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Educación y ciencia deportiva: comparación de fuerza isocinética entre varones jugadores de voleybol

Sports science and education: comparison of isokinetic force between male volleyball players

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Abstract
This study compares lower extremity isokinetic strength values of male volleyball players at two different chronological age and level of competition. 24 volunteer athletes who were playing at youth and junior teams participated in this study. The study was conducted at two different angular speed. Practise test (3 repetitions) and actual test (6 repetitions) at 60o/s angular speed and practise test (5 repetitions) and actual test (15 repetitions) at 180o/s angular speed were conducted with participants. Whether the groups had normal distribution was determined with Shapiro-Wilk test. The means of the data with normal distribution were compared using Independent Samples T-Test; the means of the data with non-normal distribution were compared using Mann-Whitney U Test. The results showed that there was no meaningful statistical difference (p>0.05) in the angular motions which were dominated by quadriceps and hamstring muscles with both legs at 60o/s and 180o/s Consequently, it was seen that in volleyball, isokinetic strength was not affected by motor actions required in the sports field like jumping and sprinting. It is believed that specific training in strength trainings should be done to improve isokinetic strength.

Keywords: Strength, isokinetic, volleyball, sports, training, performance

Resumen
Este estudio compara los valores de fuerza isocinética de las extremidades inferiores de jugadores de voleibol masculinos en dos edades cronológicas y niveles de competencia diferentes. En este estudio participaron 24 atletas voluntarios que jugaban en equipos juveniles y de menores. El

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estudio se realizó a dos velocidades angulares diferentes: se efectuaron con los participantes la prueba de práctica (3 repeticiones) y la prueba real (6 repeticiones) a 60o / s de velocidad angular y la prueba de práctica (5 repeticiones) y la prueba real (15 repeticiones) a 180o / s de velocidad angular. Se determinó si los grupos tenían una distribución normal con la prueba de Shapiro-Wilk. Las medias de los datos con distribución normal se compararon mediante la prueba T de muestras independientes; las medias de los datos con distribución anormal se compararon mediante la prueba U de Mann-Whitney. Los resultados mostraron que no hubo diferencia estadística significativa (p> 0.05) en los movimientos angulares que fueron dominados por los músculos cuádriceps e isquiotibiales con ambas piernas a 60o / sy 180o / s. En consecuencia, se observó que en el voleibol, la fuerza isocinética no se ve afectada por las acciones motoras requeridas en el campo deportivo como saltar y correr. Asimismo, se cree que debe realizarse un procedimiento específico en entrenamientos de fuerza para mejorar la fuerza isocinética.

Palabras clave: Fuerza, isocinética, voleibol, deportes, entrenamiento, rendimiento

Introduction

As volleyball which is one of the most popular sports in the world requires male and female athletes to demonstrate explosive moves like blocking over the net with the height of 2.43 or 2.24 metres respectively for males and females, performing vertical jumps to offense, and shuffling quickly and swiftly (Dal Pupo et al., 2014; Moket. et al., 2014), vertical jump performance is particularly significant. During a volleyball game at a relatively small court (9x9m), these anaerobic energy system dominant moves are not only repeated in a short span of time, the players are also expected to perform services, pass the ball, and perform spikes offense demanding intense vertical jumps and lands (Kim & Jeoung, 2016). While vertical jumps are commonly used in spikes (Wagner et al., 2009; Sheppard et al., 2008), vertical jumps to block are used to prevent opponent team’s offences on defence.

As the ability to jump well is the base of the advanced game, athletes and trainers put particular significance on evaluation and development of this characteristic (Malatesta et al., 2003; Voelzke et al., 2012). It is emphasised that in volleyball, unique moves to the sport like spike and block should be evaluated first (Sattler et al., 2012; Sharma et al., 2012; Hughes & Watkins, 2008).

