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ORIGINAL ARTICLE

Investigation and Interpretation of Maximal and Reactive Strength Index Characteristics of 16-17 Age Group Basketball Players

SİNAN KARA[1], MERVE ÖZAL[1], MEHMET ÖZAL[2]
[1]*Gazi University, Faculty of Sports Sciences*
[2]*Ankara Yıldırım Beyazıt University, Faculty of Sports Sciences*
Correspondence to: Mehmet Özal, Email: mozal@ybu.edu.tr, Cell: +903129061949

ABSTRACT

Aim: The aim of the study was determined as the examination of the reactive strength index parameter, which shows the maximal strength and explosive force characteristics of 16-17 age group basketball players determined by isometric test.

Method: The basketball branch X_{age} = 16.50 ± 0.51 years, X_{Height} = 177.22 ± 8,56 cm, X_{BW}= 73.14 ± 12,43 kg, X_{BMI}= 23.26 ± 3,46 kg / m^2, and X_{BFP} = 14.72 ± 5.67% of which 32 are men. In the study, the measurements of the height of the participants were made with Holtain brand stadiometer, body weight and fat percentage ratio measurement with Tanita BC 418 MA, reactive strength index measurement with Opto Jump Next, and maximal strength measurement with Baseline brand leg dynamometers. Pearson test was used to determine the relationship between branch-specific MS and RSI.

Results: According to the correlation results, no significant relationship was found between MS and RSI (p>0.05).

Conclusions: As a result, it has been determined that basketball players between the ages of 16-17 do less quality work on developing MS and explosive force.

Keywords: Basketball, Maximal Strength, Reactive Strength İndex.

INTRODUCTION

In this part of the study, conceptual information about the Maximal and Reactive Strength Index features demanded by basketball players was given.

Strenght includes different forms in itself. Especially the Maximal Strength (MS) took place in the studies in detail. In the literature, MS is defined as the ability to produce the highest level of force in the nervous musculature system by voluntary [1,2]. In another definition, MS is stated as the highest value force that can be developed voluntarily in situations where isometric contraction will occur or during a slow-motion practice[3].

Maximal strength is an integral part of athletic performance[4,5]. Therefore, observing and evaluating the MS production characteristics of athletes is of great importance for sports scientists, strength and conditioning trainers[4]. To determine the effectiveness of the training and to have information about the future performance of the athlete, the methods of determining the MS capacity of a very common repetition such as the back squat, deadlift, and power clean are considered appropriate[4,6]. It has been stated that these methods cause injury to the athlete, so isometric strength measurements are used to evaluate MS capacity[4]. In addition to these definitions, according to MS Muratlı et al. 2011, weightlifting, gymnastics, hammer and shot put, wrestling, judo, etc. It is of great importance in sports[7]. In the branches where there is competition, more power increase is aimed by increasing the MS level[8].

The concept of Reactive, which is one of the subjects of our study, is defined as the ability to instantly switch from the eccentric to the concentric phase of a dynamic movement. The purpose of a reactive movement is to lose as little power as possible from the stretch-shortening cycle (SSC) that builds up during the eccentric and isometric phases. The reactive nature of the movement means that all three phases must be completed as quickly as possible[9].

Especially after the MS development process, it is desired to increase the reactive strength of the athletes. In studies, reactive strength is defined as the ability of the muscle-tendon unit to produce a strong concentric contraction after a rapid eccentric contraction[10].

Features such as jumping force, shooting force, and sprinting force[11] have an important place in the implementation of technical movements[12]. Strength, force, and speed is an important factor for performance athletes in intermittent sports branches[13].

Recently, the reactive strength index (RSI) has been used in sports sciences to determine the plyometric or stretch-shortening cycle as well as to quickly determine strength and conditioning[14].

Reactive strength is determined by RSI, usually by making a depth jump (DJ)[10,14,15,16]. Developed first at the Australian Institute of Sports, DJ and RSI assessments are made by jumping from a certain height to the ground, minimum contact, and maximum jumping. The RSI determined by DJ is calculated by dividing the jump height by the ground contact time (the time it contacts the ground when falling from a height)[14,17,18,19]. A range of box heights, usually between thirty and sixty centimeters, is used to determine the athlete's RSI against different eccentric tension loads[10]. In a study conducted by Flanagan et al. in 2008, it was stated that performance increased as the vertical jump height increased from ten to forty centimeters in trained athletes[14].

