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ACTIVE FLEXIBILITY IN GIRLS BEFORE AND AFTER THE ANNUAL CYCLE OF STRETCHING CLASSES

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Abstract

Background and Study Aim: the decrease of motor activity among the younger generation and reducing interest in traditional physical education lessons requires finding ways to attract students to specially organized motor activity. The aim of the study is to analyze the indicators of active flexibility and mobility in the joints of the spine after an annual cycle of extracurricular stretching classes.

Material and Methods: We involved 35 high school girls (15-16 years old) in the study. Mobile tests were performed (control exercises and tests): bending the trunk forward from a standing position and from a sitting position, bending and unbending the cervical spine, bending the thoracic and lumbar spine, bending the trunk to the right and to the left from a standing position, the rotational ability of the spine to the sides, the exercise "Bridge" (calculated in conventional units).

Results: After a year of systematic stretching classes, the level of joint mobility and overall flexibility increased in the study participants. At the beginning of the study, the vast majority of high school girls had average and below-average levels of physical fitness. At the end of the study, the level was above average. There is a certain correlation between the indicators and the statistical significance of the results obtained.

Conclusions: it can be argued that specially organized motor activity in the form of stretching classes changes the mobility indicators in large joints and joints of the spine.

Key words: joint mobility, high school age girls, motor tests.

Introduction. Analysis of the learning process in modern schools has shown that the interest of students in physical education has a tendency to decline. This requires the teacher to constantly improve the physical education of young people by increasing the volume and variety of motor activities, attracting to new interesting types of recreational physical culture (Petruk L. et al., 2019; Sanzharova NM., 2015; Shevtsiv Z. et al, 2020; Zabolotna O. et al, 2019). One of the forms of specially organized motor activity is stretching. Stretching is aimed at improving well-being, appearance, and health (Kylymystyi M., 2015). The basis of stretching is the performance of special exercises for developing mobility in the joints and general flexibility of the body.

The body flexibility as one of the indicators of physical qualities is the subject of research by modern scientists. They studied the indicators of flexibility during the process of training among athletes in gymnastics (Favorytov VM, 2014, Ruda I., 2013); football (Fakhro MA. et al., 2020, Judge LW et al., 2020), volleyball (Takeuchi K, 2019), wrestling (Fyrnskaia EA., 2011), sports dancing (Aleksandrova VA., 2014), handball (Zmijewski P et al., 2020), tennis (Lapkovskiy E et al., 2013), fitness aerobics (Soroka SO., 2012), breakdancing (Aftimichuk O., 2020).

Increasing the range of motion and flexibility of the body can be achieved by performing stretching exercises (Mayorga-Vega D. et al., 2014, Muanjai P, 2015, Sotnyk Zh et al., 2013). The latter have such features as: smooth motor actions, accompanied by a smooth change in muscle tension, a rounded trajectory when changing the direction of movement and the maximum amplitude of movements. Positive effects of stretching: improved blood circulation and lymph circulation; increased flexibility, improved posture; prevention of chronic pain; reduced nervous tension and the rate of aging; increased tone of muscle fibers; prevention of injuries (Andriichuk O. et al., 2019, Ulianytska N. et al., 2020).

A wide range of stretching exercises allows young students to increase the level of motor activity, physical fitness and overall flexibility of the body.

The aim of the work is to analyze the change in indicators of active flexibility and mobility in the joints of the spine in girls aged 15-16 years after an annual cycle of extracurricular stretching classes.

MATERIAL AND METHODS

Participants. 35 girls of high school age (15-16 years old) were involved in the ascertaining and forming experiment during the school year, they attended stretching classes as an extracurricular activity.

Research design. The research was conducted in accordance with the Helsinki Declaration. All participants and their parents were informed about the purpose and objectives of the study, and informed consent was obtained. The individuals involved in the study were normotensive, without any cardiovascular diseases, metabolic disorders, neurological disorders, injuries or disorders of the musculoskeletal system.

We evaluated the mobility of spine joints using mobile tests at the beginning of the study (before systematic stretching) and at the end of the study (after a formative experiment – a summer cycle of stretching).

The annual cycle of stretching classes was divided into two modes. In the first half of the year (developing mode) classes are aimed at teaching stretching techniques, increasing mobility in the joints and flexibility of the body. In the second half of the year (a supportive regime) classes were dedicated to maintain the achieved level, prevent a decrease in joint mobility indicators, improve motor skills, and enrich motor experience.

During the school year, the study participants engaged in stretching three times a week. Classes lasted for 90 minutes and had a traditional structure: preparatory, main and final parts.

