Slovenian Medical Journal

Effectiveness of the prevention programme on posture and the incidence of back pain in primary school children: a pilot study

Učinkovitost preventivnega programa »Pokončna drža« na držo in pojavnost bolečine v hrbtu pri osnovnošolcih: pilotna študija

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Abstract

Background: The incidence of back pain in childhood is rising and significantly impacts its incidence in adulthood. Important risk factors include poor posture, which is common due to a largely sedentary lifestyle. Our study aimed to determine the effect of a primary prevention programme on posture and pain incidence in primary school children.

Methods: The research was conducted in eight 4th grades of four primary schools. Half of the grades were part of the posture hygiene programme throughout the school year, while the other half served as a control group. Before and after the programme, pupils were measured, their posture assessed, and a survey about back pain was conducted.

Results: 179 pupils were included in the study. A history of back pain was found in 36.5% of the children, and only 9% had ideal posture. The implementation of the programme resulted in a 20% absolute reduction in the risk of pain and a 52% reduction in those who reported pain before the programme. At the end of the study, there was a statistically significant difference ($p<0.001$) between the two groups in all the measured parameters, except in the cranioclavicular angle.

Conclusion: The study showed marked improvement in posture and reduced back pain in the students who were included in the programme. A preventive programme to improve postural hygiene could contribute significantly to addressing the problem among young people, thus reducing the incidence of back pain in the adult population.

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Key words: bad posture; back pain; back pain in children; posture habits; school preventive programmes

Ključne besede: slaba drža; bolečina v hrbtu; bolečina v hrbtu pri otrocih; drža; šolski preventivni program

Received / Prispelo: 19. 9. 2022 | **Accepted / Sprejeto:** 2. 4. 2023

Cite as / Citirajte kot: Hojker M, Vaishnav J, Staparski Dobravec S. Effectiveness of the prevention programme on posture and the incidence of back pain in primary school children: a pilot study. Zdrav Vestn. 2023;92(9–10):347–55. **DOI:** https://doi.org/10.6016/ZdravVestn.3388

Izvleček

Izhodišča: Bolečina v hrbtu se vedno pogosteje pojavlja že v otroški populaciji in pomembno vpliva na njeno pojavnost v odrasli dobi. Med pomembnimi dejavniki tveganja je tudi slaba drža, ki je zaradi večinoma sedečega življenjskega sloga pogosta. Kljub povečanju incidence bolečine v hrbtu med mladimi je raziskav o dolgoročnih vplivih in učinkovitosti preventivnih programov malo. Namen naše raziskave je bil ugotoviti učinek primarnega preventivnega programa (Pokončna drža) na držo ter pojavnost bolečine pri osnovnošolskih otrocih.

Metode: Raziskava je potekala vse šolsko leto z učenci 4. razreda na 4 osnovnih šolah. Učence so bili razdeljeni v intervencijsko in kontrolno skupino. Program »Pokončna drža«, v katerega je bila vključena intervencijska skupina, je zajemal izvajanje sklopa aktivacijskih in raztegovalnih vaj ter meditacije v šolskem in domačem okolju. Vaje so izvajali 2-krat dnevno vsaj 4 dni v tednu. Pred pričetkom in po zaključku programa so pri vseh učencih opravili meritve, oceno drže in anketo o pojavnosti bolečine v hrbtu.

Rezultati: V raziskavo je bilo vključenih 179 učencev, od tega jih je program opravilo 88, ostali so predstavljali kontrolno skupino. Dotlej je bolečino v hrbtu že imelo 36,5 % otrok, idealno držo je imelo le 9 % otrok. Izvajanje programa je v celotni skupini prineslo za 20 % absolutno znižanje tveganja za bolečino in za 52 % znižanje pri tistih, ki so bolečino navajali že pred pričetkom. Med skupinama je prišlo do statistično pomembne razlike ($p<0{,}001$) pri razdalji med lopatico in prsno hrbtenico, razdalji med akromionom in podlago ter naklonom medenice. Pri kranioklavikularnem kotu pomembnih razlik ni bilo.

Zaključek: Študija je pokazala izrazito izboljšanje drže in zmanjšanje pojavnosti bolečine v hrbtu pri učencih, ki so bili vključeni v program. Preventivni program za izboljšanje higiene drže bi lahko pomembno prispeval k reševanju problematike med mladimi in s tem tudi na zmanjševanje incidence v odrasli populaciji.

