STABILIZATION EXERCISES AS A MEANS OF FITNESS DEVELOPMENT IN FIGURE SKATERS

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Abstract:
Contemporary training approaches indicate benefits of core training for athletes. Core musculature is composed of approximately 29 pairs of trunk muscles: abdominal, gluteal, back and pelvic floor muscles contributing to spinal stabilization. The examination of the role of core training most probably allows for more effective use of its functionality by investigating the level of contribution to skating performance. The selected experimental design partially confirmed the positive effect of stabilization exercises on core stability as one of the factors underlying structure of skaters' success. A sample of 9 figure skaters participated in the study. The skaters performed tests designed to measure 6 variables consisting of static and dynamic balance, stability and trunk strength. The experiment was conducted in the course of 8 weeks during the preparation and competition period. The results showed that the efficiency of incorporation of stabilization exercises into training may be considered a means of developing static and dynamic balance and strength of figure skaters.

INTRODUCTION

Core muscles enable figure skaters to perform faster and more coordinated and effective movements. Core plays an important role during the transfer of forces from the lower body which is in contact with ice to the upper body and vice versa [9]. Functional level of core stability is needed to achieve tightness and to keep the body upright when performing figure skating skills. Such approach requires a more detailed analysis of the core functionality determined by approximately 29 pairs of trunk muscles activated during execution of figure skating movements [10]. Core muscles contribute to spine and pelvis stabilization and their kinetic changes. The core consists of a group of abdominal muscles in the front, back and gluteal muscles at the back, diaphragm at the top and muscles of pelvic floor muscles [7]. Core muscles are activated 100 ms before the activation of limb muscles, which forms the basis for the effective movement of the entire body and limbs [3, 6]. Stabilization is associated with the term core stability defined as core strengthening resulting in enhanced control of executed movement [1]. Hibbs et al. distinguish between two inter-related types of core training consisting of core stability training and core strength training. This division results from the core functions underlying spine stabilization and execution of faster and strength-determined movements. The objective of core strength training is to strengthen global stabilizer muscles, which are phasic and rapidly fatigable and indirectly contribute to stabilization. Core stability training is designed to strengthen deep local stabilizer muscles, which are tonic and directly contribute to stabilization [7, 8]. Global stabilizer muscles create movement and act against external forces, but cannot maintain spine stable [5]. Based on knowledge coaches incorporate training designed to strengthen local stabilizer muscles into figure skating training. During rapid movements stabilizer muscles have to resist extreme load and also maintain correct position of the passive subsystem. Snelling emphasizes the role of the functional relationship oriented towards training of global stabilizer muscles aiding in stabilization. Strengthening core muscles optimizes functioning of the local system and creates conditions for the activation of the global system [2].

THE AIM OF THE WORK

The aim of the study was to determine the effect of stabilization exercises performed off ice fitness development of figure skaters.

THE MATERIAL AND THE METHODOLOGY

The experimental group consisted of 9 figure skaters aged 9 to 17 years (3 boys and 6 girls) who are members of the figure skating club KK Kraso Prešov (see Table 1). The skaters participated in 5 training sessions within a weekly microcycles.

Table 1. Subjects characteristics

Subject (n=9)	Age (years)	Body height (cm)	Body weight (kg)	Sports age (r)
F.K.	14	164.5	54.1	8
K.K.	11	142	32.5	6
P.A.	9	142	46	2
P.M.	17	157	50.6	10
T.K.	11	142	31.4	6
C.H.	11	141.5	36.9	5
D.K.	10	143.5	44.9	5
N.D.	9	147.5	33.4	4
L.A.	9	130.5	26.1	3

Note. n - sample size, cm - centimeter, kg - kilogram

During the pre-competition period of 2014/2015 season figure skaters were tested within pre-testing for balance, stability and trunk strength (see Table 2). The test battery consisted of 6 test items designed to measure variables of static and dynamic strength: 1. Flamingo test with eyes closed, 2. Flamingo test with eyes open, 3. Lower quarter Y Balance test (dynamic balance test) and trunk stability and strength: 4. Upper quarter Y Balance test (core stability test), 5. Trunk extension and 6. Curl-up test. The study was conducted in the course of 8 weeks during which figure skaters participated in 12 training sessions. Exercises were designed to activate gluteal muscles and to improve core stability. The program also included stabilization exercises imitating skating skills in the standing position. Post-testing measurements were taken during the competition period. The test results were processed by Spearman’s rank order correlation. To determine the effect of training, Wilcoxon paired samples t-test was administered and evaluated at $p<0.05$.

RESULTS AND DISCUSSION

Table 2 presents the results of correlation analysis between particular variables.

