

# An active school supporting the dynamic function of the spine in younger school-age pupils

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## Abstract

**Introduction.** The school environment plays an important role in promoting postural health in pupils. An active school provides pupils with many opportunities for being physically active. It enables them to be active before school, during the school day, and after classes as well. The Active School concept also includes health-oriented physical activities regularly implemented during breaks. **Aim of Study.** The research was aimed at examining the effect of an active school exercise program on the dynamic function of the spine in pupils with headaches. **Material and Methods.** The sample consisted of 89 primary-school fourth-graders. The pupils completed a 6-week movement program consisting of 12-minute exercise sessions performed five days per week during the long break. We used standardized tests to assess the dynamic function of the spine. **Results.** The results indicate a positive and significant effect of the health-oriented exercise program on the spine in the lateral and sagittal ( $p < 0.01$ ) planes. In addition, the reduction in muscle tension achieved by regular stretching helped to relax the stiff muscles, which also alleviated pain ( $p < 0.01$ ) in the pupils. The aforementioned findings confirm that spinal flexibility is essential to reducing pressure on the vertebrae and intervertebral discs. Flexibility not only provided physical benefits, such as better posture and increased range of motion, but also psychological relaxation and stress reduction. A short and effective health-oriented program within the Active School improved a particular aspect of postural health in younger school-age pupils. **Conclusions.** A short and effective health-oriented program within the Active School improved a particular aspect of postural health in younger school-age pupils. The above points underscore the importance of the active school concept as a means of preventing postural problems and supporting the postural health of younger school-age pupils.

**KEYWORDS:** prevention, Active School, postural health, pupil.

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## Introduction

Deteriorating population health in many countries, including Slovakia, together with growing obesity among children, adolescents [1] and adults, as well as an earlier onset of civilization diseases largely resulting from increasing physical inactivity and a sedentary lifestyle [2-6], have led to a reassessment of the overall volume of physical activity in schools and the objectives of physical and sports education. This reassessment emphasizes a more direct orientation towards preventing health disorders and promoting an active, healthy lifestyle among pupils [7], in which regular physical activity is indispensable [8]. An increasingly significant aspect is the growing number of young individuals experiencing learning disabilities [9], a challenge in which physical activity can also play a pivotal role.

To promote higher levels of physical activity, the World Health Organization (WHO) [10] issued a document

called *Global Action Plan on Physical Activity 2018–2030*, in which it recommends coordinated action across several areas to implement effective policy measures organized around four strategic pillars: Active Society, Active Environments, Active People and Active Systems. These strategic objectives support the creation of an important subsystem named “Active School”. According to Scheuer and Bailey [11] and Scheuer and Heck [12], this concept can be viewed as a school that provides many opportunities for pupils to be physically active at school - before classes [13], during the school day, and after classes as well [14, 15]. The Active School promotes physical activity before school by encouraging active transport of pupils from home to school through safe walking, cycling and other types of physical activity, and by organizing regular pre-school physical activities. During the school day, Physical and Sports Education plays the most important role. In an active school, this is supplemented by regularly organized physical activities during breaks and within other classroom-taught subjects. The active school also provides pupils with an array of extracurricular activities in school sports clubs. In addition, it encourages participation in town clubs and activities as well as active transport home from school. An active school, which focuses on physical activity, supports the adoption of a healthy lifestyle, behavior and learning. In this context, the concept of movement literacy plays an important role.

The concept of movement literacy, which is part of the educational area called Health and Movement in Slovakia, creates space for the development of movement literacy, including lifelong movement competences, with a focus on acquiring knowledge and skills related to a healthy lifestyle through the prism of physical activity – that is, a physically active lifestyle. What is more, this concept should have the same educational value as other educational literacies.

Motivation to be physically active is the basis for the development of lifelong movement competences. It is based on the satisfaction of needs. Movement is one of the biological necessities of human beings. Such programs not only support young individuals at the local level but also extend their impact to the regional scale [16], providing assistance in talent development and fostering athletic talents while facilitating the learning process.

Creating a positive attitude towards movement through education in the school environment is an essential prerequisite for the development of lifelong movement skills [17]. This attitude develops, among other things,

at a younger school age, which is why it requires special attention. The first stage of primary school is crucial for its adoption, as participation in an active school is essential at this age. Overall, active learning in active classrooms is an effective, enjoyable, and motivating strategy to increase pupils’ daily physical activity in school without limiting other educational goals [18].

