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Original Article

Changes in the posture of students due to equipment-aided exercise programs that are applied in physical and sport education

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Abstract:
The studies present and highlight the importance of applying equipment-aided exercise programme in physical and sport education at schools. Their main purpose is to show diversification and realization of innovative content filling lessons through interventional exercise programmes with health aspect especially from the point of view of primary prevention of health of students and improvement of level of dynamic stereotype of posture. The monitored group consisted of 60 female students of a high school at age of 17.4±0.9 (height = 167.1±3.6 cm, weight = 60.3±3.9 kg) from the town L. Mikuláš. From the point of view of data collecting, we used standardized methods, which rely on pedagogical and medical practice of posture evaluation. The obtained qualitative and quantitative data were processed within individual groups by means of the Wilcoxon sign-ranked test and between the groups to rate effectiveness of individual equipment-aided exercise programmes we applied the Kruskal-Wallis test. The results significantly ($p<0.05$ a $p<0.01$) showed a positive effect of applied exercise programmes on the health aspect within individual groups in terms of overall posture and its individual components. What is more, they confirmed efficiency of these programmes as regards the monitored determinants without significant differences ($p>0.05$).
Key words: posture, equipment-aided exercise programmes, physical education and sports, students.

Introduction

In the past two decades, there has been a growth in the number of lifestyle diseases (obesity, diabetes, allergies) and dysfunctions among school children and pupils and students excused from physical education classes in Slovak elementary and secondary schools. Several studies conducted by Slovak and foreign authors, who focused on bad posture, have pointed to problems regarding the musculoskeletal system of the school children. (Chen et al., 1998; Kania, Gudzio, & Wiernicka, 2002; Kratěnová et al., 2005; Langmajerová et al., 2012; Lemos et al., 2012; Bendíková et al., 2014; Šmída & Pavlovič, 2015).

According to documents made by the Ministry of Education of the Slovak Republic, approximately 30 % of children and youth are regularly excused from physical education classes due to several objective and subjective reasons. In average, 27.7% to 39.6% of boys and 38.2% to 48.1% of girls do not participate in physical education lessons (Antala, 2012). This high percentage was one of the reasons for the more intense curriculum transformation at elementary and secondary schools in Slovakia, which was carried out at the beginning of the new millennium in cooperation with the European Union and the White Paper. As regards the subject Physical and Sport Education, performance oriented classes have changed to lessons focused on health and healthy lifestyle. As a result, physical and sport education directly and indirectly opened the space for diversification and implementation of innovative syllabi (Holzweg et al., 2013).

One of the health aspects is also the musculoskeletal system, which Véle (2006) perceives holistically. It has the following basic functions: locomotion, postural, communication, manipulation as well as the fundamental life functions, such as respiration and nutrition. This system reflects dysfunctions of individual body systems as viscerovertebral syndromes. However, dysfunctions of the musculoskeletal system are reflected in other systems as vertebrovisceral syndromes (Mathias & Clench, 1995; Vaňasková & Tošnerová, 2005). Bad posture has become a negative symptom, or more precisely, a contemporary lifestyle disease that reflects and affects the entire condition of the human body. Kinesiology considers the body posture as the current result of configuration of individual body parts. Any change in one movement segment results in a chain of other changes (Véle, 2006). Vařeka & Dvořák (2001) claim that posture is the result of a certain shape and function of the spine, movement of postural muscles and postural reflexes. It accompanies each activity and it is an activity and a routine that we can largely control. Keeping the posture includes inherent dispositions, physical abilities, the environment, person’s mental condition and social relationships. At the present time, definitions and examinations of the body posture are mostly based on upright trunk and girdle posture in a standing position, which is determined by the configuration of individual spinal and pelvic segments (Labudová, Vajcziková 2009). However, this is not a clearly defined condition, which is mostly based on the Gaussian distribution of individual posture types. The main objective of the study was to determine the influence of the health-focused exercise

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programmes, implemented within physical and sport education lessons, on the girls' postural stereotypes and individual posture segments.

Method

Subject characteristics

The monitored groups consisted of the third-year students at one secondary school in Liptovský Mikuláš (n = 60, age 17.4±0.9 years, height =167.1±3.6 cm, weight = 60.3±3.9 kg), the selection of which was intentional. In the past, they were not interested in physical and sport education. What is more, these girls were diagnosed with functional disorders of the musculoskeletal system during a preventive medical examination. Table 1 shows the primary characteristics of the groups A to E. The girls were assigned to individual groups according to individual classes.

