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ORIGINAL RESEARCH

The examination of the relationship between body composition and acceleration

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Abstract

The aim of this study is to investigate the effect of body composition on acceleration. A total of 63 men, who are recreationally active and part of different sports branches (soccer, judo, basketball, tennis, taekwondo, and athletics), participated in the research voluntarily. Some of the participants' characteristics were measured respectively including mean age (20.52±1.635 years), mean body height (179.25±7.121 cm), mean body weight (72.44±10.066 kg), and mean sports age (6.90±3.125 years). Data were collected through using a 3-door photocell, a measuring tape, and a Skinfold caliper. When the results were examined, mean body mass index (BMI=22.498±2.217 kg/m2), mean skinfold measurements (SM=8.34±2.975 mm), mean body circumference measurements (BCM=71.76±4.581 cm), mean body fat % (19.277±4.731), mean 10 m acceleration (1.74±0.096 sec) and mean 15 m acceleration (2.40±0.171 sec). It was concluded that one unit change in body fat percentage (BF%) affects 10 m acceleration performance at the rate of 0.006, while one unit change in BF% affects 15 m acceleration performance at the rate of 0.01. It was observed that the SM affected the acceleration performance of 10 m at the rate of 0.008, while it affected the acceleration performance of 15 m at the rate of 0.017. Additionally, it was determined that BMI affects 15 m acceleration performance at the rate of 0.19. In addition, the body fat percentage explains the 10 m acceleration performance by 9.4% ($p<0.05$), while the 15 m acceleration performance explains 7.7% ($p<0.05$). While the skinfold thickness explains the acceleration performance of 10 m by 7.5% ($p<0.05$), it explains the acceleration performance of 15 m by 8.3% ($p<0.05$). It was determined that the body mass index explained the 15 m acceleration performance by 6.3% ($p<0.05$). In conclusion, body composition has been found to affect acceleration performance. Moreover, as the running distance increases, the effect level of body composition also increases.

Keywords: Acceleration, body fat percentage, body mass index.

Introduction

Body composition is used to describe the body parts that form body weight. The human body consists of different tissues. The main components are musculoskeletal system, limbs, essential fatty tissue, and adipose tissues. The ratio of the musculoskeletal system and adipose tissue has a considerable place for sports branches (Lukaski, 2003). The main reason for the change in body composition is the changes in muscle and fat mass (Sun et al., 2003). Body composition is divided into two subcategories; fat mass and lean mass. While lean mass consists of muscle, bone and water, fat mass comprises of essential and non-essential fat stores. Essential fat tissue, which is used as an energy source and stored as fat, is found in the central nervous system,

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heart, lungs, liver, spleen, kidneys, muscles and bone marrow. Non-essential fat stores are used for energy and to protect the body during hunger. On the other hand, non-essential fat, known as tallow, found in the whole body around the organs and under the skin (Mahan et al., 2012). Since the measurements with skinfold demonstrate the amount of subcutaneous fat, the total amount of fat in the body has a significant relationship with the amount of subcutaneous fat (Gomes et al., 2020). Relevant studies indicate that skinfold thickness measurements obtained by a skinfold instrument provide information about the subcutaneous storage fat of the region where the measurement is made (Bauer et al., 2022; Bonilla et al., 2022; Can et al., 2023). Not only skinfold thickness measurements from different parts of the body provide comprehensive information about the total body fat ratio but also very important for the calculation of total BF% (Alves et al., 2021; Cherif et al., 2022).