Postural health focuses on the musculoskeletal system, where poor posture has increasingly become a negative syndrome, or a contemporary lifestyle-related condition, as evidenced by studies conducted by both Slovak and international authors [19, 20]. This is caused not only by a sedentary lifestyle, but also by the frequent use of tablets, smartphones and other modern technologies. Although these devices are useful, their long-term and improper use can lead to health problems, with pain being the most common symptom.

Based on the high prevalence of postural deviations and weaknesses in the school population, we present the possibility of primary prevention aimed at improving pupils’ postural stereotype and their individual components through the application of regular movement exercises and programs consisting of active, health-oriented movement breaks at school. Posture is a set of interactions between muscles and their dynamic functions. That is why overall posture can be positively and intentionally influenced by appropriately chosen (health-oriented) physical activity [21], which supports the correct physical, motor, psychological and social development of pupils [22].

### **Aim of Study**

This research aimed to investigate the effect of an active-school movement program on dynamic spinal functions in pupils with headaches.

### **Materials and Methods**

#### *Participants*

The sample group consisted of 89 pupils, including 47 girls (decimal age  $10 \pm 0.53$  years; body weight  $41.53 \pm 8.13$  kg; body height  $148.05 \pm 6.39$  cm; BMI  $18.77 \pm 3.57$ ) and 42 boys (decimal age  $10 \pm 0.29$  years; body weight  $42.22 \pm 8.15$  kg; body height  $149.54 \pm 7.25$  cm; BMI  $19.04 \pm 3.26$ ). The pupils were fourth-graders students attending three primary schools in the Žilina self-governing region of Slovakia. Their selection was intentional. They did not engage in physical activity on regular basis; they were exempted from physical and sports education classes, and all of them suffered either from headaches or backaches. The research and

measurements were conducted in accordance with the ethical principles of the Declaration of Helsinki and the GDPR. All the participants, including school officials, teachers, parents and pupils, provided informed consent and voluntarily agreed to take part in the research.

#### *Procedure and measurements*

The research we conducted was a quasi-experiment. The experimental agent was pedagogical, field-focused, and multifactorial and consisted of a movement intervention program based on the Acral Coactivation Therapy method [23]. When selecting health-oriented exercises, we took into consideration the pupils' musculoskeletal condition, neck and back pain, as well as muscular imbalances. The assessment of the musculoskeletal system was implemented in cooperation with a physiotherapist who has more than 25 years of professional experience.

We conducted initial assessments and measurements ( $V_1$ ) of the monitored factors using our chosen data acquisition methods. Prior to each intervention, the pupils were instructed on how to perform each movement properly and were informed about the health-related importance of the program. This introductory explanation lasted approximately 5 minutes. Subsequently, the intervention was implemented by a trained primary education teacher (grades 1-4) in cooperation with the physical and sports education teacher. Within the active school setting, we took the opportunity to implement the intervention program during the long break periods. The pupils completed a 6-week movement program consisting of 12-minute exercises sessions performed five days per week during the long break. Each block of the movement program comprised 10 health-oriented exercises focused on individual segments of the spine and body.

Subsequently, after 6 weeks, outcome assessments and measurements ( $V_2$ ) of the monitored musculoskeletal and pain-related factors were conducted.

The active school concept effectively protects young pupils from developing physical strain while actively supporting their postural health.

#### *Data collection*

When it comes to data acquisition, we employed the following standardized procedures:

**Basic somatometry:** Body weight was measured using a Tanita RD-953 bioimpedance scale. Body height was assessed with an ADE MZ10023-1 telescopic anthropometer. Assessment of spinal dynamic function [24]: Spinal flexibility in individual spinal segments was evaluated in both the sagittal and lateral planes

using Schober's test, the Stibor distance test, the Ott test, the Thomayer test, and the lateral-flexion test. **Pain assessment:** Pain intensity was measured using a visual analogue scale (VAS), operationalized as an 11-point Likert-type scale: 0 = no pain, 1-3 mild pain, 4-6, moderate pain, 10 = worst possible pain [25]. **Overall body posture assessment [24]:** The evaluation of individual areas was expressed as a sum of points, each area scoring 1, 2, 3, or 4 according to the current level of body posture. Based on the total score, pupils were subsequently classified into qualitative body posture categories. The assessment focused on the following areas: (i) Head and neck posture; (ii) Chest (shape); (iii) Abdomen and pelvic inclination; (iv) Spine curvature; (v) Frontal body posture (Evaluation of shoulders – Shoulder blades/scapulas). **Evaluation of body postures:** (i) Correct body posture (5 points); (ii) Good (almost correct) body posture (6-10 points); (iii) Bad body posture (11-15 points); (iv) Incorrect body posture (16-20 points).

