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Examining the Relationship Between Foot Length and Ankle Muscle Strength in Swimmers

Bihter AKINOĞLU[1A], Osman Alper ŞENER[1B],
Adnan HASANOĞLU[1C], Tuğba KOCAHAN[1D]

[1]Ankara Yıldırım Beyazıt University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation;
Address Correspondence to T. Kocahan: e-mail: kocahantu@gmail.com

(Received): 08/04/2021/ (Accepted): 30.12.2021
A:Orcid ID: 0000-0002-8214-7895 B:Orcid ID: 0000-0003-1135-2960
C:Orcid ID: 0000-0003-4486-5092 D:Orcid ID: 0000-0002-0567-857X

Abstract

The aim of this study is to examine the relationship between foot length and isokinetic muscle strength of the ankle plantar and dorsiflexor muscles in swimmers. A total of 53 competitive swimmers, 18 women and 35 men, were included in the study. The athletes' foot length was assessed by calipers, and their ankle plantar and dorsiflexor muscle strength was evaluated with an isokinetic dynamometer. Spearman correlation analysis was used to examine the relationship between athletes' foot length and ankle isokinetic muscle strength. There was a moderate relationship between the foot length of the athletes and the isokinetic muscle strength of the ankle plantar and dorsiflexor muscles at an angular velocity of 60 ° / sec ($r = 450/347$; $p < 0.05$); there was a moderate correlation between the isokinetic strength of the ankle plantar flexor muscles at 180 ° / sec angular velocity ($r = 403$; $p < 0.05$); It was determined that there was no relationship between the isokinetic muscle strength of the ankle dorsi flexor muscles at an angular velocity of 180 ° / sec ($r: 0.145$; $p > 0.05$). As a result of our study, it was determined that the strength of the ankle plantar and dorsi flexor muscles increased as the foot length increased in swimmers. Based on this result, the idea that foot length can affect ankle muscle strength in swimmers has emerged. However, some studies are needed to examine the effect of this relationship on swimming performance.

Key words: Anthropometry, Isokinetic, Sports, Athlete.

Özet

Yüzücülerde Ayak Boyu ile Ayak Bileği Kas Kuvveti Arasındaki İlişkinin İncelenmesi

Bu çalışmanın amacı yüzücülerde ayak boyu ile ayak bileği plantar ve dorsifleksör kaslarının izokinetik kas kuvveti arasındaki ilişkinin incelenmesidir. Çalışmaya 18 kadın 35 erkek olmak üzere toplam 53 müsabık yüzücü dahil edildi. Sporcuların ayak boyu kaliper ile, ayak bileği plantar ve dorsifleksör kas kuvveti izokinetik dinamometre ile değerlendirildi. Sporcuların ayak uzunluğu ile ayak bileği izokinetik kas kuvveti arasındaki ilişkiyi incelemek amacıyla Spearman korelasyon analizi kullanıldı. Anlamlılık düzeyi $p<0,05$ olarak alındı. Sporcuların ayak boyu ile ayak bileği plantar ve dorsifleksör kaslarının 60°/sn açısal hızdaki izokinetik kas kuvveti arasında orta derecede ilişki olduğu ($r=450/347$; $p<0,05$); ayak bileği plantar fleksör kaslarının 180°/sn açısal hızdaki izokinetik kuvveti arasında orta derecede ilişki olduğu ($r=403$; $p<0,05$); ayak bileği dorsi fleksör kaslarının 180°/sn açısal hızdaki izokinetik kas kuvveti arasında ilişki olmadığı belirlendi ($r:0,145$; $p>0,05$). Çalışmamız sonucunda yüzücülerde ayak uzunluğu arttıkça ayak bileği plantar ve dorsi fleksör kasların kuvvetinin arttığı belirlendi. Bu sonuca dayanarak yüzücülerde ayak uzunluğunun ayak bileği kas kuvvetini etkileyebileceği fikri ortaya çıkmıştır, ancak bu ilişkinin yüzme performansına etkisini araştıracak çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Antropometri, İzokinetik, Spor, Sporcu.

