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<https://ejournal.upi.edu/index.php/penjas/article/view/44497>DOI: <https://doi.org/10.17509/jpjo.v7i1.44497>**Associations between Macronutrient Intake and Body Composition of Female Adolescent Athletes and Their Fitness Levels****Agus Hariyanto\*<sup>1</sup>, Gigih Siantoro<sup>1</sup>, Anindya Mar'atus Sholikhah<sup>2</sup>, Yetty Septiani Mustar<sup>2</sup>, Muhammad Farid Ilhamuddin<sup>3</sup>, Afif Rusdiawan<sup>2</sup>, Muhammad Kharis Fajar<sup>1</sup>**<sup>1</sup>Department of Sport Coaching Education, Faculty of Sport Science, Universitas Negeri Surabaya, Indonesia<sup>2</sup>Department of Health Education and Recreation, Faculty of Sport Science, Universitas Negeri Surabaya, Indonesia<sup>3</sup>Department of Guidance and Counselling, Faculty of Education, Universitas Negeri Surabaya, Indonesia**Article Info***Article History :**Received February 2022**Revised March 2022**Accepted April 2022**Available online April 2022**Keywords :**Body composition, Endurance, Female athletes, Nutrient intake, VO2Max***Abstract**

Adolescent athletes need more nutrient intake than adolescents of the same age due to their high activities, especially during exercise, to avoid disruption in their growth process. The athlete is also required to have a good body composition to achieve optimal performance. This study examined the relationship between body composition and nutrient intake of female adolescent athletes and their fitness level. A cross-sectional study was conducted on 28 female athletes of Tulungagung Training Centre selected using systematic random sampling. Dietary assessment (energy and macronutrient intake) and body composition (FM, FFM) were measured using 2x24 hours food recall and InBody270. The maximal oxygen uptake (VO<sub>2</sub>max) was measured using Multi-stage Fitness Test. Independent sample t-test, Mann-Whitney test, and Spearman test were performed using SPSS 25. The results found that most athletes had a lower macronutrient intake, especially energy, carbohydrate, and fat which did not meet the Recommended Dietary Allowance. However, endurance athletes consumed more protein ( $p=0,044$ ) and fat ( $p=0,873$ ) than non-endurance athletes. Spearman test revealed a negative correlation between energy intake, fat mass, and VO<sub>2</sub>max. In general, many athletes consume macronutrients less than the RDA. Dietary intake and body composition in highly trained adolescent female athletes must be optimized and monitored to achieve better performance and physical fitness.

## INTRODUCTION

Physical fitness is a person's ability to carry out daily activities effectively and efficiently without feeling under fatigue and still have the energy to carry out additional workloads (Bryantara, 2016; Sudiana, 2014; Wilder et al., 2006). Physical fitness has many components and is often conceptualized as health or performance-related (Campbell et al., 2013). Health-related physical fitness is generally associated with health status and is positively or negatively influenced by a person's physical activity habits. Conversely, performance-related physical fitness is related to physical ability and athletic performance (Campbell et al., 2013; Merino et al., 2017). It describes maximal aerobic capacity adjusted for body size and composition, which is mostly used to measure cardiorespiratory function and oxygen transport (Zou et al., 2019). Thus, physical fitness is needed for each individual to achieve better health (Asdar, 2019; Huslah & Hariyanto, 2020), especially for an athlete where physical fitness is a determinant that affects performance in various sports (Ruedl et al., 2019).

Many factors affect the level of physical fitness, with some studies mentioning age (Williyanto et al., 2021), nutrient intake (Belski et al., 2019), and nutritional status (Nhantumbo et al., 2013) were linked to fitness level. Athletes require a higher intake of nutrients than the general population, especially macronutrients (Hosseinzadeh et al., 2017). The increase in need is due to a higher level of physical activity, so they need more energy. Especially for adolescent athletes, adequate nutritional intake is crucial for maintaining health and supporting physical growth and development, improving exercise performance, and accelerating the recovery process (Iyakrus, 2018; Zahra & Muhlisin, 2020). In addition, adequate food intake in terms of quality and quantity is needed to achieve optimal nutritional status. Nutritional status and energy availability are critical because good technique and skill will not lead to better performance if it is not equipped with good nutrition (Permatasari et al., 2018). Moreover, the increased energy loss due to heavy training and the nutritional needs of athletes will be only compensated by adequate nutrition, which thereby facilitates the maximum adaptation to any physical loads (Baranauskas et al., 2015).

