The Effectiveness of the Nutrition Fulfillment Education Program on Efforts to Improve Hemoglobin and Nutrition Intake of Student Athletes

Dwi Cahyo Kartiko[1] , Mirza Hapsari Sakti Titis Penggalih[2] , Satwika Arya Pratama[3*] , Marina Hardiyanti [2]

[1] Faculty of Sports Science, State University of Surabaya,

[2] Department of Health Nutrition, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University

[3] Department of Nutrition, State University of Surabaya

Corresponding author: satwikapratama@unesa.ac.id

Abstract: Optimal athlete performance is supported by fulfilling nutritional intake and good nutritional status. Adolescent athletes need optimal nutritional intake to support growth and provide energy to carry out training activities and recovery after competition. However, based on several studies it is still found that adolescent athletes in Indonesia still experience several nutritional problems including stunting, unbalanced nutritional fulfillment, and iron deficiency anemia. The nutrition education was an important aspect to be carried out for groups of athletes in order to increase awareness and knowledge regarding the fulfillment of balanced nutrition. Therefore, the study was aimed to know the effectiveness of nutritional education programs on changes in hemoglobin levels nutrition intake, and knowledge levels in student athletes. This research was conducted at the Sports High School, East Java, involving 49 subjects from five martial sport, which was conducted in six weeks. The subjects were selected using a purposive sampling method . The intervention provided was nutrition education using the lecture method, and using educational media which was carried out once a week for four weeks. Measurement of hemoglobin levels, nutrition intake, and knowledge levels carried out twice, namely before and after the nutrition education intervention. The results of this study showed that statistically there were differences in hemoglobin levels before and after the education program with a p value <0.05, but there was no difference in food intake between before and after the education program with a p value > 0.05. In the knowledge level variable, there is an increase in knowledge from before and after the education program.

Keywords: nutrition education, hemoglobin level, nutrition intake, adolescents, student athletes

INTRODUCTION

Good nutritional status in athletes was unseparated in order to achieve optimal athlete performance. Research conducted by Penggalih *et al* (2017a), showed that the role of nutrition in athlete performance reaches 69.8%. Other research showed that athlete's nutrition intake, especially those containing macronutrients, was associated with improving athlete's anthropometric

profile which includes height, weight, and athlete's somatotype (Penggalih & Solichah, 2019; Penggalih *et al*., 2017b). Optimizing nutritional status in athletes showed a positive relationship with improving athlete performance (Miranda *et al*., 2013; Spriet, 2019; Thomas *et al*., 2016).

Facts on the ground show that in Indonesia there are still some nutritional problems experienced by athletes. Penggali *et al*. in 2016 wrote that the prevalence of stunting in gymnastic athletes at the Jakarta Kemenpora SKO was 31% and 8% was in the short category. Other nutritional problems that arise are not balanced in fulfilling macronutrients and there are still deficiencies of micronutrients experienced by athletes (Penggalih *et al*., 2016).

Iron deficiency is also a case that is often found in athletes, especially women. Female athletes have a higher risk of experiencing iron deficiency, because they lose a certain amount of iron during menstruation (Warington, 2010). Apart from menstruation, iron deficiency in female athletes can occur due to various factors, namely hemolysis (due to collisions and foot injuries), increased loss of Fe (in the gastrointestinal tract, urine and sweat), low intake of Fe, or impaired absorption of Fe. on the intestinal tract, including the inflammatory effects that occur when physical exercise (Valle, 2013). Prolonged physical exercise is also known to cause increased use and metabolism of iron in the body (Pattini *et al,* 1990 in Anschuetz, 2010). In addition, prolonged physical exercise in female athletes can cause or trigger an imbalance between the production of free radicals and the body's antioxidants, which is referred to as *oxidative stress* .

Iron deficiency results in decreased hemoglobin in female athletes. Decreased hemoglobin levels due to iron deficiency cause a decrease in aerobic endurance due to reduced oxygen binding (Suwarni, 2013). Lack of hemoglobin automatically affects the amount of oxygen transported and affects VO2 max (Kusuma, 2010). Therefore this study aims to examine changes in hemoglobin levels, nutrition intake, and knowledge level in student athletes by providing nutritional education intervention programs.

METHOD

The research method was a *quasi-experimental design with* a *non-randomized pre-post trial* without a control group. The intervention was nutrition education to increase the athlete's hemoglobin plasma level, nutrition intake, and knowledge level. Measurements of hemoglobin level, nutrition intake, and knowledge level were carried out twice, before and after the educational material was given. Hemoglobin level was measured using EasyTouch® Hemoglobin test with blood collection in finger. The nutrition intake was measured using Semi Quantitative Food

Frequency Questionnaire during a month habitual food intake. The knowledge level was measured using pretest and postest with 15 questions and total score of 100. The education intervention was given four times with frequency at once a week. The research duration was six weeks on September-October 2022. The educational material was provided using various methods, include presentation, leaflet, game media as monopoly boards and crosswords that have been modified with related material balanced nutrition.

