https://doi.org/10.36007/3778.2020.45

THE CURRENT LEVEL OF THE BODY POSTURE IN PUBESCENT PUPILS OF SPORT AND NON-SPORT CLASSES

Elena BENDÍKOVÁ, Alexandra MIKOVIČOVÁ[1]

ABSTRACT

The aim of the research was to find out the level of the body posture in pubescent pupils of sport and non-sport classes. The observed group consisted of 75 boys in average age 12.89±0.73 years from two primary school in Púchov. To acquire data, the standardized method of sport practice – siluetogram – was used. The best achieved results were found in volleyball class (B2), then hockey class (B1) and lastly non-sport class (A). The group of pupils from sport classes (B1+B2) were evaluated by average mark (x) 2.04±0.57, whereas in the group of non-sport class was achieved average mark (x) 2.11±0.56. However, these differences weren't on the significant level ($p > 0.05$). The only significant difference between groups was found in the posture of the abdomen ($p < 0.05$). Despite that, we claim positive affect and the importance of regular physical and sport activity on the body posture although, it is important not to forget about compensation and trying to decrease unilateral strain.

The listed study is the part of research project VEGA "1/0519/19 Physical activity as prevention of health of school population in Slovakia".

KEYWORDS

Body posture, pupils, specialized sport classes and non-sport classes

INTRODUCTION

Every one of us wants to live fully-fledged and healthy life and to achieve that, sufficient amount of physical activity is needed. Cardiovascular system, metabolism, muscle strength, endurance, work capacity, psychological aspects, all the above is on the better level when enough of physical activity is provided to our body (Liba, 2010; Machová, Kubátová et al., 2015; Bendíková, 2017; Müller et al., 2019). On the other hand, according to OECD (2019) about 4 % of death credit to low physical activity.

Problems of musculoskeletal system are becoming more and more discussed topic and the negative effects of the lack of physical activity and disproportionate burden can also have the negative impact on postural health status. Its significant deterioration in children is documented in the conclusions of several works (Lubkowska, et al., 2015; Bendíková, 2016; Bendíková et al., 2018; Jedlička, 2018; Kanásová et al., 2019; Lubkowska, Krzepota, 2019; Palaščáková Špringrová, Baranová, 2019; Nemček et al., 2019; Nemček, Koradyová, 2020) and provokes the need for targeted intervention, whether at home, school or outside the school environments. The high proportion of bad and incorrect body postures is in 80 % of the child population, which is currently strongly determined by the lack of physical activity. The lack of physical activity leads also to overweight and obesity which worsen the body posture as well. This shortage leads to impaired functional relationships between the postural and phasic muscular system, resulting in the muscle imbalance (Bendíková et al., 2020). Consequently, it is the most important cause of increasing number of spinal disorders, which gradually grow into structural disorders and

[1] Department of Physical Education and Sports, Faculty of Arts,Matej Bel University, Banská Bystrica, Slovakia

cause serious diseases/ disorders of muscular system in adulthood (Lebkowski, Dzieciol, 2002; Macialczyk, Paprocka, 2017). Another side effect of the lack of physical activity and incorrect body posture is headache or back pain from which suffer around 20 % of people in young adulthood (Jedlička, 2018). Even though some sports can have its negative effect on body posture when it's done unreasonably, without compensation and regards to one's own body, better results were still found in physically and sport active children than non-active ones (Fett, Trompeter, Platen, 2017; Bínovský, 2013; Stitzel, 2017).
All the above is the reason for the regular control of the body posture of children and for making compensation exercises part of their routine to prevent spinal disorders and to enjoy their life fully. That is why we also decided to, and the aim of the research was to find and analyse the level of musculoskeletal system and the effect of regular physical and sport activity on body posture in younger school age pupils attending sport and non-sport classes in schools

Method

Subject Characteristics

The sample consisted of 75 boys from two primary schools in Púchov, at the age of 12 – 14 (7^{th} and 8^{th} grade). Pupils were divided into following groups: A – non-sport class, B1 – hockey sport class, B2 – volleyball sport class. The primary characteristics of the groups A, B1 and B2 are shown in Chart 1.

Chart 1 The primary characteristics of the sample (n = 75)

Factors	Age	Height/cm	Weight /kg	BMI
A n = 25 x	13.04±0.73	165.80±6.56	58.32±10.76	21.15±3.32
B1 n = 25 x	12.80±0.65	164.00±7.64	53.92±9.87	19.93±2.58
B2 n = 25 x	12.84±0.80	166.48±5.99	53.28±8.98	19.18±2.82

Measurement Organisation

Research was conducted in three primary consecutive phases in school year 2019/2020. The main goal was to find out and analyse the current level of pubescent pupils' body posture in sport and non-sport classes by the way of standardized methods.

