ISSN 2459-1149 SHS journal R

JOURNAL OF SOCIAL AND HUMANITIES SCIENCES RESEARCH

Uluslararası Sosyal ve Beşeri Bilimler Araştırma Dergisi

Open Access Refereed e-Journal & Refereed & Indexed

Article Type	Research Article	***Accepted / Makale Kabul***	15.11.2019
Received / Makale Geliş	01.09.2019	***Published / Yayınlanma***	17.11.2019

INVESTIGATION OF THE CORRELATION BETWEEN KNEE ISOKINETIC STRENGTH AND STATIC-DYNAMIC LEG STRENGTH

Research Assistant Mehmet VURAL

Gaziantep University, Physical Education and Sports School, Physical Education and Sports, Gaziantep / TURKEY, ORCID: 0000-0003-0027-6069

Doi Number: http://dx.doi.org/10.26450/jshsr.1542

Reference: Vural, M. (2019). Investigation of the correlation between knee isokinetic strength and static-dynamic leg strength. *Journal of Social and Humanities Sciences Research*, *6*(44), 3440-3446.

ABSTRACT

The aim of this study was to investigate the correlation between knee isokinetic strength and leg static and dynamic strength in sedentary subjects. For this purpose, a total of 14 sedentary individuals (22.80 ± 1.48) participated in the study. Isokinetic measurements of the participants were performed with isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic tests were performed at 3 different motion angles (60os-1 / 180os-1 / 240os-1). Each movement angle was performed with 15 repetitions and 45 second rest intervals. Static leg strength was measured with a dynamometer. Dynamic leg strength was evaluated by vertical jump test. SPSS 20.0 package program was used for the analysis of the data. Significance level was accepted as $p < 0.05$. According to the results of research, significant correlation negatively between knee isokinetic strength at 60os-1 angular velocity including total work extension (nm), average power extension (W), time to peak torque values and dynamic leg strength ($p < 0.05$). No significant correlations between knee isokinetic strength 60os-1 angular velocity including peak torque flexion (nm), total work flexion (nm), average power flexion (W) and time to peak torque flexion (sec) values between static leg strength, and no significant correlations was detected between other angular velocity (180os-1 / 240os-1) between static and dynamic leg strength ($p > 0.05$). As a result, it can be said that there is a significant correlation negatively between knee isokinetic strength at 60os-1 angular velocity including total work extension (nm), average power extension (W), time to peak torque values and dynamic leg strength.

Keywords: isokinetic, strength, static, dynamic

1. INTRODUCTION

Isokinetic contraction is a muscle contraction in which the extremity moves continuously around a joint. The movement speed remains constant at the same speed with a special dynamometer. The resistance of the dynamometer is equal to the strength exerted at each angle during the movement. This method allows the measurement of muscular strength in dynamic movements and provides optimal load (Baltzopoulos and Brodie, 1989). In isokinetic studies, strength or velocity definitions are not appropriate. Instead, the term torque corresponding to angular velocity should be used. Strength around a point or axis is called torque and its unit is newtons / meters (Nm) or foot / pounds. Since the angular velocity cannot be mentioned in the closed kinetic chain, the term angular velocity is suitable for the open kinetic chain which is the open motion test (Dvir, 2004, Yılmaz, Kabadayı, Bostancı, Özdal & Mayda, 2019).

Strength can be defined as the nerve-muscle ability that overcomes internal and external resistances. The highest strength that an athlete can produce depends on the biomechanical properties of the movement and the contractile size of the muscle groups involved. During a physical activity that requires strength, a proper order must be found between the muscle groups involved. Muscles often participate consecutively in a certain sequence (Bompa, 2007). The capacity of the muscle to produce tension in all or part of the joint movement angle is known as dynamic contraction. A muscle can produce dynamic tension either by shortening or lengthening. If joint movement exerts a strength opposite to gravity and the tension generated by the muscle exceeds the external resistance encountered, this is a shortened contraction, and a concentric contraction. If the joint movement is in the direction of normal power and the resistance encountered is above the muscle's capacity to produce tension, this is an eccentric contraction (Perrin, 1993; Özdal, Biçer & Pancar, 2019).

Muscle strength is one of the most important components of sport for high performance, injury prevention, and the effectiveness of injury rehabilitation in athletes (Impellizzeri, Rampinini, Maffiuletti & Marcora 2007; Metaxas, Koutlianos, Sendelides & Mandroukas, 2009). Muscle strength has two components: maximal and explosive which play a decisive role in many individual and team performance. Maximal strength sets the upper functional limit of the musculoskeletal system and is important for relatively slow movement tasks, while explosive strength is considered more important where time available to develop strength is limited in sports activities such as sprinting and jumping (Tillin & Folland, 2014; Tillin, Pain & Folland, 2012; Pancar, Biçer & Özdal, 2018). Thus, these movements are closely related to maximal strength and anaerobic power of the neuromuscular system (Billot, Martin, Paizis, Cometti & Babault, 2010. Ramírez-Campillo et al, 2013).