Data collection was carried out at SMANOR Sidoarjo, East Java, involving 50 subjects consisting of athlete students of martial sports consisting of karate, pencak silat, taekwondo, judo and wrestling. The sampling technique for obtaining research samples was used a *purposive sampling method* and obtained approval from students and guardians to be involved in the research. This research had received ethical approval from Faculty of Dentistry Universitas Airlangga number 691/HRECC.FODM/IX/2022. After data collection, the data was processed by tabulation in the *excel program* and univariate analysis was carried out with descriptive analysis to describe the characteristics of the research subjects. Then bivariate analysis was performed using *paired t-test* on the SPSS 16.0 program to determine the difference between before and after the intervention.

RESULTS

The research subjects involved in this study were dominated by adolescents aged 15-16 years, namely school age grades X and XI. For the distribution of male and female respondents, it was consisted the number of 24 and 25 students (Table 1). At the beginning of data collection, the number of subjects targeted was 50 students, but because there were respondents who could not be measured at the end of the program, the research subjects included in the final analysis process were 49 students. Of the 49 respondents, the most athlete were pencak silat, followed by wrestling, judo, karate, and the least were taekwondo (Table 1).

Table 1. Characteristics of respondents

Variable	Amount (%)
Age	
15-16 years	29 (59.1%)
17-18 years	20 (40.9%)
Gender	
Man	24 (48.9%)
Woman	25 (51.1%)
Sports	
Wrestling	11 (22.4%)
Judo	9 (18.4%)
Taekwondo	5 (10.2%)
Karate	9 (18.4%)
Pencak Silat	15 (30.6%)

Different from the results of nutrition intake, the hemoglobin levels was found a statistically significant difference between hemoglobin levels before and after the educational program was given to athletes where the mean value of hemoglobin level was higher before the program (Table 2).

Table 2. Differences in hemoglobin levels before and after the intervention

Variables	Mean ± SD	*p*-value
Hemoglobin levels		
Before intervention	15.5 ± 2.5	0.000*
After intervention	13.6 ± 1.6	

In the test results on the nutrition intake variable, it was found that although there were differences in the mean of all variables, statistically there were no significant differences in the amount of energy consumed, the amount of protein, fat, carbohydrates and iron intake before and after the nutritional fulfillment education program was indicated by p value > 0.05 for all variables (Table 3).

Table 3. Differences in nutrition intake before and after the intervention

Variables	Mean ± SD	*p*-value
Energy Intake		
Before intervention	3371 ± 1301	0.069
After intervention	3032 ± 1003	
Protein intake		
Before intervention	107.0 ± 40.6	0.114
After intervention	97.9 ± 32.3	
Fat Intake		
Before intervention	72.1 ± 36.3	0.249
After intervention	66.2 ± 31.5	
Carbohydrate Intake		
Before intervention	566.7 ± 221.8	0.085
After intervention	504.0 ± 193.2	
Iron Intake		
Before intervention	11.4 ± 5.2	0.694
After intervention	11.2 ± 5.1	

In the variable knowledge level as seen from the *pre* and *post test scores,* there was an increase in the average score from 61 to 72.3 and statistically there was a significant difference in the knowledge level of athletes before and after the education program marked with a p value <0.05 (Table 4).

Table 4. Differences in knowledge level before and after the education intervention

Variables	Mean ± SD	*p*-value
Knowledge level		
Before intervention	61 ± 11.8	0.000*
After intervention	72.3 ± 10.5	

DISCUSSION

Hemoglobin

The effectiveness of providing nutrition education on hemoglobin levels showed mixed results. In this study, it was found that there were differences in hemoglobin levels before and after the nutrition education program was given, but the average hemoglobin level was tend to decrease after the education program. In Marfuah's research (2016) the results showed that there was an effect of nutrition education on hemoglobin levels in high school students after being educated for three months. In another study conducted by Mustafa (2019) at the Islamic School, similar results

were found, namely that there was an increase in students' hemoglobin levels after being given a nutritional education program.

The results of this study showed a decrease in the average hemoglobin level in athletes. This could possibly happen due to physical training factors where many competitions were participated in by the respondents during the data collection period. Meanwhile, the formation of hemoglobin can be influenced by various factors, including the mineral element iron, where the balance can be affected by intake of foods containing iron, storage of iron in the body, metabolism of iron, and loss of iron from the body (Suwarni, 2013) . Decreased hemoglobin levels due to lack of iron tend to occur more frequently in female athletes due to loss of a certain amount of iron through menstruation (Warington, 2010). In addition, iron deficiency which can inhibit the formation of hemoglobin can also occur due to hemolysis due to collisions or injuries during exercise, and release of iron through the digestive tract, urine and sweat including the inflammatory effects that occur during physical exercise (Valle, 2013).

