to rabbits for 30 days without additional treatment could increase normal hemoglobin derivatives with a ρ-value of <0.05 (16).

The mechanism of iron absorption in the body begins with the luminal phase in the stomach. The incoming iron will be processed in the stomach by break it from the bond with other compounds through the influence of gastric acid. Then there is a reduction from the form of ferric ($Fe3+$) to ferrous ($Fe2+$), which can be absorbed in the duodenum (17). Furthermore, the mucosal phase or iron absorption in the intestine occurs in the duodenum and jejunum. Iron from foodstuffs is a form of ferric ($Fe3+$) or non-heme iron, while the iron is absorbed in the way of ferrous ($Fe2+$). Absorption of ferrous iron is mediated by ferric reductases (duodenal cytochrome B – Dcytb), which reduces ferric iron ($Fe3$ +) to ferrous iron ($Fe2$ +), and the transport through erythrocyte mucous membranes is facilitated by divalent metal transporter 1 (DMT1) protein) (18). Iron is stored in the cytoplasm. The iron from the cytoplasm into enterocyte cells, hepatocyte cells, placental trophoblasts, and macrophages involves ferroportin and requires Ferro-oxidase to transport ferrous iron to transferrin. Intestinal iron absorption is regulated by hepcidin. Hepcidin also regulates the release of iron by macrophages. The synthesis of hepcidin is influenced by iron saturation. The higher the iron saturation, the more the increase in the production of hepcidin (19-20). The corporeal phase is the process of transporting iron into circulation. Iron, which has been bound to transferrin, will be distributed into the parts of the body. The breakdown of iron-transferrin bonds will be maximal in a pH state of 7.4-8, and if the pH drops to 5.5, the iron bonds to transferrin will disappear. Therefore, the iron will not be distributed to the organs and the bone marrow that need so that the supply of iron for the production of red blood cells will be reduced (21).

A study conducted showed that ERW administration among hemodialysis patients could effectively increase hemoglobin levels in hematocrit by preventing oxidative stress in the erythrocytes by lowering the metHb level with a ρ-value of <0.05 (22). The nature of the alkali can also influence increased hemoglobin levels in the administration of alkaline water because the alkaline nature in the water can balance the body's pH so that there is an increase in the metabolic cycle through the solubility of Fe and Cu in the body. Thus, it can increase the red blood cells and hemoglobin levels. The solubility of Fe and Cu occurs in the corporeal phase. Alkaline water has a large amount of dissolved oxygen, so consuming this kind of water can increase blood levels. A lot of oxygen is available to bind to hemoglobin (23).

Based on the results of this study, it can be concluded that the administration of alkaline water with a pH of 9.5 combined with an iron tablet with a spacing of 1 hour after iron tablet consumption could improve and maximize the breakdown of Fe. Due to the binding of iron and transferrin during the corporeal phase, it will be useful in the condition of the alkaline environment. The release of iron and transferrin bonds into the endocycle will be good if the condition of blood acidity is balanced. In this study, Alkaline water could slowly increase the pH of cells and body tissues and neutralize the acid. Alkaline water has obtained many free electrons through the electrolysis process and can donate electrons to free active oxygen radicals in the body. By being an antioxidant in this way, alkaline water can restrain the oxidation of normal tissue by free oxygen radicals so that the absorption of iron in the body can work optimally.

LIMITATION

A limitation of this study is that the researcher could not fully control the external variables that might influence the study results, such as socio-cultural and food factors. The evaluation in this study was limited to only two times, namely before and after the intervention.

CONCLUSION

Based on data analysis and discussion, this study concluded that the changes in hemoglobin levels in the group given a combination of alkaline water and iron tablets was higher than the group given iron tablets. Thus, it was proven that the variety of alkaline water and iron tablets could increase hemoglobin levels among adolescents.

CONCLUSION

A combination of alkaline water and iron tablets can be used as an alternative treatment for anemia among adolescents. Further studies are expected to evaluate the provision of alkaline water, as well as control for socio-cultural factors and food factors. Future researchers can develop studies related to alkaline water by adding other variables, namely blood pH and Malondialdehyde (MDA).

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