

Relationship of Energy and Nutrient Intakes on Nutritional status of Young Athletes in Semarang

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Abstract—Fulfillment of energy needs and nutrients was a major factor that could optimized the nutritional status of athletes in order to improve their performance. The aim of this study was to analyze the relationship between energy and macronutrients intake with the nutritional status of young athletes in Education Center for Student Sports Training, Semarang. This descriptive correlation study used cross-sectional design in 40 student athletes from martial arts branches. BMI and percent body fat were used as the main indicator of the nutritional status assessment of the subject. The subject's body fat thickness was measured to estimated the percent of body fat. The subject's intake and adequacy of the energy, carbohydrates, fats, and proteins also measured using a multiple 24-hours recall (three days nonconsecutive). Results show that the daily energy, carbohydrates, proteins, and fat intake are not significantly correlate with BMI for age ($p > 0.05$). In addition, daily intake of energy, carbohydrates, proteins and fats are related significantly with the percent of body fat ($p < 0.05$) despite the adequacy of energy, carbohydrate, protein, and fat levels entirely. It can be concluded that the daily intake of energy and macronutrients can affect body fat composition.

Keywords—athletes, intake, nutritional status

I. INTRODUCTION

Nutrient intake was an important part to support the performance of athletes. Inadequate energy intake will cause fatigue during the match and can also lower the recovery rate in athletes. Prolonged fatigue due to unavailability of energy can damage muscle tissue, thus disrupting athletes' performance [1]. It could be prevented by maintaining balance nutrition for each meal, so that dietary arrangement for athletes become an important aspect in order to achieve energy and nutrition adequacies also could improve athlete's performance. However, martial arts was one of sport branches which required special meal arrangement according to weight class in their competition.

In Central Java, there was a student training center managed by the local government, namely the Education Center for Student Sports Training where the management of athlete's daily meals were supervised by professional nutritionist in order to fulfill an adequate nutritional needs for athletes. Basically, the utilization of energy and nutrients was essential to meet the nutritional needs of athletes and improve their performance, so it is very important to arrange a balanced

menu of meals according to the athlete's condition. But unfortunately, the condition was contrary from the field.

Preliminary study results obtained as much as 8% the martial arts had undernutrition status. Result of eating consumption surveys show that an average of athlete's energy consumption only 74% of the recommended energy requirement, which was categorized on deficit intake [2]. However, the food consumption levels are categorized adequate ($\geq 80\%$ -110% RDA), deficit ($< 80\%$ RDA), and excessive ($> 110\%$ RDA) [3].

As for, Condition of deficit energy intake for a long period would cause negative energy balance which would impact on chronic weight loss and tissue damage also eventually decrease performance of athletes [4]. Based on that situation, the author interested to study about the relationship of energy intake and macronutrients with the nutritional status of student athletes in Education Center for Student Sports Training Semarang. The purpose of this study was to analyze the relationship between energy and macronutrients intake with the nutritional status of adolescent athletes in Education Center for Student Sports Training, Semarang

II. MATERIAL AND METHODS

This observational analytic study with cross sectional design was completed in July 2019. Located in the Jatidiri Sport Arena, Semarang, Central Java, this study took a study subject of 40 people aged between 14-18 years using simple random sampling technique. This subject was a Central Java Province martial arts athletes (wrestling, judo, karate, pencak silat, taekwondo, boxing, and wushu) of Education Center for Student Sports Training, not being illness or have a history of cardiovascular disease, metabolic syndrome, abnormalities of immunity and/or orthopedic disorders as well as not being/ever using drugs or supplements that can affect muscle work, willing to follow a series of studies through approval of informed consent.

A. Physical Measurement

Physical measurements include measuring weight, height, waist and hips circumference, abdominal circumference, femoris circumference, and fat thickness. Body weight was weighed using GEA Medical Electric Personal Scale Type BR-

9807 (0.1 kg precision level), and height was measured using a stature meter (0.1 cm precision level). Waist and hips circumference, abdominal circumference, and femoris circumference were measured using a meter (0.1 cm precision level). The fat thickness was measured using 2 ways, used the skinfold caliper and Bioelectric Impedance Analysis (BIA). The measurement of fat thickness using the skinfold caliper used 7 measurement points, include bisepts, trisepts, subscapular, suprailiac, abdominal, thigh, and pectoralis.

