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The Relationship between Body Composition and Anaerobic Capacity of Female Futsal Players

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Abstract

Measurement of Body Composition (BC) is carried out for various purposes, such as uniting the growth and development of athletes and determining motor performance, physical activity, changes in body composition, as well as nutritional interventions. This study aimed to determine the relationship between Body Composition (BC) and anaerobic ability of female futsal players aged 17-19 years. Twenty female futsal players participated in this study. Muscle mass, Body Mass Index (BMI), Body Fat Percentage, Water Percentage, Protein Percentage, Basal Metabolism, Visceral Fat, and Bone Mass were measured to determine the fat percentage of bone, air, and muscle in the body. Measurement of body composition was also intended to detect the food intake needed by the body and obtain information relevant to disease prevention and treatment. The Running Based Anaerobic Sprint Test (RAST) was conducted to measure the anaerobic endurance. The research method used was a descriptive correlation with a quantitative approach. The finding showed no correlation between Running Based Anaerobic Sprint and Body Fat Percentage, Water Percentage, Protein Percentage, Basal Metabolism, and Visceral Fat. However, there was a positive relationship between Muscle Mass, Body Mass Index (BMI), Bone Mass of the samples, and their Running Based Anaerobic Sprint ($p<0.05$). It concludes that the score of Muscle mass, Body Mass Index (BMI), and Bone Mass affected the anaerobic capacity of female futsal players aged 17-19 years. The normal status of body composition and body fat percentage can be maintained through maintaining consumption patterns and increasing physical activity.

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INTRODUCTION

The characteristic of Human Body Composition is a part of the biological variables associated with sports performances. Therefore, Human Body Composition becomes an essential factor in determining sports achievements (Sundgot-Borgen & Garthe, 2011). It is also one of the ways to detect the sports talents of prospective athletes in the future (Berzosa et al., 2011; Matic et al., 2013). It is because somatotype is associated with motor efficiency (Marta et al., 2013). The recently identified differences in age, height, body mass and body mass index of elite athletes from various playing positions suggest that a match's physical and technical demands vary for different positions (Gomes et al., 2006; Bloomfield, 2007). Therefore, it suggests that anaerobic performance and performing high-intensity movements are important in this type of sport (Dellal et al., 2011; Iaia et al., 2009).

The anaerobic performance consists of anaerobic power and capacity. Anaerobic power reflects the ability to use the phosphagen system, while anaerobic capacity reflects the ability to obtain energy from a combination of anaerobic glycolysis and the phosphagen system. Anaerobic performance depends on many factors, such as body composition, age, gender, muscle fiber composition, muscle cross-sectional area, strength, and exercise (Kin-Isler et al., 2008).

Body composition (body size and somatotype) is another factor generally believed to significantly influence sports performance (Gomes et al., 2005; Reilly et al., 2000). In particular, body fat and fat-free mass have been recognized as essential components of anaerobic performance (Mayhew et al., 2001) and sprint performance (Dowson et al., 1998; Young et al., 1995). For example, Mayhew et al. (2001) argue that body composition components become the main factors explaining anaerobic power and sprint performance (Stray-gundersen et al., 2012). Sprint performance is another fundamental activity for many sports and consists of several components, such as start, acceleration, and maximum speed phases. Running also requires a high energy production (Mero et al., 1992).

Previous research had identified the ability to produce leg strength as a key component of sprinting (Kin-Isler et al., 2008). However, this study only used the Running-Based Anaerobic Sprint Test (RAST) protocol, ignoring the specific repetitive effort requirement according to the sprint sports characteristics. In addition, the relationship between anaerobic capacity and repeated sprint ability receives only a little attention (Kin-Isler et al., 2008).

In addition, certain sports have specific player characteristics in team sports (Pantelis Theodoros Nikolaidis & Karydis, 2011). One of the problems in training and nutrition in futsal is optimizing body mass. The assessment method for monitoring body mass status is the Body Mass Index (BMI) as part of the Body Composition test, used to categorize humans as underweight, normal weight, overweight, and obese for health purposes. BMI is included in several physical fitness batteries given to futsal players (Dias et al., 2007; Peixoto et al., 2022). However, the relationship between BMI and other physical fitness components has not been studied. In addition, research has found that the overweight prevalence in team sports, such as soccer, can vary by age (for example, the lower prevalence in older age groups) (Nikolaïdis, 2012). However, the research did not discuss Body Composition in a more specific anaerobic capacity. Therefore, it was still in the physical fitness stage.

