APPLIED PHYSICAL PROGRAM ON CHANGES OF BODY POSTURES AND DYNAMIC SPINE FUNCTION IN FEMALE SECONDARY SCHOOL STUDENTS

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Abstract The aim of research was to identify the changes of body posture and dynamic spine function of female secondary school students after adaption of physical program which was within lessons of physical and sport education. The research group consisted of 45 female students of the first year of secondary school in Žilina (age – 15.42 ±0.38 years; body weight – 55.13 ±3.69 kg; height – 167.82 ±2.51 cm; body mass index – 19.72 ±1.51). In terms of data acquisition methods, we applied standardized tests and methods. To evaluate the impact of adapted physical program on muscular and skeletal system of secondary school students within lessons of physical and sport education we applied Wilcoxon test (W_{test} $p < 0.01$; $p < 0.05$). The statistical significance of differences between observed variables of pre-tests and post-tests, as practical and material significance, was evaluated by Effect size, Pearson's – r. While evaluating the body postures, positive shifts of body postures were recorded (35 ×), as it was noted with statistical significance and large effect size ($p < 0.01$; $Z = -5.8413$; $r = 0.8694$). Within the dynamic spine function, the evaluation detected all of the tests as statistically significant, but the left lateroflexion was recorded with negative effect size ($p < 0.01$; $Z = -3.7271$; $r = -0.3217$).

Key words body posture, female students, muscular and skeletal system, physical program

Introduction

The school reform, which is valid from the school year 2008/2009, has changed the status of physical and sport education and, with Education Act, the State Education Program has become the highest target and program project (Antala, Labudová, 2008). The minimum number of lessons of physical and sport education was set at two; however, there has been the possibility for an increase of one lesson, which is subject to the creation of the School Education Program (Antala, 2009; Bendíková, 2018). Despite of listed information, the Slovak Republic has reached the last place within member states of the European Union in the number of lessons of physical and sport education; however, the school institutions do not increase the listed lessons through the School Education Program (Stupák, 2017). Another modification has been accomplished within physical and sport education, as it has undergone modernization in 2015, which has led to many innovations within the State Education Program (2015).

The positive aspect of the State Education Program was the possibility of using and applying the proven innovations at lessons of physical and sport education.

While respecting the interests of pupils, students at physical and sport education, it is necessary to create and stabilize positive attitudes towards physical activity (Uherová, 2012) because for the constantly increasing number of school children and secondary school students, it is the only realized physical activity. The school children and secondary school students support it mainly through their passive (non)participation in lessons of physical and sport education. Some reasons are objective, but most of them are subjective (Boreham, Riddoch 2001; Zrnzević, Arsić, 2013; Balážová, 2014; Harris, 2015). Increasing the popularity of physical and sport education can be achieved through the possibility of creating an education program with its own program structure and curriculum, which is approved by the subject commission (Bendíková, Smoleňáková, 2018).

The physical program is an organized and systematic summary of characters, such as the physical activities, sports and recreations. It is realized during the period of free time (Miňová, 2003; Łubkowska, Tarnowski, Terczyński, 2018) but in terms of school education, it is realized during the lessons of physical and sport education. The intervention of physical programs is reflected in the levels of physical and health-oriented fitness, which is characterized as an impact on health. It has preventive measures for health problems, which are associated with the physical inactivity (Teplý, 1995).

The physical programs on muscular and skeletal systems, mainly in areas of the spine, differ as it is depending on the areas of influence (body posture, muscle imbalance and back pain). In the Slovak/Czech Republic, there are researches of the physical programs that impact the body postures or the muscle imbalances (Kopecký, 2004; Kanásová, 2006; Kanásová, Bukovcová, 2011; Bendíková, Stackeová, 2015; Bendíková, Marko, Rozim, Martinský, 2019; Marko, Bendíková, 2019), but researches of other countries, such as the United States of America or India have been dealing with spinal pain (Suni, 2006; Šarabon, 2011; Inani, Selkar, 2013; Kim, 2013).

