The Influence of Practical Curricular Courses on the Upper Body Flexibility in the Faculty of Physical Education and Sports Students

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Abstract: The range and quality of sports technique is conditioned by flexibility. This study analyzes the effects of practical activities that are specific to the first year FPES Galați courses on the upper body flexibility. Over the course of the academic year 2017-2018, the investigated group (composed of 27 girls and 46 boys) has constantly participated for 28 weeks in the 6 practical courses (gymnastics, track and field, swimming, football, volleyball, ice skating), divided in a balanced way throughout the two semesters. The analysis and comparison of the results for the two sexes, during the initial and final tests, applied at the beginning and the end of the academic year, show a superiority of the girls' flexibility in almost all events. The Wilcoxon test for paired samples has identified significant progress between the initial and final assessments in the female group, in 4 of the tests (Right lateral trunk flexibility Combined spine-hip flexibility, Shoulder flexibility, Vertical arm flexibility), recording Z values corresponding to thresholds of $P < 0.05$; however, in the male group, no significant progress was recorded not even in one of the tests, all Z values corresponding to thresholds of $P > 0.05$. The investigation of the differences recorded between independent samples, using the Mann Whitney U test, has identified significant increases in the girls' values in only 3 events, during the initial tests, and in 4 during the final ones, even if the girls' average values are higher than the boys' values for most tests. In conclusion, the boys did not record significant improvements in their performances, only a slight increase or the same values over the course of the investigated period; the girls however, recorded results that show a potential of optimizing their flexibility at this age. The authors recommend that an increased attention should be given during practical courses to develop the students' flexibility as a favoring factor of motion fluidity and improvement of the students' motor potential.

Keywords: *curricular activities; flexibility; joint mobility; students; stretching.*

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1. Introduction

The importance of flexibility in performing a large number of movements and for high motor functions in sports activities is highlighted in numerous studies. Flexibility indicates "the range of motion believed to be normal for a joint or a group of joints," the movement being performed without the occurrence of any pain. It depends on the type of joint and the ability of the periarticular soft tissue (muscle fibers, connective tissue, tendons, ligament) to stretch according to the range of movements associated with each joint. Tissue fibrosis - caused by trauma, injury, surgery - often affects the function of the joints, muscles, and thus the quality of the movements, reducing the flexibility, but having also the reverse effect - joint hypermobility, generating problems related to joint stability and movement control (Jenkins & Beazell, 2010; Konin & Jessee, 2012). Flexibility fluctuates according to age (it decreases in time, muscle mass losses generating a physical limitation of performances, and thus of range of motion), sex (it is higher in women), being perfectible within certain limits, meaning improved through specific methods. Other factors that directly influence the spine mobility are muscle fatigue, type of external loads, speed of performance, type of movement - flexion or extension, lower limb position and flexibility (Chui et al., 2020; Mocanu, 2015; Zawadka et al., 2018). The importance of flexibility exercises for the athletes' training was mentioned by (Canal, 2005). They play a preventive role and reduce pain in the back muscles, treating also various injuries, contributing to the improvement of performances in various fields: artistic, athletic, etc.

Silva et al. (2019) discuss the importance of genes for flexibility in elite rhythmic gymnastics, analyzing selectively the professional literature. They concluded that the selected female gymnasts have a high frequency of a type of allele genes - ADRB2 and FTO - that are linked to low BMI values and reduced body fat, other genes playing a role in articular hypermobility. Bayartai et al. (2020) identify the influence of heredity and environment on flexibility, lumbar posture and motion control in healthy adults. Their study, on 52 Mongolian twins (34 MZ and 18 DZ), aged between 18-50, showed that genes play a role in 77% of lordosis cases, and 67% in the manifestation of sagittal lumbar flexibility. Lumbar flexibility is influenced only moderately by the environment (33%), but it can be improved through training in healthy people and in people with lordosis; it is considered to be one of the top 5 factors that favors the manifestation of disabilities worldwide. Massidda et al. (2019) also show the hereditary component of flexibility - a basic component of physical fitness - mentioning 7 genetic markers that

influence the muscle flexibility and stiffness, and 18 markers that are responsible for joint laxity.