Jumping strength is defined as the jumping of the athlete as far as possible horizontally and vertically high (or both). The jumping strength is a combined ability and depends on the strength of the leg muscles, the explosive strength, the flexibility of the muscles involved in the jumping and the jumping technique (Günay, Sevim, Savaş & Erol, 1994). Isokinetic tests provide reliable information about the net strength of the muscles, weaknesses of muscles and the risk of disability in any way (Doğan at all., 2019; Gürol & Yılmaz, 2013). The aim of this study is to investigate the correlation between knee isokinetic strength and leg static and dynamic strength in sedentary individuals.

2. MATERIAL METHOD

2.1. Experimental Design and Participants

This study was designed according to the cross-controlled experimental design. A total of 14 sedentary individuals participated in the study. G Power 3.1 program was used to determine the number of subjects participating in the study. The subjects visited the laboratory three times in total. During the first visit, the participants were given detailed information about the measurements. In the second visit, isokinetic knee measurements were carried out. In the last visit, static and dynamic leg strength were measured. Our study was conducted according to the Declaration of Helsinki and the ethics committee permission was obtained from Gaziantep University Clinical Research and Ethics Committee.

Table 1. Descriptive Characteristics of the Participants

	Mean	Std. Deviation
Age (years)	22.80	1.48
Height (cm)	177.60	7.75
Weight (kg)	70.00	5.96
Static leg strength (kg)	79.75	19.46
Dynamic leg strength (cm)	39.70	4.47
60º peak torque extension (nm)	239.00	32.45
60º total work extension (nm)	1588.60	417.13
60º average power extension (W)	81.40	28.10
60º time to peak torque extension (sec)	0.55	0.13
60º peak torque flexion (nm)	98.50	19.76
60º total work flexion (nm)	1249.70	269.09
60º average power flexion (W)	73.00	15.56
60º time to peak torque flexion (sec)	0.60	0.15

Table 1. Descriptive Characteristics of the Participants

	Mean	Std. Deviation
180º peak torque extension (nm)	97.30	21.51
180º total work extension (nm)	1026.10	174.13
180º average power extension (W)	158.60	38.06
180º time to peak torque extension (sec)	0.24	0.04
180º peak torque flexion (nm)	85.90	35.14
180º total work flexion (nm)	831.70	104.35
180º average power flexion (W)	123.40	23.85
180º time to peak torque flexion (sec)	0.27	0.06
240º peak torque extension (nm)	79.70	11.81
240º total work extension (nm)	829.90	80.84
240º average power extension (W)	148.30	20.17
240º time to peak torque extension (sec)	0.20	0.05
240º peak torque flexion (nm)	65.40	9.25
240º total work flexion (nm)	704.70	66.86
240º average power flexion (W)	127.10	19.51
240º time to peak torque flexion (sec)	0.20	0.04

Table 1 shows that the descriptive characteristics of the participants. According to the table. the mean age of the participants was determined as 22.80 ± 1.48 years. height was 177.60 ± 7.75 cm. their weight was 70.00 ± 5.96 kg. static leg strength was 70 ± 19.46. dynamic leg strength was 39.70 ± 4.74.

2.2. Static and Dynamic Leg Strength Measurement

Static leg strength of the subjects was measured by a back and leg dynamometer (Takei- Back &Lift, Japan). After placing the legs on the dynamometer table with the knees (130-140º), the arms were stretched, the back straight and the trunk slightly tilted forward, with the hands grasping the dynamometer bar vertically at the maximum rate, using the legs until the knees were extensible (Heyward, 2002). All strength measurements were repeated 3 times and the best grades were recorded as kg.

Dynamic leg strength was measured by vertical jump test (Sargent Jump) (Sevim and Şengül, 1987). In this measurement, the distance between the height at which the participant could reach to the standing and the point where he could jump and touch was measured in meters. Then, the dynamic strength calculation was made with the formula by using the body weights of the subjects (Garnbetta, 1989; Günay et al, 1994; Tamer, 1995).