#### *Statistical analyses*

For data processing, we used the following statistical procedures: frequency ( $n$ ), arithmetic mean ( $\bar{x}$ ), standard deviation ( $s$ ), range of variation ( $V_{r_{\max-\min}}$ ), the non-parametric Wilcoxon test ( $W_{\text{test}}$ ,  $p < 0.01$ ,  $p < 0.05$ ) and effect size ( $r$ ) ( $r - 0.5$  and less = small effect;  $0.5 - 0.8$  = medium effect;  $0.8$  and more = large effect). The Mann-Whitney U-test ( $p < 0.05$ ) was used to assess differences between genders ( $p < 0.05$ ). The data were processed using R-Project statistical software and SPSS. The findings and conclusions were formulated based on a substantive, logically grounded evaluation of the results.

#### **Results**

The initial assessment of pupils' postural health revealed the presence of head and neck pain, along with back pain (most often in the lower back).

The pupils also reported feeling restless and uneasy at school and at home while experiencing this pain. Overall, 3% of pupils (boys) reported worsened reflux, and 58% (27% girls and 31% boys) indicated experiencing heavier breathing during exertion. Pain intensity ranged equally in girls and boys from 1 to 4. The girls reported mild pain in 84% of cases, while 16% reported a pain value of 4, indicating moderate pain. When it comes to the boys, we registered mild pain in the range of 1 to 3 in 87% of boys and moderate pain in 13% with a value of 4. The type of pain reported by both girls and boys was predominantly described as either

stabbing or pressure-like in nature. None of the pupils in our group were diagnosed with any diseases, except for incorrect body posture.

The typical symptoms of incorrect posture that we observed in the pupils during the initial assessment included forward head tilt, rounded shoulders with scapular winging, reduced muscle tone in the back and abdominal region.

The most common cause of pain in the pupils was increased tension and stiffness of the muscles in the neck and neck region, which contributed to reduced flexibility of the entire spine. This was primarily caused by daily improper sitting and frequent use of mobile phones, tablets, and laptops, which overloaded the cervical spine, upper back and shoulders, with the resulting strain transferring further to the pelvic region. Targeted education and the application of a health-oriented movement program within the Active School initiative, carried out during the long break five times per week, resulted in significant improvements in dynamic spinal function between the initial and final assessments. These changes were observed in both the sagittal and lateral planes and were evident in both

genders (Schober's test, the Stibor test, the Ott test, the Thomayer test, the lateral-flexion test (R, L) ( $W_{\text{test}} p < 0.01$ ) (Table 1).

The final evaluation of pain intensity showed a complete resolution of symptoms in the majority of pupils, with 98% of girls and 97% of boys reporting 0 = no pain. Only 2% of girls and 3% of boys felt the pain at level 1 – minimal pain, which was significantly confirmed by the Wilcoxon test ( $W_{\text{test}} p < 0.01$ ) (Table 2). The efficiency of the program was also confirmed by effect size (e) with mean value (Tables 1, 2). At the same time, no significant differences between genders were observed based on the Mann-Whitney U-test ( $p > 0.05$ ), indicating that the intervention had comparable effect on the evaluated factors in both girls and boys.

In the initial assessment of overall posture, both girls and boys were placed in qualitative level III, which indicates poor posture. In terms of overall posture and its segments, we would like to emphasize the fact that controlled and consciously performed physical activity led to changes in posture ( $W_{\text{test}} p < 0.01$ ) and its segments ( $W_{\text{test}} p < 0.01$ ) (Tables 3, 4), but not to improvements in movement patterns. At the outcome measurements,

**Table 1.** Dynamic spine function in pupils ( $N = 89$ )

Spinal mobility tests	Gender	z-value	p-value	Significance	Effect size (r)
Schober's test	G	-3.0493	0.00223	$p < 0.01$	0.63
	B	-3.0532	0.00203	$p < 0.01$	0.63
Stibor test	G	-3.0572	0.00223	$p < 0.01$	0.62
	B	-3.0621	0.00210	$p < 0.01$	0.62
Ott test	G	-3.0501	0.00223	$p < 0.01$	0.62
	B	-3.0563	0.00219	$p < 0.01$	0.62
Thomayer test	G	-3.0592	0.00224	$p < 0.01$	0.63
	B	-3.0485	0.00297	$p < 0.01$	0.63
Latero-flexion (R)	G	-3.0587	0.00223	$p < 0.01$	0.62
Latero-flexion (L)	B	-3.0587	0.00221	$p < 0.01$	0.62

