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| RESEARCH ARTICLE

Investigation of the Relationship Between Body Composition, Maximal Oxygen Consumption and Some Biomotor Characteristics in Young Male Long-Distance Runners

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| ABSTRACT
Biomotor characteristics and body composition in athletes are factors affecting athletic performance. The aim of this study was to investigate the relationship between body composition, maximal oxygen consumption (VO2max) and some biomotor characteristics in young male long-distance runners. 15 young male long-distance runners (age: 14.73±0.88 years) participated in the study voluntarily. The study was designed as a relational cross-sectional study model. Body analysis measurements, 20m shuttle run, 10m and 20m sprint, countermovement jump (CMJ), Illinois agility and back strength tests were applied to the participating athletes. SPSS package program was used. Shapiro-Wilk test was applied to determine the normality level of the data. It was determined that the data had a normal distribution. Pearson correlation test was used in the relational analysis of the data. No significant relationship was found between body composition parameters and VO2max, 10m and 20m sprint values in young male long-distance runners participating in the study ($p > 0.05$). Positive moderately significant relationships were found between CMJ and fat-free mass ($r = 0.560$; $p = 0.030$), mineral mass ($r = 0.558$; $p = 0.031$) and fluid mass ($r = 0.559$; $p = 0.030$). Negative moderately significant relationships were found between Illinois agility and fat-free proportion ($r = -0.572$; $p = 0.026$), mineral proportion ($r = -0.570$; $p = 0.026$) and fluid proportion ($r = -0.556$; $p = 0.031$), while a positive moderately significant relationship was found between Illinois agility and fat proportion ($r = 0.572$; $p = 0.026$). While positive and strong significant relationships were determined between back strength and lean mass ($r = 0.786$; $p = 0.001$), mineral mass ($r = 0.787$; $p = 0.000$) and basal metabolic rate ($r = 0.758$; $p = 0.001$), a very strong positive significant relationship was determined between back strength and fluid mass ($r = 0.814$; $p = 0.000$). In long-distance runners, applying training aimed at increasing lean body and fluid mass and focusing on nutritional strategies to reduce fat percentage may increase their athletic performance.

| KEYWORDS

Body Composition, Maximal Oxygen Consumption, Biomotor Characteristics, Long-Distance Runners.

| ARTICLE INFORMATION

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1. Introduction

Athletics is a sport branch that is performed on the track and field, including running, jumping and throwing branches, and the result is determined by time and rules (Demir, 1997). Athletics is considered the oldest sport branch with the combination of many movement sports that come from ancient Greece from the past to the present, and it has been seen that this sport is the main basis for the emergence of many sports branches. Therefore, it is a sport branch that is open to development and is performed as individual or team sports in accordance with the rules for the development of skills such as movement power, endurance, speed and agility. In this context, it takes its place in Olympic competitions since it continues a competitive development. Issues such as running performance, distance run, running technique and body characteristics are important factors in athletics. The fact that the distances competed in athletics are different requires athletes to have different characteristics. In addition, running speed and especially endurance parameters also have an important place.

It is stated that knowing the somatotype and body composition characteristics can be useful in determining the abilities of the athlete, in organizing training programs to increase and improve aerobic performance and technical skills, and in selecting athletes who are expected to be successful (Apti, 2010). Body composition is divided into two groups as fatty and lean. Fat masses can be classified as essential fats, subcutaneous fats and storage fats. Fat-free masses are muscle, bone, water, nerves, veins and organic substances. Since the body fat proportion depends on the balance between the energy consumed, especially in sports branches that require endurance such as long distance, having too much fat mass will negatively affect performance. As can be understood from here, in order to achieve high performance in athletics, fat and lean masses must be balanced (Zorba, 1999). It is critical for athletes to achieve physical and physiological fitness in order to achieve success (Okut and Kızılca, 2024). Body composition is only one of the criteria for an athlete to show high-level performance and, combined with other performance indicators such as strength, power, flexibility, speed, endurance and agility, it positively affects the athlete's performance (Özkan and Sarol, 2008). Inappropriate body composition values can negatively affect joint and muscle health in athletes (Walsh et al., 2018).

VO_2max is the oxygen consumption a person takes in one minute. Long-distance runners pay great attention to an important principle. This is a skill, namely the ability to do a lot of work with little energy. In order to develop this skill, increasing VO_2max capacity and thus helping to increase the strength of the organs and metabolism provides the advantage of being able to run long distances comfortably (Green and Pate, 1997). Biomotor abilities can be classified as strength, anaerobic and aerobic endurance, speed, agility and coordination. Especially in long-distance track and field runners, the development of these abilities is important in terms of their performance (Yapıcı and Ersoy, 2003). As with short-distance and middle-distance athletes, long-distance track and field runners must demonstrate motoric skills such as balanced short-acting sudden attacks and changes of direction at the beginning or end of the competition, which is an important factor in the athlete's success (Zorba, 1999).