Measurement Taking

Siletogram method, the standardized sport practice method for evaluation of chosen indicator of musculoskeletal system, was used to acquire data. Siluetogram is an inspection method (Labudová, 1993).

Data Analyses

We used mathematical-statistic methods: arithmetic mean (x), standard deviation (s), maximum (max), minimum (min), variation range ($R_{(max-min)}$), median (med), multiplicity (n), percentage (%), Chi-squared test (χ; $p < 0.05$) and Cohen's d (d) for the processing and evaluation of acquired quantitative-qualitative data.

Results and Discussions

The first evaluated area was head posture (Chart 2). The group that achieved the best evaluation in this area was non-sport group (A) which achieved average grade of (x) 1.72±0.54. Pupils from sport classes were evaluated by identical grade (x) 1.84±0.47 in hockey class (B1) and (x) 1.84±0.69 in volleyball class (B2). The difference between individual groups was not

significant (χ_1 = 0.289; p > 0.05), and even despite better results of non-sport class, the difference between A and B1+B2 was not significant either (χ_2 = 0.617; p > 0.05). The effect size between A and B1+B2 groups was medium (d = 0.21). As regards to the specific grades, the highest percentage of pupils received grade 2, which represents slightly inclined and oblique axis. In A group it was 64% (n = 16), in B1 group 76 % (n = 19) and in B2 group 52 % (n = 13). Grade 1 evaluation was awarded to 8 pupils (32 %) in A group and B2 group. The highest percentage of pupils with considerably inclined head posture or head posture leaning to one side (grade 3) was discovered in B2 group (16 %, n = 4).

Chart 2 Head posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	1.72	0.54	3.00	1.00	2.00	2.00	8 (32.00)	16 (64.00)	1 (4.00)	0.289/ 0.617 (p > 0.05)	0.21
sport hockey class B1 (n=25)	1.84	0.47	3.00	1.00	2.00	2.00	5 (20.00)	19 (76.00)	1 (4.00)		
sport volleyball class B2 (n=25)	1.84	0.69	3.00	1.00	2.00	2.00	8 (32.00)	13 (52.00)	4 (16.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

The next evaluation concerned shoulders posture – shoulder joint (Chart 3). Again, the best results were achieved by non-sport class pupils (A group) with average grade of (x) 2.36±0.49. Worse shoulder posture observed in sport class pupils may result from movement structure of sports in sport classes. The most frequent shoulder posture defect was transitional form, meaning slightly higher posture of one shoulder (grade 2). Average grades were worse in hockey (B1) and volleyball (B2) classes – B1 (x) 2.48±0.51 and B2 (x) 2.44±0.51 and their percentage of grades 2 and 3 was higher: B1 group with 52 % (n = 13) of grade 2 evaluation and 48 % (n = 12) of grade 3 and B2 group with 56 % (n = 14) of grade 2 and 44 % (n = 11) of grade 3. Not one pupil of the whole sample (n = 75) was assessed by grade 1 (horizontal shoulder posture and shoulder axis perpendicular to head axis). Small differences in average grades showed insignificant changes among A, B1, B2 groups as well as between A and B1+B2 groups ($\chi_1/\ \chi_2$ = 0; p > 0.05), however size effect was medium (d = 0.20).

Chart 3 Shoulder posture – shoulder joint (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.36	0.49	3.00	2.00	1.00	2.00	0 (0.00)	16 (64.00)	9 (36.00)	0/0 (p > 0.05)	0.20
sport hockey class B1 (n=25)	2.48	0.51	3.00	2.00	1.00	2.00	0 (0.00)	13 (52.00)	12 (48.00)		
sport volleyball class B2 (n=25)	2.44	0.51	3.00	2.00	1.00	2.00	0 (0.00)	14 (56.00)	11 (44.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Next, we focused on back posture (Chart 4), which concerns upright back posture or its deviations, as well as scapula posture. The best evaluation was once again received by non-sport class pupils (A) (x) 2.24±0.44, although the differences were minimal, which is also portrayed by insignificant level of the Chi-squared test among individual groups A, B1, B2 (χ_1 = 0.662; p > 0.05) as well as between non-sport (A) and sport (B1+B2) classes (χ_2 = 0.301; p > 0.05). Effect size was small too (d = 0.16). Hockey (B1) and volleyball (B2) classes were assessed by identical average grade of (x) 2.32±0.56. It is evident that worsened back posture in sport classes is influenced by shoulder posture, evaluated in previous section. The highest percentage of pupils was observed to have moderate deviation as well as scapula asymmetry (grade 2). Percentual representation of grade 2 evaluation received in particular classes was as follows: A group 76 % (n = 19), B1 and B2 groups 60 % (n = 15). Sport classes (B1+B2) were observed to reach higher percentage of deviation, specifically 36 % (n = 9). On the other hand, the only pupils with back symmetry (grade 1) were also observed in sport class groups – B1 4 % (n = 1), B2 4 % (n = 1).