Even basic physical activities positively influence the level of muscular and skeletal systems, which are visible in all age categories. However, the incidence of the various spinal disorders, diseases, etc. (functional and structural) increases annually – or even doubles (Bendíková, 2016) – as it starts in pre-school period, continues in younger school age/period of pubescence (Bendíková, Pavlović, 2013; Popova, Mitova, Gramatikova, 2014; Walther et al., 2014; Mitova, 2015; Azabagic, Spahic, Mulic, 2016; Müller et al., 2019) or period of adolescence (Acasandrei, Macovei, 2014; Ludwig, Mazet, Schmitt, 2016; Noll, Candotti, Rosa, Loss, 2016) and culminates in adulthood (Holmes, Freburger, Carey, 2009; Ferreira et al., 2011; Singh, Manchikanti, Falco, Benvamin, Hirsch, 2014) and old age (Anderson, Wolf, Starfield, 2002; Fleming et al., 2011; Gheno, Cepparo, Cotten, 2012).

Aim

The aim of research was to identify the changes of body postures and dynamic spine functions of female secondary school students after adaption of physical program, which was within lessons of physical and sport education.

Methods

Based on the aim of research, the research group consisted of 45 female students of the first year of secondary school in L. Mikuláš (age – 15.42 ±0.38 years, body weight – 55.13 ±3.69 kg, height – 167.82 ±2.51 cm and body mass index – 19.72 ±1.51). The selection of research group (n = 45) was intentional, in relation to not having any health problems. The research group was in period of pubescence; the measured values of primary somatometry are presented in Table 1.

Table 1. The primary characteristics of the research group (n = 45)

Measured values	Research group
Age (years)	15.42 ±0.38
Body weight (kg)	55.13 ±3.69
Body height (cm)	167.82 ±2.51
Body mass index (kg/m^2)	19.72 ±1.51

The research was realized within the interval of October 1, 2019–December 6, 2019. The realized experiment was terrain (lessons of physical and sport education), one-group (selected group, within the research group [n = 45]), pedagogical (selected secondary school) and multifactorial (areas and tests of muscular and skeletal system). The realization of adapted physical program which consisted of 12 exercises with character of strengthening was realized as follows: 10 weeks/2 ×/12 minutes at the end of lessons of physical and sport education. The research consisted of three stages:

1. Pre-test – realized by physiotherapist (October 1, 2019).
2. Realization of physical program (October 1, 2019–December 6, 2019).
3. Post-test – realized by physiotherapist (December 6, 2019).

In terms of data acquisition methods, the method of somatometry (Šimonek, 2000; Selekman, 2012) was applied, as the age, body weight and height of research group members (n = 45) was collected and calculated by using body mass index (Hošková, Matoušová, 2005). Within data acquisition methods we applied standardized tests and methods, such as Klein and Thomas modified by Mayer, which was widen by dynamic spine function. The evaluation of body posture, which is typical for physical and sport education, was based on body components (I. Head and neck posture; II. Shape of chest; III. Shape of abdomen and pelvic inclination; IV. Overall curvature of spine; V. Height of shoulders and scapulae position), to which points are given (1–4) according to quality of body posture. The overall body posture is expressed by total points (Correct posture – 5 points; Good posture – 6–10 points; Bad posture – 11–15 points; Incorrect posture – 16–20 points) (Vojtaššák, 2000). The last data acquisition method was dynamic spine function (tests of Schober, Stibor, Otto, Thomayer and Lateroflexion). It is a typical method for medical and physical practice, and therefore it was realized by physiotherapist (Labudová, Thurzová, 1992; Labudová, Vajcziková, 2009). What is more, the spine development of the research group was evaluated with gradual relaxation, symmetry of chest and paravertebral muscles.

The evaluation of research results was realized by using data processing methods such as qualitative and quantitative methods. To be more specific, analysis and synthesis, inductive and deductive approaches, comparisons and generalizations were used. The muscular and skeletal system within the research group was evaluated by primary statistics, such as median (Mdn), arithmetic mean (±), variation range ($V_{R=max-min}$) standard deviation (Sd) and percentage frequency analysis (%). To evaluate the impact of physical program on the muscular and skeletal systems of secondary school students, within lessons of physical and sport education, Wilcoxon test

(W_{test} $p < 0.01$; $p < 0.05$) was applied. The statistical significance of differences between observed variables of pre-tests and post-tests as the practical and material significance was evaluated by Effect size, Pearson's – r.