Ideal body composition varies in different sports branches. However, the low amount of fat mainly affects sports performance in a positive way. Excessive amount of subcutaneous body fat influences many performance components adversely (flexibility, strength, speed, acceleration and agility) (Engels et al., 2002). One of these performance components is acceleration. It is an undeniable fact that acceleration performance has an important place in many sports branches. Most field-based team sports, such as soccer, baseball, softball, and basketball, benefit from short sprint workouts; thereby, the acceleration phase of the sprint has a considerable significance in terms of performance in team sports (Paton et al., 2001). Although each athlete has unique biomechanical differences, it is seen that the deviations in the characteristics of sprinting are more quantitative than qualitative (Nagahara et al., 2014). For this reason, body composition should also be taken into account when evaluating acceleration performance. Knowing how much the body fat ratio affects the body has an important place in terms of performance. In a study, it was observed that the force associated with body mass and strength affects the initial velocity and acceleration in a sprint run for 18.3 meters (Brechue et al., 2010). Murphy et al. (2003) stated that the acceleration performance should be evaluated at distances of 4.57 meters or 9.14 meters to evaluate the acceleration performance and obtain accurate results. In another study, 0-10 meters of a 100-meter sprint run was considered as the acceleration phase, the distance from 36 meters to 100 meters was considered as the maximum speed, and the distance between them was considered as the transition time (Nikolaidis et al., 2015). Therefore, the aim of this study is to examine the effect of body composition on acceleration values at 10 meters and 15 meters.

Methods

Participants

A total of 63 active amateur male athletes in different sports branches at the Faculty of Sports Sciences participated voluntarily. Some of the participants' characteristics were measured respectively including mean age (20.52±1.635 years), mean body height (179.25±7.121 cm), mean body weight (72.44±10.066 kg), mean sports age (6.90±3.125 years), mean body mass index (BMI=2.498±2.217 kg/m^2), and mean body fat % (19.277±4.731). Before conducting the study, participants were fully informed about the aims of the research, its potential risks and benefits. Furthermore, an informed consent form was obtained from the participants. This study was approved by the Ethics Committee at Selcuk University Faculty of Sports Sciences (approval: 2019-64). All the procedures adhered to the guidelines of the Declaration of Helsinki.

Design and Procedures

The acceleration performances of the participants were evaluated using a 3-door photocell. The first door is located at the starting point; the second door is located at the 10th meter and the third door at the 15th meter. Participants were run 2 times with a 3-minute rest interval for acceleration performance. Body circumference measurements of the participants were measured with a measuring tape (waist, hip, forearm, thigh, shoulder, chest, calf). Skinfold thickness was measured with a skinfold Caliper (biceps, triceps, supscapula, suprailiac, chest, thigh, abdominal).

The measurements were evaluated on the same day respectively environment, skinfold and acceleration performance, and the air temperature was 23 ^{0}C. Acceleration performance measurements were carried out on an athletics track in accordance with international standards.

Measures

Body mass index

It was calculated by dividing kilograms of body weight by the square of height in meters (kg/m^2).

Body Mass Index Calculation = weight (kg/m²) (Deurenberg et al., 1998; Woolford et al., 2021; Yang et al., 2023).

Skinfold thickness measurements

The skinfold thickness measurement of the participants was measured from 7 different regions (biceps, triceps, supscapula, suprailiac, chest, thigh, abdominal). Measurements were made with a Skinfold caliper (Holtain Brand Skinfold Caliper), which applies 10 g/sq mm pressure and measures with ± 0.2 mm precision. All measurements were made on the right side of the body and by the same person. The skin and subcutaneous fat were captured with the thumb and forefinger, the Caliper was placed 1 cm away from the thumb and forefinger. Measurements of each region were made twice. Body densities were determined with the Durnin-Womersley formula (Durnin & Womersley, 1974; Mollaoglu et al., 2006). Furthermore, the BF% of the subjects was calculated with the Siri formula (Siri, 1956). These formulas were given below.

Durnin Womersley Formula = 1.1468 – 0.074 * Log (tricepsskinfold + subscapularskinfold) (Durnin & Womersley, 1974; Mollaoglu et al., 2006).

Siri Formula = (4.95/ body density – 4.5)* 100 (Siri, 1956).

