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ИЗСЛЕДВАНЕ НА СТУДЕНТИ ОТ СПЕЦИАЛНОСТТА ФИЗИЧЕСКО ВЪЗПИТАНИЕ ЧРЕЗ СКРИНИНГ НА ФУНКЦИОНАЛНОТО ДВИЖЕНИЕ

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USING THE FUNCTIONAL MOVEMENT SCREEN TO EVALUATE PHYSICAL EDUCATION STUDENTS

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Abstract: *Physical education students must perform well the basic movement patterns, in order to be successful teachers and athletes. For identifying potential movement limitations among 52 male physical education students (40 Bulgarian and 12 Greek), we use Functional Movement Screen (FMS) as an effective reliable test battery for measurement and assessment of the basic functional movement patterns. We find that 65% of the students have movement asymmetry, which is the primary reason for the inadequate tests scores and total mean scores. The combined total mean FMS score is 16.58 ± 1.94. We recommend corrective exercises for overcoming movement asymmetry and improvement of limited test movement patterns.*

Key words: *physical education students, Functional Movement Screen (FMS), movement patterns*

Introduction

Physical education students need to have knowledge and key competencies in the field of kinesiology for a successful professional career. The quality of their basic movement patterns is an important motor skill and a condition for the safe and effective health and physical fitness perfection as the main goal of any form of physical activity. Reiman and Manske point out that all people must have some basic level of ability to perform functional movements, needed for the successful performance of their everyday and professional activities (Reiman, Manske, 2009). Physical education students should know the basic functional movement patterns and perform them with high quality in order to be able to teach proper movement skills.

Functional movements and their measurement are the basis of the functional training approach, defined as a modern holistic approach, focusing on the development of movement patterns. The aim is to improve of the quality of the basic functional movement patterns that build the foundation of motor abilities, in order to reduce injuries, improve motor efficiency and quality of life. (Cook at al., 2006 a)

The Functional Movement Screen (FMS) developed by Cook et al. is an effective tool for the measurement and evaluation of the basic functional movement patterns (Cook, 2001, Cook at al., 2006 a, Cook at al., 2006 b, Cook at al., 2010). The tests correspond to the definition of functional movements: “the ability to produce and maintain a balance between mobility and stability along the kinetic chain while performing

fundamental patterns with accuracy and efficiency" (Okada at al. 2010: 252). They require an optimal level of development of the components of mobility and stability: joint range of motion and muscle flexibility, muscle strength and endurance, coordination, balance, and postural control (Cook, 2001). Some authors define the ability to perform these tests as functional movement skills and state that their good level is a prerequisite for a good performance of the basic motor skills such as running, jumping, throwing etc. (Duncan at al. 2013).

The purpose of the study is to determine the level of the functional movement abilities of Bulgarian and Greek students, Physical education teacher training, using the Functional Movement Screen. ***The tasks*** of the study include analysis of the students' FMS results and the quality of their functional movement abilities, and recommendations for their improvement.

The subjects are 52 male undergraduate students, studying Physical Education Teacher Training in *St. Cyril and St.Methodius* University of Veliko Tarnovo, Bulgaria and in *Aristotle* University of Thessaloniki, Greece. The Bulgarian group consists of 40 students with an average age of 21.1 years, of which 27 are 1st, 7 are 2nd and 6 are 3rd grade. The Greek group consists of 12 students 1st grade with an average age of 19.9 years. All subjects are healthy, with no musculoskeletal injuries during the past 6 weeks prior to the testing that could prevent it. The survey was performed in 2014 in the Sports complexes of the two universities, in the period February-April in Bulgaria and April-May in Greece.

The methods used include study of literary sources, Functional Movement Screen (FMS) test battery, and mathematical and statistical variation analysis (SPSS).

The FMS is designed to determine functional motor limitations and asymmetry in the musculoskeletal system of the body in performing certain basic patterns of functional movements in healthy individuals with varying degrees of physical activity. FMS is based on standardization of the most common functional models of human movements, defined as normal motor functions of healthy physically active individuals (Cook at al., 2010). The FMS tests are Deep squat (DS), Hurdle Step (SP), Inline lunge (ILL), Shoulder Mobility (SM), Active straight leg raise (ASLR), Trunk stability push up (TSPU), and Rotational stability (RS). Five of the tests are performed bilaterally (SP, ILL, SM, ASLR, and RS) to measure the symmetry or asymmetry between the left and right side of the body. Three of the tests (SM, TSPU, RS) have an additional clearing test to check the presence of pain during movement.

