DOI: 10.4149/BLL_2022_088

Bratisl Med J 2022; 123 (8)
555 – 559

CLINICAL STUDY

World´s COVID-19 anti-pandemic measures in the context of postural and spine disorders in primary school children in Slovakia

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ABSTRACT
INTRODUCTION: This study was aimed to estimate the effect of one-year persistence of COVID-19 anti-pandemic measures on the posture and spine in children of younger school age in Slovakia.
MATERIAL AND METHODS: A total of 135 children aged between 6 and 9 years participated in this study. The examination of posture and spine was carried out in 4 schools in 4 different districts in Slovakia. The posture was evaluated in February 2020, before anti-pandemic restrictions and in period from May 2021, after one year of anti-pandemic restrictions. Modified methodology according to Napoleon Wolanski was used to evaluate the posture.
RESULTS**:** For the entire study group, the mean posture disorder level score before anti-pandemic restrictions was 5.667 (±1.75) and it rose to 7.844 (±0.64). Prevalence of posture disorders rose from 71.11 % to 91.3 % in the study group. The most affected segments were lumbar spine and pelvis, followed by deformities of the thoracis spinae. The mean pathology level score for entire group in these segments rose as followed: in the lumbar spine from 0.6 (±0.61) to 1.022 (±0.75); in the pelvis from 0.444 (±0.54) to 0.772 (±0.73) and in the thoracis spine from 0.378 (±0.53) to 0.578 (±0.61).
CONCLUSION: Study confirmed a worsening of the posture and spine in school children after a one year of strict anti-pandemic measures. As postural changes increased by 20 % during the year, it seems necessary to implement appropriate preventives programs for children, which could have the potential to improve their postural state *(Tab. 2, Fig. 1, Ref. 37)*. Text in PDF *www.elis.sk*
KEY WORDS: anti-pandemic restriction, e-learning, COVID-19, postural disorders, spine deformities.

Introduction

COVID-19 is a disease caused by virus Sars-CoV-2, which has affected almost every human life on earth. After the outbreak in China in December 2019 it has spread rapidly worldwide (1). As early as March 2020, the WHO declared the virus-causing COVID-19 disease a pandemic (2, 3). The Institute for the Prevention and Treatment of Infectious Diseases in China has classified the disease as Category A infectious diseases (4). Due to the rate of the spread of the virus, which is easily transmitted from person to person (5), the disease in a short time overloaded health systems, devastated the world economy, severely restricted people's daily lives, required sacrifices (6). To prevent the uncontrolled spread of the virus, according to WHO recommendations by COVID-19 strategy (7, 8), the most governments have instituted anti-pandemic measures. The outbreak of the COVID-19 pandemic and the prolonged period of restrictions have exposed the problems that society has long experienced (9). Several experts are beginning not only to appeal (10, 11) but also to evaluate these social, economic, or psychological consequences of anti-pandemic restrictions, but also health consequences from the point of view of other diseases, not only from the point of view of COVID-19 (12, 13, 14, 15, 16).

Based on these findings, in the present study, we address the impact of anti-pandemic measures, especially e-learning and a lack of physical activity, on posture and spine in young school-age children.

Material and methods

We analysed the posture and spine by aspexi, using a modified evaluation scale according to Napoleon Wolansky (17). Metho-

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dology according to Napoleon Wolanski observes 8 body segments, which position directly affect posture and spine. The physiological position of the body segment is expressed by 0, a faint position is indicated by 1 and the value of 2 represents a poor position. The points for each segment count and the overall score is obtained. Based on the overall score, the subjects were categorized in 4 postural groups. The lower the overall score, the better the posture was, and vice versa (18, 19).

Posture groups were created as follows:
– physiological posture 0–4 points (postural category A),
– slightly disturbed posture 5–8 points (postural category B),
– significantly damaged posture 9–12 points (postural category C),
– serious postural disorders of 13 points or more (postural category D) (17).

Subject

The study sample consisted of 135 schoolchildren aged 6 to 9 years. The average children's age was 7.97 (± 0.71). The ratio of boys to girls was 84 : 51. The assessments of the posture and spine were carried out in 2020 and in 2021. We implemented two measurements. Input measurement was done in February 2021 and output measurement in the period from February to May 2021. Data collection took place in 4 schools, in 4 different districts in the Slovak Republic. The inclusion criteria were (a) children of younger school age (b) pupils free of neurological, orthopaedic, vestibular, and other congenital or acquired disorders (c) pupils without diagnosed disorders of the musculoskeletal system - potentially health population (d) consent of the legal guardians. Exclusion criteria: children with structural disorders undergoing posture or spine deformities rehabilitation.

