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Research Article / Araştırma Makalesi

Relationship between body composition, Yo-Yo intermittent recovery test and vertical jump test in elite young soccer players

Elit genç futbol oyuncularında vücut kompozisyonu, Yo-Yo aralıklı toparlanma testi ve dikey sıçrama testi arasındaki ilişkiler

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ABSTRACT

Objective: The aim of this study is to find out the relationships among body composition, Yo-Yo intermittent recovery (IR) test and vertical jump test in elite young soccer players.

Material and Methods: Eighteen healthy young male soccer players (Age: 16.5±0.3 years, height: 178.0±5.9 cm, body weight: 65.9±7.9kg,) voluntarily participated in the study. Total and regional body composition parameters of the soccer players were examined through a dual-energy x-ray absorptiometry (DEXA) method. Vertical jump performance tests were squat jump (SJ) and active jump (AJ), and endurance performances were determined by the Yo-Yo intermittent recovery level 1 test (Yo-Yo IR1). Relationships among body composition, Yo-Yo intermittent recovery test and vertical jump test were analyzed with Pearson Correlation coefficient. Significance level was taken as ≤0.05.

Results: A statistically significant negative correlation was found between squat jump and countermovement jump (r=-0.588, r=-0.573, p<0.05), and the leg fat rate. However, there were no statistically significant relationship among squat jump, Yo-Yo IR1 and countermovement jump and other whole/regional body composition (p>0.05).

Conclusion: Changes in body composition are important issues for the physical performance level of young soccer players, as local excess body fat may cause deterioration, especially in jumping performance.

Keywords: *Soccer, body composition, Yo-Yo intermittent recovery test, counter movement jump, squat jump*

ÖZ

Amaç: Bu çalışmanın amacı elit genç futbol oyuncularında vücut kompozisyonu, Yo-Yo aralıklı toparlanma testi ve dikey sıçrama testi arasındaki ilişkileri araştırmaktır.

Gereç ve Yöntemler: Çalışmaya 18 sağlıklı genç erkek futbol oyuncusu (Yaş: 16.5±0.3 yıl, boy: 178.0±5.9 cm, vücut kütlesi: 65.9±7.9 kg,) gönüllü olarak katıldı. Futbolcuların tüm ve bölgesel vücut kompozisyon parametreleri dual-enerji x-ray absorbsiyometri (DEXA) yöntemi ile incelendi; dikey sıçrama performans testleri, skuat sıçrama (SS), ve aktif sıçrama (AS) ile, dayanıklılık performansları Yo-Yo aralıklı toparlanma seviye 1 testi (Yo-Yo IR1) ile belirlendi. Vücut kompozisyonu, Yo-Yo aralıklı toparlanma testi ve dikey sıçrama testi arasındaki ilişkiler Pearson korelasyon katsayısıyla analiz edildi. Anlamlılık düzeyi ≤0.05 olarak alındı.

Bulgular: İstatistiksel analizler sonucunda, SS ve AS ile bacak yağ oranı arasında istatistiksel olarak anlamlı negatif ilişkiler bulundu (r=-0.588, r=-0.573, p<0.05). Ancak, Yo-Yo aralıklı toparlanma seviye 1, squat sıçrama ve aktif sıçrama testleri ile diğer tüm/bölgesel vücut kompozisyonu parametreleri arasında istatistiksel olarak anlamlı ilişkiler bulunmadı (p>0.05).

Sonuç: Bölgesel olarak fazla vücut yağı özellikle sıçrama performansında düşüşe neden olabileceğinden, vücut kompozisyonu değişimleri genç futbolcuların fiziksel performans düzeylerini etkileyebilir.

Anahtar Sözcükler: *Futbol, vücut kompozisyonu, squat sıçrama, aktif sıçrama, Yo-Yo aralıklı toparlanma testi*

INTRODUCTION

Evaluation of body composition has become crucially important in sports science when elite soccer is concerned. (1)Body composition is regularly assessed to determine how competitive and effective dietary and training interventions are (2). A body's physical composition, which includes fat-free mass, body fat and mass, is an important factor that should be taken into consideration while training players to display competitive performance. In addition, it is an essential part of physical fitness since excess adipose tissue functions as dead weight in some sports and activities that

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include jumping and running, in which it is necessary for players to repeatedly lift body mass against gravity (3,4). Moreover, excessive body fat might negatively affect aerobic and anaerobic capacity, power flows of players, power-weight ratio and thermoregulation (5,6).