There is a known fact for long-distance runners, which is that as the distance increases, the participation of aerobic energy sources in the performance increases considerably. A balanced fat proportion creates a potential for good use of the VO_2max level, and with the combination of some biomotor skills, it is possible to achieve successful performance (Safrit, 1986). Training programs generally aim to increase the general performance of athletes by focusing on these physiological and biomotor characteristics (Kızılca, 2023). In light of this information, this study, which was conducted in young male long-distance runners, will provide us with an idea about the athlete's performance by determining the relationships between body composition, VO_2max, 10m sprint, 20m sprint, CMJ, Illinois agility and back strength. Ultimately, determining these relationships will allow coaches to better improve athlete performance by taking this information into consideration when preparing training programs.

2. Methodology

This study was designed as a cross-sectional correlational study. In this model, it is attempted to determine whether there is a common change between two or more variables and its degree (Karasar, 2011). The study was conducted in accordance with the Declaration of Helsinki. Before starting the study, Ethical Approval was obtained from the Scientific Research and Publication Ethics Committee of Muş Alparslan University with the decision number 16/20 dated 27.12.2024.

2.1. Participants

The minimum sample size for this study was determined using G*Power software (version 3.1. 9.7) (Faul et al., 2009). A power analysis was performed based on the correlation model of the study. The analysis considered an α error probability of 0.05, a statistical power of 0.80 (1-β error probability), and an effect size of 0.50. The results showed that a minimum of 10 participants were required to achieve the desired statistical power. Fifteen young male long-distance runners (age: 14.73±0.88 years) participated in the study voluntarily. The runners were athletes with at least 3 years of athletics experience in Muş Province (Turkey).

2.2. Research Design

Before the study, each athlete was given detailed information about the risks and illnesses that could be encountered in the study, and a voluntary consent form was read and signed by the athletes. In addition, the parents of the athletes signed a parental consent form. Athletes with any illness were not included in this study and were instructed not to participate in any heavy exercise program the day before the study. The 15 male long-distance runners who made up this study were given a 20-minute general warm-up before the measurements, and then a 5-minute special warm-up for the branch, and the athletes were measured.

2.3. Data Collection Tools

Body Composition Measurements. The athletes' height was measured in cm with a stadiometer (Holtain, Crymych, Pembs., UK) measuring ±1 mm. The athletes' body weight and body composition measurements were measured with a Tanita MC 780 MA (Tanita Corporation, Tokyo, Japan) device. During the measurements, the participants were asked to stand on the metal surface of the device with bare feet, hold the parts of the device that needed to be touched with both hands, and release their arms parallel to the body. The measurements took 1-2 minutes for each participant and the measurement results were printed out from the device (Kelly and Metcalfe 2012).

Back Strength Measurements. A Takei brand (TKK 5402 model, Japan) dynamometer was used to measure the back strength of the athletes. In determining the isometric back strength, the athletes pulled the hand grip of the dynamometer with maximum force while the hand grip of the dynamometer was at hip level, with the legs and back straight. Two trials were taken from the athletes and the highest value was accepted (Taşkın et al 2015).

Countermovement Jump (CMJ) Test. It is a test used to determine the leg quick strength, jumping strength and alactacid anaerobic power level. The vertical jump measurements of the athletes were measured with an electronic Fusion brand Smart Jump (Australia) jumping mat. All athletes were asked to stand on the mat with their hands on their waists and when the athletes were ready, they were made to jump to the highest point they could jump and the athletes were asked to fall back on the mat after jumping. The athletes were given two trials and their jump heights were measured in cm and their best scores were recorded (Atan, 2019).

10m and 20m Speed Tests. The 10m and 20m speed test was measured with a photocell (Fusion Sport Smartspeed PRO, Australia). Photocell gates were placed at the start and 10m and 20m points along a straight line. Athletes started the test 0.5 m behind the start gate (Sari, Koz, Salcman, Gabrys, & Karayigit, 2022). The test was repeated twice and the best value was recorded.

