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AN EVALUATION OF VERTICAL JUMP HEIGHT AND ISOKINETIC KNEE STRENGTH OF ACTIVE VOLLEYBALL AND BASKETBALL PLAYERS

ABSTRACT

Study is to evaluate the relation between vertical jump performance and isokinetic knee strength in active volleyball and basketball players. Healthy 42 players volunteered for this study. Wilcoxon Test was used to evaluate the difference between isokinetic peak torque values, for dominant and non-dominant extremities at each angular velocity, of the groups that we identified as male basketball, male volleyball, female basketball and female volleyball. The Mann-Whitney U test was used to compare the quantitative values between the two groups. It was observed that H/Q ratio of dominant extremity was lower than non-dominant extremity ($p<0.05$). There was no significant difference in terms of sports type in both types of jumping, but the basketball players had statistically significant high values in the measurement formulas. Muscle strength is a significant factor in both sports due to the fact that isokinetic peak torque values of quadriceps and hamstring decrease and H/Q ratio increases gradually from lower angular velocity, is indicator of maximal force to high angular velocity, is indicator of endurance. In addition, when evaluating the athlete's jump performance, not only the jump distance but also the person's height and weight should be taken into account.

Keywords: Isokinetic, Volleyball, Basketball, Vertical Jump, Hamstring/Quadriceps

1. INTRODUCTION

Muscle strength of active athletes is a significant parameter in terms of increasing the duration on the field and success depending on maximum performance, preventing injuries and accelerating the time to return to sports as a result of injury. Therefore, muscle strength evaluation of athletes is of utmost importance [1]. Today muscle strength is measured with the isokinetic dynamometer which allows to measure the maximum performance of the related muscle or muscle group at constant speed. What makes the isokinetic dynamometer popular is its ability to easily measure the strength, practice and torque of the muscle contracted within its boundaries at varying angular velocities [2 and 3]. The expression of the numerical value obtained by dividing the normally weak muscle group torque value of the muscle or muscle groups (e.g. M. Hamstring/M. Quadriceps) that make opposite movements to each other by the strong one in percentages is called the agonist/antagonist peak torque ratio. Although it is difficult to make a generalization, H/Q ratio ranges from 50% to 80% on average [4, 5 and 6]. This ratio may exceed 100% as a result of specific

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strengthening practices to be applied on the target muscle group, which is weaker in comparison to its antagonist, or as a result of an injury that will affect the torque development ability of the strong muscle group [7]. One of the most important joints requiring the concord of agonist-antagonist muscle strength balance for stabilization is the knee joint. Therefore, the strength balance of the Hamstring and Quadriceps muscle groups is a prominent factor in knee stability. Whether determining risk factors in possible sports injuries due to imbalance in H/Q strength ratio and eliminating these risk factors or functional analysis of H/Q strength ratio in rehabilitation programs following the injuries can be a guideline in the decision-making process to return to sports [8]. Power is the force that provides the required physical movement for us to perform in everyday activities, professional life or sports. Power generation is associated with muscle strength [9]. One thing that is needed more than muscle strength to produce more power is fast muscle contraction. It is important to include high speed force applications in power training programs. The importance of developing this skill in performance enhancement is undeniable for sports that use jump activity during competitions quite frequently, especially for basketball and volleyball. The way to increase the jump height is to increase the aerobic power. And one of the most important lower extremity exercises to improve it is jump training [10].

Volleyball and basketball are among the sports branches where the effect of vertical jumping ability on performance is evaluated the most. The ability to jump vertically is crucial to the successful performance of these sports. Volleyball, one of the most popular team sports; It is a dynamic physical sport with uncertain match time, fast pace, requiring quickness, strength, flexibility, endurance and jumping [33]. Jump is a movement pattern that directly affects performance in volleyball, and is widely used both in defense and offense [34]. This situation affects performance significantly. Volleyball is characterized by short and explosive movement patterns, fast and agile positioning, jumping and blocking. For basketball sport, jumping; It is an important movement that should be performed in order to make defensive and offensive block, dunk, jump shot, hook shot, and tourniquet in the competition. Players jump an average of 44±7 times during a basketball game [35]. Since a successful leap combined with other abilities will result in a good performance, the vertical jump performances of the players are included in the evaluation list by both sports scientists and researchers.