1 Introduction

Back pain (BP) is a major health problem in modern society, affecting up to 40% of the population at least once in adulthood (1). It is one of the most common reasons to see a doctor but approaches to treatment remain very heterogeneous (2). The 2010 Global Burden of Disease Study ranked BP among the top ten diseases causing a high number of "disability-adjusted life years" (DALYs), which represents a significant socio-economic burden to society (3).

The prevalence of BP among children and adolescents is a growing concern and has been increasing in recent years. As many as 39% of young people will have at least one history of BP. The prevalence among children increases with age and is similar in both genders (4).

The causes for the increase in BP among children are still not clear. Studies on the impact of lifestyle, physical activity, and excessive sitting on the increased risk of BP have not yet provided clear answers. On the other hand, there is a growing understanding of the importance of psychological and behavioural patterns. Negative psychosocial experiences are more common among young people with BP and predict a higher likelihood of future occurrence (5). Poor posture, which is increasingly common among young people, has also been identified as an important factor in the incidence of BP (6). In a study in Poland, only three children with ideal postures were found among 503 schoolchildren. Most children had increased thoracic kyphosis, followed by lumbar and thoracolumbar lordosis (7).

Adolescents with BP have mostly mild symptoms with non-specific and self-limiting pain, rarely associated with serious pathology (5,8). In Finland, it has been reported that 33% of young people with BP have recurrent or chronic pain, and this proportion increases with age (9). In these children, chronic pain usually spreads to other areas, becoming more intense and more frequent (10). In most cases, the cause of the pain cannot be found. Although radiological abnormalities of the spine can be detected in the general population of young people, they are poor predictors of BP in adulthood. A prospective study has shown that an X-ray screening of spine cannot differentiate between adolescents with BP and those without it. Nor is it possible to detect radiologically those who will continue to have pain 25 years later in adulthood (11).

In the same study, among those who reported pain in adolescence, 84% had pain at least once as well in their adult life (11). BP in adolescence quadruples the likelihood of BP in adulthood, with those individuals who had more intense and prolonged pain in youth being at higher risk of developing BP in adulthood. Based on these findings, which suggest that the presence of BP in youth has a significant impact on the course of the disease in later years, the focus of BP management is shifting to the younger population (12). Appropriate management and treatment of BP at a young age can significantly reduce the public health burden of the disease (13).

Despite the growing awareness of the importance of prevention and early detection of BP in childhood, there are very few prevention-oriented studies and known integrated programmes in the field of BP prevention (6). A 3-year BP education programme study in a Swiss primary school reported a significant reduction in the prevalence of BP and the number of visits to the doctor because of BP in children who were part of the prevention programme (14). In Hungary, in 1995, the "Hungarian Spine Society" started a primary prevention programme of posture exercises in the context of sports education in schools; the programme has been part of the national school sports education curriculum since 2003. After a year, a prospective study showed a significant improvement in postural muscle strength and flexibility in the children following the programme (15).

There are no clear guidelines for preventing BP in primary school children, which is undoubtedly due to the limited number of studies with conclusive data on the impact of prevention programmes. The aim of our study was to determine the effect of a primary prevention programme ("Pokončna drža") on posture and BP symptoms in primary school children.

2 Methods

The research was carried out with pupils from eigth grades in four different primary schools. Pupils were attending 4th grade in the school year of 2016/2017. In each primary school, one class was included in the Upright Posture programme, and another was included in the control group. Written consent was obtained from the parents of all the pupils before the programme started. Two pupils were excluded from the study for not signing the consent form. The study was also approved by the Medical Ethics Committee (9/02/2016, approval number 0120-252/2016-2 KME 121/02/16). In order to be as objective as possible, the measurements and questionnaires of the students were anonymised.

2.1 Preventive programme

The aim of the Upright Posture ("Pokončna drža") programme is to introduce a daily short-term practice that equips primary school children with the theoretical and practical knowledge of self-maintenance in sitting and standing upright posture. The programme's core consists of muscle-strengthening and body-awareness exercises, which also have a socio-emotional impact and can be performed on and next to a chair. The pilot project of the programme was based on an interdisciplinary model (including health and school systems) of introducing uprightness hygiene. It was implemented and managed by the Primary health centre's project team (a doctor, a physiotherapist, and two registered nurses).