Stretching exercises in the preparatory part were performed in a standing position with the involvement of small and medium joints in the movement. In the main and final parts participants performed exercises in the sitting and lying position, which provides stretching of the large muscles of the body (Aftimichuk O., 2020). The proposed extracurricular form of classes corresponds to the age characteristics of girls' development and the specifics of material and technical support of secondary schools.

The overall mobility of the spine joints during flexion, as an indicator of human flexibility, we measured using two tests: the forward tilt of the trunk from a standing position and the forward tilt of the trunk from a sitting position.

When performing the test, the torso is tilted by simultaneously extending the arms (bending the spine) from the standing position – Test the fingertip-to-floor (Muanjai P, 2015) there is flexion in the hip joints, joints of the lumbar and thoracic spine (Furman YuM., 2018). This test, known as test Minora (Murashko NK. et al., 2013) or test Thomayera (Boichuk T, 2010) is used to determine the overall mobility of the spine and visually assess posture, identifying its violations.

To determine the overall flexibility, the test was performed by bending the torso forward from a sitting position on the floor (Serhiienko VM., 2015).

The assessment of mobility in the cervical spine was based on the results of two exercises: a test to determine mobility when bending the neck (chin-sternum test) and a test to determine mobility when extending the neck (chin – jugular notch test) (Boichuk T, 2010).

The assessment of the mobility of the thoracic spine joints when leaning forward was made using Otta test (Gałuszka R. et al., 2018) and the assessment of the mobility of the lumbar spine joints when leaning forward was performed using Schober test (Dheerendrac F., 2018).

The measurement of spinal mobility when tilted to the side (right and left) was performed with maximum lateral tilts of the spine from a standing position (Puhach NV., 2013).

The research of rotational mobility of spine joints when the trunk rotates relatively to the vertical axis was performed using the Fleischmann test (Boichuk T, 2010, Krutsevych Tiu. et al., 2011, Starykov SM., 2010).

A control exercise for measuring the general flexibility of the body as an indicator of total mobility in the shoulder, hip and spine joints during extension is the "Bridge" exercise. The test is evaluated by calculating the relative indicator (Sholopak LF. et al., 2017).

Statistical Analysis. Using the MedStat program, for a variation series whose distribution does not differ from the normal one at the significance level $p \geq 0.1$, arithmetic mean values (\bar{X}), standard standard deviations (δ) and errors (m) were calculated. According to the principle of extreme sigmoid deviations, the levels of preparedness were determined. On a five-level scale, the following ranges were identified: low level of preparedness from $\bar{X} - 1.5 \delta$ and less; below average level of preparedness from $\bar{X} - 0.5 \delta$ to $\bar{X} - 1.5 \delta$; average level of preparedness from $\bar{X} - 0.5 \delta$ to $\bar{X} + 0.5 \delta$; above the average level of preparedness - from $\bar{X} + 0.5 \delta$ to $\bar{X} + 1.5 \delta$; high level of preparedness from $\bar{X} + 1.5 \delta$ and more. The statistical significance of the difference between the indicators was analyzed by the Student's criterion ($p < 0.001$). Correlation analysis was determined by the Pearson correlation coefficient (r). Strength was assessed as average when r is from 0.5 to 0.3; high – when r from 0.5, to 1. A positive correlation coefficient shows a direct (positive) correlation between indicators and negative about the opposite (negative) connection.

RESULTS

Analysis of the obtained data on the dynamics of indicators of active flexibility and mobility in large joints and joints of the spine showed that the level of preparedness of high school girls after an annual cycle of stretching classes changed (Table 1):

- according to the results of the "fingertip-to-floor" test, the number of study participants who showed high and above-average levels increased by 51%;
- exercise "bending the torso forward from a sitting position", 40% of study participants showed a higher than average result after a year of stretching;
- performing the "hin-sternum" test, none of the study participants performed at a high level of preparedness at the beginning of the experiment, the main complaint was pain in the neck muscles. After a year of systematic stretching, 77.1% of high school girls achieved a high level of fitness to perform the exercise;
- the test for determining mobility in the cervical spine during extension did not show a significant change in the distribution of participants by fitness levels after a year of training.
- the Otta test showed that before stretching, half of the surveyed high school girls had a lower-than-average level of mobility in the thoracic spine. After a year of stretching, a third of the girls' mobility increased to the average level and to the above-average level;
- the Schober test proved that stretching classes made their own adjustments to the mobility of the joints of the lumbar spine: a third of high school girls-the level is above average; 45.8% - the average level;
- the measurement of the initial level of mobility of the spine joints when bending to the sides showed that at the beginning of the study, a third of girls had an average level of mobility both when performing exercises on the left and right; in a quarter – the level is above average. After a year of extracurricular stretching, mobility increased: a high level – by 42.8% when performing the exercise on the right and by 45.7% - when performing the exercise on the left;
- The Fleishman test did not find a significant difference when performing the exercise on the right and left: at the beginning of the study: 40% of the examined participants had an average level of rotation ability of the spine when performing the exercise on the right and 42.8% – when performing the exercise on the left side. At the end of the study, the above-average level was recorded in 51.5% when performing the exercise on the right and 45.8% when performing the exercise on the left;
- performing the "bridge" exercise at the end of the study showed that after an annual cycle of stretching, the overall flexibility index among 57.2% of females was at an above-average level; 40% - have an average level. There was no low level of overall flexibility in terms of exercise indicators. A high level of overall flexibility was also not recorded by any high school students.