Results

Based on the aim of research and before presenting the research results, which are subject to more accurate monitoring and processing, it is necessary to understand them in overall context, in relation to health, through the prism of muscular and skeletal systems, mainly in the spine area. The reached results cannot be generalized but one should stress the necessity and importance of using and applying various innovations at lessons of physical and sport education.

For better uptaking and understanding, the research results are presented in tables, while Table 1 shows the results of evaluation body postures of research group (n = 45). It was evaluated by the method of Klein and Thomas modified by Mayer, in which the adapted physical program as the acting factor caused positive shifts and changes, as the average given points inverted from 11.31 ±2.22 to 7.11 ±1.62. At pre-test, the correct body postures were recorded in 0%, but it changed by the physical program to 13.40%. The positive shifts and changes were discovered within the good body postures, as it increased from 26.70 to 80.00%. However, the acting factor of the adapted physical program helped to decrease the bad body postures from 73.30 to 6.60% of the research group. The incorrect body postures were not recorded within the research group, as the evaluation of body postures was statistically significant, even with large effect size (W_{test} $p < 0.01$; $Z = –5.8413$; $r = 0.8696$).

The body components such as head and neck posture, shape of abdomen and pelvic inclination, height of shoulders and position of scapulas are the most common deviations (Véle, 2006; Bendíková, 2016) of muscular and skeletal systems. The head and neck postures as the body components were recorded with positive shifts and changes in all given points (1–4), as the point 1 was given at the pre-test to 11.10% of the research group, but after acting of physical program – to 48.90%. The head was slightly deflected and leaning forward, therefore the point 2 was given to 35.50% and then to 46.70% of the research group. The acting factor of adapted physical program influenced the head postures, which were inclined forward and backward, as at the pre-test was the incidence of 42.30% and at the post-test – 4.40% of the research group. The lowest percentage representation was registered within the point 4 (from 11.10% to 0%). All the shifts and changes are statistically significant, even with the large effect size (W_{test} $p < 0.01$; $Z = –5.4424$; $r = 0.7898$) (Table 2).

Within the shape of the chest as the second body component, the point 4 was not given to the research group, not even at the pre-test (0%). However, the highest percentage representation concerned the point 1, as the physical program caused positive shifts and changes from 33.40 to 64.40% of the research group. The chest slightly flattened was recorded in 48.90% (pre-test), but after 10 weeks – only in 31.20% of the research group. The low values were recorded within the point 3, as it decreased from 17.70 to 4.40%. What is more, the statistical significance was also recorded, again with the large effect size (W_{test} $p < 0.01$; $Z = –3.9199$; $r = 0.7107$) (Table 2).

The next body components of the research group were recorded with the highest statistical significance (W_{test} $p < 0.01$; $Z = –5.2316$; $r = 0.8315$) (Table 2), as the point 1 given within the shape of abdomen and pelvic inclination positively increased from 4.40 to 44.40% of the research group. The acting factor of physical program changed the shape of abdomen, which resulted in 51.20% (post-test; pre-test – 37.90%). The huge drop of percentage was recorded within the point 3, as the value of pre-test was 48.90% and after 10 weeks – only 4.40%. Even the point 4 was observed (8.80%), however at the post-testing it vanished (0%).

Within the overall curvature of spine, 0% was recorded thrice, namely in the points 4 (re-test and post-test) and 3 (post-test). The biggest improvement was accomplished in physiological curvature range within normal limits (point 1), as the ratio (pre-test vs post-test) was 4.40 to 66.70%. The point 2 and its description positively shifted and changed from 64.50 to 33.30%. The listed shifts and changes are statistically significant and still with the large effect size (W_{test} $p < 0.01$; $Z = -5.5786$; $r = 0.7954$) (Table 2).

The last body components (height of shoulders and scapulae position) are defined by 3 × of 0%, as it was the case in previous body components (see: overall curvature of spine). The biggest increase was recorded in height of shoulders and scapulae, which were equal and symmetrical. The ratio was 20.00 to 75.60%. 24.40% was in the point 2 at post-test and point 3 at pre-test. The shifts and changes resulted in statistical significance, which was confirmed by the large effect size (W_{test} $p < 0.01$; $Z = -5.2316$; $r = 0.8170$) (Table 2).