Ethical statement

The study was conducted in accordance with the principles outlined in Helsinki Declaration and publishing approved by the Ethics Committee of Central Military Hospital in Ružomberok, Slovakia (protocol No. 8/2021-P and date of approval 18.11.2021). The written consents of the children's legal guardians were obtained. Legal guardians agreed with posture and spine examination, with the purpose of data collection as well as the presentation of the results.

Statical analysis

Collected data from the examinations were analysed in the MS EXCEL 2013 program. Demographic characteristics, position of the body segments and posture were presented with the means, standard deviations (SD) and percentages. Percentages of the posture disorders were calculated as followed: we summarised the number of children with slight, significant and serious disorders*100/total number of children. Assuming that the postural state in school children will be worsening compared to posture state before anti-pandemic restriction has been verified by using a base share count test. We tested the hypothesis of the consistency of the base set π and the constant π_0.

The zero hypothesis: H_0: $\pi = \pi_0$.

The alternative hypothesis for a two-sided test: π_1 π_0.

In the case of a one-sided test, we have formulated an alternative hypothesis: $\pi<\pi_0$, or $\pi>\pi_0$. Test characteristic (20):

$$Z = \frac{\pi - p}{\sqrt{\frac{\pi_0(1-\pi)}{\eta}}}$$

We compared the test characteristic with the critical value of z. If $|z|<z_\alpha$, we recommend accepting a zero hypothesis. Otherwise, we recommend accepting the alternative hypothesis.

To clarify our assumption, the Paired t-Test for Two Sample for means was used. If $t_{stat} > t_{crit}$ hypothesis H_1 was accepted. If $t_{stat} < t_{crit}$, then we reject hypothesis H_1 and accept the validity of hypothesis H_0. The level of significance was set at $p<0.05$.

Results

In the following section, we present the results of the examination. In the Table 1 are presented the posture deviation and body segments disorders before restriction and one year after e-learning and the absence of organized physical activities.

The most affected body segments were lumbar spine and pelvis, followed by deformities of the thoracis spinae. Mean pathology level score for the entire group in these segments rose as follow: in the lumbar spine from 0.6 (± 0.61) to 1.022 (± 0.47); in the pelvis from 0.444 (± 0.54) to 0.772 (± 0.73) and in the thoracis spine from 0.378 (± 0.53) to 0.578 (± 0.61).

For the entire study group, the mean posture disorder level score before anti-pandemic restrictions was 5.667 (1.74). After one year of anti-pandemic restriction, it rose to 7.844 (2.43).

Percentage distribution of the participants in individual posture categories is presented if Figure 1.

Before the Sars-CoV-2 pandemic (dark line in Graph), we evaluated a physiological posture in 28.89 % schoolchildren, 64.45 % schoolchildren had slight posture deviations, and 6.66 % schoolchildren had significant posture disorders. We did not measure serious disorders of school pupils and postural category D has not been evaluated. In the out-put measurement (light line in Figure), we evaluated the physiological posture in 6.66 % schoolchild, 55.56 % schoolchildren had slight posture deviations, 35.56 % schoolchil-

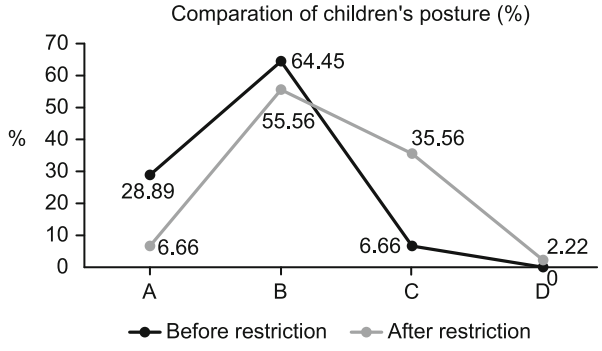

Fig. 1. Posture changes in individual categories.