Reactive strength training is generally called "plyometric". Plyometric, which was first expressed as the "shock" method in Russia, is a training method for jumping that includes an eccentric exercise applied to the muscle-tendon structure with depth jumps[10,20]. Plyometric training is widely used in speed and strength development studies[14]. Studies have shown that plyometric training increases the athlete's sprint[11], agility[20], change of direction[21] and running economy[22,23]. The ability of athletes to use eccentric and concentric contraction properties effectively is an important performance criterion in many sports[24,25,26,53,54]. The vertical jump method is one of the most preferred methods for determining the explosive power characteristics of athletes[25]. In this context, it was stated by sports scientists and strength-conditioning trainers that it is important to measure and monitor the characteristic performance of athletes and to observe the effects of the applied training[24].

The explanations of the basketball players who constitute the research group of our study are given below.

Basketball, in which jumping and strength features are dominant, is a team sport played with the ball and hand in the form of two teams of five players. It is important for basketball players to have good basic motor skills such as speed, strength, endurance, flexibility, and coordination[27]. One of the most important features among the performance criteria accepted by strength and conditioning trainers is to reach the highest vertical jump distance[28]. In order to be successful during basketball competitions, it is necessary to develop explosive strength as well as technical, tactical, and mental development[12,29]. Therefore, performing an effective performance requires sufficient lower extremity strength[29]. Vertical jump tests are used to determine this power.

In order for basketball players to be successful in the competition, it is thought that the maximal and reactive strength index parameters should be at a good level as well as their technical capacity. Maximal and reactive strength index features play an important role in athletic performance as they improve neuromuscular coordination[10,30]. In addition, the characteristic feature of the branch is the development of some features (such as maximal strength, explosive strength) as a result of the adaptation of metabolism over time, depending on the training content. maybe more[31].

Within the scope of the above literature, the aim of the research was to examine the reactive strength indexes of the 16-17 age group basketball players, which show the maximal strength and explosive strength characteristics determined by the isometric test.

MTERIAL AND METHOD

Research Group: The research group consisted of basketball players whose sports age is 2-5 years, who train two days a week at Ankara Yıldırım Beyazıt University Youth and Sports Club and participate in competitions.

In this research, X_{age}=16.50±0.51 years, X_{Height}=177.22±8,56 cm, $X_{Body\ Weight}$ =73.14±12,43 kg, X_{BMI}=23.26±3,46 kg/m2, and X_{BFP} =14.72±5.67% Thirty-two male basketball players participated. This study was carried out on volunteers who did not experience any physical, physiological, and psychological disorders in the last six months.

Before starting this research, the ethics committee approval dated 15.03.2021 and decision number 06 was obtained from Ankara Yıldırım Beyazıt University Social and Human Sciences Ethics Committee, and an "informed consent form" was obtained by informing all the volunteers about the research.

Data Collection Tools: In this section, the tools used in the measurements of height, body weight, body fat percentage, leg strength, and reactive force index obtained from the research group are given.

Height, Body Weight and Fat Measurement: The heights of the athletes were taken with a holtain stadiometer (Made in Britain, Holtain Limited, Crymych, Dyfed) with a sled system with ±1 mm accuracy. Body weight (BW) and body fat percentage (BFP) and measurements of the athletes were determined by Tanita BC 418 MA body analysis (Maeno-Cho, Itabashi-Ku, Tokyo, Japan). A baseline brand leg dynamometer was used to determine the maximal strength of the lower extremity[10,32].

Lower Lımb Strength Measurement: A baseline brand leg dynamometer was used to determine the maximal strength of the lower extremity[10,32].

Reactive Strength Index Measurement: The reactive strength index of the athletes was determined with the Opto Jump Next (Bolzano, Bozen, Italy) brand device[10,15,33]. In the researches, the vertical jump frame height of 40 cm was preferred as the most reliable measurement[34]. Therefore, in this study, the most reliable frame height, the vertical jump frame height of 40 cm, was preferred.

Data Collection: In this section, explanations about height, body weight, body fat percentage, lower extremity maximal strength, and reactive strength index measurements obtained from the research group are given.

