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THE RELATIONSHIP BETWEEN MICRONUTRIENT INTAKE AND HAEMOGLOBIN LEVELS IN MALE ADOLESCENT FOOTBALL ATHLETES

Hubungan antara Asupan Zat Gizi Mikro dengan Kadar Hemoglobin pada Atlet Sepak Bola Remaja Putra

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ABSTRAK

Atlet sepak bola dituntut memiliki stamina yang baik saat latihan maupun bertanding untuk mencapai prestasi yang baik. Kadar haemoglobin yang baik dapat membuat atlet tidak mudah mengalami kelelahan, sehingga kadar hemoglobin merupakan aspek yang perlu diperhatikan oleh atlet sepak bola. Selain itu, asupan zat besi dan vitamin C seorang atlet juga perlu diperhatikan. Hal ini dikarenakan, asupan zat besi dan vitamin C merupakan komponen yang sangat berpengaruh terhadap pembentukan kadar hemoglobin. Penelitian ini bertujuan untuk menganalisis hubungan antara asupan zat besi dan vitamin C dengan kadar hemoglobin pada atlet sepak bola remaja putra. Desain penelitian yang digunakan pada penelitian ini adalah cross-sectional. Jumlah sampel pada penelitian ini yaitu sebanyak 65 atlet sepak bola di tempat pelatihan Pendidikan Sepak Bola Bonansa UNS Solo. Penelitian ini dilakukan pada bulan Oktober-November 2021 di Surakarta. Data asupan zat besi dan vitamin C diukur menggunakan Semi-Quantitative Food Frequency Questionnaire *(SQFFQ). Data kadar haemoglobin diukur dengan metode spektrofotometer. Data dianalisis dengan menggunakan uji Spearman Rank dan Product Moment Pearson. Hasil penelitian ini menunjukkan bahwa asupan zat besi (r = 0,699 dan p < 0,001) dan vitamin C (r = 0,643 dan p < 0,001) terdapat hubungan positif dengan kadar haemoglobin. Asupan zat besi dan vitamin C memiliki hubungan yang signifikan dengan kadar haemoglobin. Pada penelitian selanjutnya disarankan untuk menentukan faktor apa saja yang dapat mempengaruhi kadar haemoglobin atlet remaja laki-laki.*

Kata Kunci: *Asupan Zat Gizi Mikro, Hemoglobin, Remaja, Laki-laki, Atlet, Sepak Bola*

ABSTRACT

Football athletes are required to have good stamina during training and competition to achieve good performance. Good haemoglobin levels can prevent athletes from experiencing fatigue easily, so haemoglobin levels are one aspect that football athletes need to pay attention to. In addition, an athlete's iron and vitamin C intake also needs to be considered. This is because iron and vitamin C are components that greatly affect the formation of haemoglobin levels. This study aims to analyze the relationship between iron and vitamin C intake and haemoglobin levels in male adolescent football athletes. The research used a cross-sectional design. The sample of this study consisted of 65 football athletes at the Bonansa Football Education training Center UNS Solo, in the city of Surakarta. This research was conducted in October-November 2021 in Surakarta. Data on iron and vitamin C intake were measured using the Semi-Quantitative Food Frequency Questionnaire (SQFFQ). Haemoglobin level data was measured using the spectrophotometer method. Data were analyzed using the Spearman Rank test and

Pearson's Product Moment. The results showed that iron intake ($r = 0.699$ and $p < 0.001$) and vitamin C intake ($r = 0.643$ and $p < 0.001$) had a positive relationship with haemoglobin levels. Iron and vitamin C intake had a significant relationship with haemoglobin levels. Future research is recommended to determine factors can affect haemoglobin levels in male adolescent athletes.

