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The Association Between Sprint Speed Test and Isokinetic Knee Strength in Healthy Male Volleyball Players

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Abstract

Background: Volleyball is a sport with technical elements and explosive power.

Objectives: This study investigates the relationship between sprint speed and isokinetic knee strength applied at different angular velocities in male volleyball players.

Methods: This study was conducted on 15 volunteer male volleyball players (age; 17 - 25 years, height; 1.75 + 0.12 m). Isomedx 2002 isokinetic dynamometer is employed to measure the isokinetic strength, and a 20 m sprint test is conducted to measure the speed. In measuring knee flexion and isokinetic extension strength, quadriceps and hamstring concentric/eccocentric are measured separately on both legs at 60°/sec angular velocity for three repetitions, at 180°/sec for six repetitions, and at 300°/sec for nine repetitions. For statistical analysis, the Spearman's correlation test was performed using SPSS 18.0 (SPSS Inc., USA) software.

Results: The highest torque value in subjects was recorded on both sides at 60°/sec angular velocity, 180 and 300 degrees, respectively, were lower. There was no significant relationship between speed and isokinetic strength at different angular velocities.

Conclusions: Based on our results, the highest peak torque in volleyball players was found to be at 60°/sec angular velocity while no significant correlation was found between isokinetic strength of the knee at different angular velocities and speed of volleyball players.

Keywords: Volleyball Player, Isokinetic, Strength, Speed

1. Background

Playing volleyball in professional level requires a certain amount of strength, agility, flexibility, mobility, endurance, and jumping with no predetermined duration (1). Hence, numerous and various muscles work together to maintain a player's performance during a match (2, 3). Maximal power is necessary for jumping and running which is key technical elements of this sport (4). Thus, high levels of muscle strength and motor activity is needed, specifically in hamstrings and quadriceps for a player to have an acceptable performance during a match (5, 6).

Precise and timely decision actions in serving and spiking are high velocity responses which require explosive muscle movements for running, jumping, and ultimately the shot itself. Volleyball also requires short-distance sprints for fast movement inside the court. Volleyball players have speed and agility in their movements when performing technical elements. They need a fast approach run and strength-spiking arm to make a stronger spike. Several studies have analyzed the speed of musculature response in professional volleyball players. The result of such studies conclude that a perfect balance in the extension and flexion of knee musculature is necessary to maintain an improved normalized response speed (7-10). The response speed is also associated with a player's position and tends to be lower in liberoes, setters, and substitute players compared to fixed middle blockers, outside and inside hitters (11). One study reported that professional volleyball players perform hip and knee extension as well as ankle plantar flexion to generate 200 - 300 high power activities (6). Also, another study indicated that in the landing phase, knee extensors muscles are activated at maximum level in eccentric mode to control the knee flexion. In addition, rapid lower limb extension after landing needs a rapid muscle transition movement from eccentric to concentric in the lower extremities (12). The optimal ratio between knee extensors peak torque and the flexors peak torque is associated with the greater mechanical power in the countermovement jump. The contralateral deficit does not seem to be associated with the countermovement jump performance. Although the knee extensor peak torque is associated with Countermovement jump power, the findings suggest that strength-based training in volleyball athletes should not omit the conventional muscle ratio (13). These findings illustrate the role of the quadriceps and hamstring muscles in volleyball players, which requires explosive power and speed.

Several methods have been introduced for evaluation of muscle strength and its influential factors among professional athletes. Among these various methods, isokinetic dynamometry is a valid and reliable method which has been previously used in various studies (6, 13-15). Isokinetic dynamometry is a novel method which is used both in clinical and research settings that examines joint torque. This method can be used to evaluate muscular contractions that accompanies constant velocity of muscle movements around a joint. Th dynamometer measures the resistance force which is equal to the muscle contraction force, hence a model to measure muscle strength (15, 16). Although several studies have used this method to record and compare muscle strength in different sports such as soccer, basketball, and long-distance runners (17-21), scarce evidence has been found regarding a through investigation of such a topic among professional volleyball players (3, 4, 22, 23).

Since power generation capacity and muscle strength directly affect a player's performance, certain influential factors should be detected to improve a player's performance and maintain it at high level during a match. Also, training programs should be assessed according to these findings in order to create the most efficient program for training professional athletes (24).