Illinois Agility Test. To determine the agility performance of the athletes; The Illinois agility test, which is a track consisting of 4 cones arranged in a straight line with 10 m length, 5 m width and 3.3 m intervals in the middle, was used. The test consists of a 40 m straight run and a 20 m slalom run between cones, with 180º turns every 10 m. After the test track was prepared, a two-door photocell electronic stopwatch system (Fusion Sport Smartspeed PRO, Australia) was installed that measures the start and finish with a precision of 0.01 seconds. Before the test, the athletes were introduced to the track and given the necessary explanations, and then they were allowed to try 3-4 times at a low tempo. The subjects started from the starting line of the test track, lying face down and with their hands touching the ground at shoulder height. The time to finish the track was recorded in seconds. The test was repeated twice with a 3-minute passive rest interval and the best time was accepted as the test score (Hazır et al., 2010).

20m Shuttle Run Test. A 20-m distance was determined with a tape measure in the gym. The test area was limited with colored strips, and the lines were clearly visible with funnels and dots. A signal was given with decreasing frequency in accordance with the test protocol and with sound. The levels at which the athletes left the test will be marked on the previously prepared level tracking form and the subjects' VO_2max levels were recorded as estimated in ml/kg/min by looking at the evaluation table. The VO_2max values of the athletes were calculated with the formula V02 max = 31.025 + 3.238 x (running speed) – 3.248 x (age) + 0.1536 x (running speed) x (age). (Leger et al. 1988).

2.4. Statistical Analysis

The data were given as mean and standard deviation for general characteristics and variables. SPSS package program was used in the analysis of statistical data. Before the data analyses, the Shapiro-Wilk test was used to evaluate whether the data showed normal distribution. Pearson correlation test was used in the correlation analyses for data showing normal distribution. To interpret the correlation coefficient results, Evans coefficient classifications ($r \geq 0.80$ very strong, 0.60–0.79 strong, 0.40–0.59 moderate, 0.20–0.39 weak and <0.20 very weak correlation) were used (Evans, 1996). $P<0.05$ was accepted as the statistical significance value.

3. Results

Descriptive statistics of the general characteristics of the young male long-distance runners participating in the study are presented in Table 1. Descriptive statistics of the body composition measurements and VO_2max, speed, jumping, agility and strength tests applied to the long-distance runners are presented in Table 2.

Table 1. Descriptive statistics regarding general characteristics of athletes

General characteristics	N	Mean	SD	Min	Max
Age (years)	15	14.73	0.88	14.00	16.00
Height (cm)	15	166.07	10.41	150.00	185.00
Body mass (kg)	15	53.97	9.48	40.60	77.10
BMI (kg/m^2)	15	19.44	1.78	16.80	23.30

Table 2. Descriptive statistics results of measurements and tests

Parametreler	N	Mean	SD
Fat-Free Mass (kg)	15	46.19	8.04
Fat-Free Proportion (%)	15	85.59	3.03
Mineral Mass (kg)	15	2.40	0.42
Mineral Proportion (%)	15	4.45	0.16
Fluid Mass (kg)	15	34.01	5.22
Fluid Proportion (%)	15	63.22	2.52
Fat mass (kg)	15	7.79	2.38
Fat Proportion (%)	15	14.41	3.03
Basal Metabolic Rate (kcal)	15	1.63	0.18
VO_2max (ml/kg/dk)	15	59.03	3.78
10m Sprint (sn)	15	1.79	0.13
20m Sprint (sn)	15	3.19	0.19
CMJ (cm)	15	31.93	5.23
Ilinois Agility (sn)	15	17.32	1.06
Back Strength (kg)	15	101.68	20.84

The correlation results between body composition parameters and VO_2max, speed, jumping, agility and strength in long-distance runners are presented in Table 3.

Table 3. Relationship between body composition and VO_2max, speed, jump, agility and strength

Parametreler		VO_2max	10m Sprint	20m Sprint	CMJ	Ilinois Agility	Back Strength
Fat-Free Mass (kg)	r	.037	-.301	-.386	.560*	-.093	.786**
	p	.895	.275	.156	.030	.741	.001
Fat-Free Proportion (%)	r	-.196	-.208	-.490	.273	-.572*	.020
	p	.483	.457	.064	.325	.026	.943
Mineral Mass (kg)	r	.039	-.302	-.385	.558*	-.091	.787**
	p	.890	.274	.157	.031	.748	.000
Mineral Proportion (%)	r	-.189	-.209	-.492	.275	-.570*	.024
	p	.499	.454	.062	.322	.026	.932
Fluid Mass (kg)	r	.110	-.352	-.412	.559*	-.119	.814**
	p	.696	.198	.127	.030	.673	.000
Fluid Proportion (%)	r	.090	-.195	-.316	-.034	-.556*	-.266
	p	.749	.486	.252	.903	.031	.338
Fat mass (kg)	r	.161	.049	.224	.078	.465	.449
	p	.566	.862	.422	.782	.081	.093