Table 1 Characteristics of the groups (n = 60)

Group	n	Age	Height/cm	Weight/kg	BMI
A group	11	17.2	166.4	59.4	21.4
B group	12	17.5	167.1	59.5	21.3
C group	12	17.4	166.3	61.3	22.2
D group	12	17.4	168.0	61.1	21.6
E group	13	17.3	167.3	60.2	21.5
x	60	17.4	167.1	60.3	21.6

BMI – Body mass index, x – arithmetic mean

Measurement organisation

The static component of the posture was evaluated within the preventive medical examination (September 2014) by means of the standardized method used in medical and athletic practice according to Jaroš, Lomíček (Vojtaššák, 2000). During the initial, continuous and final medical evaluation, we monitored the efficiency of exercise programmes according to Antošovská (1997),

- A group /exercise programme with overball,
- B group /exercise programme with flexband,
- C group /exercise programme with a fitness ball,
- D group /exercise programme with a BOSU ball,
- E group /exercise program with a Flowin board,

which should result in upright and correct posture. The exercise programmes were implemented within physical and sport education lessons three times a week (Monday, Wednesday, Friday) in the school year 2014/2015. The total number of the lessons was 72. In December 2014, we did continuous evaluations and in May 2015, we conducted final assessments of the monitored factors of the musculoskeletal system.

Measurement taking

Each component (I.–V.) is given points (1, 2, 3, 4) according to quality of posture. The overall body posture is expressed by total points and the quality level (I.-IV.). The assessment is focused on:

I. Head and neck posture
II. Chest (shape)
III. Abdomen and pelvic tilt
IV. Spine curvature
V. Front posture (assessment of posture of shoulders – shoulder girdle)

Classification of postures:

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

Data Analyses

We processed the acquired data on the posture quality by means of the arithmetic mean (x), the extent of variation ($R_{max\ -\ min}$), standard deviation (s) and the median (m), which provided us with the basis for evaluation of differences between individual groups in terms of exercise programme efficiency. We determined the statistical significance of the difference between the parameters measured in initial and continuous and initial and final evaluations by means of a non-parametric test called the Wilcoxon signed-rank test (W_{test}, $p<0.01$, $p<0.05$). We used the Kruskal-Wallis test ($p<0.01$, $p<0.05$) to assess the efficiency of the difference in individual exercise programmes. We also used the logic analysis and synthesis as well as inductive and deductive methods and comparison.

Results and discussions

Based on our objective, we would like to present the part of our results, which are the subject for further and more exact monitoring and processing. The presented results cannot be generalized. They should be perceived as the basis for development of syllabi for physical and sport education in relation to pupils' and students' health.

During initial medical examinations, the doctor assigned most of the female students from the five groups (A, B, C, D, E) to the quality category III., which means the poor posture. In group C there were seven students with this quality. In groups A, B, D, E there were 8 students. Groups A and B had one student with poor and also bad posture. In groups C and E there were 3 students with this quality and in group D there were 2 students. Initial measurements also revealed that none of the students had the perfect posture, classified as quality level I. However, the final medical examinations showed that 2 students in group A, 3 students in group B and 4 students in groups C, D and E had achieved the quality level I. What is more, none of the students had the posture classified in the fourth category, which we regard as positive. One student from the group A, one student from the group C and two students from the group E still belonged to the third category. These students had improved their posture, which was almost within the limits of the second quality category. We have to point out that their initial posture belonged to the highest category. After the final examinations, we had 8 students in groups A and D, 7 students in groups C and E and 9 students in group B, who all had the posture belonging to the category II. This was a very positive finding.

Evaluation of group A. In group A, we found significant changes (W_{test} = 2.934, $p<0.01$) between initial (12.6±2.21) and final (7.3±1.67) evaluations, with an average difference 5.3±1.35 as well as the changes between initial (12.6±2.21) and continuous (8.2±1.71) assessments with an average difference 4.4±1.37 (W_{test} = 2.934). The extent of variation during initial evaluation was min. 8 and max. 17, with the differences $R_{max - min}$ 9.0±2.71, whereas after the final examination it was min. 5 and max. 11, with the difference $R_{max - min}$ 6±1.67. These figures prove improvements in the overall posture quality after the final measurements (Table 2). Assessment of individual segments showed subjective and objective improvement with all the students in group A as regards head and neck posture, where the difference between initial (3.0±0.60) and final (1.4±0.48) evaluations with the difference 1.6±0.48 was significant (W_{test} = 2.934, $p<0.01$). As far as abdomen and pelvic tilt are concerned, we could see the improvement, with the difference between initial (3.2±0.72) and final measurements (1.4±0.64) where the difference 1.8±0.57 was statistically significant (W_{test} =2.934, $p<0.01$). Significant changes occurred also in the chest posture ($p<0.05$).

