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Analysis of body type, dietary intake, and cardiorespiratory function in college soccer players

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Abstract: This study aims to analyze college soccer players' body type, dietary intake, and cardiorespiratory function. Thirty-two players (20 players from Yogyakarta State University and 12 players from Gadjah Mada University) were involved in this study. Body type, or somatotype, was calculated based on anthropometric measurements (weight, height, epicondylar humerus and epicondylar femur width, arm and calf circumference, and subcutaneous fat thickness). 24-hour food recall was used to measure the athlete's dietary intake. VO_2max was used to describe the athlete's cardiorespiratory function, and it was measured by yo-yo intermittent recovery test level 2. The data were analyzed descriptively using statistical software. More than three-quarters of the players had normal nutritional status with body mass index=21.54±1.84. The majority of players' body types were balanced mesomorph (2.6-4.4-2.7). Balanced mesomorph players and ectomorphic mesomorph players had adequate energy and protein intake (2,623.83 kcal energy and 75.82 g protein for balanced mesomorph players; 2.724.68 kcal energy and 84.83 g protein for ectomorphic mesomorph players). Ectomorphic mesomorph players had the highest VO_2max level (52.37±2.61 ml/kg/min). Soccer players with a mesomorph component supported by good energy and protein intake have the most optimal VO_2max level.

Keywords: body type, cardiorespiratory function, dietary intake, soccer, VO_2max.

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INTRODUCTION

Somatotype measurement, commonly referred to as body type, is important in sports because body type is one of the factors that affect athletes' performance. The somatotype component, which consists of the endomorph component (relative fatness or adiposity), mesomorph component (musculoskeletal component), and ectomorph component (linearity or slenderness), can be used as a guide and determiner for choosing the right type of exercise and training method for athletes. Some studies stated a significant relationship between the type of sport and the somatotype category (Gutnik et al., 2015; Rahmawati et al., 2007). Body type can affect the biomechanics of body movements (Massidda et al., 2013). However, the results for concluding optimal body types in sports, including soccer, are still inconsistent.

A study conducted on 305 Turkish soccer players declared that most Turkish soccer players had body type as balanced mesomorph (Hazir, 2010). Different results were seen in 145 elite soccer players, and the players were ectomorphic mesomorph dominantly (Bidaurrazaga-letona et al., 2016). In West Bengal, India, soccer athletes also had an ectomorphic mesomorph body type (Bandyopadhyay, 2007). While a study of 72 elite professional athletes (equivalent international level athlete) and lower-level athletes (students from Lithuanian Sports University) aged 18-24 years compared somatotypes between soccer (football), basketball, and kayak athletes. In the elite footballer, the mesomorph component was 0 to 4.6. This study showed that non-elite football athletes had a ratio of endomorph-mesomorph-ectomorph of 2.64-3.57-3.00, which was not much different from the somatotype component of elite soccer athletes, with a ratio of 2.41-3.55-3.33, with the dominant component being a mesomorph. When viewed from the overall profile, nonetheless, the majority of football players in this study were ectomorphic, with a percentage of 83.3% (Gutnik et al., 2015).

The differences in somatotype categories can be caused by different medical support and nutrient intake (Hazir, 2010). Good morphological characteristics can be obtained by applying good eating habits combined with physical activity and good exercise and training programs (Da Silva et al., 2011). A study explained that as many as 75% of soccer players consumed fruit daily, but only 18.75% consumed fruit more than once a day. As for vegetable intake, 43.75% of soccer athletes consumed vegetables once a day, and only 18.75% consumed vegetables more than once a day. As many as 31.25% of soccer players visited fast-food restaurants more than once in one week. The study showed that some players had inadequate eating habits. Fulfilling adequate nutritional needs can improve body composition (Hernández-Camacho et al., 2017).

Athletes with anthropometric or somatotype structures and body composition that are proper with their sports accompanied by appropriate dietary management and adequate nutrition fulfillment tend to show better performance (Gutnik et al., 2015; Massidda et al., 2013; Rahmawati et al., 2007). Previous researchers also suggested something similar: adequate nutrition fulfillment improves body composition, but it was also thought to enhance soccer athletes' performance (Hernández-Camacho et al., 2017). Furthermore, optimal cardiorespiratory function, described by Vo_2max measurement, is the key to an athlete's achievement and performance. Cardiorespiratory function explains the athlete's compliance to a load without causing fatigue (Latifah et al., 2019; Putra et al., 2017).

Many talented soccer players are starting to emerge in Indonesia; unfortunately, the players do not have a good understanding of fulfilling nutritional needs related to the formation of body morphology or body type and achieving optimal performance. The study conducted on young soccer athletes in Real Madrid Soccer School and Baturetno Soccer School showed that athletes had poor knowledge about the nutritional and fluid requirement in soccer with scores 56,67 and 50,31 for young soccer athletes in Real Madrid Soccer School and Baturetno Soccer School, respectively (Afriani et al., 2021; Puspaningtyas et al., 2019). Moreover, the athletes had not been able to arrange a diet menu to fulfill their requirements yet. The athletes did not include fruit and vegetable in their diet also did not consume carbohydrates properly (Sari et al., 2018). Studies about dietary intake and the correlation between body type and athletes' performance are essential. With the description of players' body type, dietary intake, and cardiorespiratory function, players and trainers are expected to be able to combine forms of training and fulfillment of nutritional requirements so that the optimal body types contribute positively to the performance and achievements of athletes can be obtained. This study aims to provide an overview of anthropometry, especially body type, description of dietary intake, and description of the performance measured as cardiorespiratory function of college soccer players.