Procedure. The standardized test procedures, instructions, scoring criteria and individual result sheet (Cook at al., 2010), were used in order to ensure the scoring accuracy. The test battery is run without warming up, with demonstration and instructions before each test. A maximum of three attempts of the seven main tests and one of the clearing tests are made. The scores are reported in a four-point system: 3 - correct performance according to the criteria; 2 - there is a compensatory movement; 1 - inability to take the starting position, significant loss of balance or inability to perform; 0 - there is pain. The best score is recorded. In the five bilateral tests, the left and right side of the body are evaluated separately, and the lower score is recorded as the final test score. Each of the three zero tests is evaluated with a plus (+) if there is pain, in which case the final score of the respective main test becomes 0 points. If there is a score of 3 points in the first or second attempt, the test is considered complete. The maximum FMS total score is 21.

Analysis of results

The variation analysis of the tests (**Table 1**) shows that the Bulgarian group is homogeneous for the TSPU test (V% 5.31) and approximately homogeneous in the other tests. The Greek group is homogeneous for HS (V% 0), approximately homogeneous for ILL and ASLR, and heterogeneous in the other tests which may be due to the smaller number of the group. In the total FMS score both groups are approximately homogeneous (BG group V% 11.13 and GR group V% 13.53%). Overall, both groups combined are relatively homogeneous, as evidenced by V% 11.73% of their combined total FMS score.

Table 1. *Variation analysis of FMS tests and total FMS score*

№	Indicator / Test	Group	n	X min	X max	R	$\bar{X}$	S	V%	As	Ex
1	Deep squat (DS)	BG	40	0	3	3	2,20	0,61	27,62	-0,84	3,35
		GR	12	1	3	2	2,08	0,67	32,09	-0,09	-0,19
		Combined	52	0	3	3	2,17	0,62	28,41	-0,64	2,06
2	Hurdle Step (HS)	BG	40	1	3	2	2,10	0,44	21,02	0,53	2,16
		GR	12	2	2	0	2,00	0,00	0,00	.	.
		Combined	52	1	3	2	2,08	0,39	18,70	0,77	3,65
3	Inline lunge (ILL)	BG	40	0	3	3	2,65	0,66	24,99	-2,26	5,90
		GR	12	1	3	2	2,33	0,65	27,91	-0,44	-0,34
		Combined	52	0	3	3	2,58	0,67	25,89	-1,74	3,41
4	Shoulder Mobility (SM)	BG	40	1	3	2	2,45	0,55	22,55	-0,27	-1,00
		GR	12	0	3	3	2,00	1,04	52,22	-1,15	0,73
		Combined	52	0	3	3	2,35	0,71	30,30	-1,30	2,73
5	Active straight leg raise (ASLR)	BG	40	1	3	2	2,58	0,55	21,34	-0,80	-0,43
		GR	12	2	3	1	2,58	0,51	19,93	-0,39	-2,26
		Combined	52	1	3	2	2,58	0,54	20,83	-0,71	-0,69
6	Trunk stability pushup (TSPU)	BG	40	2	3	1	2,98	0,16	5,31	-6,32	40,00
		GR	12	0	3	3	2,75	0,87	31,49	-3,46	12,00
		Combined	52	0	3	3	2,92	0,44	14,91	-6,34	41,84
7	Rotational stability (RS)	BG	40	1	2	1	1,93	0,27	13,86	-3,35	9,74
		GR	12	0	2	2	1,83	0,58	31,49	-3,46	12,00
		Combined	52	0	2	2	1,90	0,36	18,78	-4,05	17,26
8	Total FMS scores	BG	40	12	20	8	16,85	1,87	11,13	-0,61	-0,21
		GR	12	12	18	6	15,58	2,11	13,53	-0,31	-1,33
		Combined	52	12	20	8	16,58	1,94	11,73	-0,47	-0,67

Active straight leg raise (ASLR) and *Shoulder mobility* (SM). ASLR and SM are defined as primitive movement patterns. They are easier to perform and require primarily active motility of the lower and upper limbs. One needs to perform the tests very well, since they form the basis for the other FMS patterns, requiring higher level of motor skills necessary in all sports (Cook at al., 2010). The ASLR mean score is the same for both groups (2.58), while the SM mean score is lower: 2.45 for the BG and 2.00 for the GR group (**Fig. 1**). The weak mean scores for each group and for the combined group total ($\overline{X}$ ASLR = 2.58 and SM = 2.35) are due to the insufficient active mobility of the limbs, and to the difference in the mobility of the right and left limbs, as evidenced by the large number of asymmetric results (**Table 2**). In ASLR 7 of the BG and 2 of the GR students have asymmetric performance, and in SM the number is higher: 14 and 3. The total number of asymmetries in SM is 17 and in ASLR - 9, respectively the largest and the third largest number of asymmetric performances of the bilateral tests. This indicates insufficient active flexibility of the lower and upper limbs and a difference in the mobility of the right and left limbs.