Height Measurement: Athletes who took the height measurement with bare feet in shorts and T-shirts were asked to stand in an anatomical position by touching the vertical metal bar of the dynamometer with their back and heels. Height measurement results were read on the device and recorded in cm.

Body Weight and Body Fat Percent Measurements: Athletes should not eat anything, should not consume liquid food (water, coffee, alcohol, etc.) at least 3 hours before the measurements of their body weight and body fat percentage, in shorts and T-shirts, should not train before the day of the test, should not enter the sauna or bathroom. First of all, information about meeting their toilet needs was conveyed the previous day and the test day. Before starting the test, 0,5 kg of tare was taken from the Tanita measuring instrument and the age and height values of the participants were entered into the device. Afterward, the participants were asked to step on the metal part of the Tanita device with their bare feet, and after the Tanita measuring device determined their body weight, they were asked to hold the right and left-hand grips on the device with both hands without bending their elbows, their arms parallel to their body and five centimeters away from their body until the measurement was completed. After the Tanita instrument completed the measurement, the participant's BFP (%) and BW (kg) values were taken as a printout.

Leg Strength Measurement (Maximal Strength): Athletes were asked to participate in the test in shorts, T-shirts, and sneakers. Before starting the test, 5 minutes of low-tempo jogging and two minutes of dynamic stretching exercises were performed as part of the warm-up. Athletes were asked to put their feet on the places marked with the foot-stripe section on the dynamometer, to bend their knees up to $131^0 \pm 9^0$, and to keep their waist straight[10]. The chain of the dynamometer was adjusted so that it reached the middle of the thigh above the participant's knee. After a trial was made for the participants to get used to the test, they were given the right to pull twice and a recovery period of two minutes between the pulls. Athletes were challenged with verbal phrases to motivate while doing traction. The last data indicated by the needle of the dynamometer was recorded in kg[35].

Reactive Strength Index Measurement: The vertical jump protocol in the Opto Jump Next® program was used to determine the RSI value. After giving verbal information about the measurement before the test, the participants were warmed up for two minutes for jumping. After making familiarization jumps to the test, the participants were asked to climb onto the wooden box with a height of 40 cm[10,14,34,36,37,38,39,40,41,42]. With their hands on their waists, they were asked to extend one foot forward and fall into the $1m^2$ interior of the device, which is parallel to each other on the floor, and jump as high as they can as soon as they touch the floor[41]. The athletes were asked not to bend their knees during this jump and to complete the test with tension. The test was repeated twice with 30-second rest intervals, and ground contact time and jump height were recorded for RSI based on the highest RSI (m/s) result (the formula is given below)[10].

Statistical Analysis: Descriptive statistics (mean and standard deviation) were applied for numerically obtained variables such as age, height, and body weight of a total of 32 athletes participating in the study. Whether the variables were suitable for normal distribution was determined by the Shapiro Wilks test and graphical methods. For the correlation analysis, "Pearson Correlation" analysis was performed for the variables satisfying the normality condition, and "Spearman Correlation" analysis was performed for the variables not meeting the normality condition. The level of significance for statistical analyzes was accepted as $p<0.05$[43]. SPSS 22.0 program was used for statistical analysis of the data.

RESULT

Table 1. Physical Characteristics of the Participants.

Physical Properties	N	Average	Standard Deviation
Age (y)	32	16,50	,51
Height (cm)	32	177,22	8,56
Body Weight (kg)	32	73,14	12,43
Body Mass index (kg/m^2)	32	23,26	3,46
Body Fat Percentage (%)	32	14,72	5,67

As seen in Table 1, the average age, height, body weight, body mass index, and body fat percentage of basketball players are indicated.

Table 2. RSI and MS values of basketball players.

Physical Properties	N	Average	Standard Deviation
RSI (m/s)	32	1.13±0.23	,23
MS (kg)	32	144.30±28.37	28,37

p<0.05*

In Table 2, the RSI and MS values obtained as a result of the measurements made on the basketball players are indicated.

Table 3. The relationship between MK and RKI characteristics of basketball players.

Physical Properties	N	Average	Standard Deviation	Statistics	
				r	p
RSI (m/s)	32	1.13±0.23	,23	,359	,188
MS (kg)	32	144.30±28.37	28,37		

p<0.05*

No statistically significant relationship was found between the maximal strength and RSI values of basketball players(p>0.05).