METHODS

This study was a quantitative descriptive study aimed at assessing body type and cardiorespiratory function level and evaluating food intake in college soccer players. The research was conducted in Yogyakarta involving 32 male college soccer players aged 18-22 years, consisting of 20 players from Universitas Negeri Yogyakarta and 12 players from Gadjah Mada University.

Medical and Health Research Ethics Committee (MHREC) of Gadjah Mada University had approved this study, and an ethical clearance number had been obtained before the research was carried out. The ethical clearance number is KE/FK/257/EC. The subject was asked to sign an informed consent. All information and data in this research are confidential and only used for scientific purposes.

Body Type Measurement

Measurement of body type or known as somatotype was done through anthropometric measurements, which included measurement of height, weight, skinfold or subcutaneous fat thickness (including triceps, suprailiac, subscapular, and medial calf), flexed-and-tensed arm circumference, calf circumference, biepicondylar humerus breadths, and biepicondylar femur breadths. All measurements were made three times, except weight only one time. All anthropometric measurements were carried out with minimal clothing. Measurements were made in the morning before the subject got breakfast, and all anthropometric measurements were carried out on the same day. Measurements of skinfold thickness (including bicep, triceps, suprailiac, subscapular, and medial calf), flexed-and-tensed arm circumference, calf circumference, the width of biepicondylar were performed on the right side of the body.

The body weight was measured using a digital scale with an accuracy of 0.1 kg, and height was measured with a microtoice with an accuracy of 0.1 cm. Subcutaneous fat thickness was performed using a skinfold caliper with an accuracy of 0.1 mm. Measurement of flexed-and-tensed arm girth and calf girth was performed using a metline with 0.1 cm accuracy. The width of the biepicondylar humerus and biepicondylar femur was performed using a 0.1 cm accuracy of spreading caliper. All tools used in this study had been calibrated before the study was conducted. After anthropometric measurements, the values of each somatotype component were calculated using the Heath-Carter formula. Somatotype was divided into three components, i.e., endomorph, mesomorph, and ectomorph. The components used in the Heath-Carter formula to determine the somatotype were height, weight, skinfold thickness, flexed-and-tensed arm circumference, calf circumference, and biepicondylar breadths (Carter, 2002; Carter & Heath, 2005).

Endomorph= -0,7182 + 0,1451(X) -0,00068(X^2) + 0,0000014 (X^3). X= (sum of tricep, subscapula and suprailiac thickness) x 170,18/ height (cm). *Mesomorph*= [(0,858 x humerus breadth (cm)) + (0,601 x femur breadth (cm)) + (0,188 x (arm circumference (cm)) – (tricep thickness mm/10) + (0,161 x (calf circumference (cm)) – (calf thickness mm/10) – (0,131 x height (cm)) + 4,5]. *Ectomorph* value was calculated by *height weight ratio* (HWR) (Carter, 2002; Carter & Heath, 2005).

In addition to triceps, suprailiac, subscapular, and calf skinfold thickness, bicep skinfold thickness was also measured to determine body fat percentage. Measurement of body fat percentage was done by calculating body density according to age and sex of the subject using the Durnin-Womersley Body Fat Formula in the first step. Body density in male subjects aged 17-19 years was measured by the formula D=1.1620 - (0.0630xL). While, body density in male subjects aged 20-29 years was measured by the formula D=1.1631 - (0.0632xL) in which D was body density while L was the logarithm of the sum of subcutaneous fat thickness in bicep, triceps, subscapular, and suprailiac (Durnin & Womersley, 1974; Thecalculator.co, 2016). Furthermore, body fat percentage was calculated using the Siri equation, which is %body fat = (495/body density) - 450 (Thecalculator.co, 2016).

Dietary Intake Measurement

Measurement of dietary nutrient intake was carried out using 24 hours of food recall collected three times non-consecutive days. Subjects were asked to remember the amount and type of food and drink consumed during the last 24 hours, from waking up yesterday to waking up the next day. Results from 24 hours of food recalls are compared to the nutritional requirements of the subjects. Energy requirement in student soccer players was calculated individually by considering body weight, height, age, activity level, and type of exercise for each subject (Kementerian Kesehatan RI, 2014). Levels of nutrients adequacy were measured by comparing a result of food consumption to individual requirements. Then, the nutrient adequacy levels were categorized as good if the subject's intake met 80-120% (Dinny, 2019).