Table 1. Distribution of high school girls according to the results of tests of active flexibility and mobility

		The level of fitness (n =35)									
		At the beginning of the study					At the end of the study				
Test	n	High	Above the average	Average	Below average	Low	High	Above the average	Average	Below average	Low
		Torso tilt	n	3	8	13	8	3	8	21	5

forward from a standing position, cm	%	8,6	22,8	37,2	22,8	8,6	22,9	60,0	14,3	2,8	-
Torso tilt forward from a sitting position, cm	n	0	5	24	6	0	1	14	20	0	0
	%	-	14,3	68,6	17,1	-	2,8	40,0	57,2	-	-
Chin - sternum test, cm	n	0	16	11	8	0	27	5	3	0	0
	%	-	45,8	31,4	22,8	-	77,1	14,3	8,6	-	-
Chin - jugular notch test, cm	n	5	7	11	12	0	5	7	13	10	0
	%	14,3	20,0	31,4	34,3	-	14,3	20,0	37,1	28,6	-
Otta test, cm	n	4	5	9	17	0	9	12	13	1	0
	%	11,4	14,3	25,7	48,6	-	25,7	34,3	37,2	2,8	-
Schober test, cm	n	0	5	7	23	0	6	11	16	2	0
	%	-	14,3	20,0	65,7	-	17,1	31,4	45,8	5,7	-
Torso tilt to the right from a standing position, cm	n	2	9	12	9	3	15	16	4	0	0
	%	5,7	25,7	34,3	25,7	8,6	42,8	45,8	11,4	-	-
Torso tilt to the left from a standing position, cm	n	1	10	12	10	2	16	14	5	0	0
	%	2,8	28,6	34,3	28,6	5,7	45,7	40,0	14,3	-	-
Fleishman test (right), cm	n	0	12	14	4	5	1	18	8	7	1
	%	-	34,3	40,0	11,4	14,3	2,8	51,5	22,9	20,0	2,8
Fleishman test (left), cm	n	0	12	15	3	5	1	16	11	4	3
	%	-	34,3	42,8	8,6	14,3	2,8	45,8	31,4	11,4	8,6
Exercise "bridge", conventional units	n	0	12	12	7	4	0	20	14	1	0
	%	-	34,3	34,3	20,0	11,4	-	57,2	40,0	2,8	-

To establish statistically significant values of the obtained results, we compared data collected at the beginning of the study and at the end of study calculating Student's criterion and a significance level of p (Table 2). The analysis showed that according to the Student's criterion, the difference in average values is statistically significant at the level of significance $p \leq 0.001$ for such indicators as: torso tilts forward from a standing position and from a sitting position, mobility of the cervical spine (chin-sternum test), mobility of the thoracic and lumbar spine (Otta and Schober tests), torso tilts to the right and left from a standing position, the "Bridge" exercise. At the same time, there was no statistical significance between the indicators obtained at the beginning of the study and at the end of the annual course of

stretching for indicators: the rotational ability of the spine to the sides (Fleishman test) and the index of mobility of the cervical spine during neck extension (chin-jugular notch test).

Table 2. Dynamics of test results of active flexibility and mobility

Test	At the beginning of the study			At the end of the study			<i>p</i>
	X	δ	m	X	δ	m	
Torso tilt forward from a standing position, cm	3,34	4,22	0,71	6,68	2,78	0,48	<0,001
Torso tilt forward from a sitting position, cm	7,82	4,54	0,76	11,2	3,76	0,63	≤0,001
Chin -sternum test, cm	0,41	0,38	0,06	0,04	0,14	0,02	<0,001
Chin -jugular notch test, cm	18,17	1,54	0,26	18,3	1,45	0,24	>0,1
Otta test, cm	4,01	0,92	0,15	4,71	0,76	0,13	<0,001
Schober test, cm	4,24	0,37	0,06	4,82	0,38	0,06	<0,001
Torso tilt to the right from a standing position, cm	29,43	6,92	1,17	18,97	4,96	0,83	<0,001
Torso tilt to the left from a standing position, cm	29,49	5,74	0,96	19,69	4,54	0,76	<0,001
Fleishman test (right), cm	43,38	2,11	0,35	43,96	1,76	0,29	>0,1
Fleishman test (left), cm	43,1	2,04	0,34	43,54	1,78	0,3	>0,1
Exercise "bridge", conventional units	1,58	0,49	0,08	1,31	0,29	0,05	<0,001