On the other hand, fat free mass is a factor helping players to produce power during activities with high-intensity while players' resistance to high static and dynamic loads is higher due to fat-free mass (7). Soccer, in which low body mass due to low body fat contributes to high performance, is a popular team sport often characterized with high-intensity activities (8). Reilly et al. found lower levels of fat, more aerobic power, and higher levels of endurance to fatigue in elite young male footballers, compared with others (9).

Skinfolds, dual-energy X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA) are among the most popular assessment methods to measure body fat mass of soccer players (6). DXA is the ideal tool to analyze body composition since it allows estimates regarding lean and mineral mass and reproducible fat. (2-10,11).

Basically, body composition consists of lean and fat body mass. The higher the body fat, the lower the athletic performance of players (12). Hilgemberg-Figueiredo et al. found negative correlations between physical performance parameters and body fat ratio according to tests applied before the season, which clearly demonstrated that body composition has great impact on physical performance (13). In addition, Ostojic reported higher body fat ratio in professional soccer players at the beginning of season and suggested that these ratios considerably decreased throughout the season (14). Considering the limited number of studies conducted on young soccer players in the literature in this respect, Atakan et al. could not find significant relationships among CMJ, SJ and body fat percentage in young soccer players (15), while Silvestre et al. found a negative correlation between body fat percentage and vertical jump in young soccer players. In another study (12), Nalbant and Özer found significant relationship between aerobic fitness (Yo-Yo IR1) and body fat (r=-0.55) in young soccer players (16). There are many studies focusing on young soccer players' body composition. However, most of these studies deal with the following variables: age (17) morphologic structure (18), ethnicity (2), playing position (19,20), different performance levels of players (7,8), and how their body compositions change throughout the season.

On the other hand, there are various studies conducted to examine how body composition affects adult soccer players' performance (12,13). However, regarding young soccer players, the correlation among total/regional body composition, Yo-Yo intermittent recovery test and vertical jump test was limited. Once the correlation between physical performance and demands of young soccer players are figured out, practical implications for training prescription, talent identification and the quantification of training loads might be made. Another important issue for the coaches to work on comes out to be the relationship between body composition and physical performance changes. This study aims to investigate the correlations between elite young soccer players' body composition, Yo-Yo intermittent recovery test and vertical jump test. The hypothesis of this research was based on body composition's playing an important role in physical performance level, and body fat ratio increase's playing a detrimental role in physical performance tests.

MATERIALS AND METHODS

Participants

Eighteen elite young male soccer players (Age: 16.5±0.3 years, height: 178.0±5.9 cm, body weight: 65.9±7.9 kg,) participated in the study voluntarily. All the participants were playing for the same Turkish club competing in the U17 team of Elite Academy League. They trained for 60 to 90 minutes five days a week in soccer sessions with their team in their normal training cycle. Completion of body composition measurements, full performance assessment during the investigation period, and not present injures during the investigation period were constraints to gather data about the participants in the final analysis. The participants were informed verbally first, and then were given a consent form for participation. If the participant was below 18, the consent form was taken from his parents. This study was conducted in accordance with the principles of Helsinki Declaration. As for the ethical issues, it was approved by Eskişehir Technical University Health Sciences Institute Scientific Research and Publication Ethics Committee on 28.06.2019 (Protocol number 16403).

Procedure

All measurements and tests were carried out at the beginning of the in-season period in August. The test sessions were completed in two days between 9:00 and 12:00 a.m. On the first day, anthropometry, body composition measurements and jumping performance were carried out at the Laboratory of Kinanthropometry of the Faculty of Sport Sciences, Eskişehir Technical University. On the second day, the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test was carried out on a natural grass soccer field. Subjects were warned not to take any drugs, drink coffee, and get involved in physical activities at least 24 hours before the test day.