INTRODUCTION

Swimming; It is a branch of sports that includes many factors such as physical strength, technical skills, coordination, rhythm and correct technique (28). Swimming performance in swimmers is associated with various anthropometric, biomechanical and physical components (20). Swimming performance depends on force generation, and therefore strength and speed parameters are important in training a swimmer (14). Stronger athletes perform better in competitions (9, 33, 35). Motoric features such as muscular flexibility and performance, sensory features such as proprioception, physical and anthropometric features such as range of motion and extremity length are among the factors affecting muscle strength (8, 15, 20, 30, 33). For this reason, the factors affecting muscle strength, muscle strength, and the relationship between muscle strength and swimming performance in swimmers have been frequently studied (6, 23, 25).

Anthropometry is a field of science that generally size and shape the physical properties of the human body with various measurement methods and make a classification by revealing the physical structure features (1, 8, 30). On the other hand, sports anthropometry determines the physical characteristics of athletes and examines both the general and special conditions of their physical development specific to the sport branch (11). Structural and anthropometric features play a role in sports success (20). It has been reported that successful athletes with degrees in swimming generally have a tall body type with long extremities and broad shoulders (13). In addition, it is stated that the anthropometric effect should be taken into account when comparing sprint performance and skill description in swimmers, since anthropometric differences have an acceptable effect on sprint performance in young swimmers (26, 34).

It is accepted that muscle strength positively affects sports performance in all sports branches (21). The relationship between anthropometric parameters that will be able to affect muscle strength and muscle strength, and the relationship of these parameters with sports performance has been investigated in many studies (4, 13, 18, 22, 27). It has been reported that the anthropometric properties of the extremities in swimmers affect sports performance (4, 29, 32, 35) and there is a relationship between lower-upper extremity muscle strength and swimming performance (17). In addition, foot length is an anthropometric parameter that is frequently evaluated due to its possible effect on performance in swimmers (4, 35). In the light of this information, it is thought that anthropometric properties can affect muscle strength, and in this case sports performance will also be affected. Although there are some studies in the literature examining the relationship between some anthropometric features and sports performance (12, 24, 26, 29), studies examining the relationship between foot length and ankle circumference muscle strength in swimmers are limited. In addition, there is no study investigating the relationship between foot length and ankle isokinetic muscle strength in swimmers. Therefore, the aim of our study is to examine the relationship between foot length and the isokinetic muscle strength of the ankle plantar and dorsi flexor muscles in swimmers.

MATERIAL METHOD

The study was conducted in the Sports Training Health and Research Center. Necessary information was given to the athletes participating in the study about the tests, and verbal and written consent was obtained from the athletes and the legal representatives of the athletes under the age of 18. The study was conducted in accordance with the 2008 Helsinki Declaration Principles, and the necessary approval was obtained from the University Social and Human Sciences Ethics Committee (2019/328/52).

Inclusion criteria in the study; Being a contestant swimmer, not having any acute or chronic injury, and volunteering to participate in the study. Having any history of injury or injury related to the ankle and having a history of surgery related to the lower extremity are the criteria for exclusion from the study.

The study was carried out with both lower limbs of a total of 53 swimmers, 18 women and 35 men. It was determined that the average age of the athletes included in the study was 16.13 ± 1.57 years, the average body weight was 63.02 ± 8.04 kg, the average height was 1.72 ± 0.08 m and the average body mass index was 21.27 ± 1.74. kg / m2 (Table 1).