2. Objectives

This study aimed at evaluating the association between speed and knee isokinetic strength at different angular velocities in male volleyball players using isokinetic dynamometry.

3. Methods

3.1. Participants

Fifteen male volleyball players volunteered in this study (Table 1). Before the study, all participants were informed about and consented to the research protocols by a form. In the beginning, the volunteers took part in a practice session to learn the research process. However, measurements were recorded just before the competition period. Prior to measurement tests, the dominant legs of subjects were identified. Two participants out of 15 contestants had a dominant right leg while the rest had a dominant left leg. Athletes with lower extremity disorder, such as pain, injury, or surgery in the last six months, were excluded from the study.

Table 1. Characteristics of the Subjects

Variables	Mean ± SD
Age (y)	19.2 ± 4.3
Years of experience (y)	8.0 ± 5.2
Body height (cm)	175 ± 12
Body weight (kg)	65.3 ± 6.1
Fat percentage (%)	19.8 ± 3.4

3.2. Study Design

All participants underwent two separate tests at Shiraz Movement Analysis and Research Center. In order to measure each player's speed performance, we conducted 20 meters sprint test after a 30-minute warm up session. For the sprint test, we used the Newtest Powertimer 2000 photocell (12, 25). The sprints were performed from a standing position behind the starting line. Measurement of the 20 meters sprint initiated when the player broke the beam from the first photocell (time zero), and times for 10 meters, and 20 meters were measured. The best result was gathered for data analysis. After the sprint test, players rested for one day.

The following day, after another 30-minute warm-up session, each player underwent isokinetic dynamometry to measure the isokinetic strength of the quadricep muscles at different angular velocities. An IsoMed 2000 dynamometer (D&R Ferstl, Hemau, Germany) was used (26, 27).

Before the isokinetic strength test, subjects sat on the dynamometer, and their hip, waist, and shoulder were stabilized by a belt to a dynamometer according to protocols. Knee flexion and extension (Q/H) isokinetic strength were measured separately on both legs at 60°/sec angular velocity for three repetitions, at 180°/sec for six repetitions, and at 300°/sec for nine repetitions concentrically/ecconcentrically. During tests, the examiner guided athletes verbally. Before the isokinetic strength test, subjects were asked to perform a submaximal and a maximal repetition on the isokinetic dynamometer. Then, peak torque values were recorded for both legs at different angular velocities.

3.3. Data Analysis

SPSS 18.0 (SPSS Inc., USA) software was used for statistical data analysis in this study. Spearman's correlation test was applied to evaluate the relationship between speed and knee isokinetic strength at different angular velocities. P-values of less than 0.05 were considered to be statistically significant.

4. Results

The peak torques by isokinetic measured by dynamometer are presented in Table 2. The highest torque value in subjects was recorded on both sides at 60°/sec angular velocity. 180 and 300 degrees, respectively, were lower (Table 2).

Table 2. Isokinetic Knee Strength at Different Angular Velocities [a]

Variables	Dominant	Non-dominant
60°.s-1 flexion (H) (Nm)	90.1 ± 12.3	89.9 ± 12.6
60°.s-1 extension (Q) (Nm)	141.4± 20.3	145.0 ± 21.4
180°.s-1 flexion (H) (Nm)	78.5 ± 7.9	75.9 ±8.8
180°.s-1 extension (Q) (Nm)	107.0 ± 12.0	108.4 ± 12.87
300°.s-1 flexion (H) (Nm)	66.7 ± 8.4	67.3 ± 7.4
300°.s-1 extension (Q) (Nm)	89.3 ± 7.6	86.5 ± 8.7

Abbreviations: H, Hamstring; Q, Quadriceps femoris.
[a] Values are expressed as mean ± SD.

According to Table 3, there was no significant relationship between speed and knee isokinetic strength at different angular velocities.