Cardiorespiratory Function Measurement

The performance of college soccer players was measured through the cardiorespiratory function, which was described as VO_2max. VO_2max was measured using yo-yo intermittent recovery test level 2. In this measurement, subjects were asked to run rhythmically based on the rhythm of the tape-recorder in which the rhythm gradually increased. VO_2max was described in units of ml/kg/minute. The equation used to calculate VO_2max: VO_2max (ml/kg/minute) = [distance (m) × 0.0136] + 45.3 (Bangsbo et al., 2008).

Statistical Analysis

Data were analyzed by using a descriptive approach and presented in mean values and standard deviations for normally distributed data and median (minimum-maximum) for data that were not normally distributed. Statistical analysis using Pearson correlation was performed to determine the correlation of dietary intake with cardiorespiratory function, and the level of significance used 5%.

RESULTS AND DISCUSSION

This study involved 32 college soccer players with various player positions, and the majority of players were midfielders and defenders (Table 1). Height and weight measurements were carried out on 32 subjects. Next, body mass index (BMI) was calculated by comparing body weight to height (Table 1). Of the 32 subjects involved, it was found that the average BMI of the subjects was 21.54±1.84. One subject (3.1%) was underweight (BMI <18.5 kg/m^2), 30 subjects (93.8%) were categorized as normal with BMI 18.5-25 kg/m^2, and one subject (3.1%) belonged to overweight category (>25 kg/m^2).

Skinfold measurement was performed to estimate body density, which was then used to calculate body fat percentage in college soccer players. Calculation of body density refers to the calculations of Durnin-Womersley based on measurements of subcutaneous fat in the bicep, triceps, subscapular, and suprailiac. After knowing body density, body fat percentage was calculated. It was found that the rate of body fat of college soccer players was 12.27±2.66%, in which the lowest percentage of body fat was 7.67%, and the highest percentage of body fat was 18.22% (Table 1). There were 22 players (68.8%) who had a standard body fat percentage of 6-13%. As many as ten players (31.2%) had a high percentage of body fat (>13%), however. Other anthropometric measurements were flexed-and-tensed upper arm circumference (28.78±2.92 cm) and calf circumference (35.68±2.17 cm), followed by measurements of biepicondylar humerus breadth and biepicondylar femur breadth (Table 1).

Tabel 1. Position and Anthropometric Measurements of College Soccer Players

Position	n (%)
Forwards	4 (12.5)
Midfielders	13 (40.6)
Defenders	14 (43.8)
Goalkeeper	1 (3.1)
Measurements	**Mean±SD**
Body structure	
Height (cm)	167.46±4.90
Weight (kg)	60.47±6.64
BMI (kg/m^2)	21.36 (17.95 – 29.27) *
Subcutaneous fat thickness	
Bicep (mm)	3.38±0.87
Triceps (mm)	8.50±2.33
Subscapular (mm)	9.12±1.93
Suprailiac (mm)	7.67 (4.83 – 19.50) *
Medial calf (mm)	6.59 (4.50 – 12.67) *
Body fat percentage (%)	12.27±2.66
Girths	
Arm girth (cm)	28.78±2.92
Calf girth (cm)	35.68±2.17
Epicondylar Breadths	
Biepicondylar humerus (cm)	6.31±0.52
Biepicondylar femur (cm)	9.25±0.50

* median (minimum – maximum)

Body weight (60.47 kg) and height (167.46 cm) of subjects in this study looked lower than body weight (64.5 kg) and height (172 cm) of athletes assisted by the Indonesia Ministry of Youth and Sports and also lower than professional Turkish Super League soccer players (weight=76.1 kg; height=178.4 cm) (Hazir, 2010; Penggalih et al., 2016). Data on body weight and height were used to calculate body mass index (BMI). Subjects in this study had normal body mass index (21.54 kg/m^2) according to the Indonesia Ministry of Health's BMI cut-off (Iqbal & Puspaningtyas, 2018; Kementrian Kesehatan RI, 2014). This BMI was lower than Indonesian soccer athletes assisted by the Indonesia Ministry of Youth and Sports (21.8 kg/m^2) (Penggalih et al., 2016) and professional Turkish soccer athletes (with BMI ranged 23-24 kg/m^2) (Hazir, 2010). The difference in BMI was possible because the subjects' nutritional intake was lower than the nutritional intake of professional soccer players. The subjects' energy, protein, fat, and carbohydrate intake were 2,429 kcal, 70.40 grams, 68.98 grams, and 386.45 grams, respectively. While, Indonesian soccer athletes handed by the Ministry of Youth and Sports had energy, protein, fat, and carbohydrate intake of 2,502 kcal, 96 grams, 81 grams, and 346 grams (Penggalih et al., 2016).