Joint hypermobility (JH) - which is more frequent in children and women, with an incidence that drops with age - is associated with states of anxiety (Bianchi Sanches et al., 2012). Agoraphobia (fear of open spaces) is the disorder most often associated with JH, while other associations, less with joint hypermobility, were recorded for social anxiety and various types of simple phobias.

Morley & Traum (2019) have proven that too reduced thoracolumbar mobility values have negative effects on running, pace length, energy efficiency and vertical movements of the center of mass. They conducted an experiment in the U.K. on 15 men aged between 19-39, restricting their running through the use of devices that limited their spine movements.

Flexibility movements are favored or limited by clothes. Chen et al. (2020) conducted a study on 20 male students with various degrees of back muscle flexibility. The ones wearing fit jeans manifested a reduction of the erector spinae muscles, presenting limitations in pelvic movements, with an increased tension of interspinous ligaments during the power flexion of the trunk at an angle $> 45^{\circ}$. Thus, wearing tight pants is contraindicated for jobs that require power flexion of the trunk on the pelvis, while wearing looser clothes is useful, to reduce the back muscle loads.

2. Material and Methods

The purpose of this research is to identify the effects of practical activities that are specific to the first year FPES Galati courses on the upper body flexibility, highlighting the progress and differences recorded between the sexes, and individually, within each group.

Research hypotheses

H1: There are significant differences between the final and initial tests used to assess the upper body flexibility, on sexes, as a favorable effect of going through the practical courses.

H2: The female group records better statistically significant results than the male group, during both initial and final tests, for the entire battery of tests.

Organization of the research: the study was conducted over the course of the academic year 2017-2018, the results in this paper being only a part of the flexibility tests used in this investigation. The evaluation of the

students - 27 girls and 46 boys - was performed at the beginning of the academic year and at its end, all the subjects taking part constantly in the practical courses - each with 28 hours of practical activities - with a balanced division of courses and number of hours per semester: first semester - Basic Gymnastics, General Bases of Athletics, Winter sports applications / Skating; second semester - Scientific Foundations of Football, Scientific Foundations of Volleyball, and Theory and Practice of Swimming. (Abalasei & Popescu, 2015; Alexe, 2010; Badau & Badau, 2011; Bădău et al., 2015; Dobrescu & Constantinescu, 2006; Enoiu, 2006; Grigore, 2003; Potop & Marinescu, 2014; Preda & Păcuraru, 2012; Savu, 2019). It results a number of 168 practical hours, during which the authors observed the influence of varied physical demands on the flexibility. The study eliminated the subjects who were absent for more than 10% of the total number of the curricular physical activities. The set of skills proposed by these courses is diversified and demands joint mobilizations and stretches of various muscle groups. The research was conducted at the FPES Human Performance Research Center, in Galați. The research used a series of methods: analysis of professional literature, observation, observational experiment, testing method, statistical-mathematical method, graphical representation method and tabulation (Murariu, 2018; Murariu & Munteanu, 2018; Opariuc-Dan, 2011). The statistical calculation was done using the S.P.S.S.20 software, while the charts were done in Microsoft Office Excel. The elaboration of the paper respected the rules of academic writing (Sandu, 2012).

Test description

Assessment test for the lateral mobility of the trunk, right/left: In a standing position, the subjects bend their trunk on their right side, right hand fingertips sliding on the right leg until reaching the maximum range of motion. The distance from the initial position of the fingertips to the final one is measured in centimeters. The test is performed also for the left side.

Combined assessment test for the spine and hip flexibility: In a sitting position, legs apart, the subjects bend their trunk forward up to maximum range of motion. The examiner measures the distance from the sternoclavicular area to the floor. Low values indicate better performances.