Table 2. The measured values of body components within the research group (n = 45) (%)

Body components/ Given points	Head and neck posture[a]		Shape of chest[b]		Shape of abdomen and pelvic inclination[c]		Overall curvature of spine[d]		Height of shoulders and scapulae position[e]	
	Pr.T.	Po.T.	Pr.T.	Po.T.	Pr.T.	Po.T.	Pr.T.	Po.T.	Pr.T.	Po.T.
1	11.1	48.9	33.4	64.4	4.4	44.4	4.4	66.7	20.0	75.6
2	35.5	46.7	48.9	31.2	37.9	51.2	64.5	33.3	55.6	24.4
3	42.3	4.4	17.7	4.4	48.9	4.4	31.1	0.0	24.4	0.0
4	11.1	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0

Legend: Pr.T. – Pre-test; Po.T. – Post-test; [a] $p < 0.01$; $Z = -5.4424$; $r = 0.7898$; [b] $p < 0.01$; $Z = -3.9199$; $r = 0.7107$; [c] $p < 0.01$; $Z = -5.2316$; $r = 0.8315$; [d] $p < 0.01$; $Z = -5.5786$; $r = 0.7954$; [e] $p < 0.01$; $Z = -5.2316$; $r = 0.8170$.

The evaluation of dynamic spine function is based on spine bending. It consists of 5 tests, of which the most visible shifts and changes are in tests of Schober (norm of 4–6) and Stibor (norm of 7.5–10.0). If it is below the norm, it is defined as decreased flexibility, however if it is above the norm, it is defined as increased flexibility (Labudová, Vajcziková, 2009). At the pre-test, the decreased flexibility of the test of Schober was recorded in 93.30% of the research group (which equals 43 members), as the average values were 2.86 ±0.76. The most of decreased flexibility was due to wrong spine arch, which was not smooth, and it was caused by the paravertebral muscles. However, the acting factor of physical program caused that the average values increased to 4.86 ±0.73. The number of research group members who were in the norm increased to 97.80% (44 subjects), thus it can be seen as an effective physical program. The positive shifts and changes within test of Schober were proved by the statistics at 5.00% level of significance, even by the large effect size (W_{test} $p < 0.05$; $Z = -1.9131$; $r = 0.5303$) (Table 3) (Rosnow, Rosenthal, 2009).

Based on testing the mobility of thoracic spine (Test of Stibor), the pre-test uncovered the alarming numbers, as the norm (Vojtaššák, 2000) was reached by 4.40% (2 members) of the research group. The average values of the pre-test were 6.44 ±0.80, which was less than 1 point from the norm, however the most of research group was around the lower limit of being in the set norm. After applying of the 10-week physical program, there was not registered any increased flexibility, but all of the research group members were in the norm of 7.50–10.00. Therefore, the adapted physical program which was applied 2 ×/12 minutes, within the lessons of physical and sport education, was effective and successful. It is supported by the statistical significance at 1.00% level significance and even by the large effect size (W_{test} $p < 0.01$; $Z = -2.8251$; $r = 0.7406$) (Table 4). The statistical improvements within the tests of Schober (W_{test} $p < 0.05$; $Z = –1.913\ 1$; $r = 0.5303$) and Stibor (W_{test} $p < 0.01$; $Z = –2.8251$; $r = 0.7406$) were reached because of larger extension of pelvis around the joints of hips.

Table 3. Measured values of Schober's test within the research group (n = 45)