College soccer players in this study had flexed-and-tensed upper arm circumference and calf circumference, which were almost similar to upper arm circumference and calf circumference of soccer athletes in the Ministry of Youth and Sports. Still, our subjects had smaller bone widths than athletes in the Ministry of Youth and Sports (Penggalih et al., 2016). However, the width of the biepicondylar humerus (6.31 cm) and biepicondylar femur (9.25 cm) of subjects were the same values as the width of biepicondylar humerus (6.90 cm) and biepicondylar femur (9.87 cm) of Turkish professional soccer players (Hazir, 2010) and also with soccer players in West Bengal India with biepicondylar humerus of 6.26 cm and biepicondylar femur of 9.89 cm (Bandyopadhyay, 2007). The game levels and types of exercise are related to athletes' physical characteristics (Hazir, 2010). Types of exercise are thought to contribute to the width of the bone. The more exercises involve upper body movements, the greater upper bone, and muscle mass.

This study carried out skinfold thickness or subcutaneous fat measurements to calculate body fat percentage. Durnin-Womersley Formula used to estimate body fat percentage can be used to determine the percentage of body fat. This formula was developed from a study of 481 men and women ranging in age from 16 to 72 years (Durnin & Womersley, 1974). It was known that the average body fat percentage of student soccer players was 12.27±2.66%. The percentage body fat category of the subjects was still normal (6-13%). Compared to soccer athletes at the Indonesia Ministry of Youth and Sports, the results of this study indicated that subjects had lower skinfold thickness and body fat percentage (Penggalih et al., 2016). This result could be possible because the subject's fat intake was lower compared to the fat intake of soccer athletes in the Indonesia Ministry of Youth and Sports. Fat intake of soccer athletes assisted by the Indonesia Ministry of Youth and Sports was 81 grams (Penggalih et al., 2016), while student soccer players' fat intake was 68.98 grams.

Nonetheless, when compared to elite soccer players, the percentage of body fat of the subjects was still higher. The study of 145 elite soccer players showed body fat percentage for U-11 soccer athletes was 10.50%, U-12 was 9.85%, U-13 was 10.17%, and U-14 was 10.24% (Bidaurrazaga-letona et al., 2016). The differences in in-game levels and types of exercise that professional players and college soccer players own result in body fat percentage differences. Elite soccer players involved in the previous study were athletes who participated in professional soccer clubs (La Liga) (Bidaurrazaga-letona et al., 2016), had a daily soccer training schedule, and played one or two official matches every week (Hazir, 2010). College soccer players in this study had a different training schedule and history of matches participating compared to professional soccer players. College soccer players had other main activities outside of training (such as studying on campus) and had fewer match histories. The previous study suggested that high-fat mass was related to lower exercise (Hazir, 2010).

Percentage of body fat was negatively correlated with an athlete's performance. Normal accumulation of body fat percentage can be a positive indicator of better performance (Saha et al., 2014). Conversely, excessive body fat percentage became a negative factor related to player selection and performance (Bidaurrazaga-letona et al., 2016). Of course, it was not surprising that professional soccer players have better performance indicators than college soccer players considering the percentage of body fat of professional soccer players was more optimal than the percentage of body fat of college soccer players.

Anthropometric measurements were performed to determine college soccer players' body type (somatotype). Somatotype was an anthropometric measurement used to determine body shape and composition. There are three components of somatotype, namely endomorph (relative fatness or adiposity), mesomorph (musculoskeletal component), and ectomorph (linearity or slenderness). The ratio of 0.5 to 2.5 was included in the low category, the ratio of 3-5 is the medium category, the ratio 5.5 to 7 was included in the high category, and the ratio ≥7.5 was very high (Carter, 2002).

Based on the average ratio of players' body type components, the largest component ratio was owned by the mesomorph, which was 4.4±1.1 (medium category), followed equally by the endomorph (2.6±0.7) and ectomorph (2.7±0.8) (Table 2). Most college soccer players in this study had balanced mesomorph body types (2.5-4.6-2.5) (Table 2). Other body types possessed by college soccer players were endomorphic mesomorph (3.4-6.0-1.9) and ectomorphic mesomorph (2.0-4.2-2.9), pursued by mesomorph-ectomorph (1.9-3.5-3.5) and central (2.7-3.5-3.1). Furthermore, there was one player in each body type, i.e., balanced ectomorph (2.0-2.4-5.1), mesomorph-endomorph (4.5-4.9-1.1), mesomorphic endomorph (3.9-3.3-2.6), and mesomorphic ectomorph (2.0-2.8- 3.6) (Table 2).

Tabel 2. Body Types and The Body Type Components of College Soccer Players

Body types	n (%)	Components of body type		
		Endomorph	Mesomorph	Ectomorph
Central	3 (9.4)	2.7±0.3	3.5±0.1	3.1±0.3
Balanced mesomorph	12 (37.5)	2.5±0.3	4.6±0.7	2.5±0.3
Balanced ectomorph	1 (3.1)	2.0	2.4	5.1
Mesomorph-Ectomorph	3 (9.4)	1.9±0.2	3.5±0.1	3.5±0.1
Mesomorph-Endomorph	1 (3.1)	4.5	4.9	1.1
Endomorphic mesomorph	5 (15.6)	3.4±0.2	6.0±1.2	1.9±0.9
Ectomorphic mesomorph	5 (15.6)	2.0±0.3	4.2±0.8	2.9±0.3
Mesomorphic endomorph	1 (3.1)	3.9	3.3	2.6
Mesomorphic ectomorph	1 (3.1)	2.0	2.8	3.6
Total	32 (100)	2.6±0.7	4.4±1.1	2.7±0.8

Overall, it can be said that the subjects in this study had heterogeneous body types, with the majority of subjects having mesomorph body types. These results align with previous studies that stated soccer players had mesomorphic characteristics in general, with the main characteristics being balanced mesomorphs. Somatotype in high-level players was more homogeneous and more mesomorph. Still, somatotype in lower-level players was more heterogeneous, considering the level of games and matches related to athletes' physical characteristics and somatotype (Hazir, 2010).