Table 2 Impact of overball exercise programme on the students' overall posture (n = 11)

Values/measurements (n = 11)	**V1**	**V2**	**R_1 (V1 - V2)**	**V3**	**R_2 (V1 - V3)**
x	12.6	8.2	4.4	7.3	5.3
min.	8.0	6.0	2.0	5.0	3.0
max.	17.0	12.0	6.0	11.0	7.0
$R_{max - min}$	9.0	6.0	4.0	6.0	4.0
s	2.71	1.71	1.37	1.67	1.35
median	13	8.0	5.00	7.0	6.0
Wilcoxon test	V1 – V2		p<0.01	V1 –V3	p<0.01

V_1 – initial measurement, V_2 – continuous measurement, V_3 – final measurement, R_1 – difference between V_1 a V_2, R_2 – difference between V_1 a V_3, x – arithmetic mean, s – standard deviation, $R_{max – min}$ – extent of variation

There was also a significant (W_{test} = 2.665, $p<0.01$) improvement in the physiological spinal curvature between initial (2.0±0.85) and continuous (1.2±0.83) measurements with the difference 0.8±0.39, as well as initial (2.0±0.85) and final (1.0±0.74) measurements with the difference 1.0±0.60. What is more, we recorded significant improvement in the front posture (assessment of posture of shoulders – shoulder girdle) (W_{test} = 2.934, $p<0.01$) between initial (3.1±0,67) and continuous (1.8±0.57) measurements as well as between initial (3.1±0.67) and final (1.7±0.62) measurements. After final measurements, there were 2 students in the quality category I. There was 1 student with bad posture, but only after initial examination. However, after implementation of the overball exercise programme, none of the students had the bad posture after continuous and final measurements. Overball exercises proved to be efficient in qualitative assessment of the overall body posture, where 7 in 11 students were replaced from the category III. to the category II. after final examinations. The second category means a good or almost perfect posture.

Evaluation of group B. As regards the overall body posture in group B, we found a significant (W_{test} = 3.059, $p<0.01$) difference (5.8±1.67) between initial (12.6±2.81) and final (6.8±1.48) assessments (Table 3). There was also an average difference 5±1.80 (W_{test} = 3.059, $p<0.01$) between initial (12.6±2.81) and continuous (7.6±1.32) assessments. Furthermore, we found significant differences after evaluation of individual segments. As far as head and neck posture is concerned, there were worse initial (2.8±0.80) values in contrast to final(1.3±0.47)assessment, where the difference (1.5±0.50) was significant (W_{test} = 3.059, $p<0.01$). In terms of abdomen and pelvic tilt, the difference (1.9±0.64) was significant (W_{test} = 3.059, $p<0.01$), with initial results (3.4±0.76) and final results (1.5±0.50). The flexband exercise proved to be efficient also during assessment of the physiological spinal curvature with significant (W_{test} = 2.520, p<0.05) differences of means (0.7±0.47) between initial (2.0±0.71) and final (1.3±0.47) assessments. Significant changes occurred also in the chest posture (p<0.05).

Table 3 Influence of flexband exercise on the students' overall body posture (n = 12)

Values/measurements (n=12)	V1	V2	R_1 (V1 - V2)	V3	R_2 (V1 - V3)
x	12.6	7.6	5.0	6.8	5.8
min.	8.0	6.0	2.0	5.0	3.0
max.	17.0	11.0	7.0	10.0	8.0
$R_{max - min}$	9.0	5.0	5.0	5.0	5,0
s	2.81	1.32	1.80	1.48	1.67
median	13.0	8.0	6.0	7.0	6.0
Wilcoxon test	V1 – V2		p<0.01	V1 –V3	p<0.01

V_1 – initial measurement, V_2 – continuous measurement, V_3 – final measurement, R_1 – difference between V_1 a V_2, R_2 – difference between V_1 a V_3, x – arithmetic mean, s – standard deviation, $R_{max – min}$ – extent of variation

The flexband exercise programme had an impact on the symmetrical posture of shoulders (shoulder girdle), with the significant (W_{test} = 3.059, p<0.01) difference of means (1.9±0.76) between initial (3.2±0.90) and final (1.3±0.43) assessments. We also found significant changes between initial and continuous measurements. We did not find significant differences between individual measurements with regard to the chest. Thanks to the flexband exercise programme, we found statistically significant differences as far as the overall body posture of the students in group B is concerned. There were also significant changes concerning individual segments, where the doctor replaced 8 students from the third to the second quality category, 3 students to the first category and 1 student from the fourth to the third category, while her results were close to the second category.