Keywords: Micronutrient Intake, Haemoglobin, Adolescent, Male, Athlete, Football

INTRODUCTION

Football is a sport that is popular with people all over the world, including Indonesia. Football are mix between power and endurance sport. This game is a team game where each team has eleven players. The football game is played in two halves, each half lasting for forty-five minutes with a ten-minute break in between [1]. Football is a sport that requires players to have excellent stamina. This is because football is a sport that takes place very fast over a relatively long period. The movements carried out by the players include running, kicking, jumping, and short sprints with quite high percentages. Other typical and dominant movements in the game of football are dribbling the ball, colliding with opponents, and heading the ball. Football athletes need good stamina to be able to carry out activities continuously for a long time without experiencing significant fatigue [1]. The more duration of playing and the higher of exercise intensity, the more oxygen is required. The decrease in the amount of oxygen in the body is affected by haemoglobin concentration. Low haemoglobin concentration can reduce the physical fitness of athletes. According to research conducted by Sepriani and Rahman, low physical fitness in young athletes is still found in Indonesia, as many as 48% have a poor physical fitness category and 40% of athletes have a very poor physical fitness category [2].

Haemoglobin is an oxygen-carrying pigment and the main protein of red blood cells [3]. Low haemoglobin levels can reduce an athlete's stamina during training and competition. This is because the players will quickly experience fatigue due to muscle cells used for work not getting enough energy supply [4]. Low haemoglobin levels are also still found in young football athletes, namely 46.7% in Anyelir football school athletes and 47.6% in Bangau Putra football school athletes [5].

One of the factor increasing haemoglobin levels is the fulfillment of good nutritional intake. Athletes who have poor nutritional intake are more prone to experience fatigue and decreased stamina [6], [7]. Unbalanced nutrition affect haemoglobin levels. Iron is an important nutrient in the formation of haemoglobin levels. Iron binding the protoporphyrins is a combination of four pyro-compounds formed by protein synthesis of 2 succinyl coenzyme-A and 2 glycine in mitochondria. This compound will form a heme molecule that binds to a globin molecule and forms haemoglobin [8]. The recommended intake of iron for athletes is 15-18 mg/day [9]. Iron intake recommendations for athletes are higher if compared to non-athletes, this is because athletes have higher activity when compared to someone who is not an athlete [10].

Iron absorption is strongly influenced by the availability of vitamin C. The role of vitamins in the iron absorption process is to help reduce ferric iron to ferrous in the intestine, so that it is easily absorbed. The reduction process will be greater if the pH in the stomach is more acidic. Vitamin C in this case can increase acidity, thereby increasing iron absorption by up to fourfold when vitamin C is present [11], [12].

Vitamin C is a micronutrient that can help the absorption of iron, especially non-heme iron. This is because vitamin C can bind factors that inhibit iron absorption such as phytic acid and oxalic acid. Vitamin C acts as a strong enhancer in reducing ferric ions to ferrous ions, so they are easily absorbed at a higher pH in the duodenum and small intestine [8]. Vitamin C deficiency can cause athletes to easily feel fatigue, muscle damage, and decreased immunity during physical activity. Furthermore, vitamin C deficiency can also interfere with a person's ability to exercise [13]. The recommended intake of vitamin C for athletes is 200 mg/day [9]. The recommended intake of vitamin C for athletes is higher if compared to non-athletes, this is because athletes have higher activity when compared to someone who is not an athlete [10].

Adolescents between the ages of 12-16 years are the right age to build quality football players. According to Soewito [14], male athletes of this age have increased physical fitness. Quality football players can be formed by nursery at a young age [15]. Football training center (PSB) is one of the nurseries for young soccer athletes. PSB Bonansa UNS Solo is the only place in Surakarta that still has a regular training schedule during the Covid-19 pandemic.

The novelty of this study is the research was conducted during the Covid-19 pandemic. This research was carried out with due regard to and implementation the health protocols imposed by the Ministry of Health of the Republic of Indonesia. Based on the description above, the researcher wants to analyse and find out the relationship between iron and vitamin C intake and haemoglobin levels in male adolescent football athletes.

METHOD

This study is an analytic observational study with a cross-sectional approach. The subjects of this study were the adolescent athletes of football education (PSB) Bonansa UNS Solo. The population in this study was 95 athletes. Sample determination was carried out using a-purposive sampling technique. The inclusion criteria in this study are athletes aged 12-16 years, male, actively training at PSB Bonansa UNS Solo, and in good health (by asking the athlete's parents and coachs, whether the athlete is sick or in health condition). In addition, the exclusion criteria in this study were students who were never present at the time of data collection. The sample in this study consisted of 65 athletes of PSB Bonansa UNS Solo. This research protocol has been approved by the Ethics Committee of the Faculty of Medicine, Sebelas Maret University of Surakarta with protocol number 95/UN27.06.6.1/KEP/EC/2021. This research was conducted in October-November 2021 in Surakarta.