The training consisted of nine exercises: five activation exercises to strengthen the chest muscles, shoulder girdle, back, abdomen, and pelvis, two exercises to stretch the thoraco-lumbar fascia, one to stretch the deep anterior fascia, and one meditation exercise. The exercises took 10 minutes to complete (16).

In September, an additional qualified registered nurse with special skills in health education taught children the exercises step-by-step and then came to the class once a month during the school year to check their engagement and motivation. In addition, during the school year, a physiotherapist and a doctor came into the classroom to check and, if necessary, correct the posture and exercises. Four days a week, children performed the training at school with a teacher who had received prior training as a part of the project. In addition, they were encouraged to repeat exercises at home as homework signed by a parent or guardian. The whole programme took place throughout one school year.

No exercises were carried out in the control group classes.

2.2 Study

In September 2016, before the start of the programme, and in June 2017, after the end of the programme, baseline data on age, gender, height, and weight were collected from all the subjects included in the study. They were asked about their exercise performance and history of back pain. Measurements and clinical postural assessment were performed as well.

The literature suggests different objective and subjective methods for a more accurate assessment of the individual postural segments. Given the limited resources and the desire to minimise intervention within the school system, for evaluating changes and assessing improvements in posture, we decided to use measurements that are easily feasible in the school setting.

Angles and distances, which give a rough description of the posture or the position of the spine in relation to the different parts of the body, were measured. The displacement of the head from the vertical body line was assessed using the craniovertebral angle. Forward head posture (FHP) occurs at angles of less than 50 degrees (normal values should range from 52-58 degrees). Patients with a smaller angle have both a more severe forward head movement and a greater likelihood of cervical pain (17,18). To assess the dynamics of thoracic kyphosis and scapular protraction, which indicates reduced scapular stability, we used the distance of the acromion to the base and the distance between the thoracic spine and the scapula (19,20). The degree of lumbar lordosis was evaluated by measuring the pelvic tilt relative to the spine.

Measurements performed:

1. Measurement of the craniovertebral angle (CV angle) bilaterally in degrees.

   In the standing subject, the angle between the line connecting the external auditory meatus to the seventh cervical vertebra and the horizontal line of the spinous process of the seventh cervical vertebra was measured.
2. Measurement of the thoraco-scapular distance (TS distance) bilaterally in millimetres.

   In the standing subject, the distance from the spinous process of the fourth thoracic vertebra to the superior angle of the scapula was measured.
3. Measurement of the distance of the acromion to the base (AC distance) bilaterally in millimetres.

   In the standing subject with feet together and heels against the wall for 30 seconds, the distance from the most posteriorly convex part of the acromion to the wall was measured.
4. Measurement of pelvic tilt (SP angle) in standing and sitting positions in degrees.

   Measurement of the angle between the sacrum at the level of PSIS (posterior superior iliac spine) and the spinous process of the fourth lumbar vertebra with an inclinometer.

The physician assessed the type of posture (ideal, kyphotic, scoliotic, flatback, swayback) based on the pGALS protocol (21) and recorded a history of back pain.

The assessments and measurements were blindly performed by a physiotherapist and a physician following a standardised protocol that was identical for all participants. Children were anonymised during the evaluation, and both experts were not present during the educational phase and supervision of the training.

2.3 Analysis

The baseline characteristics of all included subjects and the distribution between the test and control groups were expressed as absolute numbers and percentages for categorical variables and as the mean and standard deviation for normally distributed continuous variables. Body mass index was calculated from body weight and height using a standardised formula.

The overall results for each group are presented by absolute number and percentages for categorical variables and by median and interquartile range for non-normally distributed continuous variables. The Shapiro-Wilk test was used to determine the normality continuous variables distribution.

The difference between the two groups was analysed by the chi-square test for categorical variables or by the Fisher-exact test when N was smaller than 5 in each category, and the Mann-Whitney Wilcoxon test for non-normally distributed variables.

The difference between beginning and ending was analysed by t-test for independent variables.

To analyse exercise performance between the baseline and end-point measurements, we used the Anova test for repeated measures. For a statistically significant difference, $p<0.05$ was considered.