The majority of college soccer players (37.5%) in this study had balanced mesomorph with an endomorph-mesomorph-ectomorph ratio of 2.5-4.6-2.5, and the average ratio of each component for all subjects was 2.6-4.4-2.7 (Table 2). Balanced mesomorph means mesomorph was more predominantly followed by the same proportion of endomorph and ectomorph; in other words, the muscle component was much larger, followed by proportional fat components and linearity level (Carter, 2002; Carter & Heath, 2005). This study was in line with previous studies which found that somatotype in soccer athletes was balanced mesomorph (Fidelix et al., 2014; Orhan et al., 2010; Penggalih et al., 2016; Rahmawati et al., 2007) with a ratio of 2.6-6.6-2.9 (Penggalih et al., 2016) and the ratio of 2.7-4.9-3.0 (Rahmawati et al., 2007). Turkish Super League professional soccer players also showed the same results, i.e., balanced mesomorph (as many as 38.5%) (Hazir, 2010). The ratio of somatotype (2.5-4.6-2.5) of subjects in this study almost matched the somatotype ratio of Turkish Super League soccer players (2.5-4.8-2.3), Turkish First League soccer players (3.0-4.5-2.6) and Spain soccer players aged 19 years old (2.4-4.3-2.4) (Gil et al., 2010; Hazir, 2010).

Other body types possessed by student soccer players in this study were endomorphic mesomorph (3.4-6.0-1.9) and ectomorphic mesomorph (2.0-4.2-2.9). Subsequently, it was followed by mesomorph-ectomorph (1.9-3.5-3.5) and central (2.7-3.5-3.1). There was one player in each body type, such as balanced ectomorph (2.0-2.4-5.1), mesomorph-endomorph (4.5-4.9-1.1), mesomorphic endomorph (3.9-3.3-2.6), and mesomorphic ectomorph (2.0-2.8-3.6). The body type of the subject of this study was almost the same as the body type of male Turkish soccer players, which was more mesomorphic and less endomorphic, less ectomorphic (Hazir, 2010). Likewise, several other studies stated mesomorph was dominant in soccer athletes (Fidelix et al., 2014; Hazir, 2010; Orhan et al., 2010; Penggalih et al., 2016; Rahmawati et al., 2007).

The mesomorphic component described the coherence relationship of fat-free mass and height, while the endomorphic component showed the relationship between body weight and body fat. It can be concluded that body types with high muscle mass can benefit athletes, especially in high-intensity sports and intermittent activities, such as soccer (Hazir, 2010; Silvestre et al., 2006). Also, body types with mesomorph components can be used to predict athletes' sports abilities (Gutnik et al., 2015). It was due to the mesomorphic component describing skeletal muscle mass in the human body (Fidelix et al., 2014; Hazir, 2010; Orhan et al., 2010; Penggalih et al., 2016; Rahmawati et al., 2007).

Furthermore, the nutrients measured in this study were energy, protein, fat, and carbohydrate. Dietary intake was measured by using a 24-hour food recall form. The subjects' energy, protein, fat, and carbohydrate intake were 2,429 kcal, 70.40 grams, 68.98 grams, and 386.45 grams, respectively. This study also measured the nutrient requirements of athletes. College soccer players' average energy, protein, fat, and carbohydrate requirements were calculated individually by considering weight, height, age, activity level, and type of exercise were 3,001.12 kcal, 90.03 grams, 100.04 grams, and 435.16 grams, respectively. After being compared with the requirements, the average intake of energy (81.39%) and carbohydrate (89.39%) of college soccer players were in a good category, while the protein intake (78.40%) of subjects was in the mild deficit category, and fat intake (69.26%) was in the moderate deficit category.

More than 50% of subjects had deficit protein and fat intake. Furthermore, only a portion of subjects had energy and carbohydrate intake in the good category. Almost 10% of subjects had carbohydrate intake in high categories (Table 3). Excessive carbohydrate intake was obtained from the intake of sugary beverages and sugary foods usually consumed by the subject. Based on the interviews, as many as 5-10% of subjects visited street food stalls (angkringan) and chose sugary drinks such as ice tea, ice orange, ice milk as drink choices and ate leaves-wrapped rice containing sambal tempeh or sambal anchovies (nasi kucing).