Flexibility test for the back muscles: In a supine position, the subjects lift both legs simultaneously over their head. Interpretation: the feet touch the floor; the knees are bend near the ears and touch the floor - 10 points; the feet touch the floor with the knees extended - 5 points; the feet do not touch the floor - 0 points.

Assessment test for the scapulohumeral flexibility / The baton test: In a standing position, legs apart, the subjects hold a baton with both hands; they rotate their arms overhead backwards until the baton touches the pelvis, then forwards. The movement is repeated, gradually bringing one's palms closer to each other on the baton. The distance between palms in the last correct performance (without bending the elbows) is measured and recorded in centimeters.

Apley test for the shoulder flexibility, right-left: In a standing position, the subjects lift one arm and bend it palm facing downwards and backwards, while the other arm is bent along the body, palm at back level. The subjects try to touch/grab the fingers of the two hands at the back of their trunk, then reverse the arms. Interpretation: complete grab of the fingers - 10 points; the fingers only touch - 5 points; no contact between the hands - 0 points.

Assessment test for the shoulder flexibility, arms stretched horizontally: in a sitting position, back against the wall, arms stretched laterally and parallel to the floor, palms against the wall, the trunk is bent forwards, while the palms are maintained on the wall. Interpretation: the obvious forward inclination of the trunk - 10 points; a less pronounced forward inclination of the trunk - 5 points; inability to bent forwards - 0 points.

Assessment test for the shoulder flexibility, arms stretched vertically: in a sitting position, back against the wall, arms stretched vertically, palms against the wall, the trunk is bent forwards, while the palms are maintained on the wall. Interpretation and scoring: just like the previous test.

3. Results

The average values for both sexes are represented graphically in figures 1a, 1b, 2a, 2b, 3a, 3b, with the mention that they could not be used to determine the significance of the differences in the paired and independent samples, because the verification of the normality curve through the Shapiro-Wilk test indicates for most tests values associated to thresholds of $P < 0.05$, which means that the distribution of the results does not follow the Gauss curve, except for 3 tests in the case of the female group (Lateral trunk flexibility, Comb. spine-hip flexib., Shoulder flexibility) and one test in the case of the male group (Shoulder flexib.), thus it was necessary to apply parameterless statistical tests, based on ranks, as presented in table 1.

Table 1. *Shapiro-Wilk test values verifying the normality of the distribution*

Tests	Females			Males		
	Statistic	df	Sig.	Statistic	df	Sig.
Right lat. trunk flexibility	.894	27	.010	.794	46	.000
Left lat. trunk flexibility	.955	27	.282	.848	46	.000
Comb. spine-hip flexib.	.951	27	.226	.902	46	.001
Back muscle flexib.	.652	27	.000	.730	46	.000
Shoulder flexib.	.970	27	.610	.958	46	.093
Apley test - R	.294	27	.000	.530	46	.000
Apley test - L	.544	27	.000	.764	46	.000
Arm flexib. - horiz.	.427	27	.000	.509	46	.000
Arm flexib. - vert.	.795	27	.000	.802	46	.000

Table 2 indicates the average (mean) values for the investigated groups, as well as the differences recorded within the same group, but also between the sexes, for the 2 times of testing.

Table 2. *Mean values and differences*

Indicator	Sex	$X_i \pm m_i$	$X_r \pm m_r$	Dif. Mean pairs	Ti dif. Mean indep.	Tf dif. Mean indep.
Right lat. trunk flexib.	M	24.60±.5651	24.71±.5531	-.1084	1.0531	.8285
	F	23.55±.5732	23.88±.5581	-.3333		
Left lat. trunk flexib.	M	25.80±.5935	26.02±.5415	-.2174	.3229	.3551
	F	25.48±.5633	25.66±.5443	-.1852		
Comb. spine-hip flexibility	M	32,37±1,2477	32,41±1,2085	-.0435	8.2214	8.8945
	F	24,14±1,1568	23,51±1,0918	.6296		
Back muscle flexib.	M	6.95±.4250	7.17±.4008	-.2173	-.1546	-.4928
	F	7.11±.4754	7.66±.4804	-.5556		
Shoulder flexib.	M	86,65±2,8996	86,50±2,8852	.1522	12.800	13.6111
	F	73,85±3,2746	72,88±3,1853	.9630		
Apley test - R	M	8.37±.4928	8.58±.4302	-.2177	-1.2601	-1.2279
	F	9.63±.2568	9.81±.1852	-.1852		
Apley test - L	M	5.88±.6254	5.98±.6314	-.1087	-2.6381	-2.8998
	F	8.51±.5856	8.88±.4077	-.3704		