Chart 4 Back posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.24	0.44	3.00	2.00	1.00	2.00	0 (0.00)	19 (76.00)	6 (24.00)	0.662/ 0.301 (p > 0.05)	0.16
sport hockey class B1 (n=25)	2.32	0.56	3.00	1.00	2.00	2.00	1 (4.00)	15 (60.00)	9 (36.00)		
sport volleyball class B2 (n=25)	2.32	0.56	3.00	1.00	2.00	2.00	1 (4.00)	15 (60.00)	9 (36.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

In this paragraph, we will focus on hip posture evaluation (Chart 5). The best evaluation was achieved by volleyball class (B2) with average grade of (x) 1.68±0.56, where 9 pupils (36 %) had correct horizontal hip posture (grade 1). Next was hockey class (B1) with average grade of (x) 1.80±0.58 and last was non-sport class (A) with average grade of (x) 2.08±0.57. As in the previous areas, transitional form prevailed, meaning one hip mildly higher than the other (grade 2). Distinct asymmetry of pelvis (grade 3) was altogether observed in 8 pupils, the highest number in the A group – 20 % (n = 5). Differences between individual groups were higher in this area, but still not high enough to be considered significant (χ_1 = 0.176; p > 0.05), and the same goes for differences between non-sport (A) and sport (B1+B2) classes (χ_2 = 0.055; p > 0.05), even though size effect was large (d = -0.60).

Chart 5 Hip posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.08	0.57	3.00	1.00	2.00	2.00	3 (12.00)	17 (68.00)	5 (20.00)	0.176/ 0.055 (p > 0.05)	-0.60
sport hockey class B1 (n=25)	1.80	0.58	3.00	1.00	2.00	2.00	7 (28.00)	16 (64.00)	2 (8.00)		
sport volleyball class B2 (n=25)	1.68	0.56	3.00	1.00	2.00	2.00	9 (36.00)	15 (60.00)	1 (4.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Let us move on to the side view components evaluation. As first, we observed cervical section (Chart 6). Hockey class (B1) achieved the best average grade (x) 2.24±0.60 in this area, then followed by volleyball class (B2) (x) 2.28±0.46 and lastly non-sport class (A) with average grade of (x) 2.36±0.57. Worse average grade in non-sport classes can also be result from the fact that 10 pupils (40 %) were observed to have considerable forward head and neck posture (grade 3). Despite that, transitional form was prevailing in all groups, meaning mildly forward neck posture (grade 2), which occurred in 56 % (n = 14) of the A group 60 % (n = 15) of the B1 group and 72 % (n = 18) of the B2 group. Pupils with correct neck posture were also observed in individual groups, except group B2, where none of the pupils were evaluated by grade 1. Achieved results and differences neither among A, B1, B2 groups ($\chi_1 = 0.539$; $p > 0.05$) nor between A and B1+B2 ($\chi_2 = 0.682$; $p > 0.05$) were high enough to be considered significant. Size effect was small (d = -0.18).

Chart 6 Cervical section (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.36	0.57	3.00	1.00	2.00	2.00	1 (4.00)	14 (56.00)	10 (40.00)	0.539/ 0.682 ($p > 0.05$)	-0.18
sport hockey class B1 (n=25)	2.24	0.60	3.00	1.00	2.00	2.00	2 (8.00)	15 (60.00)	28 (32.00)		
sport volleyball class B2 (n=25)	2.28	0.46	3.00	2.00	1.00	2.00	0 (0.00)	18 (72.00)	7 (28.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%),Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Next up is the arched chest evaluation (Chart 7). This area received the best average grades from all assessed areas. The best average grade was received by volleyball class (B2) (x) 1.56±0.65, then hockey class (B1) (x) 1.68±0.63 and last non-sport class (A) (x) 1.72±0.54. The highest percentage of the grade 1, correct posture and arched chest, was observed in the B2 group, that is 52 % (n = 13). In other groups, transitional form and grade 2 was prevailing, specifically in 64 % (n = 14) of the A group and 52 % (n = 13) of the B1 group. Even despite quite good overall results, there were also pupils with poor posture discovered. Together it was 5 pupils – 1 (4 %) in the A group and 2 (8 %) in the B1 as well as B2 groups. Significant difference was not ascertained neither among groups A, B1, B2 ($\chi_1 = 0.556$; $p > 0.05$) nor between A and B1+B2 groups ($\chi_2 = 0.328$; $p > 0.05$) even though the differences were bigger than in the previous area. Effect size was small in this case (d = -0.17).

