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ORIGINAL ARTICLE

The effect of consuming iron supplements and continuous running exercises on the increasing level of hemoglobin

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ABSTRACT

BACKGROUND: Low hemoglobin level is a problem which can affect students' fitness and health condition. When students suffer from iron deficiency anemia, their physical endurance could decrease in performing daily activities either in academic or nonacademic environments. Iron deficiency can reduce hemoglobin levels in the blood, which if remain untreated, this condition could make students look pale and unmotivated. Other conditions which could be caused by iron deficiency anemia is the decrease in learning achievement, physical fitness and endurance. To increase hemoglobin levels, additional iron supplements such as Fe tablets accompanied with regular and programmed physical exercises are needed to increase hemoglobin levels.

METHODS: This study aims to determine the effect of consuming Iron (Fe) supplement, and continuous running or jogging exercises to increase hemoglobin (Hb) levels of undergraduate students in Sports Science Study Program Faculty of Sports Science Universitas Negeri Padang enrolled in 2016/2017 academic year. The population in this quasi-experimental study was 215 undergraduate students of FIK UNP Sports Science Study Program. Twenty students were chosen as sample for this study through purposive sampling technique. Data collection was conducted through measurement of hemoglobin levels in the pretest and posttest after the administration of Fe tablets for 18 treatments.

RESULTS: Data was analyzed using comparison test (t-test) at a significance level of 5%. This study found that the average hemoglobin level of respondents before receiving treatment was (14.18), whereas after treatment was (15.66). T-test revealed the value of $t_{calculated}$ (3.80) > t_{table} (1.73).

CONCLUSIONS: There is a significant impact from consuming iron supplement accompanied with continuous running exercise to the increasing students' hemoglobin (Hb) level in Sports Science Study Program at the Faculty of Sport Science, Universitas Negeri Padang.

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KEY WORDS: Iron; Running; Hemoglobins.

Nowadays, the role of sports is increasingly important not only for the improvement of health and for physical fitness, but also for achievement in sport field which ultimately can elevate the nation's dignity. To help realizing these roles, it certainly takes the availability of young people who are qualified and possess good level of physical fitness so that they can continue to fight for nation's pride. Good physical fitness is strongly related to nutritious intake, such as: carbohydrates, proteins, fats, vitamins and minerals.[1] These nutrients are very important for physical activities and growth,[2] especially for students who are in the first and second year in the university and are still classified as young adult (18 to 21 years old).

The prevalence of anemia in Indonesia is still quite high, especially in vulnerable groups such

as; pregnant women, babies, children under five years old and teenagers, and most of them are caused by iron deficiency.[3] According to the data from Indonesia's Basic Health Research in 2013, the prevalence of anemia in Indonesia is 21.7%, where 26.4% for patients aged between 5-14 years and 18.4% for patients aged between 15-24 years.[4] Even though the occurrence of iron deficiency is quite common in most countries,[5-8] Indonesia needs to address this issue appropriately to improve the well-beingness of the people especially young generations in this country.

Blood hemoglobin level is related to physical abilities,[9, 10] physical endurance[11-13] and cognitive performance,[14] as it functions as one of the compounds in red blood cells to carry oxygen to entire cells within the body's. The Ministry of Health of the Republic of Indonesia added that the lack of hemoglobin in the blood results in a lack of oxygen to be transferred throughout the body and brain, causing several symptoms such as; tired, lethargic, and tired quickly.[15] This will consequently results in a decrease in physical fitness and eventually students' achievement in academic and non-academic environment.[16]

The importance of hemoglobin's function in human body and the urge for someone to regularly do sports activities are two interrelated things. The relationship between one's hemoglobin levels in physical activity (*e.g.* sports) can be explained as follow: when there is a significant increase in metabolic activity, the acids produced (hydrogen ions, lactic acid) also increase, resulting in a decrease in blood's pH.[17] Change in blood's pH, to certain extent, could be anticipate by the buffer system in human body.[17] However, when acid concentration in blood in too high and the blood's pH become low, the attraction between oxygen and hemoglobin would be reduced[18] which will cause hemoglobin to release more oxygen and thus increasing oxygen delivery to muscles.

Iron deficiency can reduce Hb levels in blood from normal level. Research report has found that low physical fitness especially cardiorespiratory endurance (VO_2max) is associated with low level of hemoglobin in human blood.[19] This condition was also found among students of FIK UNP Padang. The results of special tests conducted on those taking Sport Fitness courses in the Sport Science Study Program UNIK FIK revealed that many students had low VO_2max. Among 215 students being tested, 35 students (15%) fell into good category, 75 students (35%) in medium category, and 105 students (50%) in poor category.