Table 2. Results of correlation analysis

Test		1.	2.	3.		4.		5.	6.
				L	R	L	R		
1. Flamingo test with eyes closed		-							
2. Flamingo test with eyes open		.75**	-						
3. Lower quarter Y Balance test	L	.77**	.86**	-					
	R	.68*	.83**	.90**	-				
4. Upper quarter Y Balance test	L	.88**	.93**	.83**	.78**	-			
	R	.83**	.83**	.83**	.78**	1,**	-		
5. Trunk extension		-	.76**	.71*	-	.90**	.90**	-	
6. Curl-up test		.74*	.77**	-	-	.80**	.80**	-	-

Significance level: *$p<0.05$, **$p<0.01$, L - left; R - right

Table 2 shows values of correlation coefficients at $p<0.05$. The correlation analysis indicates values of a common criterion between core stability and dynamic balance. Correlation between these variables was confirmed at post-testing, and at pre-testing only for push-up position on the left arm. High degree of correlation was found between core stability and trunk strength. The selected strength tests activate deep core muscles although global stabilizer muscles perform most of the work due to performing tests requiring increased levels of strength. Parameters of back extensor strength correlated with dynamic balance parameters for flamingo test (left leg) at post-testing while taking into account muscle imbalance. Greater range in trunk extension most probably allows for shifts in the center of gravity when assuming extreme positions. No correlation was found at pre-testing. In terms of determined correlations strength abilities may partially affect parameters of dynamic balance, however such effect may be random. Correlations were found between static balance and all test items except for flamingo test with eyes closed and parameters of back extensor strength. Trunk strength may contribute to balance maintenance without further lower-body movement.

Flamingo test with eyes closed measured static balance without visual control, i.e. functioning of the vestibular system. At pre-testing, lower scores were found for figure skaters with shorter sports age. Decline at post-testing was recorded for F.K. (boy) and for T.K. (girl). The most significant improvement was found for the youngest figure skater L.A. Differences were minimal due to high degree of test difficulty.

Table 3. Flamingo test scores – dominant leg – eyes closed

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test (s)	5.4	3.78	3.02	4.58	5.32	4.76	3.82	3.9	3.13
Post-test (s)	5.03	5.47	3.09	6.11	5.18	5.68	5.1	4.36	6.31

Note. s - second

Parameters of static balance were measured also by administering the flamingo test with eyes open. There were greater differences within the group. Mostly younger subjects aged 9 years achieved scores below 10 seconds. All subjects achieved better scores at post-testing except for P.M. and T.K., who achieved the highest possible score. More significant improvements in test scores were found predominantly for girls.

Table 4. Flamingo test scores – dominant leg – eyes open

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test (s)	57	10.5	3.9	60	60	10.75	17.17	6.22	9.58
Post-test (s)	60	23.7	4.65	60	60	41.2	60	9.8	54.9

Note. s - second

Table 5 presents Y Balance test scores. All subjects achieved better scores at post-testing. Only 3 subjects improved their scores when performing the test on their dominant leg. Figure 1 shows differences in pre-testing and post-testing scores displaying partial compensation of muscle imbalance for F.K. and L.A. At post-testing, a four-point difference between right and left leg indicating high injury risk was not found for any of the subjects.

Table 5. Balance test scores

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test L	112.21	106.22	100.46	107.72	114.91	109.91	108.56	107.02	109.62
Post-test L	118.41	112.67	109.72	116.67	120.83	115.54	115.32	114.25	114.55
Pre-test R	106.59	105.33	100.93	109.96	115.35	112.61	110.81	104.61	104.69
Post-test R	115.31	111.78	107.41	118.70	121.71	117.57	117.34	111.84	111.97