Body circumference measurements

Body circumference measurements were obtained from 7 different regions (waist, hip, forearm, thigh, shoulder, chest and calf). Measurements were performed using a 2 cm wide tape measure. During the measurement, the subject was kept standing still. Extremity measurements were applied on the right side of the body. During the measurement, care was taken that the tape measure was not loose and did not compress the area too much so as not to exert pressure. Measurements were made in duplicate for each region and the mean of the two measurements was taken (ACSM, 2009; Aktuğ et al., 2019).

Table 1
Physical and performance characteristics of the participants.

Variables	Mean ± SD (n=63)
Age (year)	20.52 ± 1.635
Height (cm)	179.25 ± 7.121
Weight (kg)	72.44 ± 10.066
Sports age (year)	6.90 ± 3.125
10 m acceleration (sec)	1.74 ± 0.096
15 m acceleration (sec)	2.40 ± 0.171
Total SM (mm)	8.34 ± 2.975
Total BCM (cm)	71.76 ± 4.581
BMI (kg/m^2)	22.498 ± 2.217
BF%	19.277 ± 4.731

SM: Skinfold measurements, BCM: Body circumference measurements, BMI: Body mass index, BF%: Body fat percentage.

Acceleration measurements

Acceleration performance was evaluated using 10 and 15 meter sprint durations. Three-door photocells (SmartSpeed Fusion Sport) were placed at the starting point, at a distance of 10 meters and 15 meters. Before the run, the participants exercise a dynamic warm-up for 15 minutes (5 min warm-up run, 1 min walking, 7 dynamic stretching exercises, and 2 reps: 10 m and 15 m short sprints). Participants ran the 15 meters 2 times. The best grade from the two running times was used for analysis. A 3-minute rest was given between measurements. Subjects, after taking a static standing position at the starting point (0 meters), with one knee in front and the other standing linearly at the back, ran the 15-meter distance at the highest speed, depending on their own will (Bloomfield et al., 2007).

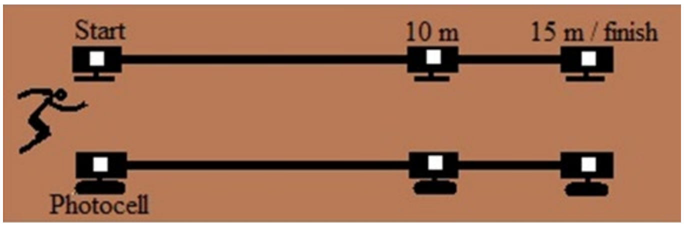

Figure 1. Acceleration test for 10 and 15 meters.

Data Analysis

SPSS IBM 22 statistics program were used for statistical analysis. The continuous variables of the study are presented in mean ± standard deviation. The Kolmogorov Smirnov test was applied to examine whether the variables show normal distribution. 10 and 15 m acceleration values are dependent variables while BMI, BF%, BCM and SM values are independent variables. Simple Linear Regression test was used to determine the effect of each independent variable on dependent variables. Pearson correlation test was used to determine the relationship between 10 and 15 m acceleration with BMI, BF%, BCM and skinfold thickness measurements. The data obtained in this study were tested at a confidence interval of 0.95.

Results

Table 1 shows demographic characteristics and accelerations and body composition measurements of the participants.

It has been determined that there is no relationship between BMI and BCM with 10 m acceleration performance of the subjects participating in the research. It is seen that the change in BMI and BCM did not affect the 10 m acceleration value (Figure 2a, Figure 2c). It has been determined that there is a significant relationship between BF% and SM with 10 m acceleration (Figure 2b, Figure 2d). It has been determined that BF% explains the 10 m acceleration value at the rate of 0.094. One unit change in BF% affects 10 m acceleration at the rate of 0.006. An increase in BF% by one unit worsens 10 m acceleration at the rate of 0.006. On the other hand, one unit decrease in BF% improves 10 m acceleration at the rate of 0.006 (Figure 2b; $p<0.05$). Moreover, it was observed that the SM explained the acceleration value of 10 m at a rate of 0.075. One unit change in SM affects 10 m acceleration at the rate of 0.008. One unit increase in SM worsens the 10 m acceleration at the rate of 0.008. On the other hand, one unit decrease in SM improves 10 m acceleration at the rate of 0.008 (Figure 2d; $p<0.05$).