Research group/Measured values	Schober's test (norm: 4.00–6.00)								
	1	2	3	4	5	6	7	8	9
Pre-test	3.00	2.00	3.00	2.00	3.00	1.00	2.00	2.00	3.00
Post-test	5.00	4.00	4.00	4.00	4.50	4.00	4.10	4.00	4.20
Research group	10	11	12	13	14	15	16	17	18
Pre-test	3,50	2.80	3.90	4.00	3.00	3.00	3.00	3.50	3.00
Post-test	5.00	4.20	5.00	5.50	4.30	4.60	5.50	5.00	5.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	4.00	2.00	3.00	2.50	3.40	2.90	3.80	3.80	3.50
Post-test	5.90	4.00	4.80	4.20	4.50	4.00	5.00	5.50	4.30
Research group	28	29	30	31	32	33	34	35	36
Pre-test	2.40	1.90	2.30	4.00	2.70	3.60	3.00	3.00	2.00
Post-test	4.00	3.90	4.60	6.00	5.10	4.50	6.00	6.00	5.00
Research group	37	38	39	40	41	42	43	44	45
Pre-test	3.50	3.00	3.80	2.50	3.00	3.00	3.50	2.00	2.90
Post-test	6.00	6.00	6.00	5.40	6.00	5.90	5.50	5.00	4.00
Wilcoxon test	p < 0.05; Z = –1.9131								
Effect size	r = 0.5303								

Table 4. Measured values of Stibor's test within the research group (n = 45)

Research group/Measured values	Stibor's test (norm: 7.50–10.00)								
	1	2	3	4	5	6	7	8	9
Pre-test	6.00	6.50	5.00	5.40	5.80	7.00	7.20	7.00	5.40
Post-test	8.30	8.50	7.90	8.00	8.10	9.00	10.00	10.00	7.90
Research group	10	11	12	13	14	15	16	17	18
Pre-test	6.90	7.00	7.00	5.00	4.90	5.90	6.30	6.20	5.50
Post-test	8.00	9.00	9.00	9.00	7.50	7.90	8.40	8.90	9.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	5.90	7.30	7.00	6.00	5.80	7.20	7.00	6.40	7.00
Post-test	8.70	10.00	10.00	9.00	8.00	9.50	8.90	8.10	10.00
Research group	28	29	30	31	32	33	34	35	36
Pre-test	7.00	7.50	6.90	7.50	7.00	7.30	5.00	5.00	7.00
Post-test	9.00	10.00	10.00	9.80	10.00	10.00	7.50	8.00	9.00
Research group	37	38	39	40	41	42	43	44	45
Pre-test	7.00	7.00	7.00	6.00	7.00	7.00	5.00	7.00	7.00
Post-test	9.00	10.00	10.00	9.00	9.50	10.00	7.50	10.00	7.50
Wilcoxon test	p < 0.01; Z = –2.8251								
Effect size	r = 0.7406								

The ratio of pre-test and post-test was 0% to 77.80% (35 members), which translates to: 4.07 ±1.15 to 5.94 ±0.15. The decreased spine mobility was showed by weakened thoracic spine and the problems with declination were due to weakened areas of lumbar spine. However, the physical program helped 35 × (77.80%) and it is proved by the statistics at 1.00% level significance, but with small effect size (W_{test} $p < 0.01$; $Z = –3.3057$; $r = 0.2812$) (Table 5).

Table 5. Measured values of Otto's test within the research group (n = 45)

Research group/Measured values	Otto's test (norm: 6.00)								
	1	2	3	4	5	6	7	8	9
Pre-test	3.00	2.00	3.00	4.00	2.00	3.00	2.00	4.00	5.00
Post-test	6.00	6.00	6.00	6.00	6.00	6.00	5.50	6.00	6.00
Research group	10	11	12	13	14	15	16	17	18
Pre-test	3.00	2.00	3.00	3.50	4.50	5.50	4.00	4.00	5.50
Post-test	5.90	6.00	5.80	6.00	6.00	6.00	6.00	6.00	6.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	5.80	4.30	5.30	4.00	5.00	5.20	3.00	2.00	4.00
Post-test	6.00	5.90	6.00	6.00	6.00	6.00	6.00	5.80	6.00
Research group	28	29	30	31	32	33	34	35	36
Pre-test	3.00	5.00	5.00	5.00	5.00	5.00	4.00	5.00	5.00
Post-test	5.90	6.00	6.00	6.00	6.00	6.00	5.50	6.00	5.70
Research group	37	38	39	40	41	42	43	44	45
Pre-test	7.00	4.00	4.00	4.50	4.50	5.00	2.90	4.00	4.00
Post-test	6.00	6.00	6.00	6.00	6.00	5.80	5.70	6.00	6.00
Wilcoxon test	p < 0.01; Z = –3.3057								
Effect size	r = 0.2812								