Chart 7 Chest posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	1.72	0.54	3.00	1.00	2.00	2.00	8 (32.00)	16 (64.00)	1 (4.00)	0.556/ 0.328 (p > 0.05)	-0.17
sport hockey class B1 (n=25)	1.68	0.63	3.00	1.00	2.00	1.00	10 (40.00)	13 (52.00)	2 (8.00)		
sport volleyball class B2 (n=25)	1.56	0.65	3.00	1.00	2.00	1.00	13 (52.00)	10 (40.00)	2 (8.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Next area, shoulder posture (Chart 8), received the worst overall evaluation. Sport classes (B1, B2) received worse results than non-sport classes (A). The last to end up was the hockey class (B1) with average grade of (x) 2.52±0.51, where the highest number of pupils were evaluated by grade 3, specifically 52 % (n = 13). Grade 3 shows considerable forward shifted shoulders posture and protruding scapula. Better results were received by volleyball class (B2), that is (x) 2.44±0.51 where transitional form (grade 2) prevailed in 56 % (n = 14). The best posture, even though still not correct, and average grade was received by non-sport class (A) with grade of (x) 2.40±0.58. In this group, the most frequent grade was 2, in 52 % (n = 13) of pupils, 1 pupil (4 %) was also evaluated by grade 1. Once again, the differences among A, B1, B2 groups (χ_1 = 0.666; p > 0.05) and between A and B1+B2 groups (χ_2 = 0.358; p > 0.05) were not significant. Size effect was small (d = 0.15).

Chart 8 Shoulder posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.40	0.58	3.00	1.00	2.00	2.00	1 (4.00)	13 (52.00)	11 (44.00)	0.666/ 0.358 (p > 0.05)	0.15
sport hockey class B1 (n=25)	2.52	0.51	3.00	2.00	1.00	3.00	0 (0.00)	12 (48.00)	13 (52.00)		
sport volleyball class B2 (n=25)	2.44	0.51	3.00	2.00	1.00	2.00	0 (0.00)	14 (56.00)	11 (44.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Next, we focused on torso posture evaluation (Chart 9). In this area, the results were more or less the same, which means that changes among groups A, B1, B2 (χ_1 = 0.132; p > 0.05) as well as differences among groups (χ_2 = 0.219; p > 0.05) were insignificant. Effect size was also small (d = -0.15). Pupils of sport classes received the best evaluation, by grade (x) 1.80±0.50 in B1 group and grade (x) 1.80±0.71 in B2 group. In pupils of non-sport class (A), this value was only slightly higher, that is (x) 1.88±0.44. From percentual point of view, grade 2 was prevalent (torso slightly inclined backwards) in 80 % (n = 20) of A group pupils, 72 % (n = 18) B1 group pupils and 48 % (n = 12) B2 group pupils. On a scale between good posture (grade 1) and poor posture (grade 3), more pupils were observed to have good posture, specifically 16 % (n = 4) in A group, 24 % (n = 6) in B1 group and 36 % (n = 9) in B2 group. Biggest number of pupils with poor posture (4 pupils, or 16 %) was observed in B2 group.

Chart 9 Torso posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	1,88	0,44	3,00	1,00	2,00	2,00	4 (16,00)	20 (80,00)	1 (4,00)	0,132/ 0,219 (p > 0,05)	-0,15
sport hockey class B1 (n=25)	1,80	0,50	3,00	1,00	2,00	2,00	6 (24,00)	18 (72,00)	1 (4,00)		
sport volleyball class B2 (n=25)	1,80	0,71	3,00	1,00	2,00	2,00	9 (36,00)	12 (48,00)	4 (16,00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

We continue with abdomen area evaluation (Chart 10). This area showed the greatest and most significant differences between the sport class pupils (B1, B2) and non-sport class pupils. This is confirmed by Chi-squared test among A, B1 and B2 groups ($\chi_1 = 0.044$; $p < 0.05$), as well as between A and B1+B2 groups ($\chi_2 = 0.010$; $p < 0.05$). Effect size was large in this area (d = -0.77). Hockey class pupils (B1) received the best abdomen area evaluation (x) 1.52±0.65, among them 56 % (n = 14) received grade 1 (good posture, flat abdomen) and only 8 % (n = 2) received grade 3 (limp, visibly protruding abdomen). Hockey class pupils were followed by volleyball class group B2) with average grade (x) 1.68±0.75. In this group, majority of pupils (48 %) also received grade 1 (n = 12), and the least amount of pupils (16 %) got grade 3 (n = 4). The worst evaluation was given to non-sport class pupils (A), with average grade (x) 2.16±0.75. In this group, most pupils, that being 44 % (n = 11), received grade 2 (slightly forward-protruding abdomen, transitional form). In comparison with B1 and B2 groups, in A group, the least number of pupils received grade 1 (20 %, only 5 pupils).