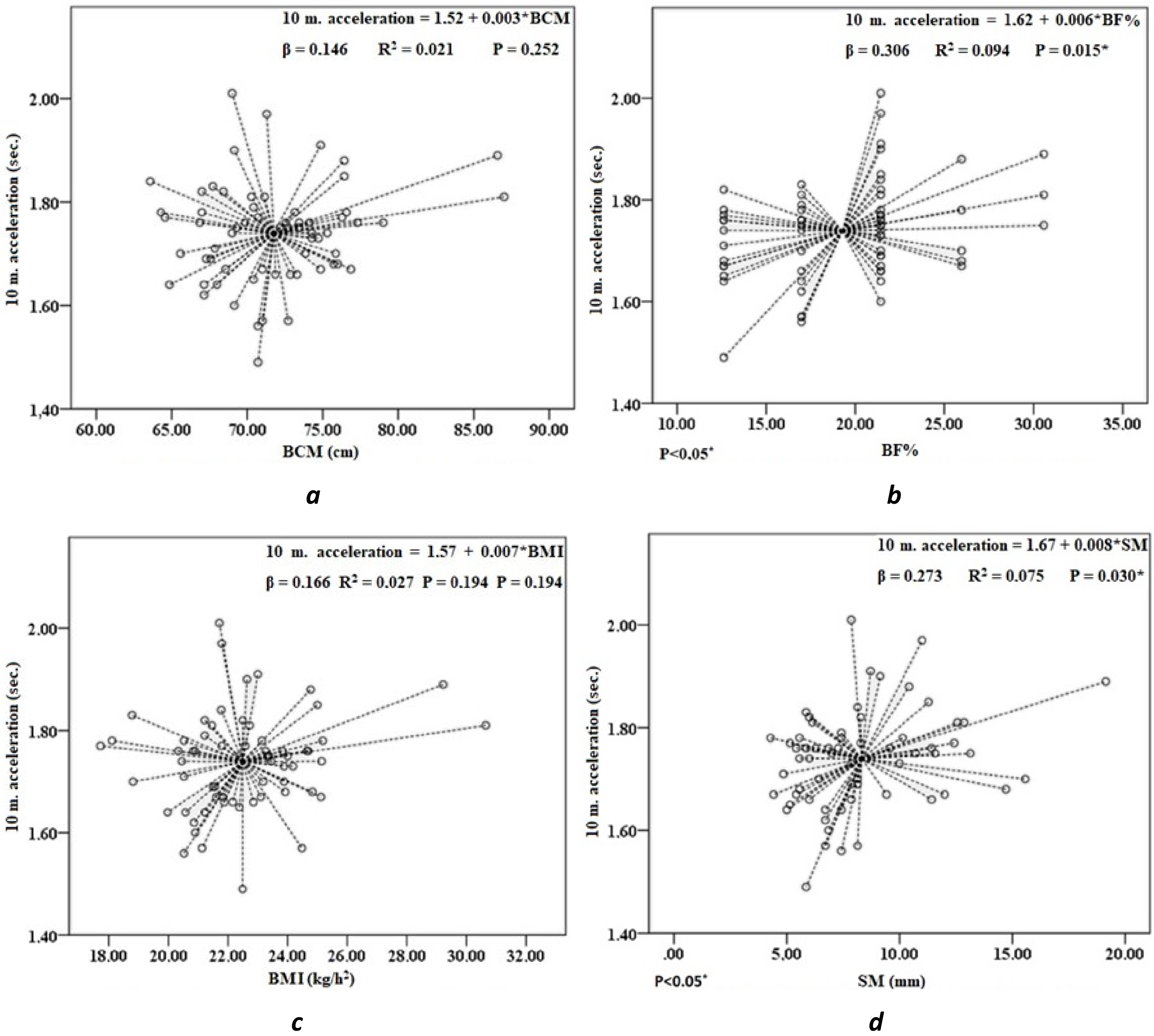

Figure 2. a: Relationship between 10 m acceleration and BMI, b: Relationship between 10 m acceleration and BF%, c: Relationship between 10 m acceleration and BCM, d: Relationship between 10 m acceleration and SM.