Although the research as mentioned earlier improves our understanding of the relationship between anthropometry and physical fitness in various team sports (Nikolaïdis, 2012; Nikolaidis & Ingebrigtsen, 2013), this topic has not been studied in futsal. However, given the popularity of futsal, this information would have practical application for practitioners working with futsal players (such as coaches and fitness coaches). Furthermore, it should be underlined that physical fitness components, such as aerobic capacity and sprinting, have been identified to differentiate futsal players from different levels of competition (Ayarra et al., 2018). Therefore, this study aimed to determine the relationship between Body Composition (BC) and anaerobic capacity of female futsal players aged 17-19 years.

METHODS

Participants

Twenty female futsal players participated in this study voluntarily. The means of age, body mass, and body fat were 17.8 ± 0.79 years, 53.16 ± 7.04 kg, and 24.23 ± 8.58%, respectively. The average subject training experience was 3.3 ± 2.9 years. Subjects were informed about the possible risks and benefits of the study and gave consent to participate in the study.

Instrument and Procedure

In this study, two measurements were taken, including the measurement of human body composition and aerobic capacity. Human body composition was measured using Mi Body Composition Scale 2 with the following specifications, 1) Model: XMTZC05HM, 2) Type: Intelligent Body Fat Scale, 3) Function: Basal Metabolic Rate, BMI, Body Fat Percentage, Bone Mass, Moisture, Muscle Mass, Physical Age, Portable, Protein, Visceral Fat, Weight, 4) Feature: High-precision compatible with Android and IOS, 5) Glass Material: Tempered Glass, 6) Body Material: ABS, 7) Weight Range: 100g – 150kg, 8) Power Supply: 4 x 1.5V AAA Battery, 9) Product Weight: 1.7000 kg, 10) Product Dimension: 30.00 x 30.50 x 2.50 cm.

BMI score consists of low/normal /increased/high/ very high scales. Body fat percentage is expressed in the ideal range for the height and age of female futsal players, with the reduction in kg/lb as the target. Water percentage is the value plotted on scales, including insufficient/normal/great scales. Protein percentage is the stated value plotted on scales, including insufficient/ normal/good along with some usual dietary advice. Basal Metabolism is the estimated calories the body needs each day. Visceral fat is usually the value plotted on the graph. Muscle mass is the weight value plotted on scales involving insufficient/normal/great scales. Bone mass is to estimate the amount of phosphorus, calcium, and other compounds in the bone, provided with advice on how to improve the rankings. Other indicators included body age, ideal weight, and body type shown in the matrix based on body fat to muscle ratio.

In the Anaerobic Capacity Measurement developed in the late 1990s, the Running-Based Anaerobic Sprint Test (RAST) was designed to measure anaerobic power and capacity. It is a simple test requiring feasible equipment and demonstrating a significant test validity and reliability. Many of these test results can be used and developed; thus, it has become a good choice for strength and conditioning coaches and exercise scientists. Developed in the UK in 1997 by Draper and Whyte (Queiroga et al., 2013) at the University of Wolverhampton, the Running-Based Anaerobic Sprint Test (RAST) is a testing protocol designed to measure anaerobic power and capacity (Zagatto et al., 2009). The test involves six repetitions of sprints over a 35-meter distance, with a 10-second recovery time between each sprint repetition.