Anthropometric and Body Composition Analysis

A scale (Seca, Vogel & Halke, Hamburg) with a precision of 0.1 kg was used to measure participants' body mass. The height of the players was measured barefoot, the heads of players were placed in the Frankfurt plane using a stadiometer (Holtain Ltd, UK) with an accuracy of 0.1 cm.

As for the evaluation of regional and total body composition (fat ratio, muscle mass, and fat mass) through DXA, the researchers preferred a total body scanner called the Dual-energy X-ray absorptiometry (Lunar Prodigy Pro; GE, Healthcare, Madison, WI, USA). In addition, they used phantoms in order to calibrate the scanner in the morning before the actual measurements by following the manufacturer's standard guidelines. The consistency was realized by performing all the scans and analyses with the same operator. Before the measurements, the participants were asked not to wear any jewellery or have any metal objects in their bodies while being screened. A standard supine position was achieved during the scans by tying the subjects' knees and ankles with a Velcro strap and their arms were extended by their sides. Typically, the examinations lasted between 6-8 min depending on the height of the participant.

Physical Performance Assessment

Vertical Jump Measurements. The testing was preceded by a standard warm-up procedure (5-min self-paced running and 10 min of callisthenic and dynamic stretching). The participants were asked to perform jump tests: squat jump (SJ) and counter movement jump (CMJ) in order to measure the explosive power of their lower limbs by using Smartspeed (Fusion Sport Pty Queensland, Australia). The participants were told to place their hands on their hips while jumping so that the effects of arm swing could be avoided. Following the instructions provided for the squat jump, the players began to jump as high as possible when their knee was approximately at 90° angle. When it comes to countermovement jump from the standing position, participants were asked to do a maximal vertical thrust (stretch-shortening cycle) by bending their knees to 90°. Finally, the participants were asked to keep their bodies straight and descend with their knees fully extended during the jump. Any incorrectly performed jump was repeated. As in previous studies, 1 min of rest was allowed between consecutive trials, and 2-3 min between the series of different jumps (SJ, CMJ), to minimize the effects of fatigue (21). The measurements from the best performance of two trials were recorded in cm.

Yo-Yo Intermittent Recovery Test Level 1. The test was carried out on a natural grass soccer field following a 15-min standardized warm up procedure as by Krustrup et al. (22). During the test, the participants gradually increased their repeating 20 shuttle runs each time when they heard a bleep sound coming from a CD player. When the shuttle ended, participants were instructed to jog for 10 seconds within a 10 m area (5 m go + 5 m return) marked behind the finishing line. The test was stopped when the participants failed to complete the shuttle run in the given time in two occasions. The number of successfully completed shuttles was recorded and running distance (YO-YO IR1 distance (m)) was calculated. The procedures outlined and proposed by Bangsbo et al. (23) were followed.

Statistical Analyses

The data were statistically analysed by using SPSS 18 software (SPSS Inc., Chicago, IL, USA) and presented as means and standard deviations (SD). The level of significance was taken as 0.05 in the analyses. In order to test the normality of the data, Shapiro-Wilk test was applied. Finally, Pearson correlation coefficient was used to analyse the correlations between body composition, Yo-Yo intermittent recovery test and vertical jump test. Probability level was taken as ≤0.05.

RESULTS

Table 1 below displays the descriptive statistics related to physical and total/regional body composition, while Table 2 presents the results of Yo-Yo intermittent recovery and vertical jump test results. Additionally, the relationships between total/regional body composition, Yo-Yo intermittent recovery test and vertical jump test are shown in Table 3. Asignificant negative correlation between squat jump, countermovement jump ($r=-0.588$, $r=-0.573$, $p<0.05$) and percentage of leg fat were found out in the study. However, there was no significant correlation among countermovement jump, Yo-Yo IR1, squat jump and other total/regional body compositions ($p>0.05$).