Arm flexib. -	M	8.91±.3074	9.13±.2825	-.2174	-.3462	-.4992
horiz.	F	9.25±.3483	9.63±.2568	-.3703		
Arm flexib. -	M	4.23±.5376	4.34±.5519	-.1086	-.3905	1.0225
vert.	F	4.63±.7973	5.37±.7513	-.7407		

The statistical analysis of the results suggests relatively close average initial and final results for the male group. In this case, the improvement of the result is reduced; there is a test where there is even a drop in the results: combined spine-hip flexibility. The girls recorded higher values for the entire battery of tests during the final testing, compared to the initial one. There are tests in which a part of the boys recorded scores of 0, both during the initial and the final testing: back muscle flexibility 2 cases (4.3%) during the initial testing and one case (2.2%) during the final testing; Apley right 5 cases (10.9%) during the initial testing and 3 cases (6.5%) during the final testing; Apley left 12 cases (26.1%) during both testings; vertical arm flexibility, 16 (34.8%) during both testings; in the last 2 cases, there is no progress for the subjects with a null score.

Figure 1a. Flexibility test results – females

For the female group, there are only two tests with a 0 score: Apley left 2 cases (7.4%) during the initial testing and remediation of the problems during the final testing with 0 cases (0%); vertical arm flexibility, 10 cases (37%) during the initial testing and 7 cases (25.9%) during the final testing.

Figure 1b. Flexibility test results - males

Figure 2a. Flexibility test results – females

Figure 2b. Flexibility test results - males

Table 3 shows the significance of the differences recorded for the paired and independent samples, between the initial and final testings, through the 2 nonparametric tests.

The female group recorded, during the Wilcoxon test, significantly higher results for 4 challenges: Right lateral trunk flexibility, with $|Z|=2.714$, a value associated to a $P=0.007<0.01$; combined spine-hip flexibility, with $|Z|=2.804$, a value associated to a $P=0.005<0.01$; shoulder flexibility, with $|Z|=3.376$, a value associated to a $P=0.001<0.01$; vertical arm flexibility, with $|Z|=2.000$, a value associated to a $P=0.046<0.05$.

For the rest of the flexibility tests in the case of the girls, and completely in the case of the boys, there are values of $|Z|$ corresponding to thresholds of $P > 0.05$, indicating an insignificant progress, so the curricular physical activities generate some improvements on the flexibility of the male subjects, but statistically, these are insignificant.

Table 3. *Results of the nonparametric tests on paired and independent samples*

Indicator	Sex	Wilcoxon nonparametric test of paired samples		Ti - Mann Whitney U nonparametric test independent samples		Tf - Mann Whitney U nonparametric test independent samples			
		Z	Asymp. Sig. (2- tailed)	Mann Whitne y	Z	Asymp. Sig. (2- tailed)	Mann Whitne y	Asymp. Sig. (2- tailed)	
Right lat. trunk flexib.	M	-1.013 ^b	.311	519.000	-1.175	.240	550.000	-.818	.413
	F	-2.714 ^b	.007						
Left lat. trunk flexib.	M	-1.619 ^b	.105	616.000	-.058	.954	612.000	-.104	.917
	F	-1.667 ^b	.096						
Comb. spine-hip flexib.	M	-.220 ^b	.826	240.000	-4.358	.000	215.000	-	4.644
	F	-2.804 ^c	.005						
Back muscle flexib.	M	-1.414 ^b	.157	610.000	-.143	.886	564.000	-.742	.458
	F	-1.732 ^b	.083						
Shoulder flexib.	M	-.939 ^c	.348	366.000	-2.915	.004	348.500	-	3.115
	F	-3.376 ^c	.001						
Apley test - R	M	-1.414 ^b	.157	527.000	-1.667	.096	507.500	-	2.087
	F	-.577 ^b	.564						
Apley test - L	M	-1.000 ^b	.317	408.500	-2.728	.006	396.000	-	2.913
	F	-1.414 ^b	.157						
Arm flexib. -	M	-1.000 ^b	.317	578.000	-.720	.471	559.000	-	.234

