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Examination of Lower and Upper Extremity Isokinetic Strength Parameters and Speed Performance of Water Polo Athletes

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Abstract

The aim of this study is to examine the relationship between the isokinetic lower and upper extremity parameters andspeed performance of water polo athletes aged 15-17.Ten elite male water polo players, aged 15-17, voluntarily took part in the study. Right and left shoulder internal / external rotator, right and left knee flexion/extension isokinetic force measurements (60° sec-1and 180° sec-1) and 25m swimming speed measurements were measured. Linear regression analysis was used to analyze the data, $p < 0.05$ was taken as a significance level. As a result of the analysis of the obtained data, between 25m and 60° right and 60° left knee extension and knee flexion values ($F(4,9) = .51$, $p > .05$, $R2 = -. 28$) and 180° right and left knee extension and knee flexion, there was no statistically significant difference ($F(4,9) = 1.26$, $p > .05$, $R2 = .50$). Furthermore, no statistically significant difference was found between the external and internal rotation values of 25m and 60 ° right and left shoulder and external and internal rotation of the right and left shoulders 180 ° ($F(4.9) = 2.63$, $p > .05$, $R2 = .68$).As a result, it is thought that the major force that draws the fluid during swimming is provided by the arm and shoulder muscles, while the leg muscles play a supporting role. In addition, it is thought that water polo players' body, arm and shoulder muscles need higher energy and force requirements during swimming than pelvic and leg muscles are an important factor for performance. Therefore, it is supported by the view that the upper extremity muscles of elite water polo players can be trained at a higher level than lower extremity muscles.It can be suggested that lower and upper extremity strength exercises should be included more in the training programs of water polo athletes.

Keywords: Force, Isokinetic strength, Speed, Water polo.

Su Topu Sporcularının Alt ve Üst Ekstremite İzokinetik Kuvvet Parametreleri İle Sürat Performansının İncelenmesi

Özet

Bu çalışmanın amacı; Su topu sporcularının izokinetik alt ve üst ekstremite parametrelerinin sürat performansı ile ilişkinin incelenmesidir. Çalışmaya 15-17 yaş arası, 10 elit erkek su topu oyuncusu gönüllü olarak katıldı. Sporcuların sağ ve sol omuz internal/eksternalrotator, sağ ve sol diz fleksiyon/ekstantionizokinetik kuvvet ölçümleri (60° ve 180°açısal hız) ve 25 metre yüzme sürat ölçümleri yapıldı. Verilerin analizinde linear regresyon analizi kullanıldı, anlamlılık düzeyi olarak p.05, R2=-.28) ve 180°açısal hız sağ ve sol diz ekstansiyon ve fleksiyon, arasında istatistiksel olarak anlamlı fark tespit edilmemiştir ($F(4,9)= 1.26$, $p>.05$, $R2= .50$). Ayrıca sporcuların 25m ile 60°açısal hız sağ ve sol omuz eksternal ve internal rotasyon değerleri ile 180° açısal hız sağ ve sol omuz eksternal ve internal rotasyon arasında istatistiksel olarak anlamlı fark tespit edilmemiştir ($F(4,9)= 2.63$, $p>.05$, $R2=.68$). Sonuç olarak yüzme sırasında akışkan biyomekaniğinin çekici gücü kol ve omuz kaslar tarafından sağlandığı, diz kaslarının ise destekleyici rol oynadığı düşünülmektedir. Ayrıca su topu sporcularının gövde, kol ve omuz kaslarının pelvik ve diz kaslarına göre yüzme sırasındaki enerji ve kuvvet gereksiniminin daha fazla olması performans için önemli bir etken olduğu düşünülmektedir. Bu nedenle elit su topu oyuncularının üst ekstremite kaslarının alt ekstremite kaslarına oranla daha yüksek seviyede antrene olabildikleri görüşünü desteklemektedir. Su topusporcularının antrenman programlar içindealt ve üst ekstremitekuvvet çalışmalarının daha çok yer verilmesi önerilibilir.