Statistical analysis was performed using SPSS Statistics version 23 (SPSS Inc, Chicago, USA).

3 Results

A total of 179 students were included in the study, 82 (45.8%) boys and 97 (54.2%) girls. There were 88 (49.2%) children in the test group and 91 (50.8%) in the control group. The mean age of the subjects was 9.2 ± 0.5 years.

In the total population of subjects, 65 (36.3%) children had a history of BP. Ideal posture was found in 16 (9%) children, 15 (8.5%) had kyphosis, 91 (51.7%) had “flatback”, and 54 (30.7%) had “swayback” posture.

No statistically significant difference in BMI between the two groups was detected at baseline (median in the test group 17.2 (IQR 3.8) and control group 16.8 (IQR 4.6), p=0.472), nor at end line (median in the test group 17.1 (IQR 4.5) and control group 16.4 (IQR 4.5), p=0.426).

A positive history of BP before starting the programme was reported by 31 (35%) pupils in the test group and 34 (37%) in the control group; the difference was not statistically significant. At the end of the programme, 12 (14%) pupils in the test group and 31 (34%) pupils in the control group had a history of BP;

Table 1: Types of postures in the control and intervention group at the end of the programme.

	Control group	Intervention group
Ideal posture	13 (16%)	59 (72%)
Kyphosis	13 (16%)	5 (6%)
Flatback posture	33 (41%)	14 (17%)
Swayback posture	22 (27%)	4 (5%)

the difference was statistically significant (p=0.001). The absolute risk reduction of pain with the programme was 19 (20%), and the relative risk reduction was 61%. In the subgroup of pupils who reported BP at baseline, the absolute risk reduction in the test group was 52%.

There was no statistically significant difference in posture type at baseline between the two groups (p=0.210). At the end of the programme, there was a significant difference between the groups (p<0.001). The results are presented in Table 1.

Testing for differences between control and intervention group at the beginning of the programme showed no differences between groups for all measured variables. There were also no differences between the two groups in the CV angle neither in sitting nor standing positions at the end of the programme. However, a significant difference between the groups was found in the measurements at the end for both the left and right sides of TS (p<0.001) and AC distance (p<0.001). The same was true for the SP angle in sitting (p=0.001) and standing (p=0.028) positions.

Testing differences between measurements at the beginning and the end of the programme in both groups gave a significant difference in all measurements except in SP angle in standing.

The results of the measurements are given in Table 2 and Figures 1-4.

Analysis of variance for repeated measures showed no statistically significant difference between the groups for CV angle and SP angle in standing position between the beginning and end of the programme. However, a statistically significant difference (p<0.001) between the groups was detected for the TH and AC distance bilaterally and the SP angle in the sitting position.

Table 2: Measurements of tested variables in the control and intervention groups.

	Control group			Intervention group			t-test	P-value
	Beginning*	End*	Difference**	Beginning*	End*	Difference**		
CV sitting	54 (13)	55 (10)	1.9 (5.5)	55.5 (8.75)	55 (7)	-0.5 (5.8)	2.4 (0.7; 4.1)	0.005
CV standing	57 (8)	56 (7)	0.7 (4.6)	57 (6.5)	55(8.25)	-1.2 (4.8)	1.9 (0.5; 3.2)	0.009
TS left	6,5 (1)	8 (1.5)	1.4 (1.2)	6.6 (1.5)	7 (1)	0.3 (1.0)	1.1 (0.8; 1.5)	< 0.001
TS right	6 (1,5)	8 (1.25)	1.6 (1.1)	6.5 (1)	7 (2)	0.5 (1.0)	1.1 (0.8; 1.4)	< 0.001
AC left	10 (1,5)	10(1.75)	0.6 (1.4)	10 (2.5)	8.5 (2)	-0.8 (2.0)	1.4 (0.9; 1.9)	< 0.001
AC right	9 (2)	10 (1.5)	0.8 (1.3)	9 (1.5)	8.5(2.13)	-0.4 (1.6)	1.2 (0.7; 1.6)	< 0.001
SP standing	25 (7,25)	25 (6.5)	0.4 (5.5)	21.5 (10)	20 (5)	-0.3 (5.7)	0.7 (-1; 2.3)	0.436
SP sitting	25 (10)	25 (10)	0.7 (6.9)	25 (10)	20 (15)	-6.2 (7.9)	6.9 (4.1; 9.8)	< 0.001

Legend: CV – craniovertebral angle; TS – thoraco-scapular; AC – acromio-clavicular distance and SP – spine-pelvis angle.
* Values displayed as median (intraquartile range);
** values as mean (standard deviation).
Mean values (95% confidence interval) for the t-test. The P-value for the t-test for independent variables for differences.