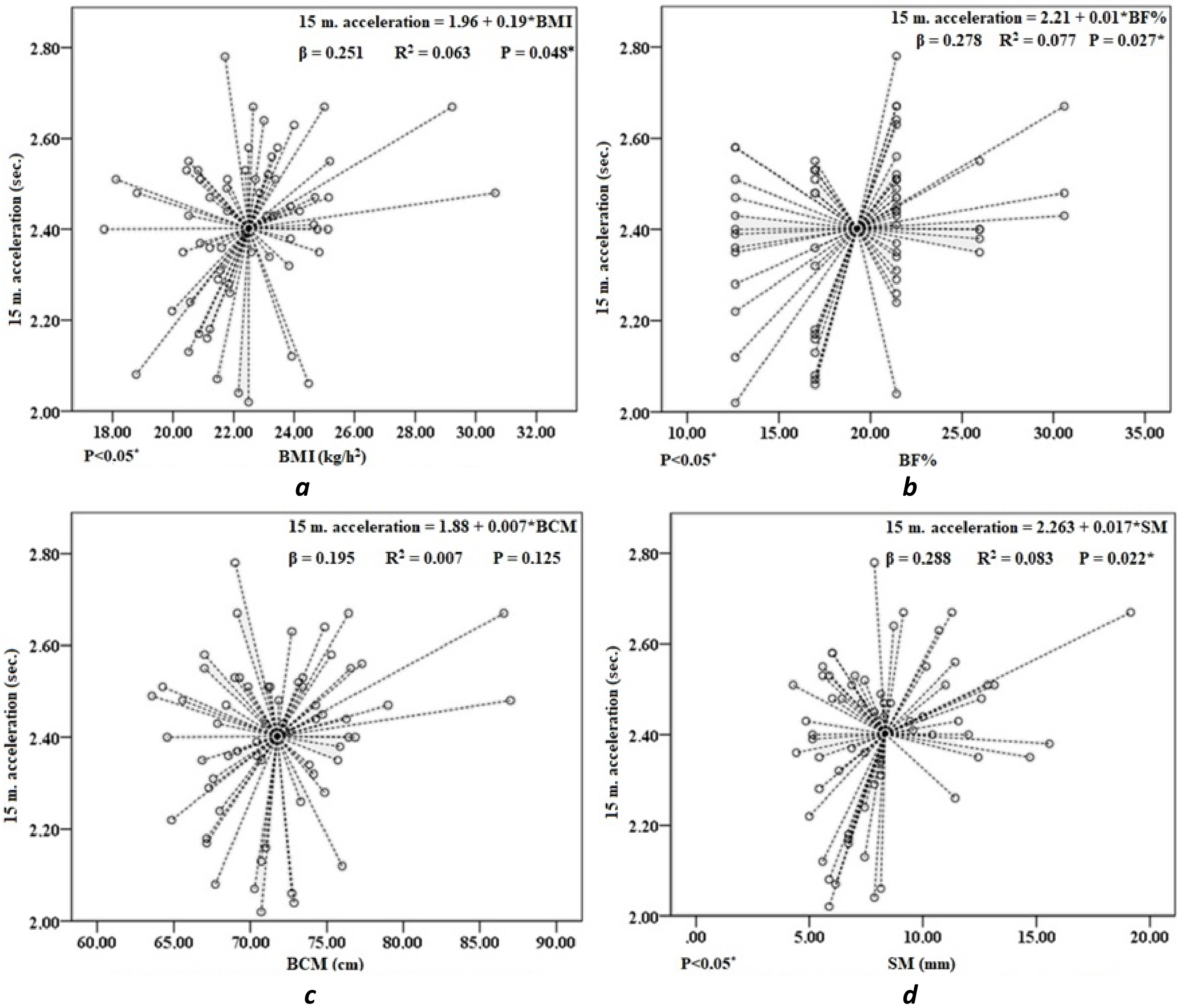

Figure 3. a: Relationship between 15 m and BMI, b: Relationship between 15 m acceleration and BF%, c: Relationship between 15 m acceleration and BCM, d: Relationship between 15 m acceleration and SM.