Anahtar Kelimeler: Su topu, İzokinetik, Sürat, Kuvvet

INTRODUCTION

Water polo includes explosive loads of less than 15 seconds and repetitive activities of varying intensity, combining high-intensity and short-duration actions. It is also a sports branch in which technical and tactical skills and biomotor features are used extensively(1). Water polo players perform actions consisting of combinations of movements such as rising, diving, blocking, sprinting, ball control and agility(2). During these actions, they use their lower and upper extremity intensively. Movements such as scissors, jumping, rotation, foot hitting for the lower extremity, and holding-pushing, block, shooting, pass and goal throw for the upper extremity are techniques that require strength and skill(3). Strength and swimming performance of water polo players and swimmers are highly correlated(4).

During water polo competition, explosive actions such as jumping, throwing against opponents are performed almost vertically rather than a horizontal swimming position in the water, and this has a significant impact on the match(5,6,7,8). Therefore, it is possible to achieve the ability to swim, push the body up and stay up with a strong scissors movement. The scissors movement consists of the circular movements of the legs and generates the force to keep the athlete above the water in a vertical position. In this movement, the knee joint participates in the action together with flexion / extension and medial / lateral rotation(9).

Isometric, concentric, eccentric and isokinetic contraction types are the main types of exercises using in the development of muscle strength(10,11). Isokinetic strength is measured by isokinetic dynamometers. The isokinetic dynamometer has a high reliability and can measure peak moment at different velocity and throughout the complete range of motion(12,13). Due to shown as a gold standard strength assessment method(17,18), isokinetic dynamometry was used in the study. Isokinetic strength outputs can show muscular force produced by athletes in the lower and upper extremity(14,15,16), relation of neuromuscular structure with sport skill, determining muscle imbalances. In addition, isokinetic strength evaluation helps in creating a training program.

It is emphasized that studies on isokinetic force and water polo are insufficient in the literature. Since force and water polo movements are highly related, the aim of our study is to examine the relationship between the isokinetic lower, upper extremity parameters, and speed performance of water polo athletes (students) aged 15-17.

MATERIALS AND METHODS

Participants

The sample group of the study consisted of 10 male athletes (age15.6 ± 0.84 years, height 176.5 ± 6.0 cm and body weight 65.4 ± 11.6 kg) playing in the Selcuklu Municipality Sports Club (also studing in different high schools) which is in the Water Polo 2nd League. Participants and their family were informed about the aim and the risks of the study. All participants' family were provided with written informed consent.The study protocol was approved by the Ethics Committee of Selcuk University, Sport Sciences Faculty (code 409900478-050.99/11237).

Research Design

Both groups were taken to the sports science faculty laboratory at 09:00 am.Athletes did not use any ergogenic aids and drugs that would affect their performance during the test. Participants were warned to not participate in any exercise in the past 48 hours until the end of the test section. Subjects were applied to a standard warm-up including stretching movements. Following that, participants were taken to isokinetic strength measurement by Cybex (Cybex NORM®, Humac, CA, USA). Firsty, all participants' shoulder isokinetic strength, then knee extension and flexion strength were measured.

Isokinetic Knee Strength Measurement

The isokinetic strength measurements of knee were performed by an isokinetic dynamometer (Cybex NORM®, Humac, CA, USA) in the kinatropometry laboratory of Selcuk University. Each Participant was given a familiarization in shoulder at 60° sec-1 for 5 repetitions(19). When the familiarization done, each participant had a 2-min rest. After the rest period, each participant was asked to perform 5 repetitions as hard and as fast as he could at a speed of 60° sec-1 and 180° sec-1. 2 minutes were given beetwen velocity differences. After the test for right shoulder was performed, each participant was given a 5-min rest, and then other shoulder strength was measured. After all the shoulder internal and external test were done, participants' knee extension and flexion were taken with the same frame.

Shoulder internal and external rotation strength were obtained from the participants in a standing position, with elbow flexed at 90°. To measure the muscle strength of shoulder internal and external, the peak moment (Nm) done with 5 repetitions at a velocity of 60° sec-1(20) and 10repetitions180° sec-1was determined.