As the test of Thomayer evaluates deep bending forward while reaching the ground, the set norm was not reached by the research group at the pre-testing. What is more, in some cases there was a deficit of –21.00 points, which was associated with weakened and shortened thigh muscles (Véle, 2006). It reflects in not being able to reach the ground, therefore nobody from the research group was able to fulfil the set norm of 0.00. However, after applying the physical program the research results shifted to 12 members (26.70%) who were able to reach the ground with the fingers. The listed changes are statistically significant, even with the large effect size (W_{test} $p < 0.01$; $Z = –3.1894$; $r = 0.8879$) (Table 6). Not to mention the recorded average values of pre-testing and post-testing, which were in ration of –10.01 ±4.07 and –2.37 ±1.83. The statistical improvement (W_{test} $p < 0.01$; $Z = –3.1894$; $r = 0.8879$) was reached in terms of larger extension of pelvis around the joints of hips. What is more, the listed improvement was also reached because the research group (n = 45) was informed about the importance of larger extension of pelvis around the joints of hips.

Table 6. Measured values of Thomayer's test within the research group (n = 45)

Research group/Measured values	Thomayer's test (norm: 0.00)								
	1	2	3	4	5	6	7	8	9
Pre-test	–15.00	–12.00	–10.00	–13.00	–18.00	–16.00	–10.00	–12.00	–9.00
Post-test	–5.00	–4.00	–3.00	–4.00	–5.00	–6.00	–2.00	–3.00	–2.00
Research group	10	11	12	13	14	15	16	17	18
Pre-test	–8.00	–5.00	–2.00	–5.50	–8.90	–13.40	–12.10	–11.00	–15.00
Post-test	–2.00	0	0	0	–2.00	–4.00	–2.00	–3.50	–5.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	–21.00	–13.00	–12.60	–5.00	–4.60	–5.90	–8.90	–11.00	–12.00
Post-test	–6.00	–4.50	–2.90	0	0	0	–3.00	–5.00	–2.00
Research group	28	29	30	31	32	33	34	35	36
Pre-test	–10.00	–9.00	–8.90	–7.00	–5.00	–2.00	–10.00	–5.00	–5.00
Post-test	–2.00	–2.00	0	0	0	0	–2.00	0	0
Research group	37	38	39	40	41	42	43	44	45
Pre-test	–12.00	–11.00	–9.00	–7.00	–15.00	–14.00	–9.00	–9.00	–13.00
Post-test	–2.00	–3.00	–4.00	–1.00	–3.00	–4.00	–2.00	–2.00	–4.00
Wilcoxon test	p < 0.01; Z = –3.1894								
Effect size	r = 0.8879								

While evaluating the left and right later flexion as the tests of dynamic spine function, the pre-tests showed limited spine motions to both sides of the research group. Even the pre-tests showed that set norm was less reached in left (20.00%, n = 9) than in right (22.30%, n = 10) lateroflexion of the research group; the average values were higher in left (19.43 ±1.53) than in right (18.79 ±0.87) lateroflexion. The reached results proved decreased mobility of lumbar spine; however the post-testing results were matching the set norms (Vojtaššák, 2000), as the average values were 20. 93 ±1.67 (left lateroflexion – 100.00%) and 21.62 ±0.38 (right lateroflexion – 100.00%). The both lateroflexions proved statistical significance at 1.00% level significance, however the left lateroflexion was recorded with negative effect size ($p < 0.01$; $Z = –3.7271$; $r = –0.3217$), in contrast to right lateroflexion, in which small effect size was recorded ($p < 0.01$; $Z = –4.3915$; $r = 0.2235$) (Table 7, 8).