horiz.	F	-1.414 ^b	.157					1.189	
Arm flexib. -	M	-.577 ^b	.564	591.500	-.361	.718	531.000	-	.272
vert.	F	-2.000 ^b	.046					1.100	

The analysis of the differences between the female and male performances, using the Mann Whitney U nonparametric test, shows superior values recorded by the females even during the initial tests, but significant only in three cases (combined spine-hip flexibility, with $|Z| = -4.358$, a value associated to a $P = 0.000 < 0.001$; shoulder flexibility, with $|Z| = -2.915$, a value associated to a $P = 0.004 < 0.01$; Apley Test left, with $|Z| = -2.728$, a value associated to a $P = 0.006 < 0.01$). This aspect is true also for the final tests, this aspect being true also for the final tests, where there are significant differences on independent samples: combined spine-hip flexibility, with $|Z| = 4.644$, a value associated to a $P = 0.000 < 0.001$; shoulder flexibility, with $|Z| = 3.115$, a value associated to a $P = 0.002 < 0.01$; Apley Test right, with $|Z| = 2.087$, a value associated to a $P = 0.037 < 0.05$; Apley Test left, with $|Z| = 2.913$, a value associated to a $P = 0.004 < 0.01$. For the rest of the tests, the rank differences generate values of $|Z|$ corresponding to thresholds of $P > 0.05$, meaning insignificant progress.

Figure 3a. Comparative results for the final flexibility tests males-females

Figure 3b. Comparative results for the final flexibility tests males-females

4. Limitations and discussions

This research is an objective image of the upper body flexibility development level in FPES Galati students. The limitations of this study are determined, on one hand, by the relatively small number of subjects that were investigated, and on the other, by the impossibility to isolate them from other stimuli that might have a positive effect on the tested motor skill, meaning the specific training from the various events and sports that some subjects were engaged in. Another limitation of the study is that it does not propose an experimental program based on contents that are strictly directed toward the development of flexibility, measuring actually the indirect effect of the 6 practical courses on the range of motion, this being focused primarily on the students' assimilation and familiarization to their own technique. One identified problem were the exaggerated values recorded usually by the male group for the shoulder flexibility test / baton test, where the subjects with long arms and increased biacromial width would record longer distances between palms, even at the same joint angle, the test being thus conditioned by the anthropometric variables. The results of other studies regarding the assessment of spine flexibility and upper body joints, conducted at various times, on various groups and locations, confirms the importance of this research, highlighting mainly the proposed methodologies, their role and effectiveness.