Evaluation of group C. The fitness ball exercise programme also proved to be efficient in group C, like it was with the two previous programmes. When comparing the overall posture of the students in group C, we can say that the difference, improvement, between initial (13.0±2.94) and final (6.9±1.98) assessments was the significant (W_{test} = 3.0594, p<0.01) difference 6.1±1.44 (Table 4). As far as the overall body posture is concerned, there was also significant improvement (W_{test} =3.0594, p<0.01), which can be proved by the difference 5.3±1.55 between initial (13.0±2.94) and continuous (7.7±1.93) assessments. As regards the neck and head posture in group C, there was the significant (W_{test} = 3.059, p<0.01) difference (1.8±0.39) between initial (3.2±0.72) and final (1.4±0.48) assessments. In terms of abdomen and pelvic tilt, there was a significant difference (W_{test} = 3.059, p<0.01), with the difference mean 1.9±0.64 between initial (3.2±0.69) and final (1.3±0.43) assessments. Concerning spinal curvature, we found significant changes (W_{test} = 2.366, p<0.05), with initial (1.9±0.76) and final assessments (1.3±0.43) and the mean difference 0.7±0.62. Significant changes occurred also in the chest posture (p<0.05).

Table 4 Impact of the fitness ball exercise programme on the students' overall body posture (n = 12)

Values/measurements (n=12)	V1	V2	R_1 (V1 - V2)	V3	R_2 (V1 - V3)
x	13.0	7.7	5.3	6.9	6.1
min.	8.0	6.0	2.0	5.0	3.0
max.	18.0	12.0	7.0	11.0	7.0
$R_{max - min}$	10.0	6.0	5.0	6.0	4.0
s	2.94	1.93	1.55	1.98	1.44
median	13.0	7.0	6.00	6.0	7.0
Wilcoxon test	V1 – V2		p<0.01	V1 –V3	p<0.01

V_1 – initial measurement, V_2 – continuous measurement, V_3 – final measurement, R_1 – difference between V_1 a V_2, R_2 – difference between V_1 a V_3, x – arithmetic mean, s – standard deviation, $R_{max – min}$ – extent of variation

As regards posture of shoulders (shoulder girdle), we found the significant difference (W_{test} = 3.059, p<0.01,1,5±0,50) between initial (3.0±0.71) and final (1.5±0.65) assessments. We also found significant changes (p<0.01) between initial and continuous assessments. The students in group C took part in the fitness ball exercise programme, thanks to which they significantly improved their overall posture as well as individual posture segments. Consequently, after final assessment 4 students were replaced to the first quality category, 7 students to the second category (II.) and 1 student, who was diagnosed with the highest points at the initial examination, was replaced to the third category (III.). All the students have improved their posture.

Evaluation of group D. This group took part in the BOSU ball exercise programme. We found the significant difference (W_{test} = 3.0594, p<0.01) with the difference 5.9±1.32 between initial and final assessments because the mean at the initial assessment was 12.4±2.43 points and at the final assessment it was 6.5±1.71 points (Table 5). The difference mean 5.1±1.35 between initial (12.4±2.43) and continuous (7.3±1.55) assessments also proves significant improvement (W_{test} = 3.0594, p<0.01) as far as the overall body posture is concerned. Assessment of the overall body posture in group D proved the importance of the BOSU ball exercise programme implemented in physical and sport education lessons. This programme also had a positive impact on individual posture segments. Similarly to groups A, B and C, the group D also proved significant (W_{test} = 3.059, p<0.01) difference (1.9±0.28) between initial (3.2±0.55) and final assessments (1.3±0.43) as regards head and neck posture, between initial (2.9±0.64) and final (1.2±0.37) assessments of abdomen and pelvic tilt with the average difference 1.7±0.43, which was significant (W_{test} = 3.059, p<0.01). We found significant changes (W_{test} = 2.520, p<0.05) between initial (1.9±0.49) and final (1.3±0.43) assessments of the spinal curvature with the difference 0.7±0.47 and the difference 1.4±0.47 (W_{test} = 3.059, p<0.01) between initial (2.7±0.75) and final assessments (1.3±0.47) of the front posture (shoulders). As regards the chest, we found the significant changes only between initial and final assessments (W_{test} = 2.022, p<0.05). In terms of the above mentioned segments, we also found significant changes between initial and continuous assessments. Speaking of group D, which participated in BOSU ball exercise programme, we can confirm significant improvements in overall body posture as well as its individual segments. Consequently, after final assessment 4 students were replaced to the first quality category and 8 students to the second category (II). What we regard as positive is the fact that, in the end, none of the students were assigned to either category III. or IV.