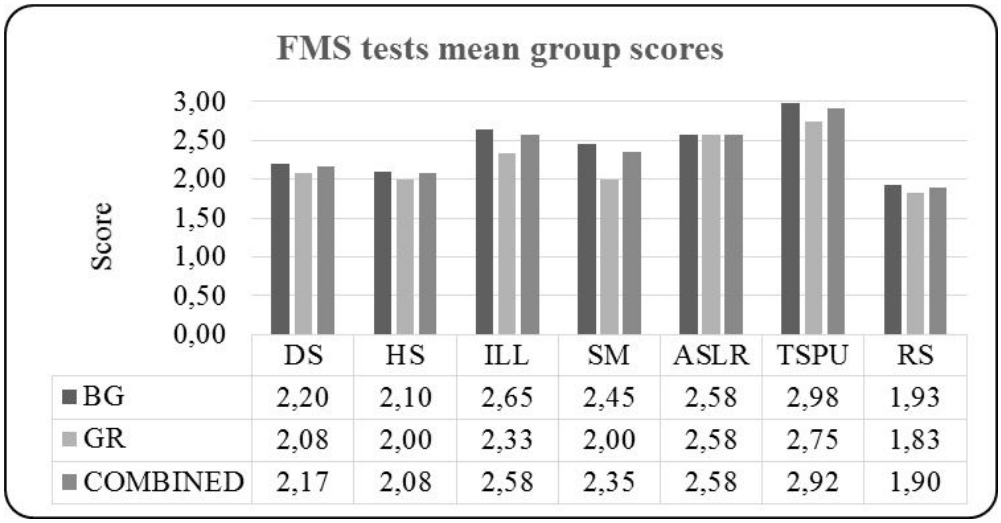

Fig. 1. *FMS mean group tests scores*

Rotary stability (RS). RS has the lowest mean score of all the tests in both groups: 1.93 for the BG and 1.83 for the GR group, with a combined total score of 1.90 (**Fig. 1**). This may be due to the difficulty of the test model, which was performed for 3 points only by one Greek student, but due to pain his final score was 0. These results show an insufficient level of rotational stability, as the test mainly measures spinal anti-rotational stability in the transverse plane.

Table 2. *Asymmetries in the bilateral FMS tests*

Group	n	Asymmetrical performances					Asymmetrical performers				
		HS	ILL	SM	ACLR	RS	Total (%)	In 1 test	In 2 tests	In 3 tests	In 4 tests
BG	40	10	3	14	7	2	26 (65%)	19	5	1	1
GR	12	1	4	3	2	-	8 (67%)	6	2	-	-
Combined	52	11	7	17	9	2	34 (65%)	23	7	1	1

Trunk stability push up (TSPU). TSPU has the highest mean score: 2.98 for the BG group and 2.75 for the GR group, with a total score of 2.92 (**Fig. 1**). TSPU is a modified version of push up and measures mainly the core stability in the sagittal plane of motion. The high scores show that the students use this traditional exercise and have the necessary stability in the performance of this movement pattern.

Inline lunge (ILL). The ILL mean score is the second best score for the BG group (2.65) and third best (2.33) for the GR group (**Fig. 1**). It is the second best combined score (ILL=2.58), identical to ASLR. The lower mean score of the GR group is due to the greater number of asymmetric performances - 4, which for the BG group are 3. We suggest that students should perform ILL for the maximum of 3 points because as future teachers or coaches they must be able to demonstrate technically correctly the exercises with the lunge movement pattern. It is needed in the sports practice where the lunge in variants is a basic exercise in physical training.

Hurdle step (HS) and Deep squat (DS). HS and DS mean results are second and third lowest respectively 2,20 and 2,10 for the BG and 2,08, and 2,00 for the GR group with combined totals HS = 2,08 and DS = 2.17 (**Fig. 1**). The weaker result for HS for the BG group is due partly to the 10 asymmetric performances (**Table 2**). Most of the students have insufficient stability and mobility of the joints involved in the performance of these patterns. As for the ILL test, we consider that the students should be able to perform the tests for the maximum score of 3 points.

Asymmetries. The majority of the students surveyed (65%) have one or more asymmetric performances. These are 26 students (65%) from the BG and 8 (67%) from the GR group (**Table 2**). The large number of asymmetries of the bilateral tests is the main reason for the low scores of the five bilateral tests, which has a significant downward effect on the individual and combined group FMS scores.

