PHYSICAL AND SPORT EDUCATION PARTICIPATING IN QUALITATIVE CHANGES IN MUSCULAR SYSTEM OF FEMALE STUDENTS

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Abstract:

Background: Functional weaknesses in musculosceletal system of pupils/ students in Slovakia have been increasing in the last decade, which are involved in development of structural disorders in adulthood and many times due to lack of the primary prevention. Therefore, the aim of research was to verify influence of physical program on selected factors of musculoskeletal system (body posture, physiological curvature of spine and dynamic spine function) in the secondary school students in physical and sport education, in terms of content change. Material and methods: The monitored group consisted of 12 adolescent aged girls (years old 16.33±0.39, body height 167.43±5.89 cm and body weight 56.38±7.51 kg) and from the town Žilina. They were the second year students of selected secondary school. Results: The realized physical program within the physical and sport education and in terms of changes in its content indicated positive changes in selected factors of the musculoskeletal system. Significant ($p<0.01$) improvement was recorded in overall body posture of female students, significantly ($p<0.01$) was improved the physiological curvature of spine in cervical and lumbar spine, as well as the dynamic spine function, as was evidenced by ($p<0.01$) resupts of Thomayer's, Schober's, Stiborv and Otto's tests and lateroflexia. Conclusions: The experimental verification of the outlined "intensification factor" in teaching of the physical and sport education in secondary school is the knowledge and basis for the theory and practice of school physical and sport education in cooperation with the health physical education.

INTRODUCTION

The physical education from the earliest times to the present has changed its design for the last time in 2008 by the school reform, when under the new education act; the National Educational Program (NEP) is the hierarchically highest educational targeted project, which includes profile of graduate, framework, curriculum and school curriculum. The NEP should represent about 70 % of the total content of education and should be binding on schools. The school educational programs should represent about 30 % of the content of education and schools create them independently on the basis of material conditions, school orientations and traditions, staff possibilities and pupils'/ students' interests [Antala, Labudová 2008].

Within the school reform, the physical education has been renamed to physical and sport education and has included in educational area of Health and movement. It has consisted of 4 main modules [Antala, 2009]: Health and its disorders (10 %), healthy lifestyle (10 %), physical fitness and physical performance (30 %), sports activities of physical regime (50 %).

In focus and aim of the physical and sport education, it has markedly diverted from performance-oriented teaching towards developing the pupil's/ student's competences and shaping his/ her values and attitudes towards the health. In aims of the physical and sport education, the emphasis is placed in association intentions to health care and creating healthy lifestyle, as individual forms of the physical and sport education, health physical education or integrated physical and sport education are prerequisites for acquiring habits, attitudes and knowledge about physical activity and health - healthy lifestyle in pupils/ students [Bendíková 2012].

The number of school lessons was reduced by the school reform in 2008 to 2 lessons per week from the original 3 lessons. However, the increase in the number of lessons through the school educational programs in practice only happens in minimum extent in Slovakia.

Antala [2010, 2011], Bendíková [2012] point out that with changes in focus of the physical education in Europe, the extension of existing space for physical activity in school curricula is also strongly preferred. That preference is also reflected in several international documents on education at the level of the European Union, most notably in 2007 - Report on the Role of Sport in Education of the Committee on Culture and Education of the European Parliament. In that document was clearly expressed the requirement to adjust the number of compulsory physical education lessons in the European Union to 3 lessons per week. That requirement has been gradually fulfilled by most countries (e.g. Poland, Ukraine, Slovenia has increased weekly lessons from 2 to 3, Poland from 2 to 4, France has had 5 lessons). Significant changes were also recorded in Hungary, where the physical education lessons at primary schools were extended to 5 lessons per week.

At present, the innovative direction of the content of physical and sport education should be more closely linked to the care of pupil's/ student's health and emphasis should be placed on the physical activity, as mean of preventing health disorders [Bendíková, Jančoková 2009]. It means that there should be more space for pupils/ students to choose different forms of the physical activities, in which experience is essential and superior to performance. In this context, Bendíková [2009a] points out the health-oriented fitness, which not only represents philosophy and conception, but also broadly focuses on the pupils/ students, in terms of their stimulation to their own health and fitness. If current research suggests decline of functional fitness of children and youth, then the causes should be sought not only in the reduced number of the physical and sport education lessons in schools, but mainly in their “content”. Criticism towards content and organizational forms in the school physical and sport education is increasing. The preferences of new types of physical and sports activities of pubescents and adolescents in the physical and sport education are not very "perceived" by teachers, which are the active part of their leisure time [Bendíková, 2009b], as well as an expression of their attitude and relation to the school subject. The teacher plays a key role in that process, which builds on a presumption of establishing the pupil's/ student's relationship to lifelong activity through the physical and sport education. That increases the workload of the teacher, as well as their responsibility in planning and implementing the curriculum in fulfilling the set aims. Therefore, scientific discussions and research works seek ways to improve and increase the effectiveness of the school physical and sport education. Bebčáková [2000], Šimonek, [2003, 2006], Lakóová [2005], Antala [2009] state that the teacher is change implementer who has the opportunity to create conditions in accordance with the interest of most pupils/ students, school facilities and materials, climatic conditions and his/ her experience will be involved in developing the competences and health of the pupils/ students.