In addition to nutrient intake, body composition

also affects physical fitness (López-Sánchez et al., 2019). However, most previous studies have evaluated body composition by measuring only one indicator, such as body mass index (Correa-Rodríguez et al., 2017). In fact, the role of body composition assessment using other than BMI, especially during adolescents and early adulthood, has not been thoroughly investigated. Moreover, few studies that have been done reported conflicting findings, resulting in the increased need to examine this topic in the athlete population.

Current estimates suggest that nearly 35 million children and adolescents aged 5-18 years have participated in various sports fields (Smith et al., 2015). The proportion of female athletes increased, covering almost 50% of the total sport's participants. In contrast to these high numbers, the attention or interventions that focus on the health and nutrition aspects of female adolescent athletes are still scarce. Research that raises the topic of nutrient intake is mainly done on a broad population of athletes and is not specific to a particular gender. In addition, research on physical fitness in athletes has focused more on measuring the components of physical condition in general. Not many studies have explored the relationship between physical fitness and health indicators such as body composition, food intake, and nutritional status. Therefore, this study examined the relationship between body composition, nutrient intake, and fitness level in female adolescent athletes.

## METHODS

### Participants

It was a descriptive and analytical cross-sectional study on adolescent athletes' dietary intake, body composition, and physical fitness. The population of this study was 67 female athletes who belonged to Puslatkab Tulungagung. The participants were then selected using systematic random sampling from the population, with inclusion criteria as follows :

1. Age 16-20 years;
2. Practicing in endurance sports (i.e., athletic, swimming, diving, badminton, etc.) and non-endurance sports (i.e., taekwondo, karate, weightlifting, boxing, etc.);
3. Actively participated in regular training scheduled by Puslatkab Tulungagung during the last three months;

4. Was not in menstrual period; and
5. Did not take any medication containing glucocorticoids, corticosteroids, and diuretics.

In addition, exclusion criteria included having any lower-limb injury or disease that prevented them from performing a physical fitness test, a lack of completing the questionnaire, and drop-out or unwillingness of the athletes to continue their participation in the study. A total of 28 athletes agreed to participate in this study, and all of them, including their coaches, were explained the purpose of the study and the procedures beforehand.

### Instrument and Procedure

#### Dietary Assessment

The trained interviewer obtained dietary intake using 2 x 24-h recall on two consecutive days. The recorded intake for each food item portion was then converted to gram weights using household measures. The data obtained were analyzed using Nutrisurvey 2007 software and then compared with The Indonesian Recommended Dietary Allowance (AKG) 2019, corrected with age (16-18 years), gender (female), and standard bodyweight ( $\pm 52$  kg), as following: energy intake 2100 kcal, carbohydrate 300 g, Protein 65 g, and fat 70 g.

#### Body Composition

Body composition assessments were measured using InBody370 (InBody, Cerritos, CA, USA) before any measurement, with each subject wearing only light clothing. Measuring body composition began with the subject standing barefoot on a scale and hands holding the handles. The tool will analyze body composition based on the differences in the ability to conduct electric current by body tissues with different resistances due to differences in water content. The variables measured were body weight (BW; kg), height (cm), fat mass (FM; kg), fat-free mass (FFM; kg), and body mass index (BMI; kg/m<sup>2</sup>).

#### Physical Fitness

Physical fitness measurement was carried out by measuring the cardiopulmonary level (VO<sub>2</sub>max) using Multistage Fitness Test (MFT).

### Data Analysis

All data were presented descriptively as mean  $\pm$  standard deviation. Data were checked for normal dis-

tribution using the Shapiro-Wilk test. Independent sample t-test and Mann-Whitney test were done to compare the measured variables between different types of sport. Lastly, Spearman correlation was performed to examine the correlation between nutrient intake, body composition, and physical fitness. All statistical analysis was performed using SPSS 25 for Windows with a significant level of 0,05.