Table 7. Measured values of left lateroflexion within the research group (n = 45)

Research group/Measured values	Lateroflexion – left (norm: 20.00–22.00)								
	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	10
Pre-test	19.00	18.00	19.00	16.00	19.00	18.00	17.00	19.00	19.50
Post-test	22.00	21.00	22.00	21.50	22.00	20.00	21.00	22.00	22.00
Research group	10	11	12	13	14	15	16	17	18
Pre-test	18.80	17.00	18.00	18.00	19.00	19.50	19.00	20.00	17.90
Post-test	21.50	21.90	21.00	21.00	22.00	22.00	22.00	22.00	20.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	18.00	19.00	20.00	17.00	18.00	19.00	18.00	19.00	20.00
Post-test	22.00	21.00	21.00	22.00	21.00	22.00	22.00	22.00	22.00

1	2	3	4	5	6	7	8	9	10
Research group	28	29	30	31	32	33	34	35	36
Pre-test	18.60	19.30	20.00	20.00	20.00	20.00	22.00	22.00	21.00
Post-test	22.00	22.00	22.00	22.00	22.00	22.00	18.00	18.00	19.00
Research group	37	38	39	40	41	42	43	44	45
Pre-test	20.00	21.00	21.00	21.00	22.00	22.00	21.00	22.00	22.00
Post-test	17.00	18.00	19.00	20.00	20.00	20.00	19.00	18.00	18.00
Wilcoxon test	p < 0.01; Z = –3.7271								
Effect size	r = –0.3217								

Table 8 Measured values of right lateroflexion within the research group (n = 45)

Research group/Measured values	Lateroflexion – right (norm: 20.00–22.00)								
	1	2	3	4	5	6	7	8	9
Pre-test	18.00	18.00	19.00	17.00	19.00	18.00	17.40	19.00	19.00
Post-test	21.00	22.00	22.00	21.00	22.00	20.00	21.50	22.00	22,00
Research group	10	11	12	13	14	15	16	17	18
Pre-test	19.00	18.00	19.00	19.00	19.00	19.50	19.10	20.00	18.00
Post-test	21.50	22.00	21.00	21.00	22.00	22.00	22.00	22.00	20.00
Research group	19	20	21	22	23	24	25	26	27
Pre-test	18.40	19.50	20.00	18.00	18.00	19.00	18.00	19.00	20.00
Post-test	22.00	21.00	21.00	22.00	22.00	22.00	22.00	22.00	22.00
Research group	28	29	30	31	32	33	34	35	36
Pre-test	18.00	19.00	20.00	20.00	20.00	20.00	18.00	18.00	18.00
Post-test	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Research group	37	38	39	40	41	42	43	44	45
Pre-test	19.00	17.00	18.00	19.00	20.00	20.00	20.00	19.00	18.00
Post-test	21.00	21.00	21.00	21.00	21.00	22.00	22.00	21.00	22.00
Wilcoxon text	p < 0.01; Z = –4.3915								
Effect size	r = 0.2235								

Discussion

The incidence of bad and incorrect body postures have been discussed by many authors in various studies and researches (Majerík, 2006; Marko, Bendíková, 2019). For example, in research of Kratěnová (2005), the bad and incorrect body postures were recorded in 33.00% (7 years of age), 40.80% (11 years of age) and 40.60% (15 years of age) of research group. The most alarming was the research by J. Majerík (2006), who recorded the incidence of muscle imbalances in 100% of the research group, which consisted of school children (15–17 years of age). Even J. Kanasová (2006) recorded similar findings of muscle imbalance, which was shown by around 93.2% of the research group which consisted of school children (10–12 years of age). After two years, the same author realized research in which bad and incorrect body postures were recorded in 91.6% of girls and 100% of boys, while the physical program reduced the high incidence of listed body postures. What is more, the research group consisted of school children who were from 10 to 12 years of age. In terms of physical programs and changes of body postures, the impact of physical program was recorded by M. Malátová, J. Markesová and J. Kanásová (2014) who recorded positive shifts and changes of research groups (12–13 years of age) in relatively short period of time (6 weeks). In terms of length, E. Bendíková et al. (2019) realized research which lasted for 12 weeks and showed positive shifts and changes of body postures. The given points of body components decreased from 12.4 to 7.9, which was significant at 5.00% level of significance.