In terms of the primary prevention, the physical programs, health-oriented exercises, etc. are important in contributing to improving of the muscular system through external prism of body posture. Therefore, by appropriately chosen targeted health exercises also in the school physical and sport education, it is possible to influence the quality of the muscular system and body posture (postural stability) [De Franco et al. 2009; Lemos et al. 2012; Acasandrei, Macovei 2014], support its proper development, act preventively, thereby contributing to improving the quality of pupils'/ students' health [Kolář 2001].

If research shows decline in pupils'/ students' functional fitness, then the causes must be sought not only in the reduced number of physical and sport education lessons in schools, but mainly in their "content".

AIM

The aim of research was to verify influence of physical program on selected factors of musculoskeletal system (body posture, physiological curvature of spine and dynamic spine function) in the secondary school female students, within the physical and sport education, in terms of the content change.

MATERIAL AND METHODS

The monitored group consisted of 12 adolescent aged girls (years old 16.33±0.39, body height 167.43±5.89 cm and body weight 56.38±7.51 kg) and from the town - Žilina. They were the second year students of selected secondary school. The primary characteristics of the monitored group is presented by table 1.

Table 1 Primary characteristics of experimental group (n=12)

Factors	Years	Body height (cm)	Body weight (kg)	BMI
x	16.33	167.43	56.38	19.86
s	±0.39	±5.89	±7.51	±3.11

Note: BMI - Body mass index, x - arithmetic mean, s - standard deviation.

The research monitoring (input and output evaluation) was carried out by application of standardized methods for physical and medical practice by a physiotherapist. The static component of the body posture was based on the method of body posture evaluation according to Thomas and Klein modified by Mayer [Hošková, Matoušová 2005], as well as the physiological curvature of spine, dynamic spine function [Labudová, Vajcziková 2009].

Evaluation of body posture [Hošková, Matoušová 2005]

The body posture evaluates the sum of points. Each part is evaluated by points 1, 2, 3 and 4, according to the level of body posture. The posture evaluation follows:

I. Posture of head and neck
II. Chest (shape)
III. Abdomen with pelvic inclination
IV. Back curve (spine curvature)
V. Posture of frontal plane (evaluation of shoulders posture - shoulder girdle)

- -

Classification of body posture:

I. Perfect body posture..5 points
II. Good (almost perfect) body posture...6 - 10 points
III. Poor body posture...11 - 15 points
IV. Incorrect body posture..16 - 20 points

Note: In the evaluation is not included the lower limb (VI.) classification, which we write as a fractionated index. I + II + III + IV + V/ VI = number of points.

Evaluation of dynamic function of the spine [Labudová, Vajcziková 2009]

I.Thomayer's test (Th) - (forward bend aimed at touching the floor, overall mobility of the spine)

Procedure: the patient is in a standing position and bends deeply forward towards the floor.
Standard: patients touch the floor with their fingertips.
Decreased mobility: doctors can measure the distance between the fingertips and the floor.

II. Schober's test (Sch) - (lumbar spine)

Procedure: a mark is placed at the level of the fifth lumbar vertebra and the second mark is placed 10 cm above the first mark.
Standard: when the patient bends forward as far as possible, the increase in the distance between the two points should be from 4 to 6 cm.
Decreased mobility: the distance is shorter than the standard one.

III. Stibor's test (St) – (lumbar and thoracic spine)

Procedure: the examiner measures the distance between the spinous process of the 7th cervical vertebra and the fifth lumbar vertebra (C7–L5) in a standing position.
Standard: the increase in this distance when the patient bends forward is from 7.5 to 10 cm.
Decreased mobility: when the distance is shorter than the standard one.

IV. Otto's inclination and reclination test (Ott) - (thoracic spine)

Procedure: The patient is in a standing positon. A mark is placed on his/her back at the level of the 1st thoracic vertebra and the second mark is placed 30 cm below the first one.
Standard: when the patient bends forward, this distance increases by 2 to 3 cm. When the patient bends backward, the distance decreases by 2.5 to 3 cm. The total of the deviations should be 6 cm.
Decreased mobility: when the total of the deviations is lower than the standard. The total of inclination presents an index of the sagittal range of motion of the thoracic spine.