Score of 1. The students with a score of 1 point in some of the tests are 6 in the BG group and 2 in the GR group, approximately equal in percent: 15% and 17%, respectively. In total 8 students score 1 point in one of the tests, or 15% of the combined group (**Table 3**). Such score indicates a significant difficulty in performing the test and students of physical education should not have such a result.

Score of 0. The students with pain in performing some of the tests (score of 0) are 2 in the BG and 3 in the GR group, 5% and 25% respectively, which is 10% of the combined group (**Table 3**). Pain is the most significant movement constraint in the FMS, and may indicate temporary musculoskeletal problems or micro injuries (Cook et al., 2010), so we recommend consulting a physiotherapist or kinesitherapist.

Table 3. *Pain and low score of the FMS tests and total FMS score ≤ 14*

Group	n	Pain	Low score of 1 point	Total FMS score ≤14
BG	40	2 (5%)	6 (15%)	4 (10%)
GR	12	3 (25%)	2 (17%)	5 (41%)
Combined	52	5 (10%)	8 (15%)	9 (17%)

Individual test results. Individual total scores below 14 (FMS d"14) have 4 Bulgarian students and 5 Greek, 10% and 41% of the respective groups (**Table 3**). In total of 9 or 17% of students have such a result that shows poor overall functional motor skills. It has been found that a total FMS score of d"14 in college female students practicing soccer, volleyball and basketball (Chorba at al., 2010) and that a total FMS score of d"14 or asymmetry in some of the tests in professional American football players increases the risk of injury (Kiesel et al., 2007, Kiesel et al., 2014). Another study of men and women competing in rowing, volleyball and soccer shows that a total FMS score of d"14 is not an indication of an increased probability for musculoskeletal injury and that such indicators are asymmetric scores or weak scores of 1 point in some of the FMS tests (Mokha at al., 2016). Since our students are physically and sports active, probably those with asymmetrical FMS performance or score of 1 point have an increased risk of trauma.

***Table 4**. Group mean total FMS scores*

Group	n	Total FMS score (Mean±SD)	Range Max 21
BG	40	16,85 ± 1,87	12-20
GR	12	15,58 ± 2,11	12-18
Combined	52	16,58 ± 1,94	12-20

Group mean total FMS scores. The total FMS score of the BG group exceeds that of the GR with 1.27 points (**Table 4**) because of better scores in six of the tests (**Fig. 1**), but due to the large difference in the number of students in the groups we do not calculate the significance. The evaluation of the mean total FMS score is limited by the lack of available normative data for our subjects, students of Physical education teacher training. The normative data for the mean total FMS score as established by Schneiders for competitive or recreationally active male subjects aged 18 to 40, is 15.8 ± 1.8 (Schneiders at al., 2011). In our study, the mean total FMS score of the BG group exceeded (16.85 ± 1.87), and that of the GR group is almost equal (15.58 ± 2.11) to this norm. A study of sport-active college students in the United States (48 males and 8 females aged 20.63 years) established a mean total FMS score of 16.46 ± 2.89 (Zou, 2016). In comparison to this study, the BG students score is slightly higher and the Greek is lower. The mean total FMS score of the combined group 16.58 ± 1.94 is above Schneiders's norm and slightly above the college students score, having approximately the same functional motor skills. We believe that students of Physical education, as active athletes and future sports teachers, should have a better performance and FMS scores than the above cited.

Conclusions and recommendations

The functional movement abilities are important to the Physical Education students, being the basis of good physical condition necessary for a successful professional career and an effective and safe exercising of sports. Therefore, we consider that the FMS test results for the functional-movement patterns of both groups are insufficiently high.

We conclude that the main reason for the under optimal test results is the high number of asymmetries in the bilateral tests (65%), which may be associated with an increased risk of injuries in the competitive sports and school sport training.

To improve the quality of functional-movement skills of the participants, we recommend corrective exercises. For SM and ASLR scores the active mobility of the lower and upper limbs can be increased by systematically performing exercises for passive and dynamic stretching. The asymmetry correction is possible by performing a greater number of repetitions for the limb with less mobility. DS, ILL and HS scores can be improved with functional progressions of lunge and squat exercises and single leg stand exercises with a gradual increase in the difficulty of the exercises, for example the series suggested by Boyle for functional training (Boyle, 2004). RS can be improved by exercises for strengthening the muscles stabilizing the spinal cord in the transverse plane (internal and external oblique abdominal muscles etc.), which are part of the so-called anti-rotation training (Boyle, 2010).

We suggest that Functional Movement Screen is included in the Physical Education curriculum, following the example of Odisee University, Campus Parnas, Belgium, where the students are measured with FMS in their first year, so that in the process of studies they may improve their functional movement abilities.

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