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The Relationship Between Reactive Strength Index and Agility in Young Male Volleyball and Basketball Players

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Abstract
This study aimed to determine the relationship between the reactive strength index (RSI) and agility in young male volleyball and basketball players. A total of 24 athletes, 12 volleyball players (mean age: 17.08±1.31 years) and 12 basketball players (mean age: 16.25±1.06 years), participated in the study voluntarily. The athletes were tested for RSI and performed the countermovement jump (CMJ) test as well as the T agility, Illinois, and 505 agility tests. The assumption of normality of the data was tested using the Shapiro-Wilk test. Since the data exhibited normal distribution, parametric tests were employed: the Independent T-test to compare two independent groups and the Pearson Correlation test to examine relationships between parameters. According to our findings, whereas no significant difference was observed between the two sports with respect to the athletes' performances on the RSI, CMJ, and the T agility and Illinois agility tests ($p > .05$), there was a significant difference in the 505 agility test results in favor of the volleyball players ($p < .05$). A strong negative correlation existed between the CMJ and Illinois agility test in the volleyball players ($r = -.748$; $p = .005$), while a moderate negative association was detected between CMJ and Illinois agility and 505 agility tests in the basketball players ($r = -.634$; $p = .027$; $r = -.604$; $p = .038$). There was no correlation between RSI and agility in the volleyball or basketball players ($p > .05$). Overall, the Illinois agility test times decreased as CMJ heights increased for the volleyball players, indicating improved agility with more remarkable jumping ability. As the CMJ heights for the basketball players increased, the Illinois agility and 505 agility test times decreased, again pointing to enhanced agility. It is recommended to investigate the subject with different groups of athletes and experimental applications.

Anahtar kelimeler: *Basketball, Agility, Reactive Strength, Volleyball*

Genç Erkek Voleybol ve Basketbolcularda Reaktif Kuvvet İndeksi ile Çeviklik Arasındaki İlişki

Özet

Bu araştırma, genç erkek voleybol ve basketbolcularda reaktif kuvvet indeksi (RSI) ile çeviklik performansı arasındaki ilişkinin belirlenmesi amacıyla yapılmıştır. Araştırmaya düzenli olarak antrenman yapan 12 voleybol (yaş:17.08±1.31 yıl) ve 12 basketbolcu (yaş: 16.25±1.06 yıl) olmak üzere toplam 24 genç erkek sporcu gönüllü olarak katılmıştır. Araştırmada sporculara RSI, counter movement jump (CMJ), T testi, illinois ve 505 çeviklik testleri uygulanmıştır. Araştırmadan elde edilen verilerin istatistiksel analizlerinde SPSS paket programı kullanılmıştır. Verilerin normallik varsayımı Shapiro-Wilk testi ile sınanmıştır. Veriler normal dağılım gösterdiği için parametrik testlerden iki bağımsız grubun karşılaştırılmasında Indepentend T testi, parametreler arasındaki ilişkinin incelenmesinde ise Pearson Korelasyon testi kullanılmıştır. Bulgulara göre voleybol ve basketbolcuların RSI, CMJ, T testi ve illinois çeviklik testi performanslarında branşlar arasında anlamlı farklılık bulunmazken ($p>0.05$), 505 çeviklik testinde voleybolcuların lehine anlamlı fark tespit edilmiştir ($p<0.05$). Çalışmada voleybolcularda CMJ ile illinois çeviklik testi arasında negatif yönlü yüksek düzeyde bir ilişki belirlenmiştir ($r=-.748$; $p=.005$). Basketbolcularda CMJ ile illinois çeviklik ve 505 çeviklik testleri arasında negatif yönlü orta düzeyde bir ilişki bulunmuştur ($r=-.634$; $p=.027$; $r=-.604$; $p=.038$). Voleybol ve basketbolcularda RSI ile çeviklik arasında ise anlamlı bir ilişki bulunmamıştır ($p>0,05$). Sonuç olarak voleybolcularda CMJ yüksekliği arttıkça illinois çeviklik testi süreleri azalmaktadır. Yani voleybolcuların çeviklik performansı artmaktadır. Basketbolcuların CMJ yüksekliği arttıkça illinois çeviklik ve 505 çeviklik süreleri azalmaktadır. Yani basketbolcuların çeviklik performansları artmaktadır. Konunun farklı sporcu grupları ve deneysel uygulamalar ile araştırılması önerilmektedir.