It was determined that there was no significant relationship between BCM and 15 m acceleration of the subjects participating in the study (Figure 3c). It has been determined that there is a significant correlation between BMI, BF% and SM with 15 m acceleration (Figure 3a, Figure 3b, Figure 3d). It was seen that BMI explained the acceleration value of 15 m at the rate of 0.063. One unit change in BMI affects 15 m acceleration at a rate of 0.19. One unit increase in BMI worsens 15 m acceleration at the rate of 0.19. In contrast, one unit reduction in BMI improves 15 m acceleration at the rate of 0.19 (Figure 3a; $p<0.05$). It was seen that BF% explained the acceleration value of 15 m at the rate of 0.077. One unit change in BF% affects 15 m acceleration at the rate of 0.01. One unit increase in BF% worsens 15 m acceleration at the rate of 0.01. In contrast, one unit reduction in BF% improves 15 m acceleration at the rate of 0.01 (Graphic b; $p<0.05$). In addition, it was observed that the SM explained the acceleration value of 15 m at a rate of 0.083. One unit change in SM affects the acceleration 15 m at a rate of 0.017. One unit increase in SM worsens the 15 m acceleration at the rate of 0.017. On the other hand, one unit reduction in SM improves 15 m acceleration at the rate of 0.017 (Figure 3d; $p<0.05$).

Discussion

This study, carried out to investigate the effect of body composition on acceleration, has revealed that there is no correlation between BCM and accelerations at both 10 m and 15 m. Moreover, it was determined that a correlation was found between acceleration at both 10 m and 15 m and both BF% and SM ($p<0.05$). While it was determined that there was no correlation between 10 m acceleration performance with BMI, there was a correlation between 15 m acceleration performance and BMI ($p<0.05$). It has been observed that %BF affects 10 m acceleration performance by 0.006 and 15 m acceleration performance by 0.01. It has been determined that SM affects 10 m acceleration performance by 0.008, while 15 m acceleration performance affects 0.017. In addition, it was determined that BMI affects the 15 m acceleration performance by 0.19.

The acceleration times of 10 m and 15 m in our study are similar to the acceleration times of the studies in the literature. In this study, 10 m acceleration performance was found as 1.74 ± 0.096 sec, and 15 m acceleration values were found as 2.40 ± 0.171 sec. In a study evaluating the acceleration of soccer players by Adalı (2019), acceleration performances at 10 m and 15 m distances were measured, and the 10 m acceleration value of the subjects was determined as 1.87±0.083 seconds and the 15 m acceleration values as 2.42±0.052. In a study evaluated the acceleration of professional soccer players by Deleclusk (1997), the acceleration performance at a distance of 10 meters was measured and the acceleration value of the subjects was determined as 1.83±0.08 seconds. In a study conducted by Cochrane et al. (2004) in which the acceleration was measured at a total distance of 15 m, the times obtained among 5 m, 10 m, and 15 m distances were measured. Arı & Apaydın (2022) determined the acceleration performance of 10 m as 1.70±0.08 seconds, and the acceleration of 15 m as 2.43±0.09 seconds. In another study, the acceleration of professional soccer players was evaluated by running a distance of 10 meters as fast as possible and the acceleration value was found to be 1.83±0.08 seconds (Little & Williams, 2005).