Table 1. The descriptive statistics of physical and total/regional body composition

Variable	Mean ± SD	Min-Max
Age (years)	16.5 ± 0.3	16.0-16.9
Height (cm)	178.0 ± 5.9	168.0-188.0
Weight (kg)	65.9 ± 7.9	49.7-80.4
Body mass index (kg/m²)	20.5 ± 2.2	15.7-24.8
Body fat ratio (%)	14.1 ± 3.0	9.9-21.6
Body fat mass (kg)	8.93 ± 2.58	5.7-16.2
Lean body mass (kg)	53.4 ± 5.5	40.1-60.9

Table 1. The descriptive statistics of physical and total/regional body composition

Variable	Mean ± SD	Min-Max
Arm fat ratio (%)	12.7 ± 2.0	10.0-10.7
Arm fat mass (kg)	0.98 ± 0.30	0.5-1.6
Lean arm mass (kg)	6.14 ± 0.98	4.0-7.4
Leg fat ratio (%)	16.2 ± 2.7	12.9-21.7
Leg fat mass (kg)	3.50 ± 0.79	2.0-5.5
Lean leg mass (kg)	18.1 ± 2.0	13.3-20.9
Trunk fat ratio (%)	11.9 ± 3.8	8.0-22.0
Trunk fat mass (kg)	3.58 ± 1.57	2.0-8.0
Trunk lean mass (kg)	25.7 ± 2.8	19.6-30.2

n=18

Table 2. The results of Yo-Yo intermittent recovery and vertical jump tests

Variable	Mean ± SD	Min-Max
Squat jump (cm)	37.4 ± 4.8	28.7-49.6
Countermovement jump (cm)	38.3 ± 4.2	31.0-49.7
Yo-Yo intermittent recovery (m)	1578 ± 320	1200-2240

n=18

Table 3. Relationships between total/regional Yo-Yo intermittent recovery test and vertical jump tests for male soccer players

Variables	**SJ** (cm)		**CMJ** (cm)		**Yo-Yo IR1**	
	r	p	r	p	r	p
Body fat (%)	-0.406	0.094	-0.383	0.117	-0.132	0.601
Body fat (kg)	-0.165	0.513	-0.155	0.540	-0.279	0.263
Lean body mass (kg)	-0.452	0.060	-0.401	0.099	-0.380	0.119
Arm fat ratio (%)	-0.422	0.081	-0.441	0.067	-0.210	0.402
Arm fat mass (kg)	-0.192	0.444	-0.215	0.391	-0.349	0.156
Lean arm mass (kg)	0.462	0.054	0.376	0.125	0.358	0.145
Leg fat ratio (%)	-0.588*	0.010	-0.573*	0.013	-0.216	0.389
Leg fat (kg)	-0.259	0.300	-0.272	0.275	-0.337	0.172
Lean leg mass (kg)	0.344	0.162	0.261	0.296	-0.229	0.361
Trunk fat ratio (%)	-0.220	0.381	-0.186	0.459	-0.070	0.783
Trunk fat mass (kg)	-0.089	0.726	-0.057	0.824	-0.193	0.443
Trunk lean mass (kg)	0.441	0.067	0.379	0.121	-0.367	0.142

SJ: squat jump, CMJ: countermovement jump; *: p<0.05

DISCUSSION

The purpose of the current study was to explore the correlations between body composition, Yo-Yo intermittent recovery test and vertical jump test in elite young soccer players. It was found out in the study that there were significant negative correlations between squat jump, countermovement jump and rate of leg fat. However, no significant correlations were observed among Yo-Yo IR1, countermovement jump and squat jump with other total/regional body composition (p>0.05).

Examining the comparative DEXA analysis of the body composition of professional soccer players in the literature, it was found out that they had greater lean mass but lower body fat ratios in 1st team (10.0 ± 1.6) compared with both U21 (11.6 ± 2.5, p=0.02) and U18 (11.4 ± 2.6, p=0.01) soccer players (1). Body mass and height values of soccer players were consistent with those reported in previous studies (16-17,24). Moreover, the body fat ratio found out in this study (14.1%) was similar to those reported in some other studies (16-25,26) however, it was found out to be lower compared with some other studies (15). This discrepancy was regarded to stem from different methods used to obtain data about body fat ratio, different data collection times (pre- or during season), and differences in training programs.

It is important to study body composition in such sports where players regularly have to move body weight against gravity (27). There are many methods used to assess body composition; however, the mostly preferred method in soccer players is the bi-compartmental anthropometric method. Despite the lack of a commonly acknowledged formula to calculate soccer players' body fat ratio, dual-energy X-ray absorptiometry (DXA) has recently become a popular standard for body composition analysis (2-9,10). Thus, DXA was used in this study to measure total and regional body composition since it is acknowledged to provide a reliable measurement.