Nutrition intake

The total intake of calories and macronutrients before and after the education program was classified as adequate according to age, but the intake of iron was still classified as deficient, especially in the female group. In addition, as a population group of athletes, the nutritional needs of the research subjects had increased due to additional daily activities, scheduled physical exercise and participated in competitions. Although there was no significant difference between nutrition intake before and after the intervention, there was an average decrease in total intake of calories, protein, fat, carbohydrates and iron. Diet before and after a match could be one of the factors that influence nutrition intake in athletes. The eating plan for athletes were adjusted to the training period which can differ in amount and composition of nutrient between preparation, competition and recovery periods (Penggalih 2019; Sari, 2021).

The average of nutrition intake was 3,300 calories consisted of 100 grams of protein, 70 grams of fat, and 550 grams of carbohydrates. Carbohydrates were needed to meet needs when doing high-activity exercises and to get sufficient muscle glycogen stores (Sari, 2021). The proportion of protein and carbohydrate intake is appropriate, but fat intake was still relatively low. However, iron intake was still relatively low with 11 mg per day, while according to recommendations was approximately 15-19 mg/day (Nurdini, 2017). This can be a factor in the lack of hemoglobin levels in athletes where even though the amount of protein intake was sufficient, if

the iron intake was deficient, sufficient hemoglobin could not be formed because protein and iron were mutually continuous in the formation of hemoglobin molecules (Hoffman, 2004; Nurdini 2017).

Knowledge level

The educational program for fulfilling balanced nutrition is one of the methods that was expected to increase athlete knowledge and be able to encourage awareness and behavior change to improve eating patterns for athlete. In this study, educational programs was found in increasing knowledge level related to nutrition in adolescent athletes. By increasing knowledge, it was hoped that adolescent athletes could be motivated to choose food sources that contain iron to prevent anemia and paid more attention to the composition and amount of intake of macronutrients such as carbohydrates, fats and proteins.

In this study, the results showed that the *post test score* was increased compared to the *pre test* indicating that athletes understood more about balanced nutrition, however these was not effective enough to influence changes in nutrition intake and hemoglobin levels. The duration of education intervention in the research was too short, four times a month. It was considered one of the factors that influence of the nutrition education program. As happened in Mustafa's research (2019), there was an increase in the level of knowledge, a change in protein and iron intake and an increase in hemoglobin levels in students after the nutrition education program for five months. This is also in line with the research by Ariyanti (2017) and Kusuma (2014) which also showed an increase in knowledge in elementary and middle school-age students after being given a nutrition education program. With exposure to knowledge about the importance of fulfilling nutrition since school age, it is hoped that this will continue to motivate and increase their awareness to have a better diet.

We suggested that the interventions of nutrition education to students athlete are given over a longer period of time with more frequent frequency. In this study, there was no difference in intake and hemoglobin in athletes after being given a nutrition education intervention for four weeks, so there might have been a more significant difference if the duration of the study was longer. The intervention in the form of nutrition education showed the benefit of increasing students' knowledge and awareness of the importance of balanced nutrition, however it was not strong enough to have an effect on behavior change. So, we suggested for the future research, nutrition interventions could be targeted for affective and behavioral change. For further research, multi-intervention can

be carried out, not only providing nutrition education but also having a direct effect on increasing hemoglobin in athletes.

CONCLUSION

The conclusion, there was no significant difference in intake of carbohydrate, protein, fat and iron nutrients in athletes between before and after providing nutrition education. Whereas in the hemoglobin variable, it was found that there was a significant difference in the athlete's hemoglobin level before and after being given a nutrition education program. By being given an educational program about balanced nutrition, there was an significant increase in students' knowledge before and after being given education.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgment

We would like to thank to the East Java Sports Public High School including the coaches, students involved as research subjects and the school for giving full permission and support to this research process.

REFERENCES

Anschuetz, S., Carol, DR, Albert, WT. (2010). Meal Composition and Iron Status of Experienced Male and Female Distance Runners. *J Exerc Sci Fit*,Vol 8, No 1, 25–33.

Ariyanti, NA. (2017). The Effect of Education on Level of Knowledge, Level of Consumption of Nutrients (Protein, Vitamin C and Iron), and Hemoglobin Levels related to the Incidence of Anemia in Elementary School Children at SDN Cemorokandang 1 Malang City. *Thesis*, Poltekkes Kemenkes Malang.

Hoffman Jay, Michael J. Falvo. (2004). Protein- Which Is Best. *Journal of Sports Science and Medicine* 3, 118- 130.