The independent variables in this study were iron and vitamin C intake, and the dependent variable was haemoglobin level. Data on iron and vitamin C intake in this study were obtained by asking the respondent's food intake during the last month accompanied by the respondent's parents or family using the standardized Semi-Quantitative Food Frequency Questionnaire (SQFFQ). The data were then analyzed to determine the average daily intake of iron and vitamin C from each food item using Nutrisurvey 2007 Indonesia version. The unit of iron and vitamin C intake is milligram (mg). For univariate analysis purposes, data on iron and vitamin C intake was categorized into deficient if < 77% of the athlete's needs and sufficient if ≥ 77% of the athlete's needs [13].

Information regarding haemoglobin level data in this study was obtained through blood sampling in the respondent's veins by laboratory staff. Measurement of haemoglobin levels was carried out using the cyanmethaemoglobin method. The unit of haemoglobin level is grams per deciliter (g/dL). For univariate analysis, haemoglobin level data was categorized as deficient if < 12 g/dL and normal if ≥ 12 g/dL [16].

Univariate analysis was used to describe the characteristics of the research subjects, namely gender, age, iron intake, vitamin C intake, and haemoglobin levels. Before determining the bivariate test, researchers conducted a normality test using the Kolmogorov Smirnov test. The bivariate analysis in this study was carried out using the Spearman Rank test for non-normally distributed data and the Pearson Product Moment test for normally distributed data [17]. The significance level used was $\alpha = 0.05$.

RESULTS

Univariate Analysis

The characteristics of respondents in this study are gender, age, iron intake, vitamin C intake, and haemoglobin levels.

Table 1. Frequency Distribution of Respondents' Characteristics

Characteristics of Respondents	N	%
Gender		
Male	65	100
Age (years)		
12	38	58,5
13	15	23,1
14	9	13,8
15	2	3,1
16	1	1,5
Iron Intake		
Deficient (< 77%)	65	100
Normal (≥ 77%)	0	0
Vitamin C Intake		
Deficient (< 77%)	65	100
Normal (≥ 77%)	0	0
Haemoglobin Levels		
Deficient (< 12 g/dL)	26	40
Normal (≥ 12 g/dL)	39	60

Source: Primary Data

Table 1 shows that all respondents in this study were male adolescent (100%), subjects in this study were aged 12-16 years, most respondents were 12 years old (56.9%), the iron and vitamin C intake of respondents were all in the deficient category (100%), and the haemoglobin levels of the respondents were mostly normal (60%).

Test of Normality

In this study, before conducting bivariate tests, researchers conducted a normality test. The normality test used in this study is the Kolmogorov Smirnov test.

Table 2. Kolmogorov Smirnov Test Results

Variable	Results	Description
Iron Intake	<0.001	non-normally distributed data
Vitamin C Intake	0.200	normally distributed data
Haemoglobin Levels	0.084	normally distributed data

Source: Primary Data

Table 2 shows that the iron intake variable has a result of <0.001 which means that non-normally distributed data. Variable vitamin C intake and haemoglobin levels have results of 0.200 and 0.084, which means both have normally distributed data. The normally distributed data will use the Pearson Moment product test and the non-normally distributed data will use the Spearman Rank test in the bivariate test.

Bivariate Analysis

Table 3 shows that each of the two variables of iron and vitamin C intake has a significant relationship with haemoglobin levels.

Table 3. The Relationship between Iron and Vitamin C Intake and Haemoglobin Levels

Micronutrient Intake	Haemoglobin Levels		
	Mean ± SD	r	p
Iron Intake (mg)	7,89 ± 1,47	0,699	<0,001*[a]
Vitamin C Intake (mg)	79,61 ± 28,18	0,643	<0,001*[b]

Source: Primary Data
*Significant Correlation
a = Rank Spearman Test
b = Pearson Moment Product Test

Table 3 shows that iron intake has a significant relationship with haemoglobin levels and both have a strong positive relationship (r = 0.699, p < 0.001). Vitamin C intake also has a significant relationship with haemoglobin levels, and both have a strong positive relationship (r = 0.643, p < 0.001).