Table 1. Muscle Criteria

Criteria	Value
Insufficient	38,50 ≤
Normal	38,51—46,60
Great	≥46,61

*source criteria from the Mi body composition scale two application

Table 2. BMI Criteria

Criteria	Value
Low	18,5≤
Normal	18,6—25,0
Increased	25,1—28,0
High	28,1≥31,9
Very High	≥32,0

*source criteria from the Mi body composition scale two application

Table 3. Body Fat Criteria

Criteria	Value
Very Low	11,0%≤
Low	11,1%—17,0%
Normal	17,1%—22,0%
Increased	22,1%—27,0%
High	≥27,1%

*source criteria from the Mi body composition scale two application

Table 4. Water Criteria

Criteria	Value
Insufficient	55,0≤
Normal	55,10—65,1
Great	≥ 65,2

*source criteria from the Mi body composition scale two application

Table 5. Protein Criteria

Criteria	Value
Insufficient	16,0%
Normal	16,1%—20,0%
Good	≥20,1%

*source criteria from the Mi body composition scale two application

Table 6. Basal Metabolism Criteria

Criteria	Value
Criteria	kcal
Did not reach goals	1112 kcal≤
Reached goal	≥1113 kcal

*source criteria from the Mi body composition scale two application

Table 7. Visceral Fat Criteria

Criteria	Value
Normal	10,0≤
High	10,1-15,0
Very High	≥15,1

*source criteria from the Mi body composition scale two application

Table 8. Bone Mass Criteria

Criteria	Value
Insufficient	1,60≤
Normal	1,61—3,90
Great	≥3,91

*source criteria from the Mi body composition scale two application

Due to its accuracy and simplicity as a test, sports professionals commonly use RAST to monitor performance. It is important to understand that whenever fitness testing is carried out, it must be carried out in a consistent environment so that it is suitable for various types of weather, provided with a reliable surface that is not affected by wet or slippery conditions. If the environment is inconsistent, the reliability of the repeated test at a later date can be severely hampered, which would result in worthless data. If an automated digital tool is not available, the test administrator must record the duration of each sprint to the nearest hundredth of a second. This sprint time and body mass are then used to calculate the anaerobic capacity and power output.

The test was only carried out once in this study without any prior treatment. The samples carried out the test in the morning assumed that the sample had not carried out their daily activities, affecting the study. All samples carried out the test alternately, starting with the human body composition test using Mi Body Composition Scale 2. The results of the test were recorded. After all, samples had been tested, anaerobic capacity measurement using the Running-Based Anaerobic Sprint Test (RAST) was conducted without any rest breaks because it was not a medium to high-intensity activity. The second test was conducted individually by the tester. The samples performed the test involving six sprint repetitions at a 35-meter distance. The researcher recorded the travel time, with a 10-second recovery time between each sprint repetition. The data were processed in the testing calculator. The anaerobic capacity score was then taken. Finally, the test data were analyzed through statistical tests.

Data Analysis

Data were reported in mean and standard deviation. Before using the parametric test, the assumption of normality was verified using the Shapiro-Wilk test. Pearson Product Moment Correlation analysis evaluated the relationship between body composition and anaerobic capacity. All analyzes were administered in SPSS for Windows version 25. The statistical significance was set at $p < 0.05$.

RESULT

The body composition and anaerobic capacity of female futsal players are shown in Table 9 and Table 10. Table 9 shows that body value is an evaluation of overall body composition with a mean of 78.27. Meanwhile, bodyweight estimates overall body mass, where the average female futsal player's body weight was 53.16 kg. In addition, the samples' body mass index (BMI), as a measure of body fat based on the ratio of height to weight, was 20.68, meaning that they were in the normal category. The arrangement of muscle, as the weight of the muscles in the body, showed that the overall muscle mass of female futsal players was 37.77 kg, meaning that they were in the insufficient category. The body fat, as the actual weight of fat in the body, was 24, 23% on an average, indicating that they were included in the increased category.

The water content, as the total amount of fluid in the body expressed in an average percentage, was 52.93%, meaning that it was included in the insufficient category. The protein content in the body, as an important food substance in the body, gained 18,88% on average, showing that it was in the normal category. Basal metabolism, as the minimum energy level needed to maintain body functions at rest, was 1214.47 on average. The visceral fat of female futsal players, as fat content far below the core abdominal area around the organ, was 2.60 on average, meaning that it was included in the normal category. The average bone mass was 2.29 for female futsal players, indicating that it was in the normal category. Therefore, on average, female futsal players had a balanced body type.