2.3. Isokinetic Measurement

Isokinetic knee strength measurements were measured with an isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic tests were performed at 3 different motion angles ($60^{o}s^{-1}$ / $180^{o}s^{-1}$ / $240^{o}s^{-1}$) and 15 repetitions at each angle. The measurement was made for the right side of the knee first, and the rest of the rest of the angular velocity was calculated as the sum of rest intervals isokinetic measurement of the left knee. 10 repetitive warm-up exercises were performed on an isokinetic dynamometer at $300^{o}s^{-1}$ before testing at each angular velocity. The rest interval between each angular velocity was set to 45 seconds (Perrin, 1993).

2.4. Statistical Analysis

SPSS 20 program was used for statistical analysis. Pearson correlation analysis was used to examine the data in a correlational dimension. Values are presented as mean and standard deviation, and significance level is examined as 0.05.

3. RESULT

Table 2. Correlation Between 60º Isokinetic Knee Strength Values and Static-Dynamic Leg Strength

		Static	Dynamic
60º peak torque extension (nm)	r	.265	.196
	p	.459	.587
60º total work extension (nm)	r	-.112	**-.671**
	p	.758	**.034**
60º average power extension (W)	r	-.136	**-.606**
	p	.708	**.043**
60º time to peak torque extension (sec)	r	.476	**-.605**
	p	.164	**.044**
60º peak torque flexsion (nm)	r	.209	-.365
	p	.562	.299
60º total work flexsion (nm)	r	-.062	-.245
	p	.865	.496
60º average power flexsion (W)	r	.235	-.174
	p	.514	.631
60º time to peak torque flexsion (sec)	r	.268	.415
	p	.453	.233

Table 2 shows the correlation between the isokinetic strength values of the participants at $60^{o}s^{-1}$ and the static and dynamic leg strength. According to the table, there was a negative correlation between total work extension, average work extension and time to peak torque values and dynamic strength ($p < 0.05$). No significant correlation was found between the other values and static and dynamic leg strength ($p > 0.05$).

Table 3. Correlation Between 180º Isokinetic Knee Strength Values and Static-Dynamic Leg Strength

		Static	Dynamic
180º peak torque extension (nm)	r	.048	-.358
	p	.896	.310
180º total work extension (nm)	r	.159	-.342
	p	.662	.333
180º average power extension (W)	r	.128	-.323
	p	.724	.363
180º time to peak torque extension (sec)	r	.013	-.179
	p	.971	.621
180º peak torque flexion (nm)	r	-.493	-.002
	p	.148	.995
180º total work flexion (nm)	r	.148	-.143
	p	.683	.693
180º average power flexion (W)	r	-.041	-.238
	p	.911	.507
180º time to peak torque flexion (sec)	r	-.310	.386
	p	.384	.270

Table 3 shows the correlation between the isokinetic strength values of the participants at $180^{0}s^{-1}$ and the static and dynamic leg strength. According to the table, no significant correlation was found between isokinetic strength values and static and dynamic leg strength ($p > 0.05$).

Table 4. Correlation Between 240º Isokinetic Knee Strength Values and Static-Dynamic Leg Strength

		Static	Dynamic
240º peak torque extension (nm)	r	-.114	-.374
	p	.753	.287
240º total work extension (nm)	r	-.048	.229
	p	.895	.525
240º average power extension (W)	r	-.003	-.261
	p	.993	.466
240º time to peak torque extension (sec)	r	-.009	-.078
	p	.980	.830
240º peak torque flexion (nm)	r	-.145	-.152
	p	.689	.674
240º total work flexion (nm)	r	-.119	.207
	p	.744	.567
240º average power flexion (W)	r	-.102	.050
	p	.780	.891
240º time to peak torque flexion (sec)	r	-.283	.337
	p	.428	.341

Table 4 shows the correlation between the isokinetic strength values of the participants at 240^0s^{-1} and the static and dynamic leg strength. According to the table, no significant correlation was found between isokinetic strength values and static and dynamic leg strength ($p> 0.05$).

4. DISCUSSION

The aim of this study was to investigate the correlation between knee isokinetic strength and leg static and dynamic strength. For this purpose, a total of 14 sedentary individuals with a mean age of 22.80 ± 1.48 participated in the study. Isokinetic measurements of the participants were done with isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic tests were performed at 3 different motion angles (60^os^{-1} / 180^os^{-1} / 240^os^{-1}). Each movement angle was applied with 15 repetitions and 45 second resting intervals. Static leg strength was measured with a dynamometer. Dynamic leg strength was evaluated by vertical jump test. According to the results, knee isokinetic strength at 60^os^{-1} angular velocity including total work extension (nm), average power extension (W) and time to peak torque values were found to be negatively correlated with dynamic leg strength ($p < 0.05$). There was no significant correlation ($p> 0.05$) between isokinetic knee strength at 60^os^{-1} angular velocity including peak torque flexion (nm), total work flexion (nm), average power flexion (W) and time to peak torque flexion (sec) values and static strength and other angular velocity between static and dynamic leg strength. At the other angular velocities measured, there was no significant correlation between isokinetic knee strength and static and dynamic leg strength.