The study conducted by Domaradzki et al. (2021) identifies the effect of various sports on the sagittal evolution of the spine in the thorax and lumbar areas. A bad posture imposed by certain combat sports often leads to pain in the spine. Their investigations on 3 groups of athletes - 45 male practitioners of kickboxing, kickboxing and crossfit, and only crossfit, have shown that the people practicing only kickboxing present a higher risk of postural deficiencies, the inclination angle of the thoracolumbar and lumbosacral areas being significantly higher, while the crossfit training has positive effects in regards to maintaining a normal spine curvature and correcting postural deficiencies in those who practice combat sports, being useful as a complementary training method. Lindgren and Twomey (1988) uncovered high values of spine flexibility and higher strength of trunk extensors in hockey players, evaluated over 2 years; they recorded values significantly higher compared to the average values of Western Australian population, the only negative aspect being frequent lumbar pains. The influence of professional sports on the degree of spine flexibility was emphasized by Rätty, Battié, Videman, and Sarna (1997) in an investigation on 114 former athletes aged between 45-68, from various sports: football players, weightlifters, endurance runners, sharpshooters. Although the sagittal lumbar differences are insignificant, the authors noticed that the subjects with high BMI values recorded lower flexion values, and reduced height of vertebral discs generate limited extensions, adding a high incidence of lumbalgias. The subjects who used to be involved in sports requiring varied positions and reduced loads manifested a better lumbar mobility. The association between an affected flexibility and lumbar pains was highlighted also by Tak, Weerink, and Barendrecht (2020), who identify a limitation of the spine flexibility and problems with the internal rotation of the dominant leg hip in adult male judoka. 18- 40 years old. The effectiveness of stretching is proven by Yamauchi et al. (2016), through the implementation of stretching programs for the shoulder muscles that were stiff: teres minor, infraspinatus and posterior deltoid. The subjects - 24 male basketball players / students - have made progress in regards to the internal rotation of the shoulder, reducing their muscle stiffness and horizontal adduction movements, after daily stretching training sessions, over the course of 4 weeks. The positive association between muscle strength and flexibility is supported by Thrash and Kelly (1987). The subjects included in their study - 11 male students - have participated in a strength training program for 11 weeks, 3 sessions per week, based on 8 exercises for the great muscle groups of the body. Significant improvements were recorded for the shoulder and hip flexibility tests.

The effectiveness of Pilates - strongly promoted in the professional literature - used to optimize flexibility is supported by a study of Manshoury et al. (n.d.), conducted on a group of 22 Iranian female volleyball players / students, with an average age of 20.5. The program was applied over 6 weeks, 3 training sessions per week, 40 minutes each session. Favorable results were recorded for the flexibility of the shoulder, the posterior thigh muscles and posterior trunk muscles, the method being beneficial also for the specific technical skills required for volleyball serve. Another similar study - conducted by Amorim et al. (2011) on 15 dancers with an average age of 16, over the course of 11 weeks, 2 Pilates sessions per week, 1 hour per session - has generated an increase of the angle between segments during the various dancing moves, enhancing their flexibility and improving their technique. Emery et al. (2010) recorded favorable results using the Pilates method on a group of 10 men with an average age of 33, following a 12-week program, 2 sessions per week, 60 minutes per session. Progress was made in regards to posture, segment alignment, thorax extension and lumbar flexion, as a result of strengthening the rhomboid and spinal muscles. Positive effects have also been identified by Alves de Araújo et al. (2012), following a Pilates program - for 3 months, 2 sessions per week, 1 hour per session - applied to a group of 20 Brazilian female students, aged between 18-25, with a sedentary lifestyle and double dorsolumbar scoliosis. They recorded improvements in the flexion of the trunk and posterior muscles, and in the postural control.

Heneghan et al. (2018) identified the influence of sedentary behavior versus physical activity in regards to spine mobility, existing a frequent association between the sedentary lifestyle and neck and lumbar pains. The investigated subjects were 92 U.K students, aged between 18-30, divided into 3 groups: 30 physically inactive, 32 physically active, 30 low physically active, the groups being balanced in regards to age and BMI. They recorded significant differences in regards to spine mobility between the active and the inactive subjects, as well as between the active and the low active subjects. The weakest results have been recorded by the inactive subjects, who used to spend more than 7 hours in a sitting position and had an average physical activity under 150 minutes per week. They also recorded positive average correlations between thorax mobility and duration of physical activities, and also negative associations between thorax mobility and duration of the sitting position, the conclusion being that the sedentary lifestyle negatively influences the health of the spine and musculoskeletal system. The effects of physical activity and inactivity were highlighted also in

a study by Boukabache et al. (2020), conducted on 98 people aged between 18-65, and with BMI values <30 . The active subjects with reduced sitting time recorded higher scores for the hip joint mobility, in comparison to the subjects with low physical activity and long sitting hours. The authors observed also significant associations between musculoskeletal pains and prolonged inactivity, which is responsible for increasing the passive stiffness in the flexor muscles of the hip, but also for shortening/stiffening the abdominal muscles.