According to the correlation between the studied indicators (Table 3):

- a high-strength positive correlation ($r \geq 0.5$) is observed between most indicators;
- correlation of average strength was found between the index of the torso tilt forward from a sitting position and the Schober test index ($r = 0.41$);
- there is no statistically significant correlation between the mobility indicators in the cervical spine (flexion and extension) and the mobility indicators in the joints of other parts of the vertebral column;
- a strong correlation of negative direction is observed between indicators of torso tilt to the sides from a standing position and indicators of torso tilt forward from a standing position and from a sitting position ($r \leq -0.5$); between indicators of torso tilt from a standing position to the sides and indicators of thoracic spine mobility ($r \leq -0.5$).

Table 3. The correlation coefficient between indicators of active spine flexibility at the end of the study

Test	Torso tilt forward		Mobility of the cervical spine		Mobility of the thoracic spine	Mobility of the lumbar spine	Torso tilt forward from a standing position		Rotation of the spine on the right
	from a standing position	from a sitting position	flexion	extension			to the right	to the left	
Torso tilt forward from a sitting position	0,72								

Mobility of the cervical spine	flexion	0,25	0,12							
	extension	0,14	0,01	0,07						
Mobility of the thoracic spine		0,77	0,56	0,18	0,04					
Mobility of the lumbar spine		0,29	0,41	0,14	0,01	0,55				
Torso tilt forward from a standing position	to the right	-0,81	-0,51	-0,29	-0,03	-0,68	-0,13			
	to the left	-0,83	-0,56	-0,23	0,06	-0,72	-0,21	0,94		
Rotation of the spine	to the right	0,79	0,57	0,23	0,16	0,69	0,13	-0,77	-0,76	
	to the left	0,67	0,51	0,16	0,01	0,65	0,01	-0,74	-0,76	0,8

Discussion. In scientific and methodological literature, much attention is devoted to flexibility as a vital physical quality for a person of any age. Flexibility and mobility of the joints ensure full life activity. We have followed such interpretations of the main terms in our work: "Flexibility" is used to characterize the total (total) mobility of several locomotor units of the musculoskeletal system or the entire body;" Mobility " characterizes movements in individual joints (Erkomaishvili IV., 2004). To develop the overall flexibility of the body, it is necessary to increase mobility in all joints. There are active and passive forms of flexibility. Active flexibility is the ability of a person to achieve a large (maximum) range of motion when performing exercises. A set of tests that we conducted were aimed at determining the indicators of active flexibility and mobility of the joints. Testing is a necessary step to determine the initial level of mobility in the joints, the presence of risk factors for diseases and injuries during exercise (Kryventsova IV., 2016).

At the beginning of the study, we received data on mainly average and below average levels of fitness in terms of motor tests. Our results are confirmed by data from other researchers on the physical fitness of Schoolgirls (Andrijchuk O., 2016, Sanzharova NM, 2015, Sotnyk Zh. et al., 2013).

The involvement of students in extracurricular stretching classes was based on research (Shevtsiv U. et al., 2018) concerning the health direction of this type of specially organized motor activity. In the process of forming a lesson plan and selecting special exercises, we used fundamental principles, one of which is symmetry in the performance of the exercises.

We can say that at the end of the study, the level of fitness, for most indicators, has changed to above average and average levels. The level of mobility in the studied segments of the musculoskeletal system increased symmetrically. The symmetrical orientation of stretching exercises in our program is evidenced by the following data: a strong positive correlation between the torso tilt indicator from the standing position on the right and the torso tilt indicator from the standing position on the left ($r=0.94$) and the results of the Fleishman test for determining the rotation of the spine on the right and left ($r=0.8$).

There is a correlation between the mobility indicators in certain parts of the vertebral column in different directions and strength. Such data indicate the health-improving direction of stretching as a specially organized motor activity.

Conclusions.

The development of flexibility as a manifestation of physical qualities is a necessary element of the physical development of adolescents and an important stage of injury prevention. In the vast majority of girls of high school age, the average and below average level of physical fitness in terms of mobility in large joints and joints of the spine prevails.

It is proved that the annual cycle of specially organized motor activity in the form of stretching makes positive statistically significant changes in the indicators of active flexibility and mobility in the joints of the spine in girls aged 15-16 years who regularly attended classes. Our proposed stretching exercises have a health-improving meaning.

Conflict of interest.

The authors state that there is no conflict of interest.

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