Keywords: *Basketbol, Çeviklik, Reaktif Kuvvet, Voleybol*

Introduction

The basic biomotor properties utilized in many sports are an indispensable part of any training regimen, and, when employed regularly, positively affect athletic development (Sevim, 2002). Of the biomotor characteristics, strength constitutes one of the main determinants of success in sports. However, the importance of these properties depends on the type of sport or activity. The reactive force index (RSI) is a tool for monitoring the stress on muscles and tendons (McClymont and Hore, 2003), determining height as measured by amplitude and incorporating the length of ground contact time. The reactive force obtained following the jump is calculated by dividing the jump height (mm) by the ground contact time (ms) (Çoban et al., 2022). The RSI components of jump height and ground contact time also provide useful information for trainers (McClymont and Hore, 2003).

Another biomotor characteristic that affects performance is agility, defined as the ability to move the body and change direction between two points with ease, speed, and fluidity while employing balance, speed, strength, and neuromuscular coordination in a controlled manner (Turner, 2011). This property enables the body to rapidly change shape or transfer its mass to another side by altering the direction of movement without disturbing its balance. From a contemporary perspective, agility represents an athletic skill that is influenced by numerous physical and cognitive factors (Özbay et al., 2018) and is considered a major determinant of performance, especially in team sports (Drake et al., 2017).

Basic biomotor abilities affect athletic performance in team sports as well as the development of the athlete. Volleyball, a team sport that utilizes an athlete's personality, intelligence, and ability to work collectively, is a social sport that enhances self-confidence (Aslan, 1979). When considering the case of volleyball, the first thing that comes to mind is that the volleyball player should possess excellent jumping ability and be tall. At the same time, a successful volleyball player must be able to move quickly all over the court and have fast reaction times, low body fat, large hands, and strong yet flexible wrists and fingers in order to return the ball. As matches may last for up to 2-3 hours, high endurance levels are also critical (Günay, 2013). Another sport that requires reactive strength and agility is basketball, in which all of the basic biomotor characteristics need to be developed in a coordinated fashion. This development plays an active role in improving and shaping biomotor properties (Bektaş et al., 2007). In basketball, which incorporates high-intensity activity, fast attacks and high jumps are crucial for a successful defense. Basketball players must have well-developed agility and jumping skills in order to achieve victory over their opponents; hence, agility and jumping ability are of critical importance (Arı et al., 2017). The court time of a player during a match increases with the success of the player's dribbling, passes, and overall performance (Usgu, 2015).

In general, most of the basic properties of relevance for volleyball and basketball are similar to each other. It is thus inevitable that strength and agility, the most important basic reactive features, are shared by these two sports. In order for volleyball and basketball players, who require both good techniques and tactics, to be more successful, basic reactive properties should be further developed and studies on this topic should continue (Pulur, 1991).

Reactive strength and agility occupy an important place in volleyball and basketball, in which jumping and sudden changes of direction are imperative. The present study aimed to determine the relationship between the reactive strength index and agility in young male volleyball and basketball players. A comprehensive literature review uncovered very few studies on the reactive strength index and no study investigating the relationship between the former with agility in volleyball and basketball players. The fact that features such as jumping, reactive strength and agility are important factors for sportive success in these branches makes the study important. Thus, the results of this study are expected to represent a contribution to the literature.

Methods

Research Model

This study employed the relational screening model, which involves determining whether covariance exists between two or more variables and if so, to what degree (Karasar, 2011). The following tests were conducted on the athletes participating in this study: RSI, CMJ, and the T agility, Illinois agility, and 505 agility tests.

Participants

A total of 24 young male athletes, 12 volleyball and 12 basketball players, who train regularly, participated in the research voluntarily. Prior to the start of the study, ethical approval was obtained from Muş Alparslan University Scientific Research and Publication Ethics Committee (date: 03.01.2023, no. 77250). The athletes participating in the study verbally declared that they had not experienced any health problems or undergone any surgical operations. The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

The athletes received detailed information regarding the tests and measurements involved as well as the possible benefits and risks of the study. The measurements and tests were carried out by the athletic performance trainer by making the athletes do a standard warm-up. The general characteristics of the athletes participating in the study are presented in Table 1.