Note:  $W_{\text{test}}$  – nonparametric Wilcoxon test,  $p$  – significance level,  $r$  – effect size,  $V_1$  – input,  $V_2$  – output, R – right, L – left, G – girls, B – boys

**Table 2.** Headaches and back pain in pupils ( $N = 89$ )

Pain	Gender	z-value	p-value	Significance	Effect size (r)
Neck pain	G	-2.0933	0.00207	$p < 0.01$	0.56
	B	-2.0921	0.00207	$p < 0.01$	0.56
Head pain	G	-2.0932	0.00208	$p < 0.01$	0.56
	B	-2.0962	0.00208	$p < 0.01$	0.56
Back pain	G	-2.0004	0.00203	$p < 0.01$	0.56
	B	-2.0013	0.00203	$p < 0.01$	0.56

Note:  $W_{\text{test}}$  – nonparametric Wilcoxon test,  $p$  – significance level,  $r$  – effect size,  $V_1$  – input,  $V_2$  – output, G – girls, B – boys

**Table 3.** Evaluation of individual body posture segments in pupils ( $N = 89$ )

Posture segments	Gender	z-value	p-value	Significance	Effect size (r)
Head and neck posture	G	-3.0604	0.00226	$p < 0.01$	0.63
	B	-3.0592	0.00226	$p < 0.01$	0.63
Chest shape	G	-3.0001	0.00217	$p < 0.01$	0.62
	B	-3.0013	0.00217	$p < 0.01$	0.62
Abdomen and pelvic	G	-3.0503	0.00223	$p < 0.01$	0.62
	B	-3.0500	0.00223	$p < 0.01$	0.62
Total spine curvature	G	-3.0494	0.00224	$p < 0.01$	0.63
	B	-3.0486	0.00224	$p < 0.01$	0.63
Position of shoulder and scapulas	G	-3.0377	0.00221	$p < 0.01$	0.62
	B	-3.0386	0.00221	$p < 0.01$	0.62

Note:  $W_{test}$  – nonparametric Wilcoxon test;  $p$  – significance level;  $r$  – effect size;  $V_1$  – input;  $V_2$  – output; R – right; L – left; G – girls; B – boys

**Table 4.** Overall body posture in pupils ( $N = 89$ )

Testing $V_1 / V_2$	$V_1 / V_2$		$V_1 / V_2$			
Factors	G	G	d	B	B	d
x	12.7	8.9	3.8	13.0	9.4	3.6
s	1.4	1.2	0.2	1.5	1.4	0.1
min	8.0	7.0	1.0	9.0	8.0	1.0
max	13.0	9.0	3.0	14.0	10.0	2.0
$V_{r_{max-min}}$	5.0	2.0	2.0	5.0	2.0	1.0
$W_{test}$	3.273, $p < 0.01$			3.294, $p < 0.01$		

Note: x – arithmetic mean; s – standard deviation,  $V_{r_{max-min}}$  – variation range,  $W_{test}$  – nonparametric Wilcoxon test;  $p$  – significance level,  $V_1$  – input,  $V_2$  – output, d – difference, G – girls, B – boys

we observed that both girls and boys were reclassified into qualitative level II of overall posture. Only one girl and two boys fell into qualitative level III, although their scores were borderline with the threshold for good posture (10-11 points). For these pupils, the entry score was 14 points, and the exit score was 11 points.

**Discussion**

The aim of the research was to determine the impact of a health-oriented program on the dynamic function of the spine in 4th-grade primary school pupils. In our study group, we observed poor posture in the initial assessment of the younger school-age pupils. These pupils did not exercise, exercised only irregularly or were exempted from physical and sports education classes. Moreover, poor posture was most frequently accompanied by pain in the head, neck, or lumbar spine. Poor or incorrect posture in pupils is a serious health problem with current and future economic impacts. According to various international studies, the prevalence

of poor posture (from 45-67 %) and back pain in children ranges annually from 7% to 58 % [26].