### RESULT

A total of 28 female athletes from endurance and non-endurance sports ( $18,2 \pm 1,69$  years;  $56,10 \pm 11,60$  kg;  $158,46 \pm 5,84$  cm) fulfilled the inclusion criteria, thus were included in the study. Participants' characteristics, including age, body weight, height, BMI, FM, FFM, and training duration, are presented in Table 1.

The average of age, body weight, and height in endurance athletes were  $17,69 \pm 1,49$  years,  $58,00 \pm 12,66$  kg, and  $160,44 \pm 5,73$  cm, respectively. Meanwhile, the same variables in non-endurance athletes were  $18,92 \pm 1,73$  years;  $53,58 \pm 9,99$  kg, and  $155,83 \pm 5,08$  cm, respectively. Endurance athletes had slightly lower fat mass than non-endurance athletes but higher BMI and fat-free mass. Nevertheless, the differences were not significant ( $p < 0,05$ ). A significant difference was found in training duration ( $p = 0,008$ ), where endurance athletes spent more hours ( $4,94 \pm 2,52$  hours/week) compared to non-endurance athletes ( $2,88 \pm 0,61$  hours/week) practicing their training (other than training scheduled by Pustlatkab) at home.

The average intake of energy and macronutrients of all athletes are provided in Table 2 and Figure 1. The mean energy intake of endurance and non-endurance athletes was lower than Recommended Dietary Allowance (RDA/AKG) (2019) established by the Ministry of Health Republic of Indonesia, which were  $1637,72 \pm 619$  kcal/day and  $1602,30 \pm 362,99$  kcal/day, respectively ( $p = 0,507$ ). The mean carbohydrate intake in both endurance and non-endurance athletes was also found to be lower than RDA 2019, with athletes practicing in endurance sports having a much lower carbohydrate intake. However, endurance athletes consumed higher protein ( $74,91 \pm 25,10$ ) and fat ( $74,66 \pm 47,33$ ) intake a day, fulfilling their daily needs, according to RDA 2019. Overall, the only difference in macronutrient intakes was observed in protein, with  $p = 0,044$ .

**Table 1.** Characteristics of participants

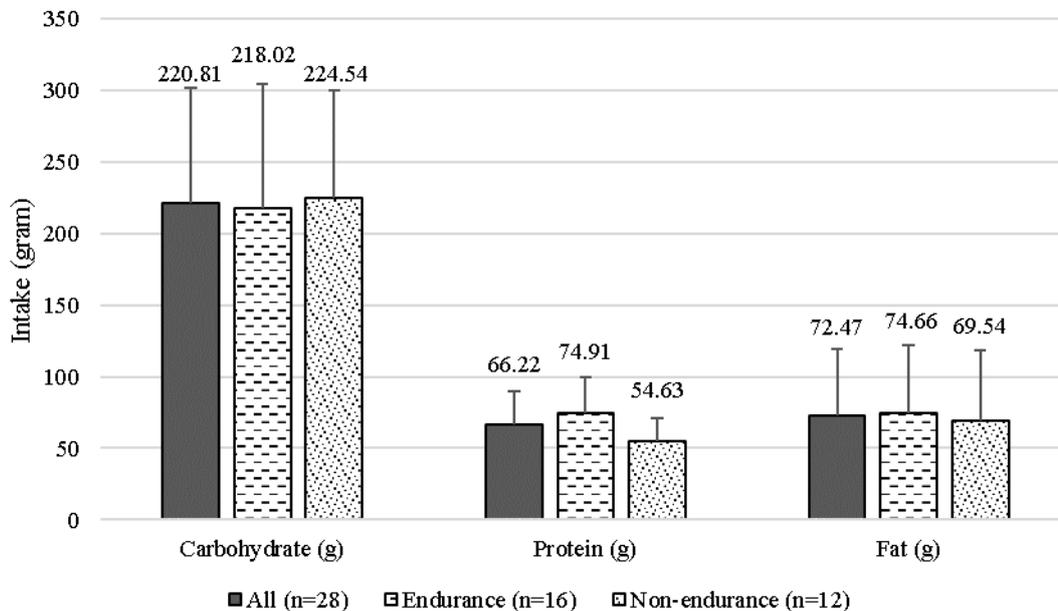
Characteristics	Mean ± SD			p-value
	All (n=28)	Endurance (n=16)	Non-endurance (n=12)	
Age	18,20 ± 1,69	17,69 ± 1,49	18,92 ± 1,73	0,066 <sup>a</sup>
Bodyweight (kg)	56,10 ± 11,60	58,00 ± 12,66	53,58 ± 9,99	0,458 <sup>b</sup>
Height (m)	158,46 ± 5,84	160,44 ± 5,73	155,83 ± 5,08	0,033 <sup>a*</sup>
BMI (kg/m <sup>2</sup> )	22,26 ± 4,01	22,45 ± 4,35	22,02 ± 3,68	0,945 <sup>a</sup>
Fat mass (kg)	15,57 ± 7,59	15,38 ± 8,42	15,82 ± 6,68	0,698 <sup>a</sup>
Fat-free mass (kg)	40,54 ± 5,53	42,62 ± 5,46	37,76 ± 4,44	0,453 <sup>b</sup>
Training duration (h/week)	4,05 ± 2,18	4,94 ± 2,52	2,88 ± 0,61	0,008 <sup>a*</sup>