Kusuma, NI and Kartini, F. (2014). The Effect of Anemia Health Education on Young Women on the Level of Knowledge and Attitudes in Preventing Anemia in Class X Students of SMA Muhammadiyah 5 Yogyakarta. *Thesis*, STIKES 'Aisyiyah Yogyakarta.

Marfuah, Dewi, Dewi, PDK (2017). The Effectiveness of Nutrition Education on the Improvement of Protein Intake and Hemoglobin Levels in Young Girls. *Proceedings National Seminar on Nutrition 2017 Nutrition Science Study Program* UMS, Surakarta: 132-138.

Miranda, REEP, Antunes, HKM, Pauli, JR, Puggina, EF, & Da Silva, ASR (2013). Effects of 10-week soccer training program on anthropometric, psychological, technical skills and specific performance parameters in youth soccer players. *Science and Sports* , 28 (2), 81–87. https://doi.org/10.1016/j.scispo.2012.02.005

Mustafa, A., Annisa, RM (2019). The Effectiveness of Nutrition Education about Local Specific Food-based Balanced Nutrition Recommendation on Dietary Intake Level and Anemia Status in Female Adolescents at the Hidayatullah Arrohmah Islamic Boarding School Malang. *International Conference on Health Profession, KnE Life Sciences*, 23-31

Nurdini, Della A., Enny Probosari. (2017). Adequacy of Nutrients and Hemoglobin Levels in Football Athletes. *Journal of Nutrition College*; Vol. 6, No. 1, 28-34. : http://ejournal-s1.undip.ac.id/index.php/jnc

Pattini A, Schena F, Guidi GC. (1990). Serum ferritin and serum iron changes after cross-country and roller ski endurance races. *Eur J Appl Physiol* 61:55–60

Penggalih, MHS, & Solichah, KM (2019). Dietary Intake and Strength Training Management among Weight Sports Athletes Category: Role of Protein Intake Level to Body Composition and Muscle Formation. *Asian Journal of Clinical Nutrition* , 11 (1), 24–31. https://doi.org/10.3923/ajcn.2019.24.31

Penggali, MHST, Juffrie, M., Sudargo, T., & Sofro, ZM (2017a). Correlation between dietary intake and anthropometry profile on youth football athlete in Indonesia. *Asian Journal of Clinical Nutrition* , 9 (1), 9–16. https://doi.org/10.3923/ajcn.2017.9.16

Penggali, MHST, Juffrie, M., Sudargo, T., & Sofro, ZM (2017b). Correlation between nutritional status and lifestyle for youth soccer athlete performance: A cohort study. *Pakistan Journal of Nutrition* , 16 (12), 895–905. https://doi.org/10.3923/pjn.2017.895.905

Penggalih, MHST, Narruti, NH, Fitria, F., Pratiwi, D., Sari, MDP, Winata, IN, Fatimah, & Kusumawati, MD (2016). Identification of somatotype, nutritional status, food and fluid intake in gymnastics youth athletes. *Asian Journal of Clinical Nutrition* , 8 (1–3), 1–8. https://doi.org/10.3923/ajcn.2016.1.8

Penggalih, MHST (2019). *Energy Systems, Anthropometry, and Food Intake of Athletes*. Yogyakarta: Gadjah Mada University Press

Sari, Siska P., Desty EP, Yuni, A. *et al*. (2021). Focus Group Discussion on Meal Arrangements According to the Training Period for Junior Athlete Football Coaches. *Sports and Nutrition Journal*; Vol. 3, No. 21, 23-31. https://journal.unnes.ac.id/sju/index.php/spnj/

Spriet, LL (2019). Performance Nutrition for Athletes. *Sports Medicine* , 49 (s1), 1–2. https://doi.org/10.1007/s40279-018-1027-9

Suwarni, S. (2013). *Effect of Iron and Vitamin C Supplements on Aerobic Resistance and Hemoglobin Levels*. Surakarta State University.

Thomas, DT, Burke, LM, & Erdman, KA (2016). Nutrition and Athletic Performance. *Medicine and Science in Sports and Exercise* , 48 (3), 543–568. https://doi.org/10.1249/MSS.0000000000000852

Valle, DMD (2013). Iron supplementation for female athletes: effects on iron status and performance outcomes. *Curr Sports Med Rep*. 2013 Jul-Aug;12(4):234-9. doi: 10.1249/JSR.0b013e31829a6f6b

Warrington S, Porter JB. (2010). Pharmacokinetics, metabolism, and disposition of deferasirox in β-thalassemic patients with transfusion-dependent dent iron overload who are at pharmacokinetic steady state. *Drug Metab Dispos* 38: 808-816. DOI: 10.1124/dmd.109.030833