B. Determination of Nutritional Status

Determination of the subject's nutritional status using the BMI for age antropometric index because the subject is a teenager aged 14-18 years old. Body mass index for age was calculated based on the results of weight and height measurements which were then related to age parameter. In addition to BMI for age, percent of body fat was also used as an indicator of nutritional status assessment of subjects. Percent of body fat was obtained from the calculation result of body density formula [5]:

$$Body\ density = 1,0970 - (0.00046971 \times \text{sum of seven skinfolds}) + (0.00000056 \times [\text{sum of seven skinfolds}]^2) \quad (1)$$

The calculated result of the formula was then used to estimate percent of body fat using a formula [5]:

$$\% \text{ of Fat Mass (Male)} = (5.12 \div BD) - 4.69(5.12 \div BD) - 4.69 \quad (2)$$

$$\% \text{ of Fat Mass (Male)} = (5.12 \div BD) - 4.69(5.12 \div BD) - 4.69 \quad (3)$$

The result was then categorized into skinny, good, and acceptable body fat.

C. Assessment of Food Intake

Food intake was obtained from interview with subjects using multiple recall 24-hours (non-consecutive days). The interview results were then converted into calories and grams of macro nutrients and then compared to Recommended Dietary Allowance (RDA) for adolescents aged 14-18 years and multiplied by 100% using the formula:

$$Intake (\%) = \frac{\text{daily intake}}{RDA} \times 100\% \quad (4)$$

D. Data Analysis

All data was analyzed using SPSS 16.0 for Windows. Data of gender , sports branch, body weight, body height, BMI for age, fat mass (bicep, tricep, supscapular, suprailiac, abdominal, pectoralis, thigh), percentage of body fat, body circumferences (waist, hip, abdominal, and femoris) waist hips circumference ratio, energy and nutrients (carbohydrate, protein, and fat) intake, energy and nutrients adequacy, and body density were analyzed descriptively. The analysis was then followed by bivariate analysis using correlation test to assess the relationship between energy and nutrients intake with nutritional status (BMI for age and percentage of fat mass).The statistical test used parametric

bivariate correlation test, that was Pearson's R Correlation Test with significant level (α) 0.05. The correlation test result were significant if p-values < 0.05 were obtained [6].

III. RESULT AND DISCUSSIONS

A. Subject Characteristics

The results of the study conducted on 7 branches of martial arts (wrestling, judo, karate, pencak silat, taekwondo, boxing, and wushu) show that most of athletes have a skinny body fat (75%). This study on respondents were mostly male athletes (82.5%). It also shows the results that all athletes have a low risk of degenerative diseases. Most of the subjects show an adequate intake of energy and macronutrients (carbohydrates, proteins, and fats) (75%) while there are still some that are still indicate deficits or even excessive intake. However, the characteristics of the subject of study based on gender, sports branch, waist-hip circumference ratio, percentage of body fat, and energy and nutrients adequacy are presented in Table I.

TABLE I. SUBJECT CHARACTERISTICS

Characteristics	BMI for Age (0.41 + 0.827 SD)						P-Value ^a
	Thin		Normal		Obese		
	N	%	n	%	n	%	
Gender							
a. Male	1	2.5	25	62.5	7	17.5	0.610 ^{ns}
b. Female	0	0	5	12.5	2	5.0	
Sport Branches							
a. Wrestling	0	0	4	10.0	3	7.5	-
b. Judo	0	0	5	12.5	1	2.5	
c. Karate	0	0	4	10.0	0	0	
d. Pencak Silat	0	0	7	17.5	4	10.0	
e. Taekwondo	0	0	4	10.0	0	0	
f. Boxing	1	2.5	4	10.0	0	0	
g. Wushu	0	0	2	5.0	1	2.5	
Percentage of Body Fat (11.23 ± 4.955%)							
a. Skinny	1	2.5	23	57.5	6	15.0	0.479 ^{ns}
b. Good	0	0	4	10.0	2	5.0	
c. Acceptable	0	0	3	7.5	1	2.5	
Waist Hips Circumference Ratio (0.82 ± 0.054)							
a. Risky	0	0	0	0	0	0	-
b. Not Risky	1	2.5	30	75.0	9	22.5	
Energy and Nutrients Adequacy							
a. Energy (94.41 ± 13.167%)	0	0	4	10.0	1	2.5	0.491 ^{ns}
- Deficit	1	2.5	23	57.5	6	15.0	
- Adequate	0	0	3	7.5	2	5.0	
- Excessive							
b. Carbohydrate (94.41 ± 13.167%)	0	0	4	10.0	1	2.5	0.491 ^{ns}
- Deficit	1	2.5	23	57.5	6	15.0	
- Adequate	0	0	3	7.5	2	5.0	
- Excessive							
c. Protein (94.41 ± 13.167%)	1	2.5	23	57.5	6	15.0	0.491 ^{ns}
- Deficit	0	0	3	7.5	2	5.0	
- Adequate	0	0	4	10.0	1	2.5	
- Excessive	1	2.5	23	57.5	6	15.0	0.491 ^{ns}
d. Fat (94.41 ± 13.167%)	0	0	3	7.5	2	5.0	
- Deficit							
- Adequate							
- Excessive							

^aCorrelation test using Spearman's Correlation Test, significant at 0.05 Significancy is showed by notation * Not significant is showed by notatin ^{ns}

Based on body weight and height measurement results and the measured Body Mass Index (BMI) for age, the average subject has a normal range, although there are still some subjects whose BMI for age values are low. The characteristics of subjects based on the results of the measurement of anthropometry (weight, height, body fat, body density, and waist and hip circumference) and the results of daily intake are presented in Table II.