2. RESEARCH SIGNIFICANCE

In this study; we aimed to investigate whether there is a discrepancy in muscle strength and vertical jump performance in different sports branches requiring jump activity, to examine the effect of anthropometric factors on vertical jump performance and to provide scientific teams and trainers with a reference by creating a database to determine knee isokinetic strength values and jump ability at different angular velocities.

3. EXPERIMENTAL METHOD-PROCESS

3.1. Participants

Participants of the study consist of male and female athletes engaged in basketball and volleyball. The sample groups consisted of male basketball, male volleyball, female basketball and female volleyball. Subjects were evaluated in the Isokinetic Test and Exercise Room at the Department of Physical Medicine and Rehabilitation at Trakya University Medical Faculty. The inclusion criteria for athletes in the study were determined as being in the range of 17-40 years old and having been exercising for 90 minutes 3 days a week for at least 1 year. On the other hand, having had any previous surgical, orthopedic or neurological problems for both lower extremities were determined as the exclusion criterion. Ethics committee approval required for the study was received from Trakya University Medical Faculty Deanery Research Ethics Committee with the decision numbered 13/30 on 04.08.2015.

3.2. Isokinetic Peak Torque

The athletes were warmed on the bicycle ergometer for 5 minutes and then stabilized on the isokinetic dynamometer (Cybex NORM®, Humac, CA, USA) according to the manufacturer's recommendations. This position was achieved by fixing the leg from the medial malleol of the lower arm tibia, with the chair leaned backwards at an angle of 85 degrees, with knee epicondyle consistent with the axial rotation of the dynamometer. After these procedures, the test protocol was applied for both hamstring and quadriceps at 60°/sec, 180°/sec and 300°/sec angular velocities as concentric-concentric contraction. The range of motion should be maintained from 90° flexion to 0° fully active knee extension. Athletes were encouraged to perform the test with maximum performance by giving verbal orders. The test was applied to both extremities. After each extremity measurement, a 2-minute rest was taken. Peak torque value was recorded as Nm/kg.

3.3. Vertical Jump Performance

Vertical jump test was measured in 2 different ways. Squat Jump; athletes' jumps with their hands on the waist, knees at 90 degrees of flexion without any spring movement were measured. Active Jump; The athletes' jumps were measured starting from a normal vertical posture with their hands on the waist, to jumping upward with a maximal force from downwards squatting movement. The jump belt (TKK 5406 Vertical Jump, Takei Scientific Instruments Co. Ltd., Tokyo, Japan) was used to measure the vertical jump distance. After the jump, the figure on the counter measuring the vertical jump distance in cm through a rope taken up by the belt at the waist, was recorded. At the same time, anaerobic powers of the subjects were calculated in kg-m/sec by using their jump heights and body weights with Lewis nomogram. The test was repeated 3 times for each extremity. There was a 30 seconds' rest between tests for the same extremity, and a 1-minute rest for two extremities. The actual jump distance (JD) performances of the athletes were recorded. Two valid and reliable formulas were used to calculate the power after measurement. The first of these is the Lewis Formula; the first formula developed to calculate the average power in the vertical jump distance, and the second one is the formula developed by considering the body length to have an effect on the power calculated with the vertical jump distance [29 and 31].

Lewis Formula:

Average Power (Watts)=√ 4.9xbody mass(kg)x√ jump-reach score(m)x9.81

Johnson ve Bohamonde Formula:

Peak Power (Watts)=78.6xVertical Jump(cm)+60.3xBody mass(kg) 15.3XHeight(cm)−1.308

Average Power (Wattts)=43.8xVertical Jump(cm)+32.7xBody mass(kg)−16.8XHeight(cm)+431

3.4. Statistical Analysis

Results were given as mean and standard deviation (SD). The suitability of the data for normal distribution was examined with the single-sample Kolmogorov-Smirnov test. In our study, where data were not normally distributed, Wilcoxon Test was used to evaluate the difference between isokinetic peak torque values, for dominant and non-dominant extremities at each angular velocity, of the groups that we identified as male basketball, male volleyball, female basketball and female volleyball. The Mann-Whitney U test was used to compare the quantitative values between the two groups. The findings of the study were performed in the IBM SPSS Statistics" statistical package program (Version 20.0)". The data were presented as numbers and percentages and $p<0.05$ was accepted as the limit of significance in all analyses.