In terms of body components of the research group, the head and neck posture was weakened because of deep neck flexors, which was confirmed by the research of E. Bendíková (2016). The shape of chest, as the second body component, was associated within the female students with gradual growth of secondary sexual characteristics, but the point 4 was not given to the research group (n = 45), not even at the pre-test (0%). Therefore, the listed body components, such as the shape of abdomen and pelvic inclination (III.), in which the most weakened muscle groups are m. rectus abdominis and m. transversus abdominis, are not affected. It is associated with the combination of wrong postural stereotype and body weight, which causes the pelvis to tilt forward and subsequently leads to spinal deformations, resulting in incorrect fixation of vertebrae and formation of the enlarged lordosis (Bendíková, Pavlovič, 2013). Within the overall curvature of spine, the most common amongst school children is thoracic hypokyphosis, which is known as flat spine. The listed body postures are functional but may transform into structural deviations (Vlach, 1986). What is more, the results of listed body postures are reflected in decreased spinal resistance to overloading, thus the weakening of muscle groups may cause less spine stiffness and flexibility. While being the indicator of bad and incorrect body postures, the research group (n = 95) who had bad and incorrect body postures was not able to lean and bend forward and backward, resp. turn around (properly). The height of shoulders and scapulae positions is one of the most affected areas of body components, while the bad and incorrect body postures are defined by the weakening of scapular muscles, which was recorded in our research group (n = 45). The spinal erectors and scapulas lower fixators did not reach the adequate strength, which was necessary for maintaining the upright body postures, thus the fixation functions failed and overactive muscles, such as pectoral muscles, increased the resting muscle tone, which caused the shortening od listed muscles, even to formation of upper crossed syndromes (Bendíková, 2016).

In terms of dynamic spine function, the research by E. Bendíková and D. Stackeová (2015) was proven by statistics at 1.00% level of significance, thus the physical program proved successful, while the content of physical and sport education was adopted for the research groups, which consisted of school children (12–15 years of age). Very similar findings were recorded by J. Kanásová (2006), J. Majerík (2006) and M. Lee, S. Park and J. Kim (2013), who registered the increased mobilities in areas of lumbar spine, which was proved by the statistical significances ($p < 0.05$), while the region of lumbar spine was closely associated with the left and right lateroflexions ($p < 0.01$; $Z = -3.7271$; $r = -0.3217$; $p < 0.01$; $Z = -4.391\ 5$; $r = 0.2235$). Within the test of Schober, the pre-testing of lumbar spine mobility revealed abnormal developments, which was caused by the spine curvatures, which were not smooth, as paravertebral muscles were weakened. At post-testing, the results showed positive shifts and changes within the research group (n = 45), which was proven by statistics at 5.00% level of significance (Bendíková, Palaščáková, Tomková, Vágner, 2018). The spine mobility, mainly of thoracic regions, was evaluated in the test of Stibor, which was also proven by statistics, but at 1.00% level of significance, while it was also reached by the larger extension pelvis around the joints of hips. The research results of the test of Otto's inclination and declination were similar to those of M. Cools (2003) and E. Heyman and H. Dekel (2009), in which the set norm was not reached by the research groups (n = 45).

Conclusions

The physical activity is closely related to lifestyle, quality of life and health (Nowak, 1997). And so the innovations and diversifications of physical and sport educations, in forms of physical programs (Abbaszadegan, Achachlouei, Eghbalmoghanlou, 2012; Ahmad, Akthar, 2014; Sivachandiran, Kumar, 2016), are usable within the School Education Program (Bendíková, Pavlović, 2013; Bendíková, Stackeová, 2015; Bendíková, 2016), as well recreational sports (Mulligan, Cook, 2013; Mignogna, Welsch, Hoch, 2016).

The findings are considered as statistically significant ($p < 0.01$; $p < 0.05$), mainly between the pre-test and post-test evaluation of body structures. The positive shifts and changes were recorded in all of the body components ($p < 0.01$); therefore, the overall evaluation of research group ($n = 45$) was statistically significant, even with the large effect size (W_{test} $p < 0.01$; $Z = –5.8413$; $r = 0.8696$). The statistical significance was detected in all of the tests of dynamic spine function, however, only the left lateroflexion was recorded with negative effect size ($p < 0.01$; $Z = –3.7271$; $r = –0.3217$). These findings are very important for physical and clinical practice, because the positive shifts and changes were reached in relatively short period of time (10 weeks). If more adapted physical programs are used and applied at lessons of physical and sport educations:

a) it may improve the self-image of school children,
b) it may increase the popularity of physical and sport education,
c) it may increase the participation of school children in physical and sport education,
d) it may prevent incidence of various diseases, disorders, etc. of muscular and skeletal systems.

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