The results of this study show that most of the nutritional status (BMI for age) of martial arts athlete as the subject of study is normal, although there are still obese and thin. Meanwhile, the whole athlete has good and acceptable percentage of body fat mass even most have skinny body fat mass. To be considerate, the results of this research also mention that athletes with obesity nutritional status mostly have very little fat mass percentage. This means that the athlete's body composition is thought to have a very high fat free mass. Increased fat free mass will be able to improve the strength and power of the martial arts athletes, conversely the increase in body fat mass can precisely decrease the strength and power of the athlete's muscle as well as can affect the aerobic endurance during the game [7].

Based on energy and nutrients adequacy estimation show that there is still a subject whose deficit of energy and nutrients adequacy despite normal or obese nutritional status. This is in line with the study conducted earlier in the taekwondo and wushu men athletes aged 14-18 years. This study stated that the daily consumption of taekwondo athletes higher than the wushu athletes, but still not able to meet the RDA [8].

Martial Arts was a sports branch that in the match was divided into several classes of weight, which in reaching a certain weight class, athletes were required to be able to adjust their weight condition in order to reach their expected weight class. This condition was become to be one of the reasons for martial arts athletes to restrict their intake, so that their intake still did not meet his daily needs. As for the weight point in the weight management of martial arts was an optimal achievement of body composition so that the martial arts are expected to demonstrate optimum performance on a predetermined weight class [9].

Body composition that greatly affects the performance of martial arts athletes was the percentage of body fat and muscle mass. An athlete who performs weight loss should refer to a decrease in body fat percentage and increased free fat mass especially lean body mass. The study of 2011 in wrestler mentioned that wrestler on lighter and higher class of body weight had a significantly less percentage of body fat compared to untrained subject [16] The explosive action was crucial in determining the performance of a martial arts athlete during a game, where optimal explosive action can be achieved if the optimal muscle mass was supported as well [10].

Martial Arts was a sport that demonstrates the technique of a person in defending themselves, which includes of boxing, wrestling, taekwondo, pencak silat, Judo, and wushu. In martial arts, an athlete was required to be able to excellent in basic technique of survival and attack, in which the technique

need both upper and lower muscle strength. In addition, the martial arts matches usually take place in 3-5 rounds each within 5 minutes with a 1-minute lag time in each round [7]. In each round it taken a large amount of energy but with a fairly short time. This means that in a single contest, the time taken by the martial arts athlete was 15-25 minutes which means the sport was still in the category of aerobic sports [11]. It certainly required the energy system settings as well as the fulfillment of energy intake and proper nutrients. As for the energy systems used by martial arts athletes almost resemble repeated sprint, in which 40% of energy using the lactate system on the first sprint which would then decline to 9% on the 10th sprint. On the other hand, oxidative metabolism was also part of the repeated sprint energy system, where at the time of the first sprint, only less than 10% of this system was used which would then increase to 40% at the end of the sprint [12].

It had been mentioned before that martial arts sports were an aerobic exercise where the energy system used was aside from fat. Therefore, a martial arts athlete would not exhibit optimal performance, if it had a higher fat mass component compared to lean muscle mass as well as fat free mass. The technical skill would decline resulting from the limited availability of energy reserves during the competition which would ultimately impact the outcome of the match final [13,14].

TABLE II. SUBJECT CHARACTERISTICS BASED ON ANTHROPOMETRY AND DAILY INTAKE

Characteristics	Mean + SD	Minimum	Maximum
Body Weight (kg)	61.59 ± 8.063	47.15	84.45
Body Height (cm)	165.70 ± 6.941	153.50	181.00
BMI for age (SD) ^a	0.41 ± 0.827	-2.38	1.82
Body Fat			
Tricep	11.01 ± 2.410	7.00	18.00
Suprailiac	11.99 ± 3.434	7.50	22.00
Abdominal Skinfold	11.79 ± 2.465	8.50	19.00
Bicep	8.15 ± 3.454	4.00	18.00
Supscapular	10.04 ± 3.313	5.00	19.50
Pectoralis Skinfold	6.64 ± 2.786	3.00	16.50
Thigh Skinfold	10.31 ± 4.483	4.00	21.50
Percentage of Body Fat ^{*b}	11.23 ± 4.955	7.16	24.68
Abdominal Circumference (mm)	723.26 ± 54.245	622.00	852.50
Femoris Circumference (mm)	249.55 ± 26.243	200.00	332.50
Waist Circumference (mm)	721.35 ± 54.115	617.50	830.00
Hip Circumference (mm)	882.51 ± 69.901	695.00	1025.00
Body Density	1.07 ± 0.007	1.06	1.09
Waist-Hip Circumference Ratio	0.82 ± 0.054	0.70	0.98