Table 5 Impact of the BOSU ball exercise programme on the students' overall body posture (n = 12)

Values/measurements (n=11)	V1	V2	R_1 (V1 - V2)	V3	R_2 (V1 - V3)
x	12.4	7,3	5.1	6.5	5.9
min.	8.0	6,0	2.0	5.0	3.0
max.	17.0	11,0	7.0	10.0	8.0
$R_{max - min}$	9.0	5,0	5.0	5.0	5.0
s	2.43	1,55	1.35	1.71	1.32
median	12.0	7,0	5.0	6.0	6.0
Wilcoxon test	V1 – V2		p<0.01	V1 –V3	p<0.01

V_1 – initial measurement, V_2 – continuous measurement, V_3 – final measurement, R_1 – difference between V_1 a V_2, R_2 – difference between V_1 a V_3, x – arithmetic mean, s – standard deviation, $R_{max - min}$ – extent of variation

Evaluation of group E. Assessment of the overall body posture in group E confirmed the efficiency of the Flowin exercise programme with the significant difference (5.6±1.0) between initial (12.7±2.55) and final (7.1±2.13) assessments with the value W_{test} = 3.179 (p<0.01). Significant improvement (p<0.01) can be proved by the difference mean 4.7±1.07 between initial (12.7±2.55) and continuous (8.0±2.18) assessments of the overall body posture (Table 6).

Table 6 Impact of the Flowin exercise programme on the students' overall body posture (n = 13)

Values/measurements (n=13)	V1	V2	R_1 (V1 - V2)	V3	R_2 (V1 - V3)
x	12.7	8.0	4.7	7.1	5.6
min.	8.0	6.0	2.0	5.0	3.0
max.	17.0	12.0	6.0	11.0	7.0
$R_{max - min}$	9.0	6.0	4.0	6.0	4.0
s	2.55	2.18	1.07	2.13	1.0
median	12.0	7.0	7.0	6.0	6.0
Wilcoxon index	V1 – V2		p<0.01	V1 –V3	p<0.01

V_1 – initial measurement, V_2 – continuous measurement, V_3 – final measurement, R_1 – difference between V_1 a V_2, R_2 – difference between V_1 a V_3, x – arithmetic mean, s – standard deviation, $R_{max - min}$ – extent of variation

As regards the head and neck posture, we found the significant difference (W_{test} = 3.179, p<0.01) between initial (2.8±0.66) and final (1.4±0.49) assessments with the mean difference (1.5±0,50). The similar values were measured in the abdominal posture, where the difference between initial (3.0±0.78) and final (1.5±0.63) assessments with the average value 1.5±0.50 was significant (W_{test} = 3.179, p<0.01). The exercise programme also had a positive impact on the physiological spinal curvature (V1 2.2±0.58, V3 1.3±0.46, s difference 0.9±0.27) with the value W_{test} = 3.059 (p<0.01) as well as on the shoulder girdle posture (V1 2.8±0.53, V3 1.5±0.63, s difference 1.4±0.49) with the value W_{test} = 3.179 (p<0.01). We found significant changes resulting also from assessment of the chest ($W_{test =}$ 2,201; p<0,05). After final assessment, 7 students were assigned to the second quality category and 4 students to the first category (I.). What is more, 2 students improved as well and, consequently, were replaced to the third category while their total points were close to the second quality category. We regard these findings as positive.

Following the significance of median differences acquired by means of the Kruskal-Wallis test, we can say that all the groups (A, B, C, D, E) have significantly improved their overall body posture as well as its individual segments. Furthermore, we did not find significant differences ($p>0.05$) between the results that individual groups reached in their initial, continuous or final assessments. This proves the same efficiency of exercise programmes conducted with various equipment as far as the overall body posture (musculoskeletal system indicators) are concerned.

Conclusions

The results of our study significantly ($p<0.01$) prove positive changes in overall body posture and its individual segments ($p<0.01$) in all the students ($n = 60$) who were divided into five groups (A, B, C, D, E). These changes were brought about by application of equipment-aided exercise programmes within physical and sport education lessons. As regards medians of the differences between individual assessments, we can say that none of the monitored groups significantly ($p>0.05$) differs from others in terms of the overall body posture. The results confirm the same efficiency and positive impact of the exercise programmes, which were applied within physical and sport education classes, in relation to overall body posture. As a result, we can conclude that appropriate exercises can have a positive impact on the factors determining the body posture and can facilitate proper development of pupils and students.

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