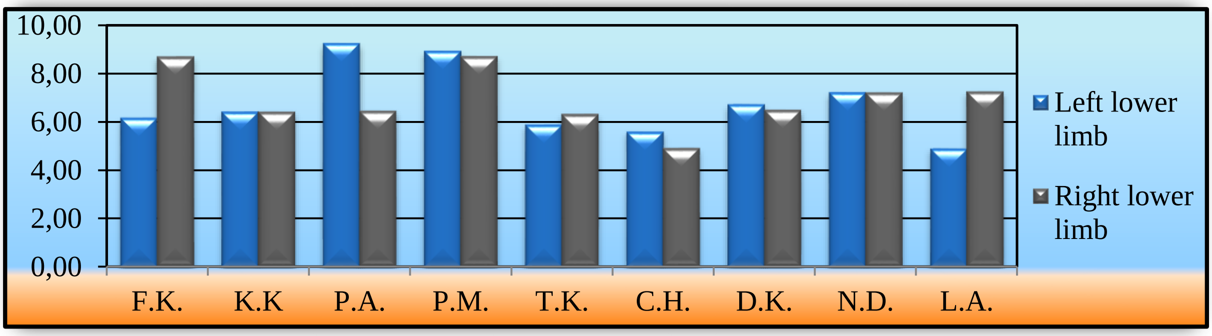

Figure 1. Differences in balance test scores

Scores for Upper quarter Y Balance test are presented in Table 6. All subjects performed significantly better at post-testing. High degree of imbalance during the test was found for T.K., where the difference in the test scores equaled 7.66 points and also for K.K. (boy) and C.H. (girl). At post-testing, a difference exceeding 4 points indicative of greater risk of spinal injury was not recorded. We may assume that rotational movements incorporated into the intervention program and performed to both sides partially compensated for muscle imbalance (see Figure 2).

Table 6. Scores for core stability test

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test L	100.39	80.44	69.84	94.95	97.30	86.53	86.98	79.78	75.00
Post-test L	107.45	99.11	85.26	107.47	109.91	99.09	101.77	93.33	88.80
Pre-test R	98.43	75.11	65.31	92.93	89.64	79.45	88.30	82.22	75.52
Post-test R	104.71	95.11	82.77	105.66	106.31	94.06	101.99	92.44	88.80

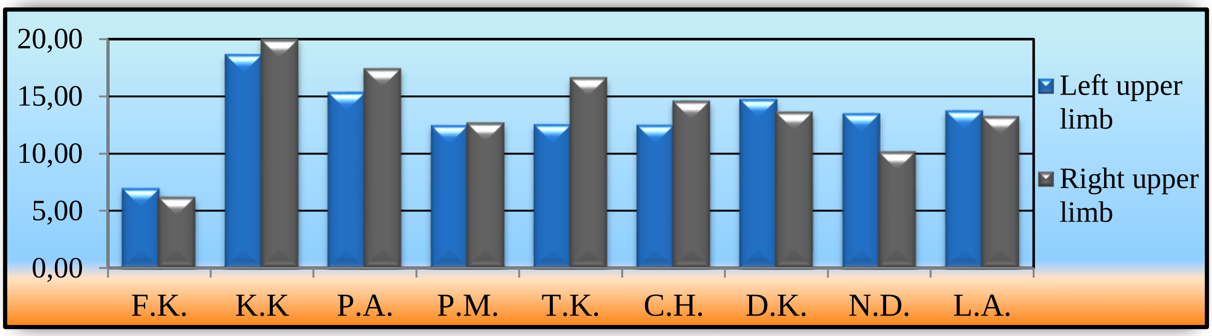

Figure 1. Differences in scores for core stability test

Table 7 shows scores for trunk extension test. At pre-testing, all subjects except for P.A. achieved a score above 30 cm, which is classified as a higher value. Overall, it may be concluded that high level of flexibility and joint range of motion are one of the factors determining fitness of figure skaters, which was confirmed by the present study.

Table 7. Scores for back extensor strength test

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test (cm)	39	40	29	36	45	35.5	36	34	31
Post-test (cm)	45	42	32	40.5	47	37	43	37	33

Note. cm - centimeter

Curl-up test scores are presented in Table 8. The test score is the number of curl-ups performed up to a maximum of 80. Maximum number of curl-ups at pre-testing was found for 2 oldest figure skaters. All subjects achieved better scores at post-testing. More significant differences between pre-testing and post-testing scores were found for younger subjects. Improvements in the curl-up test may be attributed to more effective activation of local stabilizers recruited during curl-up movement.

Table 8. Scores for abdominal endurance test

Subject	F.K.	K.K.	P.A.	P.M.	T.K.	C.H.	D.K.	N.D.	L.A.
Pre-test (n)	80	38	48	80	72	73	60	26	22
Post-test (n)	80	66	56	80	80	80	71	37	31

Note. n – number of repetitions

CONCLUSIONS

Incorporation of stabilization exercises into training during pre-competition period may be regarded a means for the development of balance, core stability and trunk strength of figure skaters. Level of balance may be partially determined by trunk strength. However, particular variables need to be differentiated. Trunk strength may have partial effect on the level of dynamic balance to a lesser extent compared to static balance with manifested inter-correlation. Improvement in balance is predominantly induced by core stability as well as strength of trunk muscles. Core stability may contribute to body strengthening and coordinated execution of movements when performing demanding skating elements, which allows for their more effective execution. These statements are difficult to verify under specific conditions.

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