Table 1. Demographic information of the athletes

N: 53	X ± SD	Minimum	Maximum
Age (year)	16,13±1,57	14	21
Body weight (kg)	63,02±8,04	47,4	80,8
Height (m)	1,72±0,08	1,57	1,93
BMI (kg/m²)	21,27±1,74	17	25,01

BMI: Body mass index, **X ± SD:** arithmetic mean ± standard deviation

After the demographic information such as date of birth, height and body weight of the athletes are obtained, ankle anthropometry evaluation is performed with a caliper on the first day; On the second day, the isokinetic muscle strength evaluation of the ankle plantar and dorsi flexor muscles was performed with the IsoMed 2000 isokinetic dynamometer.

Foot Length Assessment: Foot length assessment was measured with calipers, standing while the feet were bare and transferring equal weight to both feet. As a result of the measurement, the distance between the longest toes of both feet and the heel was recorded in cm.

Ankle Muscle Strength Measurement: Isokinetic muscle strength of the ankle plantar and dorsiflexor muscles was measured with the IsoMed 2000 (D. & R. Ferstl GmbH, Hemau, Germany) isokinetic dynamometer. Before starting the measurement of muscle strength, the athletes were exercised with a reciprocal arm leg ergometer at 60-70 rpm for 10 minutes as a warm-up exercise (SFITCI Systems Inc. Oklahoma, USA). The measurement was made in the supine position and during the measurement, the athletes were stabilized with stabilization bands over the waist, proximal femur and tibia. The Pivot point is set to be the lateral malleolus of the ankle. Three repetitive warm-up and understanding movements were performed before each movement and speed. During the measurements, athletes were verbally encouraged. The isokinetic strength of the dominant and non-dominant ankle plantar and dorsiflexor muscles was measured as concentric-concentric with 5 repetitions at an angular velocity of 60 ° / sec and 15 repetitions at an angular velocity of 180 ° / sec. As a result of the measurement; Peak force [peak torque (PT)] and relative peak force (PT / kg) values of the ankle plantar and dorsiflexor muscles were obtained separately at 60 ° / sec and 180 ° / sec angular velocities.

Statistical analysis

Statistics of the study were made using SPSS 20.0 program. Descriptive statistics of all variables were determined. Analytical methods (Kolmogorov-Smirnov / Shapiro-Wilk's test) were used to define whether the variables were normally distributed or not. It was determined that the variables did not show a normal distribution, and Spearman correlation analysis was used to examine the relationship between variables. Variables were represented as arithmetic mean ± standard deviation (X ± SD) and minimum-maximum values. Statistical error level was determined as $p < 0.05$.

RESULTS

The isokinetic strength data of the foot length, ankle plantar and dorsiflexor muscles of the athletes are shown in Table 2.

Table 2. Foot length, ankle isokinetic muscle strength data of athletes

N: 106			X ± SD	Minimum	Maximum
Foot length (cm)			23,02±3,41	8,8	28,2
Isokinetic muscle strength	**60°/ sec**	**PF (PT) (N)**	112,49±24,30	66,1	167,4
		PF (PT/W) (N/kg)	1,78±0,32	1,17	2,74
		DF (PT) (N)	25,52±5,99	8,4	37,3
		DF (PT/W) (N/kg)	0,40±0,07	0,17	0,58
	18°/ sec	**PF (PT) (N)**	76,59±16,79	33,9	114,4
		PF (PT/W) (N/kg)	1,21±0,23	0,61	1,8
		DF (PT) (N)	9,56±9,63	0,21	25,2
		DF (PT/W) (N/kg)	10,05±10,08	0,17	26,1

PT: Peak torque, PT / W: Relative peak torque, PF: Plantar Flexor, DF: Dorsi Flexor, X ± SD: arithmetic mean ± standard deviation, N: Newton.

It was determined that there was a moderate relationship between the foot length of the athletes and the isokinetic muscle strength of the ankle plantar and dorsiflexor muscles at an angular velocity of 60 ° / sec ($r = 450/347$; $p < 0.05$); there was a moderate correlation between the isokinetic strength of the ankle plantar flexor muscles at an angular velocity of 180 ° / sec ($r = 403$; $p < 0.05$); there was no relationship between the isokinetic muscle strength of the ankle dorsi flexor muscles at an angular velocity of 180 ° / sec ($r: 0.145$; $p > 0.05$) (Table 3).