The adequate food intake the subject had, the better percentage of nutrients fulfillment. Based on the comparison of the nutrient intake to the nutritional requirements of the subject, good energy intake (2,814.05 kcal) fulfilled 93.77% of energy requirement, good protein intake (87.01 grams) met 96.65% of protein requirement, good fat intake (91.74 grams) kept 91.70% of the fat requirement, and adequate carbohydrate intake (433.58 grams) fulfilled 99.64% of carbohydrate requirement (Table 3).

Tabel 3. Dietary Intake Categories of College Soccer Players

Nutrient's intake categories	Energy		Protein		Fat		Carbohydrate	
	n (%)	Mean±SD	n (%)	Mean±SD	n (%)	Mean±SD	n (%)	Mean±SD
Deficit	15 (46.9)	1,924.12±348.32	17 (53.1)	53.88±11.41	23 (71.9)	56.29±15.08	12 (37.5)	272.26±49.30
Good	16 (50)	2,814.05±328.58	14 (43.8)	87.01±9.55	8 (25)	91.74±11.94	17 (53.1)	433.58±35.40
Over	1 (3.1)	3,844.90	1 (3.1)	118.40	1 (3.1)	178.70	3 (9.4)	576.17±42.47

Subjects with dominant mesomorph components had higher energy intake than subjects with prevalent body types of ectomorph components. It was seen in subjects with balanced mesomorph (2,623.83 kcal), endomorphic mesomorph (2,387.43 kcal), ectomorphic mesomorph (2,724.68 kcal), and mesomorphic endomorph (2,944.30 kcal) having higher energy intake than subjects with mesomorph-ectomorph (2,069.93 kcal), mesomorphic ectomorph (1,524.30 kcal). The lowest energy intake was possessed by the subject with mesomorph-endomorph (1,518.20 kcal), while the highest energy intake was owned by the subject with mesomorphic endomorph (2,944.30 kcal) (Table 4).

Similar results were seen in the subject's protein intake. Overall, subjects with mesomorph body types had protein intake close to a hundred percent requirement. The highest protein intake was possessed by the subject with mesomorphic endomorph (95.30 grams), while the lowest protein intake was possessed by the subject with mesomorphic ectomorph (43.40 grams) (Table 4). The lowest fat intake was owned by subject with mesomorphic ectomorph (26.80 gram), but the highest fat intake was owned by the subject with mesomorphic endomorph (88.90 grams). Subjects with balanced ectomorph had the highest carbohydrate intake (445.40 grams), whereas subjects with mesomorph-endomorph had the lowest carbohydrate intake (207.70 grams) (Table 4).

Subjects with dominant endomorph components had greater energy intake than subjects with other body types. Also, this subject had a higher protein intake than protein requirement—furthermore, the unique results obtained from this study. One subject with mesomorph-endomorph (muscular and fat components) had inadequate energy, protein, fat, and carbohydrate intake (Table 4).

The subject's average cardiorespiratory function (VO_2max) was 50.96 ml/kg/minute. Players with mesomorph body components had VO_2max above 50 ml/kg/minute. The highest fitness level (52.37 ml/kg/minute) was owned by subjects with ectomorphic mesomorph (subjects with dominant musculoskeletal component followed by the linearity component). Subjects with the highest cardiorespiratory function had good nutritional intake and were sufficient to fulfill their nutrients requirement. On the other hand, college soccer players with balanced ectomorph, mesomorph-endomorph, mesomorphic endomorph, and mesomorphic ectomorph had VO_2max less than 50 ml/kg/minute. Subjects with balanced ectomorph and mesomorph-endomorph possessed the lowest VO2max, in which subjects with balanced ectomorph tended to have lean or small body shapes. In contrast, subjects with mesomorph-endomorph had inadequate nutrient intake (Table 4). There was a weak positive linear correlation between energy intake and carbohydrate intake with cardiorespiratory function with r = 0,427 and p = 0,015 for energy intake and r = 0,433 and p = 0,013 for carbohydrate intake (Table 5).

Tabel 4. Dietary Intake and Cardiorespiratory Function Based on Body Types of College Soccer Players

Body types	n (%)	Dietary intake				Cardiorespiratory function (VO_2max) (ml/kg/minute)
		Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	
Central	3 (9.4)	1,881.83±607.06	58.67±24.67	48.33±12.50	302.61±100.98	50.38±0.83
Balanced mesomorph	12 (37.5)	2,623.83±590.27	75.82±16.24	75.5±37.63	419.27±100.54	51.46±1.53
Balanced ectomorph	1 (3.1)	2,842.80	87.90	74.30	445.40	48.56
Mesomorph-Ectomorph	3 (9.4)	2,069.93±583.95	52.43±19.64	58.67±27.47	331.73±80.02	50.74±0.94
Mesomorph-Endomorph	1 (3.1)	1,518.20	46.40	57.10	207.70	48.56
Endomorphic mesomorph	5 (15.6)	2,387.43±404.74	62.47±9.51	66.33±11.97	390.29±84.66	50.42±0.99
Ectomorphic mesomorph	5 (15.6)	2,724.68±578.94	84.83±29.59	80.30±26.39	425.17±138.90	52.37±2.61
Mesomorphic endomorph	1 (3.1)	2,944.30	95.30	88.90	434.10	49.11
Mesomorphic ectomorph	1 (3.1)	1,524.30	43.40	26.80	267.70	49.65
Total	32 (100)	2,429.11±609.56	70.40±21.31	68.98±28.90	386.45±106.65	50.96±1.72