4. FINDINGS

The subjects in the test consist of 42 elite athletes (26 male, 16 female) at the average age of 20.81±3.32 years, the average height 180.14±12.52cm, average weight 72.03±14.94kg and the average body mass index 22.00±2.46. The characteristics of the study groups are shown in Table 1. The dominance relationship of male basketball and volleyball players is shown in Table 2, and the dominance relationship of female basketball and volleyball players is shown in Table 3.

Table 1. Means and standard deviations for characteristics of participants

		Male Basketball (n=13)	Female Basketbal (n=7)	Male Volleyball (n=13)	Female Volleyball (n=9)
Age(years)	Mean±SD	24.08±3.35	19.57±1.90	17.70±0.75	21.56±1.01
Body Mass(kg)	Mean±SD	89.24±9.83	65.14±13.21	64.77±9.32	63.0±6.16
Height(cm)	Mean±SD	194.0±8.44	171.86±7.86	176.70±10.17	171.56±4.50
BMI(kg/m^2)	Mean±SD	23.70±1.33	22.06±3.50	20.70±2.00	21.43±2.29
BMI:Body Mass Index	SD:Standard Deviation				

Table 2. The dominant and non-dominant isokinetic peak torque values (Nm/kg) of male basketball and volleyball players

		Basketball(n=13)			Volleyball(n=13)		
		Dom	NonD	p	Dom	NonD	p
60°/sec	Q	287.46±54.52	263.39±56.22	**0.001**	223.08±39.31	220.46±49.61	**0.027**
	H	190.85±31.27	192.15±32.83	**0.000**	134.54±25.66	132.00±21.69	**0.007**
	H/Q	67.69±12.61	74.92±15.99	**0.000**	65.71±8.17	71.14±6.79	0.124
180°/sec	Q	158.46±30.39	155.69±22.63	**0.028**	120.69±21.73	124.39±21.53	**0.015**
	H	134.85±24.94	134.85±20.14	**0.007**	98.69±15.11	96.54±17.72	**0.000**
	H/Q	86.08±11.61	87.00±9.82	0.079	82.77±9.45	78.00±8.69	0.449
300°/sec	Q	10985±17.73	107.15±13.58	**0.028**	81.23±15.83	76.92±20.65	**0.004**
	H	95.69±13.43	90.39±13.29	**0.037**	77.31±14.56	72.54±14.91	**0.005**
	H/Q	88.85±12.93	85.15±12.13	0.055	95.77±11.68	96.69±17.82	0.313

Dom : Dominant Extremity
NDom: Non-dominant Extremity
Q : Quadriceps Isokinetic Peak Torque Value
H : Hamstring Isokinetic Peak Torque Value
H/Q : Hamstring/Quadriceps Isokinetic Peak Torque Ratio

Table 3. The dominant and non-dominant isokinetic peak torque values (Nm/kg)of female basketball and volleyball players

		Basketball(n=7)			Volleyball(n=9)		
		Dom	NonD	p	Dom	NonD	p
60°/sec	Q	161.14±19.51	150.14±19.94	0.078	173.22±29.53	152.78±24.93	0.057
	H	105.00±8.18	106.29±11.28	0.355	104.33±16.46	101.78±19.34	0.143
	H/Q	65.71±8.16	71.14±6.79	0.585	60.56±3.97	66.33±5.79	0.529
180°/sec	Q	85.14±15.09	76.14±12.94	0.068	92.11±18.40	87.11±19.88	**0.001**
	H	69.86±3.53	71.00±7.28	0.386	75.11±16.86	74.11±14.58	**0.005**
	H/Q	84.29±15.34	94.86±15.62	0.268	82.00±10.76	86.11±12.45	0.767
300°/sec	Q	58.00±10.61	56.00±10.88	**0.028**	61.11±12.29	59.89±12.00	**0.009**
	H	53.29±492	55.57±4.28	0.876	57.78±12.82	58.11±11.86	**0.000**
	H/Q	94.00±14.55	102.14±17.45	**0.002**	95.89±15.06	97.56±8.46	0.731