Table 1

General characteristics of the participants

Characteristic	Sport	N	Mean±SD	t	*p*
Age (years)	Volleyball	12	17.08±1.31	1.715	.100
	Basketball	12	16.25±1.06		
Height (cm)	Volleyball	12	179.00±6.41	1.780	.089
	Basketball	12	174.92±4.70		
Weight (kg)	Volleyball	12	67.66±6.39	1.067	.298
	Basketball	12	64.12±9.53		
BMI (kg/m^2)	Volleyball	12	21.08±1.73	.149	.883
	Basketball	12	20.94±2.77		

Data Collections Tools

Height measurement: The height of the participants was measured in cm using a Seca brand stadiometer, while the athletes were in their bare feet.

Body weight (mass) measurement: The body masses of the athletes were determined by using a digital scale with a precision of 0.10 kg, while the participants were barefoot, wearing only shorts and T-shirts.

Reactive force index (RSI) measurement: A Fusion brand SmartJump electronic jump mat was used to determine the reactive strength index. Prior to each use, the jump mat data was reset to zero. Each athlete began the test by jumping from outside onto the mat with their hands on their waist. In total, 11 jumps were conducted for the RSI measurement, the first jump being excluded from the assessment as it was a countermovement jump (CMJ) that initiated the performance of the next 10 jumps. Vertical Ground Reaction Force (GRF) data were collected for 15 seconds at a sampling rate of 1000 Hz. The athletes were instructed to jump as high as possible while minimizing ground contact time. The average (mean) of the 5 best jumps was used to calculate the RSI. This test was performed by each athlete twice with 90 seconds of rest between trials and the highest scores were recorded (Stratford et al., 2020).

Countermovement jump (CMJ) test: The CMJ measurements of the athletes were also taken using a Fusion brand SmartJump electronic jump mat. All athletes were directed to stand on the mat with their hands placed on their waists, and when ready, to jump the maximum height possible. Following each jump, the athletes fell back onto the mat. The jump heights of the athletes were measured in cm and their best scores out of two trials were recorded (Atan, 2019).

T Agility Test: This test was measured with a Smart Speed brand photocell device with a sensitivity of 0.01 sec. The T agility test consists of four contact points that form a T-shape in an area measuring 10 m long by 10 m wide. The athletes must complete a series of movements in different directions, both forward and backward, between the contact points as quickly as possible. What distinguishes this agility test from others is that the athlete always looks in the same direction, changing direction by shifting to the right or left, or running backward. This test requires two 90-degree and 180-degree turns, as well as moving 10 m forward, right, left, and backward, for a total distance of 40 m. The athletes performed the test twice and their best scores were recorded (Özbay et al., 2018).

Illinois Agility Test: A Smart Speed brand photocell device was used to measure the test times. Following the preparation of the test track, a two-door photocell system, measuring to a precision of 0.01 seconds, was placed at the start and finish of the track. The athletes were asked to stand in the 1-meter pool of the starting photocell and to begin running when ready. The athlete moved from the starting photocell in the direction of the arrows, eventually completing the course in the second photocell at the finish. The length of the runway was 18 m, with 3 cones, placed 1.2 m apart, at the turning points. The distance between the cones in the middle section of the track was 4.5 meters. This test was performed by each athlete twice, with the best scores recorded (Miller et al., 2006).

505 Agility Test: This test, which also utilized a Smart Speed brand photocell device, consists of a 10-meter approach run followed by a 5-meter round-trip. After the track was prepared, a two-door photocell system, which measures to a precision of 0.01 seconds was placed on a 5-m line at both the start and finish. In the direction of the approach run, the first door constitutes a stop while the second door is a start. The time measured for the 5-meter round trip distance was recorded in seconds. The participants, who were allowed to make several practice runs at a slow pace after being briefed on the test, performed it twice, at an interval of 3-4 minutes. The best score for each athlete was recorded (Hazır et al., 2010).

Data Analysis

The SPSS statistical package program was used to process the data obtained in the study, including the generation of descriptive statistics and statistical analysis of the data. The Shapiro-Wilk test was employed to determine whether the data exhibited normal distribution. Since the data were determined to be normally distributed, the Independent T-test and the Pearson Correlation test (both parametric tests) were used, respectively, to compare two independent groups and to examine the relationships between parameters. A value of $p < .05$ was considered statistically significant.