Tabel 5. Correlation Between Dietary Intake with Cardiorespiratory Function of College Soccer Players

Variable	r	p
Energy	0,427	0,015*
Protein	0,290	0,107
Fat	0,286	0,113
Carbohydrate	0,433	0,013*

*Significant (p<0,05)

There was a significant correlation between body composition and physical performance, in this case, VO_2max. Body composition with excess fat components negatively correlated with VO_2max (Gil et al., 2007; Silvestre et al., 2006). Athletes with a good body fat percentage had good VO_2max. This study indicated that student soccer players had an average rate of body fat of 12.27% with an average VO_2max of 50.96 ml/kg/minute. Besides, players with mesomorph body components had VO_2max above 50 ml/kg/minute, which was parallel to the lowest VO_2max cut-off for elite soccer players. VO_2max was assessed on a laboratory test to measure aerobic capacity in elite soccer players ranging from 50-80 ml/kg/minute (Haugen & Seiler, 2015). A study stated athletes with dominant mesomorph body types (balanced mesomorph and ectomorphic mesomorph) had VO_2max in the excellent category (51.1-54.0 ml/kg/minute), while athletes with other body types had VO_2max in the good category (45.6-48.5 ml/kg/minute) (Firstbeat Technologies Ltd., 2014). In line with previous studies, subjects with body type relative fatness, in this case, mesomorphic endomorph, had lower VO_2max (49.11 ml/kg/minute) than subjects with dominant mesomorph body type (>50 ml/kg/minute).

In addition to body type, dietary intake also plays an essential role in improving the performance of soccer players (Hernández-Camacho et al., 2017). Energy requirements in college soccer players were calculated individually by considering each subject's weight, height, age, and activity. First, basal energy needs were carried out using the Harris-Benedict equation with the correction of sex, weight, height, and age. Furthermore, the correction of specific dynamic action was carried out by 10%. Total energy was calculated by correcting physical activity, both daily activities and exercise. The protein, fat, and carbohydrates requirements were calculated at 12%, 30%, and 58% of the total energy requirements. The carbohydrate, fat, and protein requirements for sports such as soccer are 50-60%, 30-35%, and 12-15% (Kementerian Kesehatan RI, 2014).

Based on the calculations, energy, protein, fat, and carbohydrate requirements were 3,001.12 kcal, 90.03 grams, 100.04 grams, and 435.16 grams, respectively. The percentage of nutritional fulfillment was calculated by comparing nutrient intake to dietary requirements. Percentage of the fulfillment of energy, protein, fat, and carbohydrate requirements for college soccer players was 81.39%, 78.4%, 69.26%, and 89.39%. Dietary intake, which in the good category, was energy intake and carbohydrate intake. While protein intake was included in mild deficits, and fat intake was a moderate deficit. This result was slightly different when compared to the previous study. A study of 14 soccer athletes at Wisma Atlet Ragunan, Jakarta, under the Ministry of Youth and Sports indicated that the percentage of nutrient fulfillment of energy, protein, fat, and carbohydrate requirement was 95% (adequate), 97% (adequate), 137 % (over) and 81% (adequate) (Penggalih et al., 2016). The previous study used 15%, 20%, and 65% of the total energy requirement to calculate protein, fat, and carbohydrates requirements. This study used 12%, 30%, and 58% of the total needs for calculating protein, fat, and carbohydrate requirements. This calculation difference caused the difference in nutrient fulfillment percentage between the subjects and soccer athletes at Wisma Atlet Ragunan.

Moreover, when viewed in terms of quantity, energy intake (2,429 kcal), protein intake (70.40 grams), and fat intake (68.98 grams) of subjects were lower than energy intake (2,502 kcal), protein intake (96 grams), and fat intake (81 grams) of soccer athletes assisted by the Ministry of Youth and Sports. However, the amount of carbohydrate intake (386.45 grams) in college soccer players was higher than the carbohydrate intake (346 grams) of soccer athletes handed by the Ministry of Youth and Sports (Penggalih et al., 2016). This intake difference possibility resulted from the different types of food consumed by the players. The higher carbohydrate intake of the subject was obtained from the intake of sugary beverages and sugary foods that were usually consumed by the subject. Based on the interviews, as many as 5-10% of the subjects visited street food stalls (angkringan) and chose drinks such as ice tea, ice orange, ice milk, and ate leaves-wrapped rice containing sambal tempeh or sambal anchovies (nasi kucing). Furthermore, the subject's protein intake came from animal protein consumption (the majority were eggs followed by chicken, and rarely fish or meat) and consumption of vegetable protein (the majority was tempeh). It was suspected that soccer athletes under the Ministry of Youth and Sports consumed more varied foods and ate more in amount.