There are several factors behind the low levels of Hb and VO_2max among FIK UNP students. Theoretically, one of the factors is iron deficiency status which has a significant influence on blood hemoglobin levels and low motivation to do exercise or sports regularly. To proof this theory, several studies have shown that iron supplementation could increase subjects' Hb levels and their endurance in doing physical activities. Such studies have been conducted for nonanemic women which involved a training program,[20] for nonanemic women rowers,[7] and for female soldiers in military training.[14] Several reviews have also been published such as analysis of several studies on the about iron supplementations,[10] systematic review of studies on iron status of nonanemic athletes[16] and iron supplementation among athletes.[6]

One of the treatments to address iron deficiency status is by taking iron supplement.[10] However, when it comes to physical endurance, participation in training has to be taken into account as well. Therefore, we formulate the purpose of this study that is to figure out the effect of giving iron supplement and continuous running exercise on the increasing hemoglobin levels among Sports Science Study Program Students in Universitas Negeri Padang.

Materials and methods

This quasi-experimental study was conducted from September to October 2017 using One-group-pretest-posttest design at the Laboratory of Sports Science Faculty, Universitas Negeri Padang. The sample was 20 students of the UNP Sport Science Study Program which was chosen through purposive sampling technique out of 215 students as population. The iron status of samples were measured through the Hb level, since Hb level is one of measurable markers of iron in human body.[7]The instrument for measuring Hb

levels was Quick Check Hemoglobin and Hematocrit.

Prior to the study, research samples were given explanation about the objectives and procedures of the study. Then, anamnesis was conducted to check the medical history, physical condition, and the willingness to be investigated during the study. After the examination is carried out, pretest is performed to all research samples by test administrators which included two authors in this paper. After taking the pretest, all samples took iron supplements (Fe) blood booster named Sangobion one capsule per day (equal with 30 mg of iron) before doing routine physical exercises which is a-3 times-a-week for 18 meetings within 6 weeks. The posttest was carried out after the 18th meeting with the same administration as the initial test (pretest) to see changes caused by the treatment.

Data obtained from the measurement results were initially tested for normal distribution with Liliefor's Test and for homogeneity with variant homogeneity test (F-test). After requirements of data analysis are met, comparison test (*t*-test) was conducted at a significance level of 5%. The comparative test (*t*-test) was aimed to test the ability of the generalization or significance of research results.[21] For hypothesis testing, we used the following formula:

$$th = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{n}}{n(n-1)}}}$$

where:

- x_1 = Mean of pretest
- x_2 = Mean of posttest
- D = Difference between samples' first and second score
- D^2 = Square of Difference
- $\sum D^2$ = Sum of Square of Difference
- n = Number of sample

Results

Profile of research subjects

Table I shows the profile of research subjects in terms of average age which is 20 years old, the average height which is 167 cm, and the average weight which is 61 kg. The average age of subjects is more likely because of accidental factors, meaning that students were chosen based on their willingness to participate in the study. The hemoglobin levels of students withing this age group fall within the range from 11 gr/dL to 17.1 gr/dL which indicates that the increasing age of respondents is not always followed by an increase in hemoglobin levels. Table II shows the increase in the average value of the respondent's hemoglobin after being treated for 18 meetings, which is 14.18±1.16 gr/dL after pretest, and 15.66±1.25 gr/dL after posttest.

TABLE I.—*Profile of Research Subjects.*

Criteria	Average±SD
Age	20±0.92
Height	167±7.21
Weight	61±10.21

TABLE II.—*Hemoglobin level of research subjects.*

Hb level	Average±SD
Pretest	14.18±1.16
Posttest	15.66±1.25

Hypothesis testing

The result of normal distribution with Liliefors test can be seen in Table III which lead us to a conclusion that data was normally distributed and data analysis was continued with parametric statistics by comparison test (*t*-test). From comparison test (*t*-test) between the pre-test and post-test the treatment group, we obtained $t_{calculated}$ (3.80)> t_{table} (1.73). With the criteria for hypothesis testing as "accept alternative hypothesis if $t_{calculated} > t_{table}$, therefore H_0 was rejected and H_a was accepted (Table IV).

TABLE III.—*Summary of data's normality testing.*

Data	N.	L_0	L_t	Summary
Hb level (Pretest)	20	0.0517	0.1920	Normal
Hb Level (Posttest)	20	0.0336	0.1920	Normal

TABLE IV.—*Result of t-test of hemoglobin level.*

Hb Level	N.	Mean	$t_{calculated}$	t_{table}	Summary
Pretest	20	14.18	3.80	1.73	H_0 Rejected
Posttest	20	15.66			H_a Accepted

Hypothesis testing as shown in Table IV led us to a conclusion that there is a significant impact of consuming iron (Fe) supplement and continuous running jogging exercise on the increasing level of hemoglobin of students in Sport Science Study Program of Universitas Negeri Padang.