Result

The results of the comparisons of the agility, CMJ, and RSI scores of the participating young male volleyball and basketball players are presented in Table 2.

Table 2

Comparison of RSI, CMJ, and agility test results by sport

Parameter	Sport	N	Mean±SD	t	*p*
T Agility (sec)	Volleyball	12	11.44±0.68	-.241	.812
	Basketball	12	11.51±0.79		
Illinois Agility (sec)	Volleyball	12	17.28±0.81	-1.190	.247
	Basketball	12	17.81±1.31		
505 Agility (sec)	Volleyball	12	2.53±0.08	-2.307	.031*
	Basketball	12	2.66±0.19		
CMJ (cm)	Volleyball	12	39.04±5.24	2.019	.056
	Basketball	12	35.09±4.31		
RSI	Volleyball	12	1.35±0.23	-1.812	.084
	Basketball	12	1.55±0.29		

*$p < .05$

According to Table 2, although there were no significant differences between the groups with respect to the T agility, Illinois agility, CMJ, and RSI parameters ($p > .05$ for all), the 505 agility test times of the volleyball players were lower than those of basketball players ($p < .05$).

Table 3

Correlation test results for volleyball

Variable		T Agility	Illinois Agility	505 Agility
CMJ	r	-.480	-.748**	-.300
	p	.114	.005	.344
RSI	r	.133	.099	.211
	p	.680	.760	.511

$^*p < .05$; $^{**}p < .01$; n = 12

A strong negative correlation was observed between CMJ and the Illinois agility test for young male volleyball players (r = -.748; $p = .005$), whereas there was no significant relationship between RSI and either of the agility tests ($p > .05$ for both).

Table 4

Correlation test results for basketball

Variable		T Agility	Illinois Agility	505 Agility
CMJ	r	-.236	-.634*	-.604*
	p	.460	.027	.038
RSI	r	-.287	-.193	-.459
	p	.367	.548	.134

$^*p < .05$; $^{**}p < .01$; n = 12

Moderate negative correlations were detected between CMJ and the Illinois agility (r = -.634; $p = .027$) and 505 agility (r = -.604; $p = .038$) tests for young male basketball players, while no significant relationship existed between RSI and either agility test ($p > .05$ for both).

Figure 1

The relationship between CMJ and illinois agility in volleyball players

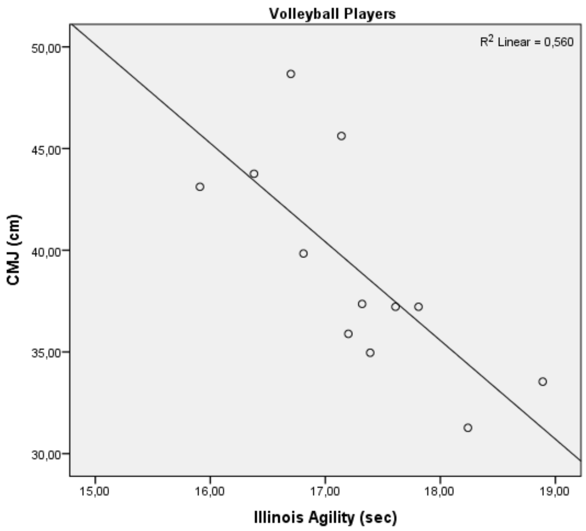

Figure 1 depicts the negative relationship between CMJ and the Illinois agility scores of the volleyball players. As the graph shows, increased CMJ heights are correlated with decreased Illinois agility test times, indicating enhanced agility performance.

