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Effects of unilateral isokinetic training on maximum strength of dynamic knee stabilizers

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Abstract
This research aims to define effects of unilateral isokinetic training of a dominant leg on development of peak torque of knee extensor and flexor of physically active female population.
Respondents who participated in the research were 30 female students from Faculty of Sport and Physical Education in Sarajevo. They were divided into two groups, an experimental and a control group. Maximum strength of dynamic knee stabilizers was tested on an isokinetic apparatus (Biodex 3) with angular speed of 60°/s and 180°/s. The experimental group conducted additional isokinetic trainings of a dominant leg with angular speed of 60°/s three times a week in the period of four weeks. Obtained results lead to the conclusion that a concentric isokinetic training with angular speed of 60°/s produced significant effects on development of maximum strength of dynamic knee stabilizers of a trained leg and that those results are statistically significally diferent from results of the control group which condusted regular classes.

Keywords: **isokinetic training, strength, dynamic knee stabilizers**

Sažetak
Cilj ovog istraživanja je utvrditi efekate unilateralnog izokinetičkog treninga dominantne noge na razvoj vršnog momenta sile ekstenzora i fleksora koljena,tjelesno aktivne ženske populacije. Ispitanice koje su sudjelovali u ovom istraživanju su studentce Fakulteta sporta i tjelesnog odgoja u Sarajevu njih 30,koj su podjeljene u dvije grupe, esperimentalnu i kontrolnu. Maksimalna jačina dinamičkih stabilizatora koljena testirana je na izokinetičkom aparatu (Biodex 3) na ugaonim brzinama veličine 60°/s i 180°/s. Eksperimentalna grupa je provodila dodatni izokinetički trening dominantne noge, 3 puta sedmično, pri ugaonoj brzini od 60°/s, u trajanju od četri sedmice. Dobijeni rezultati upućuju na zaključak da je koncentrični izokinetički trening na ugaonoj brzini od 60°/s proizveo značajne efekte na razvoj maksimalne sange dinamičkih stabilizatora koljena trenirane noge, te da se ti rezultati statistički značajno razlikuju od rezultata kontrolne grupe koja je provodila redovnu nastavu.

Ključne riječi: **izokinetički trening, snaga, dinamički stabilizatori koljena**

Introduction

Term “isokinetic training” and its advantages in regard to other types of trainings from previous researches (Thistle et al, 1967) has been used in literature for a long period of time.

However, only a small number of researches dealt in additional isokinetic training of physically active persons. If there are such researches they were mainly conducted with male population.

In his research Kazazović (2009**)** defined influence of individually formed training programs on increase of maximum strength of dynamic knee stabilizers of students from Faculty of Sport and Physical Education. In this research the experimental group (which conducted concentric isokinetic training) showed significant quantitative changes influenced by a treatment.

A transformation process was dominantly directed towards changes of maximum strength of dynamic knee stabilizers.

According to previously published researches, the purpose of this study is to define effects of unilateral isokinetic training of a dominant leg on development of peak torque of knee extensor and flexor of physically active female population. The conducted research represented only results and effects of a dominant leg. The reason for this is the fact that the isokinetic training has an unilateral character and that it is first performed on a dominant leg and the author had an intention to avoid contra-lateral effects of the unilateral training. In literature this phenomenon is called “cross education” effect. The “cross education” phenomenon has been famous for more than a hundred years (Zhou, 2000, Lee and Carol, 2007). It has been proven that unilateral strength training together with the “cross education” phenomenon cause an increase of strength of untrained limb, which could produce a wrong picture of effects on a leg which is not dominant. These results are found in researches (Munn, Herbert and Gandevia 2004, Adamsona et al. 2008)

Methods

Respondents sample:
Population of physically active women, 30 female students of the Faculty of Sport and Physical Education in Sarajevo, was divided into two groups with a random selection method:an experimental group (n = 15) and a control group (n = 15). The population included physically active women between the age of 19 and 25. None of the selected respondents could have a history of injuries of lower limbs in the last two years.

Morphologic characteristic of the sample include the average height of 168 cm, weight of 60, 9 kg and percentage of adipose tissue in total body mass of 26, 3 %.