DISCUSSION

In the study, the mean age of the basketball group was 16.50±0.51y, height was 177.22±8.56cm, body weight was 73.14±12,43 kg, and BMI was 14.72±5.67. In a study conducted by Snyder et al. in 2018 with 10 basketball players, the mean age of the athletes was 16.5±0.7y, their height was 1.78±0.07m, and their body weight was 69.5±9.1kg[44]. In a study conducted by Struzik et al. in 2016 with 8 basketball players, the mean age of the athletes was 17.0±0.2y, height 188.4±6.4 cm, and body weight 79.6±7.4 kg[29]. As a result of these results, the basketball group athletes in our research and the basketball players in the literature show similarities.

X_{BFP}=14.72±5.67 % of the basketball players in our research group were determined. In the study conducted by Erol and Sevim on basketball players, the BFP was reported as 10.96±2.15[12]. In the study conducted by Çelik and Pulur, the BFP of basketball players was declared as 8.15±1.18[27]. It is seen that the BFPs of the basketball players in the literature are lower than those of the basketball players in our research group. This low value is thought to be due to the less frequent training of our research group.

According to the results of the research, the MS values of the basketball players were determined as X_{MS}=144.30±28,37 kg. In a study conducted by Gürpınar et al. in 2009 with 19 young male basketball players between the ages of 16-17, X_{MS}= 131.11±10.54 kg[45] and Bavli in 2012 with 24 (X_{age}= 20.7±2.6 years) amateur male basketball players. It was stated that 12 athletes in the control group (X_{age}=19.2±2.1 years, $X_{spor\ age}$=7±2.3 years) weighed X_{MS}=141.8±14.8 kg[46]. In the experimental group consisting of 12 athletes (X_{age}=22.1±2.4 years, $X_{sport\ age}$=9.1±3.1 years) to whom Bavli had plyometric training, X_{MS} was stated as 166.8±6.1 kg[46]. When the data obtained and the data in the literature are compared, it is seen that the leg strength of the basketball players in our study is slightly higher than the leg strength of the control group mentioned in the literature, but it is considerably lower than the leg strength of the experimental group. As a result, we can say that the training content of the basketball players in our study did not include training to improve maximal strength.

In the study, the X_{RSI} of the basketball players was determined as 1.13±0.23m/s. In a study conducted by Struzik et al. in 2016 on young basketball players, it was stated that X_{RSI} obtained from a height of 45 cm was

1.19±0.31m/s[29]. In the study conducted by Bird et al. in 2014 with 13 male basketball players playing in the national basketball league with X_{age} = 25.8 ± 3.5 years, vertical jump at 40 cm box height was determined as X_{RSI} = 2.13 ± 0.26 m/s[34]. In the study conducted by Brandon et al. in 2018, with 10 basketball players X_{age} =16.5 ± 0.7 years, X_{RSI} determined by the vertical jump at 40 cm box height was specified as 0.82 ± 0.20 m/s[38]. In a study conducted by Santos et al. in 2012 with 15 male basketball players X_{age} =14.5 ± 0.6 years, X_{RSI} determined by the vertical jump at 40cm box height was specified as 0.99m/s[40]. In the study conducted by Kipp et al. in 2018 with 12 male basketball players competing in the NCAA premier league with X_{age} = 21.6 ± 1.8 years, X_{RSI} was determined as 1.63 ± 0.43 m/s, which was determined by the vertical jump at a height of 45 cm[47].

When we compare it with the studies in the literature, it is thought that the studies with high and low RSI values in our research group are caused by the difference in the average age and training levels of the athletes.

When the studies in the literature in sports branches other than basketball players, including our research group, are examined;

In the study conducted by Aydos et al. on 66 young wrestlers in 2009, X_{MS}= 161.61±35.70 kg[48] and in the study conducted by Cicioğlu et al. on 30 wrestlers between the ages of 15-17 staying at the Wrestling Training Center, it was stated that X_{MS}=164.01±36.32 kg[49]. When the data obtained and the data in the literature are compared, it is seen that the wrestlers in our study have higher maximal strength. This high value is thought to be due to the differences in the training content of our research group.