4.1. An Evaluation of Isokinetic Peak Torque Strength in Terms of Sport Type

In comparison of the isokinetic peak torque values of Quadriceps, Hamstring, Hamstring/Quadriceps on the dominant and non-dominant extremities of basketball and volleyball players, there was a statistically significant difference between isokinetic peak torque values of dominant and non-dominant hamstring and non-dominant H/Q at 60°/sec angular velocity, non-dominant hamstring and non-dominant H/Q at 180°/sec angular velocity, dominant and non-dominant quadriceps at 300°/sec angular velocity (Tables 4).

Table 4. A comparison of dominant and nondominant isokinetic peak torque values (Nm/kg) of basketball and volleyball players

		Basketball (n=20)	Voleyball (n=22)	p		Basketball (n=20)	Voleyball (n=22)	p
60°/ sec	Dom-Q	243.25±76.28	202.68±42.95	0.091	NDom-Q	223.75±72.06	192.77±52.94	0.279
	Dom-H	160.80±49.03	122.18±26.65	**0.016**	NDom-H	162.10±49.87	119.63±25.35	**0.009**
	Dom-H/Q	67.00±11.06	61.09±11.49	**0.050**	NDom-H/Q	73.60±13.40	64.14±10.47	**0.025**
180°/ sec	Dom-Q	132.80±44.08	109.00±24.61	0.134	NDom-Q	127.85±43.50	109.13±27.70	0.127
	Dom-H	112.10±37.52	89.05±19.48	0.057	NDom-H	112.50±35.34	87.36±19.70	**0.033**
	Dom-H/Q	89.75±12.36	81.32±10.90	0.457	NDom-H/Q	89.75±12.36	81.32±10.90	**0.016**
300°/ sec	Dom-Q	91.70±29.63	73.00±17.41	**0.041**	NDom-Q	89.25±27.94	69.95±19.29	**0.027**
	Dom-H	80.85±23.50	69.31±16.74	**0.137**	NDom-H	78.20±20.19	66.64±15.27	0.080
	Dom-H/Q	90.65±13.37	95.81±12.82	0.262	NDom-H/Q	91.10±16.07	97.046±14.45	0.194

Kolmogorov-Smirnov Test: Normally Distributed Variables are Presented as Mean Standard Deviation, Non-Normally Distributed Variables Are Presented as Median (min. max)
Dom-Q : Quadriceps Isokineticpeak Torquevalue of Dominant Ekstremity
Dom-H : Hamstring Isokinetic Peak Torque value of Dominant Ekstremity
Dom-H/Q : Hamstring/Quadriceps Isokinetic Peak Torque Ratio of Dominant Ekstremity
NDom-Q : Quadriceps Isokinetic Peak Torque Value of Non-Dominant Ekstremity
NDom-H : Hamstring Isokinetic Peak Torque Value of Non-Dominant Ekstremity
NDom-H/Q: Hamstring/Quadriceps Isokinetic Peak Torque Ratio of Non-Dominant Ekstremity

4.2. An Evaluation of Vertical Jump Performance in Terms of Sport Type

Statistically similar findings were obtained in all the tests which were conducted for the evaluation of vertical jump performance in both squat jump and active jump in basketball and volleyball players, (Table 5).