In a previous study, the correlation between lower jumping strength and vertical jumping and ball hitting performance was investigated. 19 elite football players were subjected to knee extension and flexion test at angular speeds of $60°s^{-1}$, $240°s^{-1}$ and $360°s^{-1}$. Ball hit speeds were made by video analysis. As a result, no significant correlation was found between isokinetic knee strength and ball hit performance, and there was a low correlation between vertical jump and isokinetic strength. Strengthening of the knee joint muscles may develop jumping performance, but has no effect on impact performance (Saliba and Hrysomallis, 2001). The dynamic strength measured in our study was calculated by the vertical jump performance of the participants. According to the results of the study, a significant correlation was found between isokinetic strength values at 60^os^{-1} angular velocity and dynamic leg strength values.

Previous studies have investigated the correlation between isokinetic strength generation and various performance values. In the results obtained from the studies, significant correlations were found between isokinetic strength values and performance related factors (Ermiş et al, Ermiş, Yılmaz, Kabadayı, Bostancı & Mayda, 2019; Frontera, Hughes, Lutz & Evans, 1991; Kale, Açıkada & Yılmaz, 2008; Özkan & İşler, 2010; Şirin, İnce, Lök & Çağlayan, 2009). Isokinetic strength measurements and trainings of different sports branches and sporting performance according to the correlation between the branch and the desired performance-specific angular velocity measurements can be done to improve sport performance and technical development can contribute (Tang and Shung, 2005).

A person's dynamic strength can be calculated by vertical jump. Vertical jump is a skill based on performance performed by maximal effort at one time (Sevim and Sengul, 1987). When we look at the results obtained, there is a significant correlation between dynamic leg strength and values measured at isokinetic $60^{o}s^{-1}$ angular velocity. This can be attributed to the fact that the resistance at $60^{o}s^{-1}$ is too high and the person exerts maximal or submaximal effort when performing the test.

In our study, the correlation between isokinetic strength and dynamic and static strength which is one of the performance indicators has been examined. According to the results of the study, a significant correlation was found between isokinetic knee strength and dynamic strength at 60os-1 angular velocity. Determining such correlations may be especially important for having information about the performances of athletes in order to make more accurate and objective evaluations. Because isokinetic values provide direct information on muscle strength, the data obtained are important for achieving performance efficiency. As a result, it can be said that there is a significant correlation between $60^{o}s^{-1}$ knee isokinetic strength and dynamic leg strength.

REFERENCES

BALTZOPOULOS, V., BRODIE, D. A. (1989). Isokinetic Dynamometry Applications and Limitations. *Sports Medicine, 8*(2),101-116.

BILLOT, M., MARTIN, A., PAIZIS, C., COMETTI, C. & BABAULT, N. (2010). Effects of an electrostimulation training program on strength, jumping, and kicking capacities in soccer players. *J Strength Cond Res.*,24,1407-1413.

BOMPA, T. O. (2007). *Antrenman Kuramı ve Yöntemi*. Spor Yayınevi ve Kitabevi, Ankara.

DOGAN, E., YILMAZ, A.K., OZDAL, M., MAYDA, M.H., YILMAZ, Ç. & ERMIS, E. (2019). Acute effects of reverse kinesio taping on knee muscle strength, fatigue index and H/Q ratio in healthy subjects. *Isokinetics and Exercise Science,27*(2),135-141.

DVIR, Z. (2004) *Isokinetic muscle testing interpretation and clinical applications*. Churchill Livingstone, USA.

ERMIŞ, E., YILMAZ, A. K., KABADAYI, M., BOSTANCI, Ö., & MAYDA, M. H. (2019). Bilateral and ipsilateral peak torque of quadriceps and hamstring muscles in elite judokas. J*ournal of musculoskeletal & neuronal interactions*, 19(3), 286.

FRONTERA, R., HUGHES, V.A., LUTZ, K.J & EVANS, W. J. (1991). A cross-sectional study of muscle strength and mass in 45- to 78-yr-old men and women. *Journal of Applied Physiology, 71*(2),644-650.

GARNBETTA, V. (1989). Plyometrics foür beginners-basic considerations. *New Studies in Athletics, IAAF Quarterly, 4*(1),61-66.