**Table 2.** Total mean intake of macronutrients

Dietary Component	Mean ± SD			p-value
	All (n=28)	Endurance (n=16)	Non-endurance (n=12)	
Energy (kcal)	1622,54 ± 516,92 ↓	1637,72 ± 619,49 ↓	1602,30 ± 362,99 ↓	0,507 <sup>a</sup>
Carbohydrate (g)	220,81 ± 80,51 ↓	218,02 ± 86,37 ↓	224,54 ± 75,57 ↓	0,606 <sup>b</sup>
Protein (g)	66,22 ± 23,68 ↓	74,91 ± 25,10 ↑	54,63 ± 16,16 ↓	0,044 <sup>b*</sup>
Fat (g)	72,47 ± 47,10 ↑	74,66 ± 47,33 ↑	69,54 ± 48,72 ↓	0,873 <sup>a</sup>

**Table 3.** Correlation between body mass index, energy intake, body composition, and vo2max

Variable	VO <sub>2</sub> max	
	p-value	r
Body mass index	0,033*	-0,405
Energy intake (kcal)	0,005*	-0,518
Fat mass (kg)	0,004*	-0,529
Fat-free mass (kg)	0,452	0,251



**Figure 1.** Intake of Macronutrients in Endurance and Non-endurance Female Athletes

The result of Spearman correlation (Table 3) revealed that body mass index ( $p = 0,033$ ;  $r = -0,405$ ), energy intake ( $p = 0,005$ ;  $r = -0,518$ ), and fat mass ( $p = 0,004$ ;  $r = -0,529$ ) were negatively correlated with VO<sub>2</sub>max, both in endurance and non-endurance athletes. Meanwhile, fat free mass was not associated with VO<sub>2</sub>max ( $p = 0,452$ ;  $r = 0,251$ ).

## DISCUSSION

The present study provides an insight into the dietary intake and body composition of female athletes practicing endurance and non-endurance sports, including its association with fitness level. Most athletes had lower macronutrient intake, especially energy, carbohydrate, and protein, which did not meet the Recommended Dietary Allowance (RDA/AKG) 2019 (Kemenkes, 2019). This is because athletes need more calories and macronutrients than the general population (~2000-5000 kcal/day, depending on the type of sports) (Baranauskas et al., 2015; Hosseinzadeh et al., 2017; Shruti & Singh, 2013). Therefore, besides complying with RDA 2019, the nutritional needs of athletes should follow the guideline that is established specifically for the athlete population. For instance, endurance athletes who spend 2-3 hours of physical training daily need to consume carbohydrates as much as 7-12 g/kg of body weight (Andrews et al., 2016). Meanwhile, the recommended protein intake for an endurance athlete is 1.2 – 1.6 g/kg, and the energy value contributed by fat should be between 20% - 35% of total energy intake (Costa et al., 2019; Jäger et al., 2017).