V. Lateral flexion test (bending sideways, left and right) - (lateral mobility of the lumbar spine).

Procedure: the examiner measures how far the middle finger can move along the thigh while the patient bends sideways as far as possible.
Physiological standard is from 20 to 22 cm.
Decreased mobility: when the distance is shorter than the standard one.
Increased mobility: when the distance is longer than the standard one.

The creation of physical program was based on initial evaluation of the musculoskeletal system of female students. The realized experiment was pedagogical, field, single-group and multifactorial. The realization of the experimental factor, the physical program was realized within the lessons of physical and sport education. The frequency of the physical program was 3 times per week and 12 minutes for six months, which were intervention in changing the content of the curriculum (health promoting exercises).

While processing the acquired qualitative and quantitative data on the functional status of selected factors of the musculoskeletal system of the female students' system, we proceeded from an intra-individual evaluation by the physiotherapist. We used basic methods of the mathematical statistics: multiplicity (n), arithmetic mean (M), standard deviation (SD), median (Mdn) and variation range ($V_{R=max-min}$). The overall musculoskeletal system level was evaluated on the occurrence of the individual components by Wilcoxon non-parametric test (W_{test}, $p<0.05$, 0.01). The material significance was evaluated by using Effect size (r), resp. Cramer's "Phi" (φc).

RESULTS AND DISCUSSION

Based on the partial aim and tasks, we present part of the results, which are subject to further more exact monitoring and processing within the project. These results cannot be generalized, but should be understood in their overall context as indicative and baseline with respect to the physical health of the female pupils. From the data characterizing the monitored group, we selected those that are relevant to the set aim.

In the input evaluation of the body posture, we observed the most frequent occurrence of poor body posture, which coincided with the scientific works of several authors [Żukowska et al. 2014; Łubkowska 2015]. Especially, the poor body posture occurred in up to 8 probands and at the same time we did not record any perfect body posture. By changing the content profile of the physical and sport education lesson, we noticed an average of 2.75 points of the output evaluation in all 12 cases, in which was positive improvement of the body posture. We recorded statistically significant ($p<0.01$, $r=0.63$) changes between the input (10.75 points) and the output (8 points) evaluations, with the high effect size. Similar findings were reported by Kanásová, Šimončičová [2011], Malátová [2014] who noted significant changes in the body posture of probands. In the output evaluation of the experimental period, we did not record any proband who was in the third group of the qualitative group of body posture (III. Poor body posture). We found the positive shift from the third group to the second group in eight probands (3, 4, 6, 7, 8, 9, 10 and 11) (table 2). In that evaluation we even noticed one occurrence of the perfect body posture, namely in proband 5.

Table 2 Statistical evaluation of changes in body posture in female students (n=12)

Factors/ Multiplicity (n=12)	1	2	3	4	5	6	7	8	9	10	11	12
Input (I_1)	10	8	14	11	7	11	12	12	13	11	11	9
Output (O_2)	7	6	10	7	5	8	10	9	10	10	7	7
	I_1						O_2					
Arithmetic mean (M)	10.75						8.0					
Standard deviation (SD)	1.75						1.30					
Median (Mdn)	11						7.5					
Min	8						7					
Max	14						10					
Variation range ($V_{R=max-min}$)	6						3					
Wilcoxon test	W_{test}= -2.863											
p (statistical significance)	($p<0.01$)											
Effect size (r)	0.63											

Note. I_1 - input, O_2 - output, W_{test} – Wilcoxon non-parametric test, p - statistical significance at p<0.01, 0.05

In the experimental period, we recorded statistically significant changes ($p<0.01$) with the high material significance in the abdomen with pelvic inclination at the 5 % level of significance with the medium effect of the material significance in the other three areas (posture of head and neck, back curve and posture of frontal plane (table 3). There were not any significant changes in the chest shape ($p>0.05$). The most remarkable improvement was in the area of abdomen with pelvic inclination (III.), in which the probands improved on average by 0.92 points. In probands 1 and 12, there were not any changes in that area during the experimental period, but for the others the abdomen with pelvic inclination were adjusted by 1 point (2, 3, 4, 5, 6, 7, 8, 9 and 10), even in proband 11 up to 2 points. We state that the abdominal area had been significantly strengthened by the physical program in probands, which, together with the strengthening of the pelvic muscles, had led to significant positive changes in body posture. The least significant changes were recorded in the area of chest, in which we recorded the average improvement of 0.36 points.