Fat Proportion (%)	r	.196	.208	.490	-.273	.572*	-.020
	p	.483	.457	.064	.325	.026	.943
Basal Metabolic Rate (kcal)	r	-.006	-.238	-.288	.465	.060	.758**
	p	.982	.393	.298	.080	.832	.001

There was no significant relationship between body composition parameters and VO_2max, 10m and 20m sprint values in young male long-distance runners participating in the study (p>0.05). Positive moderately significant relationships were determined between CMJ and fat-free mass (r = 0.560 ; p = 0.030), mineral mass (r = 0.558 ; p = 0.031) and fluid mass (r = 0.559 ; p = 0.030). While negative moderately significant relationships were determined between Illinois agility and fat-free proportion (r = -0.572 ; p = 0.026), mineral proportion (r = -0.570 ; p = 0.026) and fluid proportion (r = -0.556 ; p = 0.031), positive moderately significant relationships were determined between Illinois agility and fat proportion (r = 0.572 ; p = 0.026). Positive strong significant relationships were determined between back strength and fat-free mass (r = 0.786 ; p = 0.001), mineral mass (r = 0.787 ; p = 0.000) and basal metabolic rate (r = 0.758 ; p = 0.001), while positive very strong significant relationships were determined between back strength and fluid mass (r = 0.814 ; p = 0.000).

4. Discussion

This study determined the relationships between body composition, VO_2max and some biomotor characteristics in young male long-distance runners. No significant relationship was found between body composition parameters and VO_2max, 10m and 20m sprint values in young male long-distance runners. Goran et al. (2000) determined that fat mass had no effect on VO_2max. In studies with different results in the literature, a negative correlation has been reported between VO_2max and body fat percentage (Ukelund et al., 2001; Armani et al., 2010). The relationship between marathon time (< 2 hr 30 min) and VO_2max performance at the elite long-distance level is weak and this relationship is likely to be insignificant at world-class marathon times (< 2 hr 10 min) (Sjodin and Svedenhag, 1985). A high VO_2max (>70 ml/kg/min) may be a prerequisite for being an elite long-distance runner, but additional physical attributes are needed to be successful at this level (Beattie et al., 2017). Rüst (2012) found a significant and negative relationship between running speed and change in body mass in male 100 km ultramarathoners. In our study, moderately significant relationships were determined between CMJ and lean mass, mineral mass and fluid mass. Silvestre et al. (2006) found a statistically significant relationship between body composition and vertical jump. Kahraman and Okut (2025) stated that while high fat proportionnegatively affects anaerobic power and jumping performance, high fat mass, muscle and fluid proportions positively affect anaerobic power and jumping performance. Esco et al. (2018) found a high negative relationship between body fat percentage and performance tests in young male football players. A different study shows that body composition affects vertical jump (Carter et al., 2005).

In our study, negative moderate significant relationships were determined between Illinois agility and fat-free proportion, mineral proportion and fluid proportion, while a positive moderate significant relationship was determined between Illinois agility and fat proportion. Cheuvront et al. (2008) emphasize that fluid intake has a direct effect on agility, endurance and explosive strength. Aikawa et al. (2020) found significant negative correlations between fat percentage and competition scores in long-distance runners. Subak et al. (2022) found a negative relationship between fluid proportion and Illinois agility test duration.

In our study, positive strong significant relationships were determined between back strength and fat-free mass, mineral mass and basal metabolic rate, while a very strong positive significant relationship was determined between back strength and fluid mass. The fitness profile of athletes plays an important role in determining the potential for success in competitive disciplines. Certain physical characteristics, along with body composition, are required for the highest levels of performance in a given athletic discipline (Pavlović, 2021). Significant relationships have been identified between muscle strength, abdominal endurance, isometric strength, general physical fitness, and stride frequency and performance (Thuany, 2021).

5. Conclusions

It has been determined that increasing lean mass, mineral mass and fluid mass in young male long-distance runners increases CMJ distance and therefore positively affects jumping performance. One of the important results of our study is that increasing lean proportion, mineral proportion and fluid proportion decreases Illinois agility test time, i.e. increases agility performance. In addition to these results, increasing fat proportion increases Illinois time, i.e. decreases jumping performance. In addition, increasing lean mass, fluid mass, mineral mass and basal metabolic rate increases back strength. Applying training aimed at increasing lean body and fluid mass and focusing on nutritional strategies that will reduce fat proportion in long-distance runners may increase their athletic performance.

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