DISCUSSION

This study indicates that there is a significant relationship between iron intake and haemoglobin levels and that both have a strong positive relationship (r = 0.699, p < 0.001), this means that the higher of iron intake, the higher of the haemoglobin level. The average iron intake of respondents was 7.89 mg/day. This is in line with research conducted by Thamrin and Masnilawati [18] which found that there is a significant relationship between iron intake and haemoglobin levels. In addition, research by Thomas *et al.,* [19] also mentioned that low iron intake is one of the significant determinants of the occurrence of low haemoglobin levels.

Iron has a function in producing haemoglobin and myoglobin. Haemoglobin is used for carrying oxygen to red blood cells and muscles. In the adult body, iron is available in two forms: functional iron such as in haemoglobin, myoglobin, and enzymes, and storage iron in the form of ferritin, hemosiderin, and transferrin. There are 3.6 grams of iron in adult males and about 2.4 grams in adult females [20]. This is due to differences in iron metabolism between adult males and females. In addition, adult females also experience menstruation every month, which can cause iron storage in the body to be different between adult males and females [20]. Meanwhile, children and adolescents do not have iron stores, so iron intake is important for this group preventing iron deficiency [20]. Iron metabolism is also affected by nutritional status, age, gender, spinal cord activity, and some other pathological conditions such as bacterial infections [4].

Iron deficiency will cause a decrease in muscle performance and fatigue [21]. Every transport of oxygen to the muscles requires haemoglobin which is supported by adequate iron in the body [13]. Low iron stores can lead to impair immune function, temperature regulation, cognitive ability, metabolic efficiency, and performance [20]. The impact on athletes who have low iron stores is that athletes will have low haemoglobin levels, fatigue prone, and decreased performance [6], [7], [20]. A large proportion of the incidence of low haemoglobin levels in Indonesia is thought to be due to iron deficiency as a result of insufficient intake of iron-source foods, especially those originating from animals (heme iron). The results of this study showed that all respondents had deficient iron intake and the majority of respondents consumed from plant-based food sources of iron (non-heme). The main sources of iron are animal foods such as liver, beef, mutton, chicken, duck, birds, and fish. Iron originating from animal-based food (heme iron) can be absorbed by the body in 20-30% [22]. Plant-based foods also contain iron (non-heme), but the amount of iron that the intestine can absorb is less compared to animal foods. Iron from plant-based foods can be absorbed by the body by around 1-10%. Iron in plant foods is found in dark green vegetables (spinach, cassava leaves, and kale), legumes (tempeh, tofu, and kidney beans) and grains [4], [22], [23]. Plant-based food also contains iron (non-heme), but the amount of iron that the intestines can absorb is less compared to animal foods. Iron from plant-based foods can be absorbed by the body by around 1-10%. Iron in plant foods is found in dark green vegetables (spinach, cassava leaves, and kale), legumes (tempeh, tofu, and kidney beans) and grains [24].

Based on table 2, it is found that there is a significant relationship between vitamin C intake and haemoglobin levels and both have a strong positive relationship ($r = 0.643$, $p < 0.001$), this means that the higher of vitamin C intake, the higher of haemoglobin level. The average vitamin C intake of respondents was 79.61 mg/day. This is in line with research conducted by Sholicha and Muniroh [12] which found that there is a significant relationship between vitamin C intake and haemoglobin levels. In addition, the study of Setyaningsih et al., [25] also stated that there was a significant relationship between vitamin C and haemoglobin levels.

Vitamin C is an essential element in the formation of red blood cells. Vitamin C can inhibit the formation of hemosiderin which is difficult to mobilize into free iron when needed. Vitamin C in foods can provide an acidic atmosphere, causing ferric iron to be easily reduced to ferrous iron. Ferrous iron is more easily absorbed by the small intestine [26]. One of the functions of vitamin C is to help the absorption and metabolism of iron. Absorption of iron in non-heme form can increase fourfold when vitamin C is present [12]. The recommended intake of vitamin C for athletes is 200 mg [24].

CONCLUSIONS

This study concludes that iron and vitamin C intake are each positively associated with haemoglobin levels in male adolescent football athletes at PSB Bonansa UNS Solo. The researcher suggests that further research can be done to determine what factors can affect the haemoglobin levels in male adolescent athletes.

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