Tab. 1. Evaluation of the position of body segments before and after restrictions.

n=135	Before restriction	After restriction
Posture deviation mean (SD); %	5.667 (1.75); 71.11%	7.844 (0.64); 91.3%
Head anteversion mean (SD); %	0.778 (0.7); 62.2%	0.8 (0.75); 60%
Shoulder anteversion mean (SD); %	1.089 (0.41); 95.6%	1.8 (0.4); 100%
Scapula alatae mean (SD); %	1.244 (0.48); 97.8%	1.578 (0.58); 95.6%
Thorax deviation mean (SD); %	0.267 (0.53); 22.2%	0.422 (0.68); 31.1%
Pelvis anteversion mean (SD); %	0.444 (0.54); 42.2%	0.772 (0.73); 60%
Cervical hyperlordosis mean (SD); %	0.044 (0.2); 4.4%	0.089 (0.28); 8.9%
Thoracis hyperlordosis mean (SD); %	0.378 (0.53); 35.6%	0.578 (0.61); 51.1%
Lumbar hyperlordosis mean (SD); %	0.6 (0.61); 53.3%	1.022 (0.75); 73.3%
Pedes plani mean (SD); %	0.822 (0.64); 68.9%	0.778 (0.66); 64.4%

Tab. 2. Results of t-Test Paired Two Sample for means.

t-Test: Paired Two Sample for Means		
	Variable 1	Variable 2
Mean	5,666667	7,844444
Variance	3,089552	5,953234
Observations	135	135
Pearson Correlation	0,535947	
Hypothesized Mean Difference	0	
df	134	
t Stat	–12,0007	
P (T ≤ t) one-tail	2,75E-23	
t Critical one-tail	1,656305	
P (T ≤ t) two-tail	5,5E-23	
t Critical two-tail	1,977826	

dren had significant posture disorders and 2.22 % schoolchildren suffered from severe posture disorders.

As can be seen from Figure 1, before to the pandemic, 28.89 % of children had physiological posture and after one year of the anti-pandemic measures, the number of children with physiological postures decreased to 6.6 %. Pathological posture (category B, C and D) was evaluated in 71.11 % of children before pandemic and one year after anti-pandemic measures the number of children with postural disorders increased to 91.3 %. Our question was: is the increase of posture disorders to value 91.3 % statistically significantly higher? We used a base share count test to verify this assumption. The test characteristic was in the form: .

$$Z = \frac{\pi - p}{\sqrt{\frac{\pi_0(1-\pi)}{\eta}}}$$

The value of p represents the expected property of the group Z (school children aged 6–9), $\pi = 70$ (%), the value of π is the result obtained on the monitored sample, p = 91.3 (%). After substituting the numerical values, we obtained the value of the test statistic:

$$Z = \frac{91.3 - 70.11}{\sqrt{\frac{91.3 * 71.11}{135}}} = 3.0556$$

The critical value of the z-test at the selected significance level 0.05 was $z_{\alpha} = 1.9776$. The calculated value of "z" was higher than the critical value ($|z| > z_{\alpha}$). A significant increase in postural disorders was confirmed after one year of persistence of anti-pandemic measures.

To clarify our assumption the Paired t-Test for Two Sample for means was used. The results of the paired t-Test are given in Table 2.

Based on the two-sided hypothesis, the children's posture changed, and the one-sided hypothesis confirmed the deterioration of the posture in the observed children. As the absolute numbers were taken into account, t-Test confirmed: $t_{stat} = -12.0007 > 1.6563 / 1.9778 / = t_{krit}$. Results showed that the posture of school-age children was significantly affected by prolonged anti-pandemic measures.

Discussion

Coronavirus 2019 SARS-CoV-2 that causes COVID-19 disease has spread rapidly around the world, leading to a global crisis in health systems management, economics, as well as in education (9). In the beginning of 2020, full-time teaching was discontinued in 188 countries and school-wide and school-leaving affected 1.5 billion children worldwide (11). In Slovakia, teaching was interrupted on 16 March 2020 and schools were closed nationwide (21). The closure of schools in Slovakia took 38 weeks (22). Following a decision by the Crisis Staff, shortly after the closure of the schools, a government decree entered into force, abolishing all types of organized physical activities such as training, sports, cultural events and gradually introducing a ban on gatherings and going out (23). From the point of kinesiology of the musculoskeletal system, anti-pandemic measures in the form in which they were introduced and how long they lasted supported the development of hypokinesia in children, which has been understood as a major cause of postural disorders since the 1980s (24). To date, several experts in the field of postural disorders in children and adolescents identify with this (25, 26). E-learning and abolished of organized physical activities introduced during the corona highlighted children's hypokinesia. The impact of e-learning and the absence of physical activities on posture and spine in young school-age children was reported in this study.