In our study group, low muscular fitness was the primary factor associated with back pain (cervical, lumbar). In both girls and boys, the initial poor posture resulted from incorrect postural stereotypes linked to poor motor control and low neuromuscular coordination, as well as other external and internal factors that are being further investigated in this cohort.

Several studies have proven that corrective exercises can reverse early incorrect posture (up to 7- 8/10 years of age) by improving and changing the child’s movement stereotypes.

In their study, Geldhof et al. [27] present a multifactorial intervention consisting of an education program focused on promoting postural back dynamics in younger school-aged pupils with positive effects.

In their study, Vidal et al. [28] point to the intention and significance of a six-week postural education school program, which transformed into healthy daily

movement patterns and might potentially contribute to the prevention of back pain and adoption of correct body posture.

Sitthipornvorakul et al. [29] conducted a study to analyze and assess the association between physical activity and the incidence/prevalence of neck and low back pain, also in schoolchildren. Furthermore, the findings of the research carried out by Bendíková and Šagát [30] indicate that physical activity and health-oriented exercise programs implemented within the active school environment have a positive impact on both overall posture and general physical performance in younger school-age pupils.

The existing relationship between the level of physical activity and postural deviations in schoolchildren is also pointed out by the study by Singh et al. [31], which is very closely related to the whole teaching process.

We would like to note that during the implementation of the intervention, the pupils' extrinsic and intrinsic motivation, fostered by the educator, played an important role in supporting their postural health, which is very closely related to the whole teaching process.

It is the intrinsic motivation that encourages pupils to learn and acquire knowledge out of their own interest and for their own benefit. This motivation is characterized by the fact that pupils enjoy the learning itself, are pleased by the results and feel happy and good about it. It is intrinsic motivation that is more effective in increasing the effectiveness of the educational process.

Intrinsic motivation within the Active School environment appears to be an important prerequisite for successful understanding of the importance of physical activity and the promotion of postural health as part of the educational process [32]. Therefore, the teacher's efforts should focus on fostering this type of motivation in pupils throughout the education process [33, 34]. Internal motivation comes from the desire to develop one's movement literacy, eliminate pain and improve overall posture, as well as from the joy of discovering the unknown.

With this in mind, it is important to remember that primary prevention plays a crucial role in the Active School setting with regard to pupils' postural health, as it supports the proper function of the musculoskeletal system. A properly chosen physical activity of a health-oriented nature with a compensatory and relaxing character is significant. Therefore, in this overall context, it is necessary to point out the positive effects of physical activity in terms of benefits for pupils' health and the promotion of health-oriented fitness.

Limitations of the study: This study was conducted without a control group; the absence of a control group

resulted from practical difficulties of obtaining voluntary participation within school setting. All participation was voluntary and based on informed consent. The limitations of this study include: visual assessment of posture (subjective assessment by the physiotherapist), assessment of VAS pain (subjective assessment by the pupils), intentional selection of the sample group, and absence of a control group for the purpose of generalization of the results. In future research, we aim to include a larger number of participants in order to generalize the results and compare them with other participants in the follow-up assessments.

The presented results cannot be generalized. They should be interpreted within a broader context as foundation data concerning the postural health of younger school-age pupils as well as the possibility of implementing a program to deal with pupils' low interest in health-oriented physical activity.

The above findings are, and will continue to be, the subject of more detailed monitoring within the project, accompanied by ongoing communication with pupils, their legal guardians, parents, teachers and school management. It is planned to implement additional physical activity programs within school practice through the Active School initiative for both exercising and non-exercising pupils and subsequently to compare the groups with each other in terms of other factors.

## Conclusions

The results confirm a positive and significant effect of the selected health-oriented movement program and exercises on the spine in the lateral and sagittal planes. In addition, the released muscle tension achieved by regular stretching of the muscles helped to relax the tense muscles, which also relieved the pain the pupils felt. The aforementioned findings confirm that spinal flexibility is key to reducing pressure on the vertebrae and intervertebral discs.

We consider our results to be very important for both educational and clinical practice. Within a short period of time, positive changes in dynamic spinal function as well as pain elimination were achieved in the group of younger school-age pupils.

The results prove the positive impact of a targeted, health-focused exercise program implemented within the Active School environment. It is important that the exercises are performed on a regular and long-term basis.

If similar movement programs promoting pupils' postural health could be implemented within the Active School setting, it can be assumed that they would have a broad

preventive impact, potentially reducing the development of structural disorders in the musculoskeletal system.

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### Conflicts of Interest

The authors declare no conflict of interest.

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