Table 10 shows that the maximum power, as a measure of the highest power output providing information about the average maximum power and sprint speed for female futsal players, was 320.12 watts, while the minimum power, as the lowest power output achieved in six 35-meter sprints and used to calculate Fatigue index in female futsal players, was 200.63 watts. The average power indicates the athlete's ability to maintain power over time, showing that the higher the score, the higher the athlete's ability to maintain anaerobic performance. The average power of the female futsal player was 253.79 watts. The fatigue index, showing the level of power reduction in female futsal players, was 15.2. Therefore, it fell on a high fatigue index value (>10), indicating that female futsal players might need to focus on increasing lactate tolerance.

Table 9. Body composition and characteristics of female futsal players aged 17-19 years (mean ± sd)

Women Futsal Players (n=20)	Body Value	Body Weight (Kg)	Muscle (Kg)	BMI (score)	Body Fat (%)	Water (%)	Protein (%)	Basal Metabolism	Visceral Fat	Bone Mass
	78.27 ±8.36	53.16 ±7.04	37.77 ±4.84	20.68 ±2.84	24.23 ±8.58	52.93 ±5.42	18.88 ±3.13	1214.47 ±61.01	2.60 ±1.84	2.29 ±0.32

Table 10 . Anaerobic capacity for female futsal players aged 17-19 years (mean ± sd)

Women Futsal Players (n=20)	Power Time 1 (watt)	Power Time 2 (watt)	Power Time 3 (watt)	Power Time 4 (watt)	Power Time 5 (watt)	Power Time 6 (watt)	Minimum Power (watt)	Maximum Power (watt)	Average Power (watt)	Total Power (watt)	Fatigue Index (value)
	311.01 ±46.64	285.17 ±51.65	260.41 ±38.88	244.49 ±58.96	215.96 ±42.59	205.70 ±39.35	200.63 ±35.48	320.12 ±52.04	253.79 ±36.77	1522.74 ±220.64	15.2 ±2.4

Table 11 . Correlations between body composition and anaerobic capacity in female futsal players aged 17-19 years (mean ± sd)

	Muscle (Kg)	BMI (score)	Body Fat (%)	Water (%)	Protein (%)	Basal Metabolism	Visceral Fat	Bone Mass
Anaerobic Capacity	0.756*	0.613*	NS	NS	NS	NS	NS	0.649*

The correlation between body composition, anaerobic performance, and sprints is presented in Table 11. As shown in Table 11, there was no correlation between Running Based Anaerobic Sprint and Body Fat percentage, Water percentage, Protein percentage, Basal Metabolism, and Visceral Fat. However, there was a positive relationship between Running Based Anaerobic Sprint and Muscle mass, Body Mass Index (BMI) score, and Bone Mass (p<0.05).

DISCUSSION

The The main finding of this study showed that there was no correlation between Running Based Anaerobic Sprint and Body Fat percentage, Water percentage, Protein percentage, Basal Metabolism, and Visceral Fat. However, there was a positive relationship between Running Based Anaerobic Sprint and Muscle mass, Body Mass Index (BMI), and Bone Mass (p<0.05). It is well known that muscle strength is one of the important factors playing a major role in anaerobic and sprint performance. This is because the increased muscle strength would affect the muscle's ability to produce power in the short term for high-intensity activities (10, 20, and 30-meter sprints).

These results are in line with the results of previous studies. Several studies have examined the relationship between the ability ff walking sprint and muscle strength (Moirenfeld et al., 2000). From the research results, the relationship between muscle strength and vertical jump performance (CMJ and SJ) was found by different authors (Atabek et al., 2009; Paasuke M, Ereline J, 2001; Tsiokanos et al., 2002). Furthermore, (Tharp et al., 1985) found a significantly strong correlation between isokinetic knee strength and the strength and anaerobic capacity of female runners and female middle-distance runners. This implies that strength plays a significant role in high-intensity activities (especially running and jumping). On the other hand, there was no correlation between anaerobic capacity and body fat, water, protein, basal metabolism, and visceral fat; there was a weak relationship in performance rankings which might be caused by different types of exercise (Hoffman et al., 2000).

CONCLUSION

The study's findings concluded that muscle mass, Body Mass Index (BMI), and bone mass scores affected the anaerobic capacity of female futsal players aged 17-19 years. Future research suggests examining more senior female futsal players or elite athletes to complete the knowledge and data needed.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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