Table 3 Evaluation of changes in individual areas of body posture in female students (n=12)

Area of evaluation	Z-value	p-value	Significance	Effect size (r)
I. Head and neck	-2.2010	0.0274	p<0.05	0.46
II. Chest	-	-	p>0.05	-
III. Abdomen and pelvic inclination	-2.7092	0.00521	p<0.01	0.59
IV. Back curve	-2.0332	0,0399	p<0.05	0.43
V. Posture of frontal plane	-2.4535	0.0273	p<0.05	0.46

Due to the physical program, we also noted other significant differences ($p<0.01$) in the cervical and lumbar spine between input and output evaluations. In cervical lordosis, the mean value at input evaluation was ranged at 8.8±0.56 cm, while at the output evaluation was ranged at 5.1±0.43 cm, with an average difference of 3.7±0.13 cm (W_{test}=3.121; $p<0.01$).

In the lumbar part of spine was the min. value at the input evaluation at the level of 5.6 cm and max. values at the level of 10.3 cm, with the difference of $R_{max-min}$ of 4.7 cm, in which the mean of the input values was 7.3±1.52 cm and the output was 4.8±1.22. That was with the significant difference of 2.5±0.3 cm (W_{test}=3.121; $p<0.01$).

By doing the physical program the Thomayer's, Schober's, Stibor's and Otto's test values were increased (still within the norm range). That finding indicated the significantly ($p<0.01$) better mobility of the lumbar spine also in the lateral direction (table 4).

In the input evaluation of the Thomayer's test, we found values in the female students, which indicated limited movement in the sagittal plane. That listed input condition was also associated with shortened muscles at the back of the thighs ("hamstrings"). In the output evaluations, the values of all female students were at the standard level. Thar implied that by applying the physical program, the Thomayer’s test with reach had significantly improved ($p<0.01$).

In the mobility of the lumbar part of spine, which was tested by the Schober's test, the input evaluation pointed to the values of monitored group of female students that were below the minimum level of the standard. It indicated the decrease in flexibility in the lumbar part of spine. The arch of the spine was not smooth, indicating the weakening of the paravertebral muscles in the listed area.

In the Stibor's test, which tested the mobility of the lumbar and thoracic part of spine, we found out qualitative changes ($p<0.01$) in female students of the value within the norm. We assume that the improvement in the Schober's and Stibor's tests was not only due to the increase in the range of pelvic movements around the hip joints, but also in learning to use the achieved range of motion for the particular exercise.

At the same time, in conjunction with the dynamic spine function and of the Schober's, Stibor's and Thomayer's tests, we assume that they are directly related to the back erector in the lumbar area (mm. erectores spinae) and knee flexor.

Table 4 Dynamic spine function of female students (n=12)

Group/ Factors	Evaluations	Th	Sch	St	Ott	Lateroflexia	
						R	L
n=12	I1-O2	2.866	2.866	2.812	2.866	2.866	2.866
Wilcoxon test		p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01

Note. Th - Thomayer's *test, Sch - Schober*'s *test, St - Stibor*'s *test, Ott - Otto*'s *inclination and reclination test, R - Right side, L - Left side*

Otto's inclination and reclination test showed reduced mobility of the thoracic spine at input evaluations. While comparing the input and output evaluations, we can speak to the detriment of the input evaluations, the impaired reclining, performed in most female students, especially in the lumbar part of the spine. The input values ranged at an average of 3.3 cm in 9 female students compared to output values, which were at the standard level of 6 cm in all female students. The listed findings were considered as positive and significant ($p<0.01$).

Several authors [Nelson, Bandy 2004; Rodriguez et al. 2008; Yoo 2013; Bendíková, Stackeová 2015; Kim 2015; Bendíková 2016] has shown in their research that the properly selected and purposefully designed physical program, as well as exercises with compensatory and health character can positively influence individual components of the musculoskeletal system. At the same time, the authors have agreed that the above listed disorders need to be paid extra attention from childhood, in which the physical and sport education lessons also offer space to prevent the occurrence of functional disorders. At the same time, it should be pointed out that the physical and sport education currently needs revival and innovation towards higher quality and attractiveness in order to make it more attractive to both pupils/ students and teachers and to fulfill all the important functions it undeniably has for pupil's/ student's development.

CONCLUSIONS

Based on the results, we recommend that:

The empirical research contributes to the extension of knowledge about the possibility of using targeted exercises with health aspect in the form of physical programs to the monitored determinant of the body posture as the manifestation of the muscular system in relation to the dynamic spine function and its physiological curvature, within the physical and sport education.

Ultimately, properly selected and implemented physical programs positively influence and create presumption of the perfect body posture. The experimental verification of the outlined "intensification factor" in teaching of the physical and sport education in secondary school is the knowledge and basis for the theory and practice of school physical and sport education in cooperation with the health physical education.

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