In this study, subjects with the highest cardiorespiratory function or VO_2max had good nutritional intake and were sufficient to fulfill their needs. Meanwhile, the lowest VO_2max was owned by subjects with balanced ectomorph and mesomorph-endomorph, in which subjects with balanced ectomorph tend to have slim or small body shapes. In contrast, subjects with mesomorph-endomorph had very low nutrient intake. VO_2max, commonly called aerobic fitness, was a person's ability to carry out physical activities that are dynamic, moderate to high intensity, with several muscle actions in a certain time. It illustrates the cardiorespiratory and muscular system's ability to distribute and use oxygen. Each 3.5 ml/kg/minute was defined as 1 kcal/kg/hour or 1 MET (Firstbeat Technologies Ltd., 2014). Therefore, the higher value of one's VO_2max, the more energy sources are used to produce energy so that adequate intake was needed to restore the body's energy reserves.

VO_2max was influenced by physical activity, body fat percentage, intake of energy, protein, fat, and carbohydrate. Other factors were positively correlated to VO_2max, except the percentage of body fat, which was negatively correlated. There was a relationship between macronutrient intake and athlete performance, one of which was cardiorespiratory function (Cao et al., 2012; Salarkia et al., 2004). This study showed a correlation between dietary intake, especially energy and carbohydrate intake, with cardiorespiratory function. Carbohydrates act as the primary energy source for the body, both under aerobic and anaerobic conditions. Adequate carbohydrate consumption will ensure the availability of muscle and liver glycogen reserves (Puspaningtyas et al., 2015). Another study proved a relationship between food intake (carbohydrate, protein, fat) and body composition, especially BMI and body fat percentage. More importantly, there was an increase in VO_2max when there was a decrease in subcutaneous fat thickness affected by fat intake (Salarkia et al., 2004). Protein intake correlates with the value of VO_2max, presumably because protein plays a role in hemoglobin formation (Putri & Fatmah, 2016). Besides, protein also plays a role in the formation of muscle mass (Kementerian Kesehatan RI, 2014). A study indicated that VO_2max improvement through proper dietary management, exercise program, technique, skills education, and body formation could affect the maximum physical capacity of the athlete (Salarkia et al., 2004).

Some research conducted on athletes showed a relationship between nutrient intake and athlete performance. The study conducted on 33 soccer players at Club Guntur FC and HW UMY showed that athletes' VO_2max was 48.36 ml/kg/minute, where only seven players had a fitness level in a good category with VO_2max of 52.71 ml/kg/minute. As many as 26 players had poor fitness levels with VO_2max of 47.18 ml/kg/minute. Furthermore, 22 subjects had an energy intake (1,907.75 kcal) with an inadequate category. Of the 22 subjects with poor energy intake, there were 18 athletes with poor fitness levels (Desiplia et al., 2018).

Another study conducted on 48 college soccer players of Lampung State University showed that the average VO_2max score of 48 soccer players was 47.40 ml/kg/minute with the intake of energy, protein, fat, and carbohydrate was 1,921.7 kcal, 68.32 grams, 32.87 grams, and 266.6 grams. This VO_2max score falls under the VO_2max cut-off for elite soccer players. Several things were correlated to VO_2max, such as percentage of body fat, energy intake, protein intake, fat intake, and carbohydrate intake. Body fat percentage was negatively correlated with cardiorespiratory function, whereas food intake was positively associated with the cardiorespiratory function (Irdilla et al., 2016). Low food intake contributes to the low performance of athletes.

CONCLUSION

The body types of college soccer players were heterogeneous, with the majority of them having balanced mesomorph. College soccer players' energy and carbohydrate intake were included in the good category, while protein and fat intake were included in the deficit category. The cardiorespiratory function of college soccer players was good. The highest cardiorespiratory function was possessed by subjects with ectomorphic mesomorph (subjects with dominant musculoskeletal component followed by linearity component). Subjects with the highest cardiorespiratory function had good nutritional intake and were sufficient to fulfill the dietary requirements. The lowest cardiorespiratory function was owned by subjects with balanced ectomorph and mesomorph-endomorph, in which subjects with balanced ectomorph tend to have slim or small body shapes. Subjects with mesomorph-endomorph had very low nutrient intake. College soccer players with mesomorph body types supported by adequate nutrient intake owned optimum VO_2max levels. This study showed a correlation between dietary intake, especially energy and carbohydrate, with cardiorespiratory function. With this study, players and trainers are expected to be able to combine forms of training and fulfillment of nutritional requirements so that the optimal performance and achievements of athletes can be obtained.

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Limitations

This study has limitations, such as the research being only carried out in college soccer players. The study results will be better compared to professional soccer players. Also, the study needs to be conducted with more subjects to be carried out based on the position of the athlete's players. Another limitation of this study was that the study was conducted only in the form of a survey and was not longitudinal. It would be better if the study were done longitudinal to observe the effects of the environment on the possibility of body type changes, nutrient intake, and cardiorespiratory function.

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