For the other hand, it is well-known that when compared, tests unique to sports are more applicable than standard and unspecific evaluation protocols in terms of defining the actual game performances (Peric et al., 2014; Uljievic et al., 2014). Isokinetic strength test which allows full muscle tension throughout the range of motion of the joint at constant speed is commonly used. Isokinetic evaluation can be used to measure torque values of various joints. This evaluation typically consists of a comparison of values of the joint that is being evaluated with the matching one. Isokinetic test allows us to evaluate strength and functional abilities so as to compare different muscles by evaluating the torque emerging during exercise (Kim & Jeoung, 2016).

It is seen that sports participation in young people can be realized at every stage of education, whether at the amateur or professional level. It has been reported that special trainings have been created for upper and lower extremity development especially in high school athletes (Noyes et al. 2011), and the differences in the performance of high school students as a result of these trainings can be explained by various factors such as age, educational experience and competition level (Hermassi et al. 2015). Therefore, we think that the competition levels and physical capacities of high school students will be possible by comparing the performance outputs of high school students with different chronological ages.

Nevertheless, previous studies have shown that as the athletes get older, isokinetic strength (Ahmad et al., 2006; Barbel-Westin, 2006) and relative isokinetic strength increases. Moreover, some studies report that this increase continues till a certain age in adolescent athletes, that teenagers experience no strength change during puberty and that isokinetic strength decreases in adult, middle-aged and elder individuals (Gómez-Cabello et al., 2012; Bai et al., 2016). In this context, the study was done to compare lower extremity isokinetic strength values of male volleyball players at two different chronological age and level of competition.

Methodology

24 athletes playing in youth and junior levels volunteered for the study. 12 healthy athletes from the youth team whose means age were 15.97±0.19 years took part in the study. Their means height, weight, body fat percentage, and training age were 80.12±4.04 cm, 76.63±5.07 kg, 11.09±1.38 per cent, and 3.8±1.55 years respectively. 12 healthy athletes from the junior team participated in the study and their means of age, height, weight, body fat percentage, training age were respectively 18.92±0.27 years, 191.64±3.75 cm, 86.85±4.62 kg, 10.59±0.63 per cent and 3.92±1.89 years. Also, body fat percentages of the participants were obtained by using Tanita Bc 601 Innerscan Body Analysis machine, and isokinetic knee torque values were obtained with Cybex Norm 6000 dynamometer machine.

The study was conducted at two different angular speed. Practise test (3 repetitions) and actual test (6 repetitions) at 60o/s angular speed and practise test (5 repetitions) and actual test (15 repetitions) at 180o/s angular speed were conducted with participants. Isokinetic leg torque strength obtained in our study was taken as a reference and the dominant leg of the participants were determined (Lockie et al., 2012; Schons et al., 2018). Pre-test 10-minute warm-up period consisted of cycling for five minutes at 60 rpm on Monark 827E vertical bike ergometer and stretching moves particular to the field for five minutes. Ethics committee report was received from Kırşehir Ahi Evran University Ethics Committee before the study started (2020).

All volunteers were verbally informed before they were included in the study, and their written consent to participate in the study was obtained. Whether the groups had normal distribution was determined with Shapiro-Wilk test. The means of the data with normal distribution were compared using Independent Samples T-Test and the means of the data with non-normal distribution were compared using Mann-Whitney U Test.

Results

The data obtained were compared using the statistical methods in the previous section. Peak torque values and relative peak torque force values are given in different tables.

Table 1
Descriptive Information of the Participants

Characteristics	YT n=12	JT n=12
Age (year)	15.97 ± 0.19	18.92 ± 0.27
Weight (kg)	76.63 ± 5.07	86.85 ± 4.62
Height (cm)	180.12 ± 4.04	191.64 3.75
Body Fat (%)	11.09 ± 1.38	10.59 ± 0.63
Training Age (year)	3.8 ± 1.55	3.92 ± 1.89

YT= Youth Team; JT= Junior Team.