Figure 2

The relationship between CMJ and illinois and 505 agility in basketball players

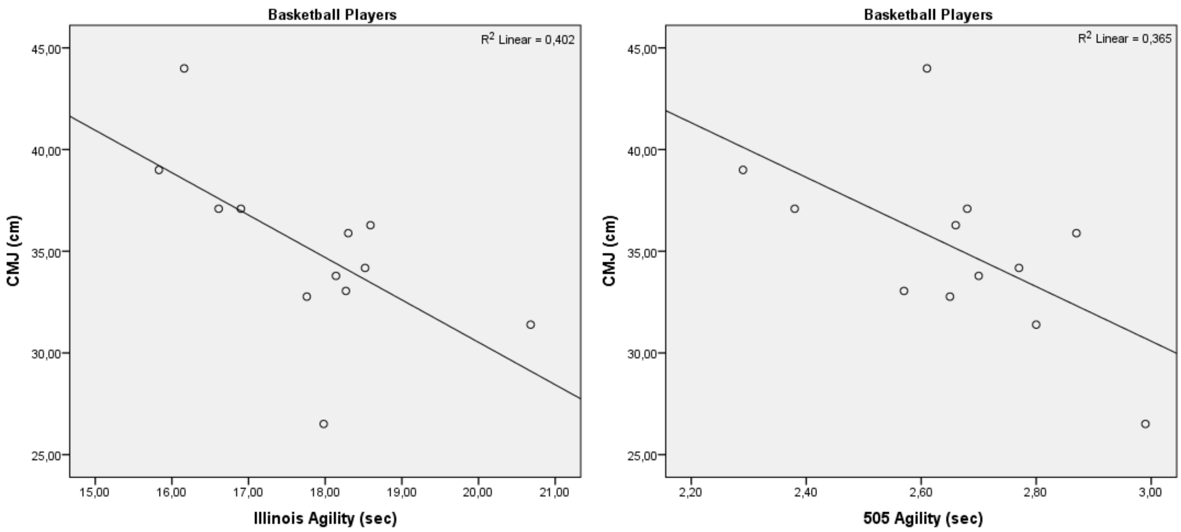

Figure 2 presents the graphs showing the negative relationships between CMJ and the Illinois agility and 505 agility test results of the basketball players. According to these graphs, as the CMJ height increases, the times recorded for both agility tests decrease, corresponding to improved agility.

Discussion

In this study, we investigated the relationship between the reactive strength index and agility in young male volleyball and basketball players. The 505 agility test performances of the volleyball players were superior to those of the basketball players, a finding that can be explained by the fact that the former, especially those who play defense, must return to their own zones immediately after striking the ball close to the ground. A strong negative correlation existed between CMJ and Illinois agility for the volleyball players, while for the basketball players, moderate negative correlations between CMJ and the Illinois and 505 agility tests were observed. As the CMJ heights of young male volleyball and basketball players increased, the Illinois agility times decreased, showing an improvement in agility performance. Among the relational studies in the literature, Ateş (2018) detected a weak correlation between the T agility test results of U19 (under 19 years of age) football players and the CMJ and squat jump tests. Aktaş et al. (2020) determined that the agility of basketball players improved as their vertical jump distances increased. In a study on elite athletes, Tatlısu et al. (2019) reported a negative significant relationship between vertical jump heights and agility times, consistent with our results. Mor et al. (2022) reported that resistance band exercises increased vertical jump and Illinois agility performance in young football players. However, Arı and Tunçel (2020) found no relationship between agility and jumping ability in their study on female futsal players. The reason for this discrepancy with respect to our results may be due to differences in gender and/or the sport being studied.

Concerning RSI, our study found no significant relationship between it and agility in the participating young male volleyball and basketball players. Hazır et al. (2010) reported no significant relationship between the strength values measured in a 30-second multiple jump test and the Illinois and 505 agility tests. In his study on professional male basketball players, Alemdaroğlu (2012) did not observe a significant relationship between anaerobic strength and the T agility test. Although these results are consistent with those obtained in the present study, the findings of other studies in the literature differ from those of our study; for example, Young et al. (2002) determined that a significant relationship existed between reactive strength and agility. Kayhan et al. (2021) detected a strong correlation between RSI and agility performances in young football players. In a study by İnce (2020) on young volleyball players, a weak correlation between RSI and the T agility test was observed, while Pandey and Chaubey (2015) reported a negative relationship between explosive strength and agility in male football players.

The discrepancies between these results and those of our study may be attributed to the training level of the athletes and/or to individual differences.

Conclusion

According to our findings, the Illinois agility test performances of young male volleyball players improved as their CMJ heights increased. Similarly, for the basketball players, higher CMJ results were also correlated with improved performances on the Illinois agility and 505 agility tests. However, no significant relationship was detected between the RSI and agility performances of the volleyball and basketball players who participated in our study. It is recommended to investigate the subject with different groups of athletes and experimental applications.

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