Characteristics	Mean + SD	Minimum	Maximum
Energy and Nutrients Intake			
Energy (kcal)	5172.70 ± 555.408	4274.00	6935.00
Carbohydrate (gram)	711.24 ± 76.368	587.68	953.56
Protein (gram)	313.17 ± 48.991	222.58	433.44
Fat (gram)	119.45 ± 11.830	94.98	154.11

^{a,b}Correlation test using *Pearson's R Correlation Test*, significant at 0.05
Significance is showed by notation *

^aEnergy, Carbohydrate, Protein, and Fat Intake p=0.202; 0.202; 0.084; and 0.875

^{a, b}Energy, Carbohydrate, Protein, and Fat Intake p=0.10; 0.10; 0.0001; and 0.022
b.

B. Relationship of Energy and Nutrients Intake with Nutritional Status

Results of analysis using Pearson's R Correlation Test show that the daily energy, carbohydrates, proteins, and fat intake are not significantly related with BMI for age of martial arts athletes ($p > 0.05$). On the other hand, daily intake of energy, carbohydrates, proteins and fats are related significantly with the percentage of body fat ($p < 0.05$) (Table II).

The results showed that the majority of martial arts athletes has adequate levels intake of energy and nutrients, although there were still some athletes whose energy levels and nutritional substances were still deficits or even excessive. This is contrary to the previous research conducted on 62 male combat athletes in Poland aged 19-27 years stated that almost all athletes had deficit of energy adequacy [15].

Body composition that required martial athletes to be in certain weight conditions based on their weight classes, often making martial arts athletes ignored the adequacy of energy and nutrients intake were even more likely to do rapid weight loss in a very short time (weight loss of 5% of body weight within a few days). Although energy and nutrients intake were very important to support the performance of athletes both during the training period or at the competition [16].

The strategy of weight management on martial arts branches was usually done a few days before the game (7-10 days before). The strategy were dietary restriction through restriction of food intake and fluid, increased duration and intensity of exercise accompanied by the use of clothes made of anti-transpirant to increase the production of sweat during exercises, some even use drugs such as laxative and diuretic agents to stimulate vomiting. That was aimed at a very high amount of weight loss but in a very short time. These strategies were not the right thing to be applied to athletes because it would cause a lot of negative impacts for the health of the athlete as well as on their performance. Athletes' performance would decline due to decreased glycogen deposits and muscles that will impact the decrease in energy deposits. If this persists, the body proteins stored as muscle mass will be used as energy sources that will result in decreased muscle mass. As for the muscle mass decreases, the strength and endurance of the muscles will also decrease so that decreases the performance. Not only that, unproprie

utilization of energy system will impact the deficit of energy reserves which will result in faster fatigue in athletes [17-19].

The study also shows the results that energy and macronutrient intake significantly related to the percentage of body fat of martial arts athletes that are the subject of the study. The results of this study were in line with the study conducted in 2013 in professional athletes that the group whose energy intake was increased will also increase body fat mass [20]. But the results of this study showed that energy and macronutrient intake are not related to nutritional status (BMI of age). The results of this study are also in line with the previous study results (2017) in 131 football athletes from Young Athletes Dormitory Ragunan, Indonesian Ministry of Youth and Sport, Jakarta, Indonesia and SSB ASIFA-Aji Santoso Intenational Football Academy, Malang Indonesia. Those study also stated that energy, fat and carbohydrate intake showed a significant effect on body weight, BMR, BMI and muscle arm [21].

This was contrary to the previous research results in 2017 on 21 football athletes in the Sinar Harapan football school, Tulangan, Sidoarjo which stated that the energy and nutrients intake are significantly correlated to the BMI of age [22].

IV. CONCLUSIONS AND SUGGESTIONS

It can be concluded that the daily energy, carbohydrates, proteins, and fat intake are not significantly related with BMI for age of martial arts athletes. On the other hand, daily intake of energy, carbohydrates, proteins and fats are related significantly with the percentage of body fat. For further research, there needs to conduct a study that examines about the measurement of nutritional status in athletes using body fat and fat free mass as indicators and also the effect of foodstuffs consumed against the physical performance of martial arts athletes.

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