Variables sample:
Variables for an assessment of the knee extensor and flexor strength with an isokinetic dynamometer:
1. KE60PT - Knee – extension – 60°/s – peak torque

2. KF60PT - Knee – flexion – 60°/s – peak torque
3. KE180PT - Knee – extension – 180°/s – peak torque
4. KF180PT - Knee – flexion – 180°/s – peak torque

A protocol for an isokinetic evaluation of the dynamic knee stabilizers strength

1. Skeletal muscle screening
2. General warming up and body stretching
3. Setting the respondents in an optimal stabilization
4. Alignment between the joint and dynamometer rotation axis
5. Verbal introduction to the concept of isokinetic exercise
6. Correction of gravity.-
7. Warming up (3 sub-maximum, 1 maximum repetition).
8. Maximum test at test speed of 60°/s (5 repetitions).
9. Maximum test at test speed of 180°/s (5 repetitions).
10. Testing extremities.

Experimental procedure description

During this training period both groups performed physical activities related to a program of regular classes at the Faculty of Sport and Physical Education, but the experimental group also performed an additional isokinetic training of a dominant leg.

The experimental group performed knee trainings on a Biodex isokinetic dynamometer with angular speed of 60°/s 3 times weekly. A number of repetitions in series and a number of series are set in a way that work performed (total work) increases progressively from week to week.

The control group acted according to a regular curriculum and a practical training program of a year of study regularly attended by students.

Data processing methods

Basic central and dispersion parameters were calculated with descriptive statistics for both groups in initial and final measuring.

Statistical significance of effects achieved between the initial and the final measuring for groups is defined on a basis of significance of differences between arithmetic means .Testing of significance of differences between arithmetic means was done with a t-test for small dependable samples.

The level of statistical significance was set to $p < 0.05$.
Data processing was done with statistical packages IBM SPSS 19, 0 for Windows and STATISTICA 9.0.

Results and Discussion

Analyzing central and dispersion parameters of all respondents in the initial and final measuring represented in tables 1 to 4 we can conclude that the results are distributed normally both in the initial and in the final measuring. An observation and analysis of average results in both measuring clearly indicate that mean values of variables applied for the experimental group (Table 1 and 2) show higher numerical characteristics in the final then in the initial measuring. Even in the first analysis these characteristics of the control group show a decrease of mean values between two time points of measurement.

Table 1. Descriptive statistics (Experimental group – initial measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60IN	15	125.1	86.9	212.0	143.260	35.8311	.253	-.686
FLEX60IN	15	71.50	40.50	112.00	76.9400	17.97052	-.084	.475
EX180IN	15	67.90	66.10	134.00	94.9200	20.58339	.300	-.775
FLEX180IN	15	46.60	33.80	80.40	55.9667	12.94586	.065	-.205
Valid N (listwise)	15							

Table 2. Descriptive statistics (Experimental group - final measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60FIN	15	124.0	120.0	244.0	169.267	31.2444	.821	.970
FLEX60FIN	15	60.00	71.00	131.00	92.1133	16.64168	.914	.739
EX180FIN	15	60.60	88.40	149.00	114.5667	17.05234	.637	-.280
FLEX180FIN	15	38.90	49.40	88.30	70.0067	12.13192	.056	-.868
Valid N (listwise)	15							

Tabela3. Descriptive statistics (Control group – initial measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60IN	15	122.50	90.50	213.00	148.0333	29.04459	.077	1.521
FLEX60IN	15	65.50	47.50	113.00	80.5733	20.50775	-.324	-.876
EX180IN	15	65.90	65.10	131.00	99.2333	19.58603	-.140	-.798
FLEX180IN	15	41.20	40.80	82.00	61.5467	11.54747	.159	-.370
Valid N (listwise)	15							

Table 4. Descriptive statistics (Control group – final measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60FIN	15	109.00	105.00	214.00	143.6000	26.08722	1.163	3.188
FLEX60FIN	15	56.30	50.70	107.00	78.2400	16.77812	-.001	-.870
EX180FIN	15	64.30	67.70	132.00	97.1333	17.91295	.152	-.650
FLEX180FIN	15	32.20	39.60	71.80	57.9200	9.53634	-.291	-.320
Valid N (listwise)	15							

According to results of previous researches (Costill, Coyle, Fink, Lesmes, Witzmann, 1979; Peterson, 1990; Kazazović et al. 2007), a concentric isokinetic training of lower limbs most probably should influence improvement of various dimensions of strength of physically active women. An analysis of results obtained from an additional four-week isokinetic training leads us to the conclusion that there are statistically significant differences between results of the experimental group in the initial and final measuring (Table 5). Namely, all pairs of variables between the initial and final measuring indicate statistical significance of differences, which practically means that the additional concentric isokinetic training at angular speed of 60°/s caused a significant increase of all parametres of maximum strength of dynamic knee stabilizers.