Descriptive information of the participants was given in Table 1. The training age of the both groups can be seen to be similar, whereas the other characteristics showed difference.

Table 2

Comparison of leg peak torque values of the participants

Limb Torque	Angular Velocity	Angular Motion	YT (n=12) $\bar{x}$	JT (n=12) $\bar{x}$	P
Right Leg Peak Torque (Nm)	180$^{o/s}$	EXT	147.42 ± 15.41	170.17 ± 36.95	.079
		FLX	95.58 ± 13.97	107.08 ± 24.02	.184
	60$^{o/s}$	EXT	211.58 ± 30.88	221.58 ± 37.93	.505
		FLX	131.67 ± 26.18	127.67 ± 25.64	.721
Left Leg Peak Torque (Nm)	180$^{o/s}$	EXT	136.33 ± 17.58	155.17 ± 34.70	.128
		FLX	98.25 ± 13.28	112.83 ± 25.98	.340
	60$^{o/s}$	EXT	193.75 ± 31.22	220.67 ± 46.43	.127
		FLX	122.42 ± 16.81	137.75 ± 37.82	.729

The comparison of peak torque values of the participants was given in Table 2. It was found out that there was no meaningful statistical difference (p>0.05) between the angular moves dominated by quadriceps and hamstring muscles with both legs at 60o/s and 180o/s. As the chronological age increased, there found no difference in the isokinetic peak torque strength rate.

Table 3

Comparison of relative leg peak torque values of the participants

Limb	Angular Velocity	Angular Motion	YT (n=12) $\bar{x}$	JT (n=12) $\bar{x}$	P
Right Leg Relative Strength (Nm/Kg)	180$^{o/s}$	EXT	1.91 ± 0.25	1.95 ± 0.42	.729
		FLX	1.24 ± 0.17	1.23 ± 0.29	.908
	60$^{o/s}$	EXT	2.74 ± 0.42	2.55 ± 0.47	.326
		FLX	1.70 ± 0.23	1.78 ± 0.41	.069
Left Leg Relative Strength (Nm/Kg)	180$^{o/s}$	EXT	1.76 ± 0.23	1.78 ± 0.41	.954
		FLX	1.28 ± 0.20	1.30 ± 0.31	.954
	60$^{o/s}$	EXT	2.51 ± 0.42	2.54 ± 0.57	.931
		FLX	1.58 ± 0.20	1.59 ± 0.48	.298

The comparison of relative peak torque values of the participants was shown in Table 3. It was found out that there was no meaningful statistical difference (p>0.05) between the angular moves dominated by quadriceps and hamstring muscles with both legs at 60o/s and 180o/s. As the chronological age increased, there found no difference in the isokinetic relative peak torque strength rate.

Discussion

There are many studies in the literature about chronological ages (Maline et al., 2007; Barber-Westin et al., 2006; Buchanan & Vardaxis, 2003) or at different competition levels (Ferreira et al., 2018; Maline et al., 2007; Gissis et al., 2006; Kellis et al., 2001; Cometti et al., 2001) in different branches. There is not enough literature about how isokinetic strength values are affected by the chronological age of volleyball players or as their competition level increases.

For the other hand, it is known that lower extremity strength plays a significant role on how high a volleyball player vertically could jump (Hendrick, 2007) and how swiftly he could shuffle from one side to another (Tramel et al., 2019). Researchers state that lower extremity strengths is a significant factor in the success of the player (Hedrick, 2007), and success and extremity strength are correlated (Sheppard et al., 2014; Sheppard & Young, 2006). It has been reported that adequate lower extremity strength promotes speed and agility (Dawes, 2019), allows quick shuffles (Sheppar et al., 2008) and is a physical must to optimize the performance (Tramel et al., 2019).