In the leg strength, participants were seated in the correct position in the test seat. The participants' holders and the middle sections of the thighs were stabilized to the seat by the tapes. In addition, they were allowed to brace for support by holding the handles on the right and left sides of the seat during the test. The Participants were instructed to complete a ROM from 90° to 10°. The point of the beginning was 90° of flexion, then moving into extension. To measure the muscle strength of knee extension and flexion, the peak moment (Nm) done with 5 repetitions at a velocity of 60° sec-1 and 10 repetitions180° sec-1was determined.Participants were supported by verbally encouraging expressions in order to achieve higher performance during the test(21) .

Anthropometric Measurements

In the anthropometric measurements, the height of the athletes was measured with a (HoltainLtd, UK) stadiometer and a body weight with a scale (Tanita TBF 401 / A, Japan)(22,23,24).

25 m Speed Test

The 25 m free-style swimming speed of the athletes was made by asking them to start the test by pushing the wall (sliding in the water) from the pool, without any command, when they felt ready. Casio brand stopwatch was used to determine the sprint swimming times. Athletes took the same swimming measurements for the second time after a full rest and their best scores were recorded to be evaluated in terms of "second"(25).

Statistical Analysis

It was determined by Shapiro-Wilks and Kolmogorov-Smirnov tests that the obtained data did not show normal distribution.The relationship between the speed parameters of the athletes and the isokinetic strength measurements was examined by means of Linear Regression Analysis. All statistical tests were performed using the software package SPSS version 24.0 (SPSS Inc, Chicago, IL). An alpha value of <.05 was considered being statistically significant.

Results

Table 1. Mean and Standard Deviation Values of 60 ° and 180 ° knee flexion and extension of the athletes

Variables Peak Torque (N/m)	*N*	*X̄*	*Ss*
Right Knee Extension 60°	10	201.70	37.15
Right Knee Flexion 60°		101.20	21.61
Left Knee Extension 60°		207.20	46.14
Left Knee Flexion 60°		104.90	24.55
Right Knee Extension 180°		137	32.51
Right Knee Flexion 180°		63.50	13.47
Left Knee Extension 180°		141.20	29.13
Left Knee Flexion 180°		65.20	14.43

Table 2. Regression Analysis of Peak torque of athletes at 60 ° right and left knee extension and flexion with 25m speed

Modal	sd	x^2	F	p
Regression	4	1396.83	.51	.73
Differences	5	2737.71		
Total	9			

* Significant differences (P < 0.05).

When table 2 examined, no statistically significant difference was found between the athletes' 25m and the dependent variables peak torque 60 ° right and left knee extension and knee flexion values according to the results of the regression analysis (F (4,9) = .51, p> .05, R2 = -.28).

Table 3. Regression Analysis of Peak torque of athletes at 180 ° right and left knee extension and flexion with 25m speed

Modal	sd	x^2	F	p
Regression	4	2421.26	1.26	.39
Differences	5	1918.16		
Total	9			

* Significant differences (P < 0.05).

When table 3 examined, no statistically significant difference was found between the athletes' 25m and the dependent variables peak torque 180 ° right and left knee extension and knee flexion values according to the results of the regression analysis (F(4,9)= 1.26, p>.05, R2= .50).

Table 4. Mean and Standard Deviation Values of 60 ° and 180 ° shoulder external and internal rotation torque of the athletes

Variables Peak Torque (N/m)	*N*	*X̄*	*Ss*
Right Shoulder External 60°	10	50	11.98
Right Shoulder Internal 60°		26.7	5.05
Left Shoulder External 60°		47.8	13.93
Left Shoulder Internal 60°		26.7	5.27
Right Shoulder External 180°		44.50	10.46
Right Shoulder Internal 180°		22.1	5.55
Left Shoulder External 180°		40.8	10.59
Left Shoulder Internal 180°		20.8	3.88

Table 5. Regression Analysis of Peak torque of athletes at 60 ° right and left Shoulder External and Internal with 25m speed

Modal	sd	x^2	F	p
Regression	4	2708.14	1.60	31
Differences	5	1688.66		
Total	9			

* Significant differences (P < 0.05).