Due to ongoing growth and maturation, adolescent athletes need special attention regarding their diet, especially females (Baranauskas et al., 2015). The present study found that our athletes, both in endurance and non-endurance sports, consumed less energy, carbohydrate, and fat. It was in line with previous studies. For the past three decades, female athletes have been listed in the group of nutrient inadequacy-risk due to insufficient intake of carbohydrates and energy (Baranauskas et al., 2015; Wohlgemuth et al., 2021). In addition to that, studies have reported that female athletes often failed to meet nutritional needs, leading to low energy availability (EA), medical-related issues, poor performance, and decreased physical fitness (Black et al., 2020; Gastrich et al., 2020). An adequate energy intake also contributes to optimizing body function, determines the nutri-

ent intake capacity, and supports improving body composition in athletes (Thomas et al., 2016). It also explains the present study's findings, which showed the correlation between nutrient intake and body composition.

Participants in this study were female athletes in their late teens who often neglected their food intake. One of the reasons was inadequate nutritional knowledge (Gastrich et al., 2020) and body image (Kantanista et al., 2018). Low nutritional knowledge in adolescents is a problem that needs more attention because its impact is directly related to poor health and physical status (Zaborowicz et al., 2016). Good nutritional knowledge impacts good dietary behavior, where these two variables simultaneously affect the increase in fat-free mass and muscle strength (Nikolaidis & Theodoropoulou, 2014). Athletes who understand the vital functions of an adequate diet and reflect knowledge into their dietary behavior are likely to have better performance (Folasire et al., 2015).

Maximal oxygen uptake, or VO<sub>2</sub>max, is an index used to evaluate physical or aerobic fitness (Zou et al., 2019). Our study found that body mass index, energy intake, and body composition (fat mass) correlated with VO<sub>2</sub>max or aerobic fitness. It was supported by a previous study which stated that VO<sub>2</sub>max from 20-m of Shuttle Run Test was associated with several body composition parameters such as fat-free mass, percentage of body fat, and body mass index (Zou et al., 2019). This is also confirmed by a cross-sectional study conducted on school children in Spain, which found that the increase in body fat percent was negatively correlated with several components of physical fitness, such as maximal oxygen uptake ( $r = -0.524$ ) and explosive strength ( $r = -0.400$ ). The same thing was also found in the research of Soodogi et al. (2016), which mentioned a negative correlation between body fat and physical fitness and general health indicators in high school students. In obese or overweight individuals, the oxygen uptake per body mass unit is significantly decreased due to the high amount of fat which later affects the heart's function. This excessive fat accumulation in muscles will lead to the failure of muscles to use oxygen effectively (Dewi et al., 2015) and thereby reduces the VO<sub>2</sub>max level, as shown in this research. Thus, it will influence the athlete's performance regardless of the sport they play.

Our study did not involve the influence of lifestyle and socio-demographic factors in analyzing its impact on physical fitness, which becomes the limitation of this study, as physical fitness is not only affected by the variables measured in this study. In addition, one of the possible explanations for nutrient inadequacies found in most athletes is likely due to the classical issue of under-reporting energy and macronutrient intake through dietary recall in human studies. Furthermore, the reason might be the low accuracy and precision of methods used to estimate energy intake in athletes. We used food recall 2x24 hours which is memory-dependent and can present lower precision and accuracy (Heydenreich et al., 2017). Thus, we encourage future longitudinal studies to use a combined method to estimate the nutritional intake for better results and explain the causality of the association between variables.

## CONCLUSION

According to the findings in this study, the nutritional intake of athletes in terms of energy and macronutrients was less than the recommended value set by RDA. Therefore, some macronutrient intake needs to be increased, especially for athletes practicing in non-endurance sports. However, the body composition results were generally normal, and we recommend that athletes continue to monitor these indicators regularly. In the end, further studies are needed involving other micronutrient intakes.

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## CONFLICT OF INTEREST

The authors declared no conflict of interest.

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