In a study, when the results of correlation analysis between the body compositions of soccer players and their speed values are examined, it has been determined that there is a similar and moderate relationship between 10 m values and BF% and mass. Therefore, as the BF% and mass of the soccer players increase, the sprint times also increase. Furthermore, it is seen that the high BF% and mass affect the sprint characteristics of the soccer players negatively (Aktaş & Aslan, 2018). Ladwig et al. (2013) emphasized that body composition is matter to many sports branches in terms of maximum physical performance. More, they stated that as the level of body fat increases, it affects performance negatively. Additionally, excessive body age makes it difficult for oxygen to reach the muscles during exercise. They have highlighted that the preservation of low body fat has a serious importance particularly in sports branches with high intensity and high metabolic demands (such as basketball). Amonette et al. (2014) determined that 9.1 m sprint values were negatively correlated with lean body mass and positively correlated with BF% in young soccer players. A study by Silvestre et al. (2006a) evaluated the relationship between physical performance tests and body composition. The study concluded there was a significant negative relationship between total body fat and sprint, standing long jump, and pull-up tests in terms of performance level. In another study, the relationship between body composition and different physical performance tests on 27 soccer players was examined. Accordingly, it was stated that there were significant relationships among 6 different parameters (body fat ratio and lean body structure, sprint, vertical jump performance, total body strength and VO_{2max}) varying at r = - 0.67 and r = 0.61 (Silvestre et al., 2006b). It was determined that the body fat ratio of soccer players was significantly negatively correlated with VO_{2max} at the level of r = -0.67; otherwise, significantly positively correlated with sprint performance at the level of r = 0.60 (Silvestre et al., 2006b). Özkan et al. (2010) stated that for all sports branches including aerobic or anaerobic exercises, the excess of fatty tissues in the body and the lack of lean body mass affect performance negatively. In the study conducted by Sheppard & Young (2006), a weak correlation was found between running speed and anthropometric variables, and the correlation coefficient between BMI and running speed was found to be r = 0.21. Çelik et al. (2022) examined the relationship between sprint performance and BF% of soccer players in their research. The results of the study showed that there is a weak positive correlation between 10 meters acceleration and BF%. Damayanti & Adriani (2021), in a study they conducted, found a positive and highly significant relationship between BF% with sprint performance. In the study conducted by Toro-Roman et al. (2021), it was determined that the 10 m acceleration performance was negatively affected as the % BF increased. Apaydın et al. (2022) found that there is a moderate negative correlation between the BF% and BMI of the athletes with their acceleration performance in their study. In another study conducted on 2342 male and 832 female high school students, it was found that excess fat had a negative effect on most physical performance tests (McLeod et al., 1983). Atakan et al. (2017) found a negative correlation between sprint times and body mass ($p<0.05$). They found that changes in the body composition of soccer players had a great importance in athletic performance, especially in sprinting and agility. Arı & Apaydın (2022) found that there was no significant relationship between BF% and acceleration performance in their study.

Conclusion

In conclusion, it was determined that the BCM did not affect the 10 m and 15 m acceleration performance. It was found that BF% and SM had an effect on both 10 m and 15 m acceleration performance. However, it was observed that BMI, BF% and SM affected the 15 m acceleration performance more. While BMI does not affect the 10 m acceleration performance, it affects the 15 m acceleration performance by 0.19. While BF affects 10% m acceleration performance by 0.006, it affects 15 m acceleration performance by 0.01. While SM affects 10 m acceleration performance by 0.008, it affects 15 m acceleration performance by 0.017. It is thought that as the acceleration distance increases, the effect level of BMI, BF% and SM increases. For a good acceleration performance, athletes should have ideal BMI, BF% and SM. Future studies should investigate sports branches separately, taking into account the gender variable.

Authors' Contribution

Study Design: İHŞ, AS; Data Collection: İHŞ, AS; Statistical Analysis: İHŞ, AS; Manuscript Preparation: İHŞ, AS; Funds Collection: İHŞ, AS.

Ethical Approval

The study was approved by the Selcuk University of Sports Science Faculty Ethical Committee (2019/64) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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The authors declare that the study received no funding.

Conflict of interest

The authors hereby declare that there was no conflict of interest in conducting this study.

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