Chart 10 Abdomen area (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.16	0.75	3.00	1.00	2.00	2.00	5 (20.00)	11 (44.00)	9 (36.00)	0.044/ 0.010 (p < 0.05)	-0.77
sport hockey class B1 (n=25)	1.52	0.65	3.00	1.00	2.00	1.00	14 (56.00)	9 (36.00)	2 (8.00)		
sport volleyball class B2 (n=25)	1.68	0.75	3.00	1.00	2.00	2.00	12 (48.00)	9 (36.00)	4 (16.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

In the following area, we focused on was lumbar spine posture (Chart 11). Again, pupils of sport classes (B1, B2) received better evaluation that non-sport class pupils (A). Hockey class pupils (B1) as well as volleyball class pupils (B2) received the same average grade (x) 2.04±0.68 (B1), (x) 2.04±0.54 (B2). However, small discrepancies among groups occurred when taking into account the percentual prevalence of individual grades.

Chart 11 Lumbar spine posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.24	0.52	3.00	1.00	2.00	2.00	1 (4.00)	17 (68.00)	7 (28.00)	0.403/ 0.285 ($p > 0.05$)	-0.35
sport hockey class B1 (n=25)	2.04	0.68	3.00	1.00	2.00	2.00	5 (20.00)	14 (56.00)	6 (24.00)		
sport volleyball class B2 (n=25)	2.04	0.54	3.00	1.00	2.00	2.00	3 (12.00)	18 (72.00)	4 (16.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

In both groups, the biggest percentage of pupils received grade 2 evaluation (slight inclination in lumbar spine area), in B1 group it was 56 % (n = 14) and in B2 72 % (n = 18). Grade 2 was followed by grade 3 evaluation (poor posture, significant inclination in lumbar spine area), which occurred in 24 % (n = 6) of B1 group pupils and 16 % (n = 4) of B2 group pupils. The least number of pupils received grade 1 evaluation (correct physiological lumbar spine posture), that is only 20 % (n = 5) in B1 group and 12 % (n = 3) in B2 group. Non-sport class pupils received average grade of (x) 2.24±0.52, however in percentual prevalence of grades, their results were visibly worse. 68 % (n = 17) of pupils received grade 2 evaluation, 28 % (n = 7) received grade 3 evaluation and only 4 % (n = 1) received grade 1 evaluation. Neither in this area there were no significant differences discovered between A and B1 + B2 group pupils ($\chi_2 = 0.285$; $p > 0.05$). Effect size between A and B1 + B2 groups was medium (d = -0.35).
Next up is the thoracic spine posture (Chart 12). In this section, non-sport class pupils (A) were again at the tail of average evaluation with a grade of (x) 2.40±0.50. Best results were achieved by volleyball class pupils (B2) with evaluation of (x) 2.32±0.48, followed closely by hockey class pupils (B1) with evaluation of (x) 2.36±0.57. Thoracic spine posture was evaluated on average by grade 2 (slightly slouched thoracic spine area). Grade 2 was received by 68 % (n = 17) of pupils in B2 group, 56 % (n = 14) in B1 group and 60 % (n = 15) in A group. Grade 3 evaluation (overly rounded upper back) was received at similar proportion in each group – 32 % (n = 10) in B2 group, 40 % (n = 10) in B1 group and 40 % (n = 10) in A group. However, only 1 pupil from all of the monitored groups was discovered to have good thoracic spina posture (grade 1), and this pupil was from B1 group. Difference between A, B1, B2 groups ($\chi_1 = 0.629$; $p > 0.05$) and A, B1+B2 groups ($\chi_2 = 0.747$; $p > 0.05$) was not on significant level. Effect size was small (d = -0.12).

Chart 12 Thoracic spine posture (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	2.40	0.50	3.00	2.00	1.00	2.00	0 (0.00)	15 (60.00)	10 (40.00)	0.629/ 0.747 ($p > 0.05$)	-0.12
sport hockey class B1 (n=25)	2.36	0.57	3.00	1.00	2.00	2.00	1 (4.00)	14 (56.00)	10 (40.00)		
sport volleyball class B2 (n=25)	2.32	0.48	3.00	1.00	2.00	2.00	0 (0.00)	17 (68.00)	8 (32.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Next to last is the feet evaluation (Chart 13). Small differences were observed among individual groups. That is represented in an insignificant level of changes among A, B1, B2 groups (χ_1 = 0.188; p > 0.05) as well as between A and B1+B2 groups (χ_2 = 0.160; p > 0.05). Effect size was small (d = 0.03). The best evaluation was received by volleyball class (B2), that is (x) 1.92±0.40, together with non-sport class (A) (x) 1.92±0.70, followed by hockey class (B1) (x) 1.96±0.61. The most frequent posture defect was mildly pronated ankle posture (grade 2) in 84 % (n = 21) of the B2 group, 64 % (n = 16) of the B1 group and 52 % (n = 13) of the A group.