Table 3. Relationship Between Foot Length and Ankle Muscle Strength

N=106			Foot Length cm)	
			r	p
Isokinetic muscle strength	60°/sec	PF (PT)	0,450*	**0,001**
		DF (PT)	0,347*	**0,001**
	180°/sec	PF (PT)	0,403*	**0,001**
		DF (PT)	0,145*	0,139

* Spearman Correlation Test, PT: Peak torque, PT / W: Relative peak torque, PF: Plantar Flexor, DF: Dorsi Flexor.

DISCUSSION

Muscle strength can be defined as the capacity to produce maximum force with a specific muscle or muscle group (5). Muscular strength affects sports performance regardless of any sport branches, and is therefore frequently studied in athletes. As a result of our study that we carried out to examine the relationship between foot length and the isokinetic muscle strength of the ankle plantar and dorsiflexor muscles in swimmers, it was determined that the ankle isokinetic muscle strength increased as the foot length increased.

Swimming performance is highly dependent on muscular strength, speed and explosive force (14, 31). For this reason, it is aimed to increase muscle strength with land training outside the water to increase swimming performance (31). The relationship between muscle strength, physical fitness parameters and sports performance is frequently investigated (7). It is stated that anthropometric properties are among the parameters that affect muscle strength (17, 35). In the literature, it is stated that there is a relationship between anthropometric characteristics and sports performance in athletes (3, 16), and similarly, anthropometric characteristics affect sports performance in studies conducted with swimmers (18, 29, 35). However, there are different information about how anthropometric characteristics affect sports performance (19, 29, 35). In some studies, it has been shown that there is a positive relationship between anthropometric characteristics and swimming performance (29, 35), while in others there is no relationship between anthropometric characteristics and swimming performance (18, 19). In this study, the relationship between foot length and ankle muscle strength (35), which directly affects swimming performance, was examined. In our study, it was determined that as the foot length increased, the isokinetic muscle strength of the ankle plantar and dorsi flexor muscles at an angular velocity of 60º / sec and the ankle plantar flexor muscles at an angular velocity of 180º / sec increased. We think that this situation is caused by the resistance of the foot against water in the plantar and dorsi flexion movement as the foot length increases. In the literature, it is stated that as the foot length increases in athletes, the ankle muscle strength increases, and this may affect sports performance (10). In parallel with the results of our study, there is information in the literature that the use of paddle increases ankle muscle strength in swimmers (2). In a study, it was concluded that the use of medium, large and very large fins affects the force-time curve and changes the swimming speed, and the paddle sizes may be beneficial for the development of force in the water (2). However, in another study conducted with swimmers, it was stated that the ankle muscle strength especially increased the stroke speed (35). As a result of study, the fact that ankle muscle strength increases as the foot length increases parallels this information existed in the literature.

With our study, it was determined that a large foot length will positively affect muscle strength. However, although it has been determined that foot length is associated with muscle strength, more studies are needed to examine the effect of this relationship on swimming performance. As a result of our study, we think that foot length can be considered as an anthropometric selection criterion for optimal swimming performance in swimmers, since the strength of muscle, which is important in sports performance, is related to foot length.

The limitations of our study are that different anthropometric properties such as athletes' swimming performance, leg length, foot width / surface area and other parameters such as lower extremity muscle strength were not evaluated in our study. However, the fact that the ankle plantar and dorsi flexor muscle strength was evaluated with an isokinetic dynamometer makes our study strong.

CONCLUSION

As a result of our study, it was determined that as the foot length increased in swimmers, the foot muscle strength increased. The ankle muscle strength of the athlete with a long foot may be excessive. Based on this result, the idea has emerged that foot length may affect ankle muscle strength in

swimmers, but further studies are needed to investigate the effect of this relationship on swimming performance.

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