Table 5. Comparison of vertical jump performances of basketball and volleyball players

		Basketball(n=20) Mean± SD Median(min-max)	Voleyball (n=22) Mean ±SD Median(min-max)	p
SJ	Jump score(cm)	63.85±12.79	61.14±9.64	0.450
	Lewis Av Power (Watts)	1573.36(1040.72-1689.95)	1069.77(98.454-1161.23)	**0.003**
	J&BF Av Power (Watts)	2309.95±747.19	1838.93±440.85	**0.016**
	J&BF Peak Power (Watts)	7041.53±1515.40	5996.02±850.20	**0.011**
CMJ	Jump score(cm)	40.40±7.64	41.00±8.15	0.820
	Lewis Av Power (Watts)	1241.635(944.10-1378.42)	883.13(776.53-942.77)	**0.004**
	J&BF Av Power (Watts)	1282.84±564.53	956.96±564.53	**0.035**
	J&BF Peak Power (Watts)	5198.36±1199.35	4413.30±772.09	**0.015**

Av : Average j&BF: Johnson and Bohamonde Formula

5. DISCUSSION

A total of 42 athletes', 13 male and 9 female basketball players, 13 male and 7 female volleyball players, test results were examined in our study that we conducted to investigate the relationship between isokinetic and vertical jump performance of athletes. After the study, hamstring, quadriceps muscle strength of dominant/non-dominant lower extremities and their ratio to each other were obtained. It is concluded that isokinetic peak torque strength of quadriceps decreases in both dominant and non-dominant extremities, isokinetic peak torque strength of hamstring decreases in both dominant and non-dominant extremities and H/Q ratios increase in both dominant and non-dominant extremities as the angular velocity increases. When we examined the conducted studies, we found that age, height, weight and BMI variables affect isokinetic strength and vertical jump performance [11, 12, 13, 14, 15 and 16]. In this study which was conducted by restricting the selected volunteers to a certain age range that height, it was observed that weight and BMI variables were effective factors in isokinetic strength and vertical jump performance. However, unlike other studies, we obtained this data not by using height, weight and BMI values directly but by using anaerobic power formula calculations in vertical jump performance.

While developing an isokinetic test and rehabilitation protocol, many clinicians will include exercises in the program which require slow, moderate and high-speed repetition. By way of each angular velocity type, it is possible to obtain and examine various data. Tests for extension and flexion movement of knee joint are applied at 60°/sec for slow speed, at 180°/sec for medium speed, at 240 or 300°/sec for high speed. The slow speed test is an important indicator of resistance to compressive strength. In addition, the shape of the torque curve in the data output provides the clinician with the best interpretation of findings such as muscle weakness, pain and signs of fatigue. First and foremost, it presents the best information with respect to peak torque value/body weight and agonist/antagonist ratios. If the ability to produce energy rather than durability matters most; medium and high-speed testing and rehabilitation programs should be preferred. It has been shown that the peak torque decreases in the performance at high speeds compared to the slow speed while the average power production increases. Therefore, these tests allow better evaluation of muscle ability at functional speeds. Since it is closer in functional activities, it is recommended that these velocity rates be preferred when evaluating individuals with high activity levels [7].

In line with this information, the angular velocities of the test and rehabilitation programs are based on slow, medium and fast test repetitions in many studies; namely 60°/sec, 180°/sec and 300°/sec [2, 17, 18, 19, 20 and 21]. However, as mentioned above, only 60°/sec has been preferred in many studies in which the data of slow-speed test programs provide more clear and understandable information and the relationship of isokinetic strength with another test is analyzed [3, 22 and 23]. According to the findings of the study, as the angular velocity increased in both dominant and non-dominant extremities of all groups, it was found that concentric isokinetic peak torque values of both quadriceps and hamstring muscle group decreased. Moreover, as the angular velocity increased, the Quadriceps isokinetic peak torque decreased more than the Hamstring muscle group isokinetic peak torque did. As a result, the H/Q peak torque ratio increased in line with angular velocity increase.

In the study where Rahnama et al. evaluated the knee strength between preferred and non-preferred extremities in footballers at 1.05, 2.09, 5.23 rad/sec angular velocities, there found to be a significant difference in isokinetic hamstring strength despite the fact that there was not a difference in isokinetic Quadriceps strength only at 2.09 rad/sec angular speed. However, they concluded that the preferred extremity strength is weaker than the non-preferred. In addition, just like our study, no strength difference was detected at any angular velocity in the concentric mode of H/Q ratio between the preferred and non-preferred extremities [24]. In contrast to this study, we used 60°/sec angular velocity in our study, and found that H/Q value turned out to be significantly different due to non-dominant hamstring strength of male basketball player being higher than dominant and quadriceps strength being lower. Based on these results, it can be stated that the isokinetic peak torque ratio of H/Q is not associated with extremity dominance. This is because both quadriceps and hamstring decrease or increase in parallelism, which makes statistically no difference. As a result, the H/Q ratio remains practically unchanged.