In the study conducted by Venegas-Cardenas et al. on 8 wrestlers consisting of men aged X_{age}=15.8±1.7 years, X_{RSI} was reported to be 1.90±0.7m/s[17]. In a study conducted by Healy et al. with 20 athletes from different sports branches with X_{age} = 23 ± 2 years, X_{height} =1.80 ± 0.05 m and X_{BW}= 81.0 ± 13.0 kg, according to the results of the drop jump test performed from a height of 30 cm, X_{RSI}= 1.28 ± 0.30 m/s[33].

In a study conducted by Beattie et al. in 2017 with 20 athletes whose X_{age} = 23.70 ± 4.00 years, who participated voluntarily from different branches, X_{RSI}=1.22±0.25m/s for weak athletes, X_{RSI}=1.55±0.37 for strong athletes determined by making vertical jumps from 40 cm. It was stated that it is m/s[10]. According to the study conducted by Beattie et al., it is seen that the wrestlers and basketball players in our study fall into the category of athletes with lower RSI values. In a study conducted by Walsh et al. in 2004 with 15 decathletes, X_{RSI} determined by the vertical jump at 40 cm box height was specified as 2.14±0.29 m/s (41). In a study conducted by Beattie and Flanagan in 2015 with 15 elite young international rugby players with X_{age} = 18.8 ± 0.35 years, X_{RSI} determined by the vertical jump at 40 cm height was stated as 1.79 ± 0,23 m/s[42]. It is seen that these three studies carried out with a case height of forty cm are higher than the RSI values of our research group.

In the study conducted by Prieske et al. in 2019 with 119 male handball players X_{age} =15.5±0.4 years, X_{RSI} determined by the vertical jump at 35 cm box height was stated as 1.38 m/s[37]. In the study conducted by Washif and Kok in 2020 with 11 male elite sprinters with X_{age} = 17.8 ± 1.3 years, X_{RSI} determined by the vertical jump at 35 cm box height was stated as 1.99 ± 2.42 m/s[50]. In the study conducted by Healy et al. in 2018 with 14 male sprinters with X_{age} =22 ± 2 years, X_{RSI} determined by the vertical jump at 35 cm box height was stated as 2.04 ± 0.49 m/s[16]. It is thought that the reason why these studies are lower or higher than the RSI values in our research is due to the average age, body height, training intensity and branch difference.

In the study conducted by Healy et al. in 2018 with 14 male sprinters with X_{age} =22 ±2 years, X_{RSI} determined by the vertical jump at 30 cm height was specified as 2.06 ± 0.43 m/s[51]. When the study of Healy et al. was examined, it was emphasized that the branch difference had a more significant effect on the RSI values.

In a study conducted by Byrne et al. in 2018 with 19 trained hurling players with X age = 23.1 ± 2.9 years, XRKI determined by the vertical jump at 50 cm height was specified as 1.76 ± 0.29 m/s[52]. When we compare it with the research in the literature, it can be said that our research group has a higher RMI value, and this is due to the height of the body.

When the relationship between the basketball players' maximal strength (isometric mid-thigh pull (IMTP)) and the reactive strength detected from 40cm (depth jump reactive strength index; DJ-RSI) was evaluated, no statistically significant relationship was found. In the study conducted by Beattie et al. in 2017 with participants from different sports branches with an age of X=23.70±4.00 years, it was determined that there was a low correlation between maximal strength and RSI determined from 40cm (r=.286; P=.056)[10]. In a study conducted by Dymond et al. in 2011 with 20 rugby players aged 19±2 years, it was stated that there was a high level of positive correlation between RSI and relative strength, and changes in MS could explain approximately 40% of reactive strength. In the study conducted by Healy et al. in 2018 with 14 male sprinters with X_{age} = 22 ± 2 years and 14 female sprinters with X_{age} = 22 ± 4 years, it was stated that there was no significant relationship between isometric peak power and RSI determined by vertical jump applied from a height of 30 cm[51]. When we compare it with the studies in the literature, it is thought that the reason for the differences in the level of relationship in our research group is due to the isometric measurement tool taken.

CONCLUSION AND RECOMMENDATIONS:

No significant relationship was found between the MS and RSI values of the basketball players aged 16-17 in our research group. As a result, it is thought that basketball players should do maximal strength and explosive force exercises in their training.

As a suggestion, it can be said that the training programs of the athletes should be included in the content of the trainings aimed at developing maximal strength, as well as the studies on the development of explosive force.

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