Chart 13 Feet evaluation (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	1.92	0.70	3.00	1.00	2.00	2.00	7 (28.00)	13 (52.00)	5 (20.00)	0.188/ 0.160 (p > 0.05)	0.03
sport hockey class B1 (n=25)	1.96	0.61	3.00	1.00	2.00	2.00	5 (20.00)	16 (64.00)	4 (16.00)		
sport volleyball class B2 (n=25)	1.92	0.40	3.00	1.00	2.00	2.00	3 (12.00)	21 (84.00)	1 (4.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

Grade 1 (correct posture) was also awarded frequently in this category, in 12 % (n = 3) of the B2 group, 28 % (n = 7) of the A group and 20 % (n = 5) of the B1 group. The smallest number of pupils was evaluated by grade 3 (distinctive ankle pronation), specifically 1 pupil (4 %) in the B2 group, 5 pupils (20 %) in the A group and 4 pupils (16%) in the B1 group.
The last area we focused our attention on was planta pedis evaluation (Chart 14). As in previous area, there was no significant difference recorded among A, B1 and B2 groups (χ_1 = 0.377; p > 0.05) nor between A and B1+B2 groups (χ_2 = 0.162; p > 0.05). Effect size was small (d = 0.19). Non-sport class pupils group (A) received the best evaluation, that is(x) 1.92±0.70, followed by volleyball class (B2) (x) 2.00±0.58. The worst planta pedis evaluation was recorded in the B1 group (hockey class) (x) 2.08±0.49. The most frequent evaluation was grade 2 (lower arch), specifically 76 % (n = 19) in the B1 group, 68 % (n = 17) in the B2 group and 52 % (n = 13) in the A group. Non-sport class pupils (A) received the highest percentage of the grade 1, which represents 7 pupils (28%). On the other hand, the lowest number occurred in the B1 group, only 2 pupils (8 %). The lowest number of pupils with grade 3 was observed in group B1 and B2, that being 4 pupils (16%).

Chart 14 Planta pedis evaluation (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_1/χ_2	d
non-sport class A (n=25)	1.92	0.70	3.00	1.00	2.00	2.00	7 (28.00)	13 (52.00)	5 (20.00)	0.377/ 0.162 (p > 0.05)	0.19
sport hockey class B1 (n=25)	2.08	0.49	3.00	1.00	2.00	2.00	2 (8.00)	19 (76.00)	4 (16.00)		
sport volleyball class B2 (n=25)	2.00	0.58	3.00	1.00	2.00	2.00	4 (16.00)	17 (68.00)	4 (16.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

We are done with comparison of individual groups A, B1, B2. In total, the best posture was observed in volleyball class (B2), then hockey class (B1) and lastly non-sport class (A) what confirms the positive influence of sport and physical activity on body posture of pubescent pupils in our sample.

When we look at overall comparison of non-sport (A) and sport (B1+B2) classes (Chart 15), sport class pupils' group (B1+B2) received better evaluation than pupils from non-sport classes (A). Approximately 18 % (n = 9) of sport classes pupils (B1+B2) received grade 1, which means that their posture was correct in the particular area, while in non-sport class (A) it was only 14 % (n = 3.5). From the description of individual components, we can see that the most frequent grade was 2 (transitional form) which means that the posture was neither correct, but not as bad to be considered poor. In B1+B2 group it was around 60 % (n = 30) and in A group 61.6 % (n = 15.4). Non-sport classes achieved predominance only in evaluation by grade 3 and that is poor posture. Grade 3 was received by 22 % (n = 11) in the B1+B2 groups and by 24.4 % (n = 6.1) in A group. Let us look at specific areas. The influence of specific sports in sport classes, their laterality and unilateral stress was visible in the areas where non-sport class (A) received better results, specifically shoulders posture – shoulders joint, back, shoulders (side view) as well as head. Motylewski et al. (2015) agree with our finding and they consider these areas as the most problematic as well. Also, Kanásová (2005), Rajabi (2012) or Grabara (2015) agree and confirm that certain sports can influence body posture.

However, even though non-sport classes received better average results, in the cases which showed body posture predominance of sport classes (B1+B2), the differences between A and B1+B2 groups were visibly larger.