The position in which the isokinetic peak torque value of the muscle whose isokinetic strength is to be evaluated is done also carries importance. In a study which aimed to determine the difference between peak torque strength and strength ratios of rugby players in sitting and supine positions and to examine the interaction of this difference with joint speed and position in rugby players, better performances were observed in both Quadriceps and Hamstring muscles for both concentric and eccentric muscle strength at both 1.05 rad/sec and 3.14 rad/sec angular velocities compared to supine position, all of them were not significant, though [25]. Additionally, the measurement results in the sitting position and the supine position, and the sitting position and the prone position were included in the evaluation in a study in which the measurement position was evaluated. In the measurement protocol including 3 maximal reciprocal concentric/concentric contraction repeats in the dominant extremity at 60, 120, 180, 240 and 360°/sec angular velocities; it was concluded that flexor angular loading (LR) in the sitting position at only 360°/sec angular velocity for flexion and extension forces produced better results than the flexor LR in the prone position. Also, it was concluded that there is no difference between sitting position and supine or prone positions at any other angular velocities [20]. When the studies on the subject are examined, the effect of the measurement position on the isokinetic strength appears in different results.

Therefore, bearing in mind that different repetition numbers and rest periods may also be effective in the results, we can say that the different results between the groups may result from the measurement position.

Knapik et all. In their study examining the power difference between the extremities of 138 female athletes, it was shown that having a power difference of more than 15% creates a high risk of injury. In our study, it is possible to talk about the risk of injury, not for female athletes, but due to the presence of limb asymmetry of male athletes [36]. A study by Meriç et al. showed that there is a difference in isokinetic peak torque values in athletes playing in different positions in the same sport [26]. In this case it was a predictable result to find a difference in isokinetic peak torque values between different sports types. We believe that motivation and participation, seasonal success, desire for maximum performance during the test, concerns for injury, and the ability to perform the test fully and correctly may have been the reason affecting the results although the training frequencies of all athletes are the same.

One important point is the effect of the motor learning on isokinetic performance. Brech, Ciolac et al. argues in a study conducted in 2011 that understanding the tests and their repetition produces more reliable results with motor learning and better neuromuscular integration [27]. The effect of motor learning on the isokinetic dynamometer is quite significant because the feeling of discomfort and restriction caused by placement in a certain position may adversely affect performance even if they complete the test successfully. The expected movement when evaluating isokinetic strength of knee quadriceps and hamstring is well known to elite athletes who have previously worked with these devices for testing or rehabilitation, but is not always known by the patients, healthy individuals and even athletes. When the studies in the literature are examined, we observe that, rather than athletes, evaluations have been carried out on people with diseases such as osteoarthritis, namely individuals who have encountered with isokinetic device for testing or rehabilitation purposes for the first time [22 and 27]. The reason for our suspicion was that most of the athletes involved in our study were exposed to an isokinetic dynamometer for the first time, as in other studies. In fact, the fact that many of the male basketball players have had this experience before and that their isokinetic performances have appeared high also intensified our opinion.

Jump tests are commonly preferred by coaches because they are simple to adjust and interpret. At the same time, they shed light on forming opinions about other parameters used in the evaluation of athlete’s performance. In a study conducted on NCAA 1st League male basketball players, it was reported that there is a relationship between various field test performances of anaerobic condition, game duration and jump height [28].

The reason we chose the squad and countermovement jump in our study is the fact that both jump types start at one point and end at the same point during the test. The device we used digitally monitored the actual jump distance of the athletes. Rather than figuring the jump strength only with actual jump distance, we used the Lewis formula, which uses gravity force and the weight of the athlete, and which is valid in the literature, and the formula developed by Johnson and Bohamonde, which adds not only weight but also height to the formula [29, 30 and 31]. There is no study in the literature in which all these variables are used together. We believe that our study is original with this multifaceted evaluation feature.