There was no statistically significant difference between the athletes' 25m and the dependent variables peak torque 60 ° right and left shoulder external and internal values according to the results of the regression analysis ($F(4,9)= 1.60$, $p>.05$, $R2= .56$).

Table 6. Regression Analysis of Peak torque of athletes at 180 ° right and left Shoulder External and Internal with 25m speed

Modal	sd	x^2	F	p
Regression	4	3265.95	2.63	.16
Differences	5	1242.41		
Total	9			

* Significant differences (P < 0.05).

There was no statistically significant difference between the athletes' 25m and the dependent variables peak torque 180 ° right and left shoulder external and internal values according to the results of the regression analysis ($F(4,9)= 2.63$, $p>.05$, $R2= .68$)

Table 7. 25m Speed Mean and Standard Deviation Values of Athletes

Variable	N	$\bar{X}$	Ss
25 m (second)	10	14.63	1.86

DISCUSSION

In the water polo branch, isokinetic exercises are used in which a constant speed and maximal tension is created throughout the whole range of joint range of motion.Isokinetic movements are considered to be effective exercises that one of the best increase muscle strength(4,26). In the study no relation was found between 20 m speed and upper or lower body isokinetic strength.

Shooting movement in water polo occurs from large segments with large joint gaps to smaller segments with narrower joint movements(27).The shooting of the water polo player starts from the lower extremity of the segmental movements and the resulting forces and transmits the resulting reaction force first to the shoulder and then to the finger(28).Although the movement starts from the lower extremity during the shooting(29), the most important part of the shooting is the shoulder junction. Therefore, shoulder muscle groups play an active role during water polo match(42). Also, the strength increase of the muscle groups that play an active role with training positively affects the performance of the athlete(30).Many studies have stated that development of shoulder girdle muscle strength positively affects athlete performance(9,31,32). When the literature is examined, it is thought that there are similarities when our study is compared with the mean values of isokinetic angular velocity, and this is due to the performance levels and mean age of the athletes(33).

In water sports, water is not only a necessary environment but also a factor that makes the movement easier or more difficult.As the water polo player descends deeper in the pool, he remains under a pressure equal to the weight of the water remaining on the upper surface.Other surfaces of the athlete are also affected by this pressure and their position in the water is affected during the movement(28). While the athlete is in the water, the direction of the force applied by the water is either to keep his position or to be vertical(34).The dynamic forces of the fluid increase as it goes deeper, so athletes apply force against pressure to always stay up(35).

Dynamic force is the net force created by the pull-drag-friction force of the fluid by lifting. As a result, the force that the athlete applies to the fluid affects both his position in the water and his ability to move.In the literature, they reported that lower extremity strength had a positive effect on resistance to fluid and friction(36,37). It is observed that the values obtained in our study and the reports given in the literature are parallel. This is thought to be due to the direct relationship between fluid mechanics and the applied force.

One of the main factors affecting performance in water polo is swimming speed(32,38). The speed of the athlete determines the friction force and the position in the water. Therefore, the technique and body profile used by the athlete during swimming affect the friction force between the fluid and reveal the kinematic feature of the athlete's swimming speed.In the literature, there are studies examining the relationship between the isokinetic forces of the knee, shoulder and hip joints with speed in different branches(39,40).In the literature, it is reported that

that there is a correlation between the isokinetic forces produced by the lower and upper extremities in two different joint movements of water polo players and their speed values(8,33,38,41,42,43).This similarity of our study with the literature is thought to be due to the performance and strength of the athletes.

CONCLUSIONS

As a result, it is thought that the attractive power of the fluid is provided by the arm and shoulder muscles during swimming and the leg muscles play a supportive role for them.In addition, it is thought that the body, arm and shoulder muscles of water polo athletes need more energy and strength during swimming than their pelvic and leg muscles are an important factor for performance.For this reason, it supports the view that elite water polo players can train their upper extremity muscles at a higher level than lower extremity muscles. It can be suggested that lower and upper extremity strength exercises should be included more in the training programs of water polo athletes.

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Conflicts of Interest

The authors declare no conflict of interest.

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