Soccer players should have the ability to produce high muscular power in lower limbs, and the counter-movement-jump and squat-jump test measures this ability in a reliable way (27). This study did not report significant relationships between total/regional body composition and SJ and CMJ values. The only negative relationships are between percentage of leg fat with SJ and CMJ. According to these results,

The findings of the present study are consistent with those of previous studies. For example, in the study of Atakan et al., no significant correlations were found among CMJ, SJ and body fat, fat mass index and body fat ratio in young soccer players (15). Similarly, Stojanović et al. did not find a significant relationship between body mass and vertical jump performance in his study conducted with adolescent male students (28). Although there were only relationships between leg fat ratio and SJ and CMJ, and no relationships were found between other total/regional body composition and SJ and CMJ in this study.

Examining the studies in literature, in contrast to the regional body composition, the relationship between total body fat percentage and jump performance were focused on mostly. Pérez-López at al. reported significant correlations between height values of the three vertical jump tests (SJ, CMJ, CMJ with arm swing) and body composition variables of height, weight, fat mass, and fat free mass ($p< 0.01$) in young soccer players (26). Similarly to this study, Silvestre et al. found that vertical jump correlated moderately with total mass and lean tissue ($r=-0.48$; $r=-0.54$). Their study also revealed a negative correlation between body fat ratio and vertical jump ($r=-0.55$) in young soccer players (12). More recently, Hilgemberg-Figueiredo et al. reported negative correlation between body fat ratio and performance of SJ ($p=0.001$), CMJ ($p=0.011$) (13).

Another finding of this study was not revealing statistically significant relationships between Yo-Yo IR1 with total/regionalbody composition. However, there are a few studies to correlate body composition variables and Yo-Yo IR performance. The findings of the present study for Yo-Yo IR1 are similar to those presented by Hilgemberg-Figueiredo et al. in college soccer players who were tested at the beginning of a season, which found no significant correlations between starting body fat and lean mass ratio during pre-season with, VO_2max and distance covered (Yo-Yo IR1) ($r=-0.18$) (13). Contrary to our study, Silvestre et al. found that total body fat had negative correlation with cardiorespiratory capacity (Yo-Yo Endurance Test) ($r=-0.67$). This study also reports that, percent body fat had a negative correlation with cardiorespiratory capacity ($r=-0.65$) (12). Similarly to this research, Nalbant and Ozer found out significant relationship between aerobic fitness (Yo-Yo IR1) and rate of body fat ($r=-0.55$) in young soccer players (16).

This significant difference might be due to the variety in duration of training and the content of the practice. In addition, different measurement protocols and number of participants might have caused such a difference. Further studies should be carried out by using larger samples. Since body composition and performance variables were only measured before the season, a further study collecting the data during the season to describe trends in body composition and performance variables among young soccer players is recommended.

To conclude; the results of the study revealed significant negative correlations between squat jump and countermovement jump with rate of leg fat. However, no significant correlations were found among Yo-Yo IR1**,** squat jump and countermovement jump with other total/regional body composition ($p>0.05$). Body composition is a significant factor that affects the physical performance level of young soccer players since regional excess body fat may detriment performance. The major findings of this study displays that soccer players with less body fat and increased lean mass rate prior to season, present an advantage for certain physical performance indicators.

Since excess body fat has a potential to decrease performance, body composition becomes a crucial aspect for the physical performance level of amateur and professional soccer players. Coaches are recommended not to allow young soccer players to increase body fat as it might cause physical performance loss before the pre-season.

Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Eskişehir Technical University Health Sciences Institute Scientific Research and Publication Ethics Committee (Decision no: 16403 Date: 28.06.2019).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept All authors; Design All authors; Supervision All authors; Materials All authors; Data Concept: EA, SO; Design: EA; Supervision: EA; Materials: EA, SO; Data Collection and/or Processing: EA, SO; Analysis and Interpretation: EA, SO; Literature Review: EA, SO; Writing Manuscript: EA, SO; Critical Reviews. EA

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