The studies conducted previously showed that lower extremity strength and power particularly for quadriceps and hamstring muscles are significant factors in terms of the base moves in team sports such as sprinting and changing directions quickly, passing, jumping, hitting the ball and shuffling quickly (Rösch et al., 2000; Stolen et al., 2005). There are studies which show that as the age increases, lower extremity strength increases as well (Buchheit et al., 2010; Kellis et al., 2001). Additionally, they state that long-term exposures to training routines and maturing lead to an increase in the leg extensor and flexor muscle strength (Agresta et al., 2017).

In our study, it was found out that chronological age and different levels of competition did not affect the isokinetic leg peak torque strength and relative peak torque strength ($p>0.05$). We will try to support our findings with results of studies done in other sports fields as in the field of volleyball, there have not been any study comparing different ages with levels of competition taking isokinetic strength parameters into consideration.

It is stated that between similar chronological age groups of 18 and 15-16, there was not a significant difference in terms of isokinetic peak torque values (Forbes et al., 2009) and there was not a correlation between age and quadriceps and hamstring peak torque absolute values and relative peak torque rates or the rate of hamstring-quadriceps (Barber-Westin et al., 2006).

It was found out that in comparison with the junior group, among the athletes between the ages of 15-17, increased body mass (43.4%) and quadriceps torque strength (60%) did not lead to relative strength difference (Buchanan & Vardaxis, 2003). It is stated that sportsmen between the ages of 15-17 had more torque strength than the group aged 11-13, which led to a significant difference. However, there was found no significant difference in terms of hamstring torque absolute and relative torque strengths (Buchanan & Vardaxis, 2003). In their study in which they conducted with three different age groups, Vargas et al. (2020) reported that leg extensor and flexor torque values increased with age and there was a significant difference between the torque values across the ages. Kellis et al. (2001) stated in their study conducted with footballers whose chronological ages ranged from 10 to 17, absolute and relative values of isokinetic leg flexion and extension torque strengths were different and age (maturity/development) affected isokinetic leg strength. In their study with footballers, Ahmet et al. (2006) observed meaningful increases in terms of chronological age (10-18 year-olds) and isokinetic strength. In the isokinetic torque strength comparison with lower-aged athletes, the older group provided higher torque values (Andrade et al., 2021).

The fact that among the athletes of more competitive sports, motor actions like gaining speed, changing directions and jumping across the different age categories showed more strength correlated with their high-level competitive needs (Ferreira et al., 2018). When young and adult athletes across different levels of competition were compared, adult sportsmen were found to generate more strength (Gissis et al., 2006; Cometti et al., 2001). However, there was no significant difference in terms of muscle strength values of young athletes at different levels of competition and chronological ages (Maline et al., 2007). Andrade et al. (2021) stated that U15 athletes had meaningfully higher torque strength values compared to U13 group and added that between sportsmen in U18 and U15 groups was no significant difference.

Our study limitations are; the competition levels of the junior and youth categories are included. Athletes playing in professional leagues could not participate in the study due to their intensity in the match calendar. That's why only two different competition categories have been compared. There is no significant difference in teen athletes in terms of age and isokinetic strength differences. It is seen that isokinetic strength in volleyball players is not affected by the needs in motor abilities such as sprinting and jumping required by the field, and differences in isokinetic strength are needed to be by taking muscular activities into consideration.

Conclusion

Literature review showed that correlation between isokinetic strength and chronological age can be observed in various sports fields across different age groups. As frequent contraction of quadriceps muscle and inadequate hamstring strength which are particularly required in volleyball are compensatory, it was seen that strength increase in quadriceps muscle is more than the one in hamstrings. It can be said that when relative values are close to each other, strengths of hamstrings which are leg flexor muscles and quadriceps groups which are extensor muscles also improve in parallel with body mass increase.

The fact that with age, the amount and speed of muscle growth increases in adolescent sportsmen explains why teenagers experience a decrease in the speed of muscle growth and why adults and elderly people experience loss of muscle mass. Therefore, it is said that isokinetic peak torque strength values of hamstrings and quadriceps affect performances of the athletes positively.

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