The aims of the current study were threefold. The first aim was to evaluate the prevalence of posture disorders in Slovak school children before ongoing e-learning. The secondary aim was to analyse the position of body segments that directly affect posture before e-learning and one year after e-learning. Finally, the third aim was to compare the prevalence of posture disorders after one year of anti-pandemic restriction with those before pandemic.

Before the pandemic, postural disorders occurred in 71.11 %. More than 95 % of children had the pathological position of the shoulders and scapula both before the pandemic and after a year of anti-pandemic restrictions. Analysis of the position of body segments showed that the most affected segment was the lumbar spine (deterioration from 53.3 % to 73.3 %) and it was followed by deformities of the thoracic spine (deterioration from 35.6 %

to 51.1 %). In cervical section we measured a deterioration from 4.4 % to 8.9 % after one year of anti-pandemic measures. Critical was also pelvis. Deformities in sagittal plane (pelvis anteversion) rose from 42.2 % to 60 %.

Based on the deteriorating of body segments, we assumed that posture in children would get worse as well. We verified the results of the posture examination using a paired t-Test, at a significance level 0.05. Analysis of the results by paired t-Test confirmed deterioration of the posture ($t_{stat.} = –12.0007 > 1.6563 / 1.9778 / = t_{crit.}$). Before the pandemic, postural disorders occurred in 71.11 % of schoolchildren, while one year after the persistence of anti-pandemic measures, this number rose to 91.3 %. The postural disorders increased in the study group by 20.11 % over one year. This is a high increase over the year, as the studies of Slovak children´s posture before the pandemic, during the years 2012–2020, showed the prevalence of postural disorders in 46 % to 66 % (27, 28, 29, 30). This representing a claim of posture disorders in 20 % over eight years. In our study, posture disorders rose in 20.11 % over one year. Experts from other countries around the world also describe a high incidence of postural disorders before a pandemic (31, 32) and state that compared to previous generation the number of children with pathologic posture is constantly increasing (33, 34, 35). However, increases of posture disorders over 20 % during one year is alarming.

Prolonged anti-pandemic measures had a negative impact on the posture and spine in school children. Long-term sitting during e-learning, the abolition of trainings and sports, but also the abolition of physical education classes have supported the development of functional postural disorders in children. Duton et al (2020) appeal that short-term changes in physical activities and sedentary behaviour in reaction to COVID-19 may become permanently entrenched, leading to an increased risk of obesity, diabetes, and cardiovascular disease in children, not only in the postural state as our study shoved. According to Duton et al. programmatic and policy strategies should be geared towards promoting physical activities and reducing sedentary behaviour over the next 12 months (36). Liška recommends improving the health by few rehabilitation methods. The most commonly used methods to improve posture according to Liška are Yoga and Pilates. Other rehabilitation methods may be used to improve other musculoskeletal problems (37). To improve posture, we suggest that the competent authorities (such as doctors, psychotherapeutists, trainers, teachers) develop videos with corrective gymnastic that could be applied in the form of telerehabilitation in the home environment. In this way, children could use computers and the Internet to their advantage and practice, under the "virtual" guidance of experts.

Finally, it is necessary to mention the limitations of the study. The study we present had several limitations. The most important is the sample size, on which we present the results (135 schoolchildren). The reason for the small feedback was bans on the entry of strangers into schools as the study was carried out during the strictest restrictions in Slovakia. Another limitation was a quarantine of children. Limitation of the study was also the use of diagnostics. In our case, the diagnosis was limited to aspexion examination only. Currently, there are several modern imaging and computer diagnostic methods that are applied in clinical practice. The advantage of imaging and computer diagnostic methods is an accurate description of deformities and numerical evaluation of postural deviations from the norm and thus a higher objectivity of the data. However, aspexi was the fastest diagnostic method that could be applied in schools during an anti-pandemic restriction.

Conclusion

The findings of our study confirmed a worsening of the posture and spine in school children after one year of strict anti-pandemic measures. As postural changes increased by 20 % during the year, it is necessary to apply preventive measurements. It is important to properly manage the children's movements activities during e-learning. The starting point could be online exercises via teleconferencing media (zoom, skype, google meet, etc.), where rehabilitation doctors, physiotherapists, teachers, or trainers could prepare corrective gymnastic or movement activities for children, so that even in critical times of anti-pandemic restrictions, children strengthen their health and physiological posture. Parents should also help in this prevention, who, with these strict measures, have the only opportunity to lead their children to physical activity, either by control and participation in online exercise, or by leading children to movement in nature or outdoors.

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Received February 16, 2022.
Accepted March 14, 2022.