In our opinion, this is the result of overall positive influence of physical and sport activity on individual body posture, as well as work of physical education teachers who focus also on compensatory exercises and exercises to reduce the unilateral stress in sport classes. Sport class pupils (B1+B2) received better evaluation in the following areas: posture of hips, cervical area, chest, torso, abdomen, lumbar area, and thoracic area. Total average grade of non-sport class (A) was (x) 2.11±0.56 while in sport class (B1+B2) it was (x) 2.04±0.57. Despite better average results and percentage in B1+B2 group, significant level of differences was not confirmed (χ_2 = 0.177, p > 0.05). Effect size was small (d = -0.13). We are not the only ones who were not able to confirm this significant level, example is Lizis, Walaszek's research (2014). However, we still claim positive influence of physical activity on the body posture and Balko et al. (2017) or Tomaszewska, Pawlicka-Lisowska (2014) agree with us. They also found out better quality of body posture in physically active people than in the ones who prefer sedentary lifestyle.

Chart 15 Overall body posture (A, B1, B2) (n = 75)

n = 75	x	s	max	min	$R_{(max-min)}$	med	grade 1 n/(%)	grade 2 n/(%)	grade 3 n/(%)	χ_2	d
Non-sport class A (n=25)	2.11	0.56	3.00	1.00	2.00	2.00	3.5 (14.00)	15.4 (61.6)	6.1 (24.4)	0.177 (p > 0.05)	-0.13
Sport hockey and volleyball class B1+B2 (n=50)	2.04	0.57	3.00	1.00	2.00	2.00	9 (18.00)	30 (60.00)	11 (22.00)		

Legend: arithmetic mean (x), standard deviation (s), maximum (max.), minimum (min.), variation range ($R_{(max-min)}$), median (med.), multiplicity
n), percentage (%), Chi-squared test A, B1, B2 groups(χ_1), Chi-squared test A, B1+B2 groups (χ_2), Cohen's d (d)

CONCLUSION

Our research aimed to find out the level of musculoskeletal system in pubescent pupils of sport and non-sport classes with focus on the body posture. Higher frequency of physical activity shows its influence in better quality of body posture of sport classes pupils (B1+B2) (x) 2.04±0.57 in contrast with pupils from non-sport classes (A) with average grade of (x) 2.11±0.56. In regards to specific sports, volleyball class group received better results than hockey class group. The areas in which the highest number of deviations occurred were as follows: posture of shoulders and thoracic area.

Even despite better results of sport classes pupils (B1+B2), ascertained overall differences were not on significant level ($p > 0.05$). The only significant difference between groups B1+B2 and A was found in the area of abdomen ($\chi_1 = 0.044$; $p < 0.05$; $\chi_2 = 0.010$; $p < 0.05$). Despite these facts we still claim positive influence and the importance of physical activity on musculoskeletal system, however we cannot forget about compensation and the reducing consequences of unilateral stress.

REFERENCES

[1] Balko, Š. et al. (2017). Influence of physical activities on the posture in 10 - 11-year-old schoolchildren. *Journal of Physical Education and Sport*, 17(1), 101-106.

[2] Bendíková, E. (2016). Changes in the posture of students due to equipment-aided exercise programs that are applied in physical and sport education. *Journal of Physical Education and Sport*, 16(2), 281-286.

[3] Bendíková, E. (2017). *Theory of health, movement and lifestyle of human beings.* Debrecen: University of Debrecen. ISBN 978-963-473-219-8

[4] Bendíková, E., Palaščáková Špringrová, I., Tomková, S., Vágner, J. (2018). Effects of an exercise program on the dynamic function of the spine in female students in secondary school. *Journal of Physical Education and Sport*, 18(2), 831-839.

[5] Bendíková, E., Novotná, B., Rozim R., Tomková Š., Fyodorov, A., Palaščáková Špringrová, I. (2020). Analysis of physical activity status and functional posture in Slovakia's young school-aged children with different body weight. *Zdravotnícke listy*, 2020, 8(2), 71-81.

[6] Bínovský, A. (2013). *Anatómia pre športovcov I : Pohybový systém*. 2. vydanie. Bratislava : Univerzita Komenského v Bratislave, 2013. 310 s. ISBN 978-80-223-3303-0

[7] Fett, D., Trompeter, K., Platen, P. (2017). Back pain in elite sports: A cross-sectional study on 1114 athletes. *Plos One*, 12(6).

[8] Grabara, M. (2012). Analysis of Body Posture between Young Football Players and their Untrained Peers. *Human Movement*, (13)2, 120-126.

[9] Grabara, M. (2015). Comparison of posture among adolescent male volleyball players and non-athletes. *Biology of Sport*, 32(1), 79-85.