Discussion

This study found that iron supplementation (Fe) accompanied with continuous running exercises for 18 meetings was proven to significantly increase hemoglobin levels in our 20 respondents. From pretest, the average value of the hemoglobin level was 14.18 gr/dL and increased to 15.66 gr dL. Statistical analysis through t-test gave the value of $t_{calculated}=3.80 > t_{table}=1.73$. This finding confirms with that of previous study by Hinton *et al.*, (2000)[20] which involved a training for non-anemic women. Therefore, it can be concluded that there is a significant effect of consuming iron supplement and supported with doing continuous physical exercise on increasing hemoglobin level.

The increasing hemoglobin levels in the treatment group can be explained as follows. Broadly speaking the metabolism of iron in the body consists of the process of absorption, transport and utilization, storage, and excretion. Iron from food is absorbed into the small intestine and then enters the blood plasma. In addition, there is a certain amount of iron that comes out of the body through feces. In the plasma, the process of turning overtakes place, at which the old blood cells get replaced by new cells. The amount of iron that got turned over everyday ranges around 35 mg which comes from food, hemoglobin, and old-processed red blood cells to be used again. However, in reality, the consumption of plant-sourced foods may not be adequate to meet the minimum amount of daily needs for iron.[9] When this need is not fulfilled, taking iron supplementation to prevent and overcome anemia is proven to be very effective and efficient.[22]

Iron is a micronutrient that plays an important role in human body,[9, 16] especially in the process of hemopoiesis (blood formation) during the synthesis of hemoglobin. The process of hemopoiesis can be obtained from iron metabolism in the body through two internal circles by continuous reuse of iron from cell catabolism in the body from an external circle.[23] On the other side, hemoglobin is a red dye in the blood occurs in the parent erythrocytes from globin and nonprotein containing iron (Fe) classified in porphyrin. Hemoglobin is synthesized in the body from amino acids which are precessors of globin and requires iron in addition to copper (Cu) as a catalyst. The main function of hemoglobin is as a carrier of oxygen from the lungs to the entire tissues in human body and continues by transporting carbon dioxide to the tissues back to the lungs.[18]

In addition to taking iron supplement, doing continuous running exercises or jogging routinely 3 times a week for 6 weeks was also proven to contribute to stimulating the body to make physiological adjustments according to the demands of increased activity. Jogging is one way to develop mitochondria to become better,[24] so that with the increasing number of mitochondria and oxygen supply, the energy available for sports activities rises significantly. Another study has also found that a training and iron supplementation could improve the iron status.[20]

However, the effect of continuous running or jogging exercises on increasing hemoglobin level is not direct. Regular running or jogging exercises conducted regularly 3 times/week can spur the possibility to meet the need for energy obtained from food intake.[23] Thus, an increase in food consumption that is sufficient for energy needs is also likely that other nutrients can increase such as iron (Fe). Therefore, an increase in hemoglobin levels in the group who did continuous running or jogging training is likely caused by the presence of nutrient intake that is fulfilled due to the increasing need for food consumption. Another possibility is the tendency for people who are doing sports activities to experience anoxidants (oxygen reduction) and consequently will stimulate the formation of hymapotin (a hormone released by the kidneys) to produce hemoglobin and erythrocytes. In this condition, an increase in hemoglobin levels can possibly occur.

This discussion so far has led us to a conclusion that the administration of iron (Fe) to a person accompanied with continuous running exercises 3 times a week can significantly increase hemoglobin levels, which confirms previous

finding.[16, 20] However, there is a limitation in this study in which we did not measure the Hb level or iron status of samples precisely prior to the treatment. Samples were chosen based on their willingness to participate in the training program. In this study, the selected students were happened to have fairly good Hb condition, take a 3-meals-a-day with fairly sufficient amount of protein intake. Thus, the increase was not so prominent compared to pretest condition. Based on this finding, we would like to recommend increasing the dose of iron supplementation to 60 to 100 mg/day as has also been suggested by earlier studies[5-7, 13, 14]

Conclusions

Our data analysis and discussion gave a conclusion that there is a significant impact of giving iron supplement and continuous running or jogging exercise on the increasing hemoglobin level among students of Sport Science Study Program of Universitas Negeri Padang with $t_{calculated}$ (3.80) higher than t_{table} (1.73).

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Apri Agus: head of research in building research framework, assigning roles for other authors, approving the final draft for publication; Wilda Wellis: assisting framework building, guiding literature review, supervising data acquisition, guiding the discussion of results; Sepriadi Sepriadi: conducting measurement, supervising treatment, conducting data analysis, contact author; Indri Wulandari: contacting samples, conducting measurement, supervising treatment, conducting data analysis; Monica P. Sari: data interpretation, drafting the work and doing revision under the guidance supervision from head of research. All authors read and approved the final version of the manuscript.

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