The effectiveness of stretching programs in regards to flexibility is shown in the study of Shariat et al. (2018), who investigated a group of 142 people with office jobs, in Kuala Lumpur, Malaysia. They divided the subjects into 2 groups, the first benefiting from stretching programs of 10-15 min, 3 days per week, for 6 months, while the second benefiting only from ergonomic adaptations of their working chairs, posture, distance from the monitors, etc. The authors noticed that the subjects benefiting from the stretching program recorded lower scores in regards to shoulder, neck, and back pain, compared to the other group. The effects of stretching on the flexibility of the main joints and muscles were studied by Zakas et al. (2005), on a group of 20 elderly people aged between 65-85. The authors propose 3 types of muscle stretching, the first of 60 sec, the second, based on two 30-sec performances, the third, on four 15-sec performances, observing that there are no significant differences between the effects of these types, all being effective in improving the flexibility, including during trunk flexion. However, there are also studies that indicate more effective types of physical activities aimed at various age categories. Barrett and Smerdely (2002) compared the effectiveness of training programs based on flexibility vs. programs based on resistive exercises, with reduced loads, for people aged > 60 . They studied these types on 2 groups of 20 elderly people, observing that the strength, balance, and gait are better in the case of the group focused on the resistive program, however none of the groups have improved their quality of life.

5. Conclusions

This paper observes the different progress paths of flexibility in the sports undergraduate students, highlighting the effects of curricular practical courses on this skill. Both groups made progress, but the boys rather kept their initial values, a fact reflected in the insignificant differences between the averages, this invalidating the first working hypothesis, while the female subjects do record some significant differences between tests, which validates, albeit only partially, the same hypothesis. The females' higher

results for most tests are not surprising - an idea mentioned by many sources - and the fact that there are some significant differences even during the initial tests, compared to the males, later confirmed during the final ones, is further proof of the females' superiority when it comes to flexibility, thus partially validating the second working hypothesis.

The authors believe that the purpose of this study was achieved, and the recorded results represent a faithful picture of the flexibility in the upper bodies of the FPES students, with favorable and less favorable aspects that were identified, constituting guidelines for the assessment of the current training level in regards of the measured parameters. The originality of this research results from the high number of the tests that were used and from the fact that there were no previous national exhaustive studies on this topic. One limitation of this study is that it was based exclusively on field tests, most of the similar international studies being based on the use of advanced technology (3D cameras, motion sensors, force transducers, etc, electronic devices measurements), which allows a detailed identification of the factors that influence flexibility, thus permitting a more precise orientation of the intervention programs, based on the identified problems. Another limitation was the impossibility to determine the influence of leisure time and professional physical activities on the flexibility of the subjects, most of them being involved at the same time in both.

The fact that there are some tests during which several students of both sexes scored 0 points constitutes a starting point for future research, based on interdisciplinary studies, in order to identify as much as possible the joints and their role in movement, the muscles involved, the angles and the motions that generate problems in regards to the range of motion. The effectiveness of the new techniques for improving flexibility needs to be verified, such as Pilates techniques, Yoga moves, types of stretching - ballistic, passive, isometric, static-active, etc., and implementing them separately or in combination during daily life activities, on representative samples of the populations.

Acknowledgement

The team that carried out the present study declares on their own responsibility that the subjects participating in the research were informed of the voluntary nature of participation in the research, understood the information received and requested for research. They understood that withdrawal from the research can be done at any time, without any adverse consequences on the participant. Research has observed the ethical

standards of research, we mention that the students have given their consent for the participation to this research.

This article is the equal contribution of all authors.

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