[10] Jedlička, J. (2018). *Zdravý životný štýl – I: sám sebe manažérom zdravia, výkonnosti a vitality.* Nitra : Slovenská poľnohospodárska univerzita v Nitre, 2018. 278 s. ISBN 978-80-552-1937-0.

[11] Kanásová, J. (2005). Monitorovanie stavbu držania tela u atlétov, tenistov, plavcov, hokejistov, volejbalistiek a moderných gymnastiek OŠG v Nitre. In *Telesná výchova a šport na univerzitách v ponímaní študentov ako objektu edukácie*. Nitra : Slovenská poľnohospodárska univerzita, 2005. [online]. Dostupné na: http://www.slpk.sk/eldo/2006/012_06/19.pdf. ISBN 80-8069-602-0.

[12] Kanásová, J., Záková, N., Divinec, L., Veis, A., Solvesterová, M. (2019). Impact of balance exercises on the elimination of functional muscular disorders in volleyball players. *Physical Activity Review*, 7: 152-159.
[13] Labudová, J. (1993). *Zdravotná telesná výchova*. Bratislava: Metodické centrum, 1993.
[14] Lebkowski, W., Dzieciol, J. (2002). Lumbar intervertebral herniation. The composition of free sequesters a morphologis study. *Chir. Narzadow Ruchu Orthop Pol.*, 67(4), 405-408.
[15] Lizis, P., Walaszek, R. (2014). Evaluation of relations between body posture parameters with somatic features and motor abilities of boys aged 14 years. *Annals of Agricultural and Environmental Medicine*, (21)4, 810-814.
[16] Lubkowska, W., Zdeb, T., Mroczek, B. (2015). Assessment of physiological spine curvature in girls who trained competitive swimming versus non-swimming girls. *Family Medicine & Primary Care Review*, 17(3), 189-192.
[17] Lubkowska, W., Krzepota, J. (2019). Quality of life and health behaviours of patients with low back pain. *Physical Activity Review* 7: 182-192.
[18] Macialczyk-Paprocka, K. a kol. (2017). Prevalence of incorrect body posture in children and adolescents with overweight and obesity. *European Journal of Pediatrics*, 176(5), 563-572.
[19] Motylewski, S. et al. (2015). Assessment of body posture in 12- and 13-year-olds attending primary schools in Pabianice. *Polski Merkuriusz Lekarski*, 39(234), 368-371.
[20] Müller, A., Bendíková, E., Lakó, J. H., Bácsné, B. E, Lubkowska, W., Mroczek, B. (2019). Survey of regular physical activity and socioeconomic status in Hungarian preschool children. Family Medicine and Primary Care Review, 21(3), 237-242.
[21] Nemček, D., Ladecká, P., Kováč, A. (2019). Subjektívna pohoda športujúcich a nešportujúcich stredoškolákov s poruchami muskuloskeletálneho systému z hľadiska rodových odlišností. *Telesná výchova & šport,* 29(3), 27-31.
[22] Nemček, D., Koradyová, A. (2020). Osobná pohoda žiačok stredných škôl s rozdielnym zdravotným stavom. *Telesná výchova & šport*, 30(2), 2-6.
[23] OECD/European Observatory on Health Systems and Policies. (2019). *State of Health in the EU: Slovensko, zdravotný profil krajiny 2019*. [online]. Brusel: OECD Publishing, 2019. 32s.
[24] https://ec.europa.eu/health/sites/health/files/state/docs/2019_chp_sk_slovak.pdf.
[25] Palaščáková Špringrová I., Baranová E. (2019). Vliv asymetrického postavení aker dolních končetin na plochonoží u kojenců a dětí předškolního a školního věku. *Časopis praktických lékařů pro děti a dorost. VOX pediatrie*, 19(7), 18-22.
[26] Stitzel, C. J. (2017). *Athletes with scoliosis – can kids with curves participate in sports?* [online].https://www.treatingscoliosis.com/blog/athletes-scoliosis-can-kids-curves-participate-sports/.
[27] SZŐKÖL, I. (2020). *Hatékony pedagógiai kommunikáció*. Bratislava : Metodicko-pedagogické centrum, 2020, 104. p., ISBN 978-80-565-1450-4.
[28] SZŐKÖL, I. (2018). *Continuous Improvement of the Teaching Process in Primary Education*. In. Journal of Language and Cultural Education, 2018, 6(1), 2018, s.53-64. ISSN 1339-4584, DOI:10.2478/jolace-2018-0004
[29] Tomaszewska, A., Pawlicka-Lisowska, A. (2014). Evaluation of an influence of systematic motor activity on the body posture of young people. *Polski Merkuriusz Lekarski*, 36(214), 336-340.