GUNAY, M., SEVIM, Y., SAVAS, S. & EROL, A. E. (1994). Pliometrik çalışmaların sporcularda vücut yapısı ve sıçrama özelliklerine etkisi. *H. Ü. Spor Bilimleri Dergisi,4*(2),38-45.

GUROL, B., YILMAZ, I. (2013). İzokinetik kuvvet antrenmanı, *Sportmetre Beden Eğitim ve Spor Bilimleri Dergisi*, XI (1), 1-11.

HEYWARD, V. H. (2002). *Advenced Fitness Assessment and Exercise Prescription*. 4. Edition. Human Kinetics.

IMPELLIZZERI, F. M., RAMPININI, E., MAFFIULETTI, N. & MARCORA, S. M. (2007). A vertical jump strength test for assessing bilateral strength asymmetry in athletes. *Med Sci Sports Exercise*, 39, 2044-2050.

KALE, M., ACIKADA, C. & YILMAZ, I. (2008) Sprinterlerin müsabaka döneminde izokinetik kriterleri ve sprint hız değişkenleri ilişkisi. *Spor Bilimleri Dergisi Hacettepe Journal of Sport Sciences,19*(3), 125-138.

METAXAS, T. I., KOUTLIANOS, N., SENDELIDES, T. & MANDROUKAS, A. (2009) Preseason physiological profile of soccer and basketball players in different divisions. *J Strength Cond Res.* 23, 1704- 1713.

ÖZDAL, M., BİÇER, M., & PANCAR, Z. (2019). Effect on an eight-week core strength training on one-leg dynamic balance in male well-trained athletes. *Biology of Exercise*, *15*(1).

OZKAN, A. & ISLER, A. (2010). Amerikan futbolcularında bacak hacmi,, bacak kütlesi, anaerobik performans ve izokinetik kuvvet arasındaki ilişki. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, VIII* (1), 35-41.

PANCAR, Z., BİÇER, M., & ÖZDAL, M. (2018). 12–14 yaş grubu bayan hentbolculara uygulanan 8 haftalik pliometrik antrenmanlarin seçilmiş bazi kuvvet parametrelerine etkisi. *Spor ve Performans Araştırmaları Dergisi,* 9(1), 18-24.

PERRIN, D. H. (1993). *Isokinetic Exercise and Assessment*. Human Kinetics, USA.

RAMÍREZ-CAMPILLO, R., MEYLAN, C. M., ALVAREZ-LEPÍN, C., HENRIQUEZ-OLGUÍN, C., MARTINEZ, C., ANDRADE, D. C., CASTRO-SEPÚLVEDA, M., BURGOS, C., BAEZ, E. I. & IZQUIERDO, M. (2013). The effects of interday rest on adaptation to 6-weeks of plyometric training in young soccer players. *The Journal of Strength and Conditioning Research*, *29*(4),972-979.

SALIBA, L. & HRYSOMALLIS, C. (2001). Isokinetic strength related to jumping but not kicking performance of Australian footballers. *Journal of Science and Medicine in Sport*, *4*(3), 336-347.

SEVIM, Y., SENGUL, E. (1987). *Sağlık Topu ile Güç Geliştirme Alıştırmaları*, G.S.G.M. Spor Eğitim Dairesi Başk. Yayın No: 83, Ankara.

SIRIN, E. F., INCE, A., LOK, S. & CAGLAYAN, H. S. (2009). Spor yapanlar ile yapmayanların izokinetik kas kuvvetleri ile kemik yoğunluğu arasındaki ilişkinin değerlendirilmesi. *Niğde Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi, 3(*1), 30-37.

TAMER, K, (1995). *Sporda Fiziksel-Fizyolojik performansın Ölçülmesi ve Değerlendirilmesi*. Türkerler Kitabevi, Ankara.

TANG, W.T. & SHUNG, H. M. (2005). Correlation between isokinetic strength and shooting accuracy at different shooting ranges in Taiwanese elite high school basketball players. *Isokinetics and Exercise Science*, *13*(3), 169-174.

TILLIN, N. A. & FOLLAND, J. P. (2014). Maximal and explosive strength training elicit distinct neuromuscular adaptations, specific to the training stimulus. *Eur J Appl Physiol.*,114, 365-374.

TILLIN, N.A., PAIN, M.T. & FOLLAND, J. P. (2012). Short-term training for explosive strength causes neural and mechanical adaptations. *Exp Physiol.*, 97,630-641.

YILMAZ, A. K, KABADAYI, M., BOSTANCI, O., OZDAL, M., & MAYDA, M. H. (2019). Analysis of isokinetic knee strength in soccer players in terms of selected parameters. *Physical Education of Students*, *23*(4),209-216.