In a study where Taşmektepligil et al. examined the effect of the athlete's field position on the jump height in footballers, the Takei Jumpmeter, a valid and reliable device, was used for the measurement of vertical jump distance [12]. There was no statistically significant difference in the study in which the defender players performed better. Therefore, we used the Jumpmeter (TKK 5106, Takei Scientific, Japan) in our study.

In a study in which Delextrat and Cohen examined the effect of the athletes' position on vertical jump performance, the active jump vertical jump distances of the basketball players in guard, middle and forward positions who are allowed for arm swing and anaerobic power in which Lewis nomogram was used were compared. When jump distances were compared, no difference was found between the three groups, and when the vertical jump distance was converted to anaerobic power formula by Lewis nomogram, it was stated that the middle players performed better than the guards [13].

It is not always possible to categorize the shape of the jump in this way and to apply the jump during the game neatly as in these categories. For example, there are some special movement patterns associated with jump in volleyball. These are block jump (BJ) and attack jump [32]. A player starts defensive block jump with the knees slightly bent and the arms in front of the chest, which is the characteristic posture. The athlete must jump as fast as possible while making a block jump. Therefore, the athlete does not have time for classic active jump, but instead uses the shortened version of the active jump technique. Furthermore, there is no time for a full arm swing because the hands must be positioned in front of the chest to make a block. Arm swing with full active jumping is very effective for maximum jump performance, but this athlete's doing it would cause delay in the block. Therefore, the defense will fail. Attack jump is a combination of drop jump and active jump with arm swing. Therefore, being a more dynamic jump than squat jump and more compatible with jump movements during the competition, active jump performance results were found to be more correlated with isokinetic peak torque results. The relationship between isokinetic peak torque values of dominant extremity and vertical jump performances was more significant especially in volleyball players than the relationship between isokinetic peak torque values of non-dominant extremity and vertical jump performances.

The evaluation of the relationship between isokinetic peak torque values and vertical jump performance is parallel to the evaluation of dominant-non-dominant performances of isokinetic peak torque values. Based on the fact that extremity dominance affects both performances to a great extent, it should be remembered that extremity dominance is considerably significant factor in increasing the sportive success of the people, in the organization of training programs in order to prevent injuries, in the development of treatment programs in order to minimize the return time, prevent the injury from repeating and maximize the success after the injury.

As the limitations of the study, the inadequate number of volunteers that we have access to in the region where we plan to work, and thus the difficulties we have in obtaining rich data, and, although the weekly training numbers of the athletes are sufficient for the inclusion criteria that we have determined, differences in the training duration, program content, training disciplines and league performances, can be put forward.

As a result; the isokinetic dynamometer and vertical jump test in elite athletes provide objective data for assessing muscle strength and anaerobic strength, respectively. Since the active time during the game is more in Basketball than volleyball, basketball athletes have more muscle strength. Besides the positive effect of muscle strength on the jump performance, the fact that the two branches contain different jump techniques and that the measurement is done in a standard way make a difference between the branches in the measurement results. When evaluating the jump performance, it is not enough to evaluate the jump distance to learn the anaerobic power, athlete's height and weight should be taken into account.

6. CONCLUSION AND RECOMMENDATIONS

Anaerobic power and strength performances and the relationship between these variables are affected by the demographic characteristics of the athletes, the sport branch, the place they play, the measurement method and many other parameters. For example; Jumping higher for a taller person does not necessarily mean that their anaerobic performance is better, nor that a person who is overweight is worse. This is a complex problem that affects an athlete's performance, just as there are many factors affecting strength in muscle architecture. In our research, we tried to show the difference between variables by using different formulas to calculate the performance in vertical jump and by using different angular velocities in isokinetic force measurement. Future studies in a larger, normally distributed population may shed light on solving this complex problem. However, not neglecting individual characteristics in training programs is an important point in achieving success.

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