Analyzing differences between arithmetic means of the experimental group from the initial and final measuring at angular speed of 60°/s we realize that an average result of knee extensors in the final measuring is higher for 25,9 Nm∼ 18 %, while that result is 15,2 Nm∼ 20 % higher for flexors (*Table 6.)*. Such results and sizes of effects of the implemented isokinetic training of the experimental group measured at angular speed of 60°/s can be explained with a phenomenon of specificity of the implemented isokinetic training. The fact that effects of a training are the strongest in an exercise that is used as a training asset and as a test for evaluation of effects of so-called "training specificity " is well known (Sale and MacDougal, 1981).

Table 5. Results of T-test for experimental group between initial and final measuring

Paired Samples Statistics									
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EX60IN EX60FIN	-26.0067	19.3273	4.9903	-36.7098	-15.3036	-5.211	14	**.000**
Pair 2	FLEX60IN FLEX60FIN	-15.17333	10.58175	2.73220	-21.03331	-9.31335	-5.554	14	**.000**
Pair 3	EX180IN EX180FIN	-19.64667	16.13266	4.16543	-28.58064	-10.71270	-4.717	14	**.000**
Pair 4	FLEX180IN	-14.04000	9.93290	2.56466	-19.54066	-8.53934	-5.474	14	**.000**
	FLEX180FIN								

Table 6. Results of T-test for control group between initial and final measuring

Paired Samples Statistics									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EX60IN EX60FIN	4.43333	12.83531	3.31406	-2.67463	11.54129	1.338	14	.202
Pair 2	FLEX60IN FLEX60FIN	2.33333	8.19753	2.11659	-2.20631	6.87298	1.102	14	.289
Pair 3	EX180IN EX180FIN	2.10000	5.93103	1.53139	-1.18450	5.38450	1.371	14	.192
Pair 4	FLEX180IN	3.62667	5.28900	1.36561	.69772	6.55562	2.656	14	.019
	FLEX180FIN								

Variables for evaluation of strength of the knee flexor and extensor measured at angular speed higher than 180°/s indicate that an average result for the knee extensor strength in the final measuring is higher for 19,6 Nm∼ 21%, while for the knee flexor strength that result is higher for 14,1 Nm∼ 25 %. These results can be explained in the way that a concentric isokinetic training at lower angular speed – in our case 60°/s- is so unspecific that it caused a significant increase of maximum knee extensor strength measured at angular speed higher than 180°/s (Kovačević, 2009).

The control group indicates that results of peak torque of the knee extensor measured at angular speed of 60°/ s are decreased for 4,2 Nm or ∼ 3% in the final measuring in regard to the initial measuring. Quantitatively expressed, the control group records a decrease of maximum strength of the knee flexor measured at the same angular speed of 2,4 Nm or ∼ 3%. Measuring peak torque of the knee extensor at angular speed of 180°/s indicates that the control group records a decrease of results of 2, 1 Nm or ∼ 2% in the applied period of time. We see similar results of the control group regarding maximum knee flexor strength measured at the same angular speed and a decrease of result of 3, 6 Nm or ∼ 6% during duration of the study.

An analysis of differences between the groups clearly shows that the additional isokinetic training produced very significant transformation effects on development of maximum strength of dynamic knee stabilizers measured at the isokinetic dynamometer at both test angular speed. If we consider the fact that the control group achieved negative results in all of the applied tests of maximum strength of dynamic knee stabilizers, then we can talk about net effects of the implemented isokinetic training.

Conclusion

According to the obtained results we can conclude that the unilateral isokinetic training of a dominant leg at angular speed of 60°/s produced positive transformation effects on maximum strength of the knee extensor and flexor expressed through peak torque measured at angular speed of 60°/s and 180°/s in the range from 18% to 21%. An additional training program at isokinetic apparatus enables development of maximum strength of dynamic knee stabilizers and confirms results of previous researches. Furthermore, we can conclude that angular speed of 60°/s is very favorable for application in isokinetic trainigs because it is unspecific and develops maximum strength of the knee extensor and flexor measured at significantly higher angular speed. These conclusions are based on differences between the experimental and control group. Namely, the control group achieved negative results in all of the applied tests of maximum strength of dynamic knee stabilizers – the strength decreased in the movement of extension and flexion of the knee joint of a dominant leg. On a basis of these facts, we can conclude that all of the achieved effects arose as a consequence of the additional isokinetic training and that they represent net effects of the implemented experimental treatment.

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