Table 3. Knee Isokinetic Strength at Different Angular Velocities and Sprint Speed Correlation

Speeds	r	P
	Dominant Side	
60°.s-1 (H)	-0.032	0.56
60°.s-1 (Q)	-0.347	0.34
180°.s-1 (H)	-0.065	0.78
180°.s-1 (Q)	-0.324	0.45
300°.s-1 (H)	-0.085	0.23
300°.s-1 (Q)	0.343	0.52
	Non-dominant Side	
60°.s-1 (H)	-0.342	0.34
60°.s-1 (Q)	-0.393	0.38
180°.s-1 (H)	0.089	0.76
180°.s-1 (Q)	-0.498	0.24
300°.s-1 (H)	0.236	0.35
300°.s-1 (Q)	-0.211	0.62

Abbreviations: H, hamstring; Q, quadriceps femoris.

5. Discussion

This study aimed at evaluating the association between sprint speed and isokinetic knee strength 15 volleyball players who were included. According to our results, the highest peak torque in volleyball players was found to be at 60°/sec angular velocity. Additionally, we found no significant correlation between isokinetic strength of the knee at different angular velocities and speed of volleyball players, according to our 20 meters sprint test.

Based on the review of recent and current literature, contradictory evidence has been found, regarding the association between speed and isokinetic muscle strength. The first studies, which was conducted by Ozcakar et al. and Newman et al., found a strong correlation between peak torque in flexion and extension and 10 to 20 meters sprint tests (28, 29). These studies did not report at which angle this peak torque is achieved. Another study, conducted by Cotte and Chatard with the same goal, evaluated this association at four angular velocities among professional football players with 10 to 30 meters sprint test. This study also concluded that a significant correlation between 20 to 30 meters sprint test and quadriceps peak torque at 180, 240, and 300°/sec was found (30). Although other studies conducted by Lockie et al. (31), and Alemdaroğlu (32) reported negative or insignificant correlation between knee flexor strength and sprint test, respectively, the result could not be relied on, since the sample size of their study was small.

Based on the recent studies conducted on volleyball players, one study evaluated the aforementioned association at 60°/sec and 300°/sec angular velocities among 20 volleyball players. Although they reported a significant correlation between isokinetic knee strength and jumping, however, no significant association between knee isokinetic peak torque, T drill agility, and 30 m sprint (33). Another recent study by Cengizel, evaluated the speed and isokinetic knee strengths among the female volleyball players in 20 m sprint and flexion and extension on concentric/concentric dominant and non-dominant legs at three different angular velocities have yielded similar results as our study. No significant correlation was found between isokinetic knee strength at different angular velocities and speed (12).

These findings share a certain limitation, which is their small sample sizes. Although most of these studies reported significant or insignificant associations between speed and knee strength, however, these results could not be relied on because of their small sample sizes. Conducting a similar study on much larger populations, may be difficult due to lower numbers of athletes in every population. However, for a robust statistical analysis with definitive results, larger sample size is definitely necessary. Also, it is highly recommended that a systematic review and meta-analysis study should be conducted to estimate the pooled effect of isokinetic knee strength and speed among professional athletes.

This study has been faced with certain limitations. We only included male participants and no women volleyball player was included. Further studies should include women players as well to examine gender disparities regarding the sprint speed test and isokinetic knee strength. Another limitation is the low number of participants. Perhaps a significant result would be found in larger populations in future studies.

5.1. Conclusions

The purpose of this study was to examine the association between sprint speed test and isokinetic knee strength in male volleyball players. The highest peak torque in volleyball players was found to be at 60°/sec angular velocity. However, no significant correlation was found between isokinetic strength of the knee at different angular velocities and speed of volleyball players, according to our 20 meters sprint test. It is further recommended that evaluating the strength and speed of other professional athletes who are active in other sports fields would be fruitful. In conclusion, there was no significant relationship between isokinetic knee strength and speed in male volleyball players.

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Footnotes

Authors' Contribution: All authors designed the study. Daryoush Didehdar collected and analyzed the data. All authors discussed the results and commented on the manuscript. All authors have carefully read and reviewed the manuscript.

Conflict of Interests: It was not declared by the authors.

Data Reproducibility: No new data were created or analyzed in this study. Data sharing does not apply to this article.

Ethical Approval: This study is approved by the local Ethics Committee of Zabol University of Medical Sciences (IR.ZBMU.REC.1396.139).

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Informed Consent: Before the study, all participants were informed about and consented to the research protocols by a form.

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