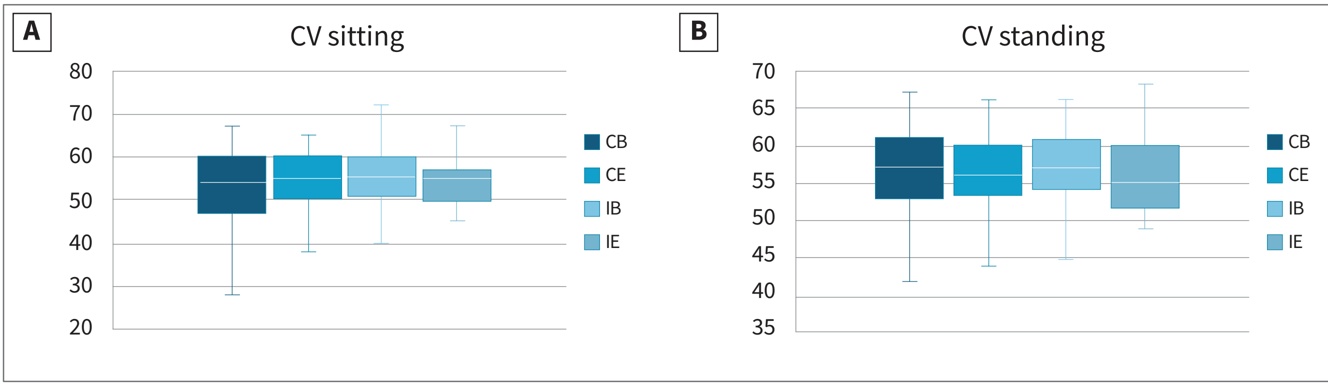

Figure 1: Craniovertebral angle in sitting (**A**) and standing position (**B**) in intervention and control group at the beginning and at the end of the programme.

Legend: CV – craniovertebral angle; CB – control at the beginning; CE – control at the end; IB – intervention group at the beginning; IE – intervention group at the end.

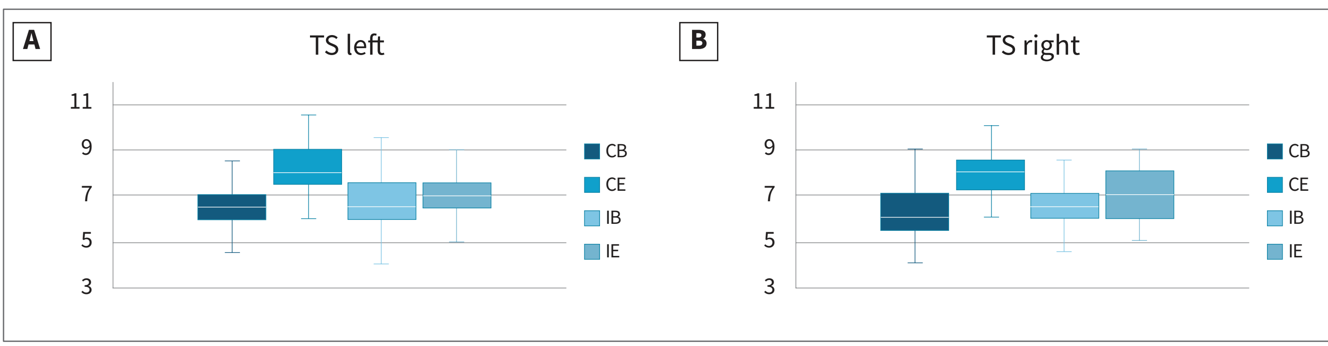

Figure 2: Thoraco-scapular distance on the left side (**A**) and on the right side (**B**) in the intervention and control group at the beginning and the end of the programme.

Legend: TS – thoraco-scapular; CB – control at the beginning; CE – control at the end; IB – intervention group at the beginning; IE – intervention group at the end.

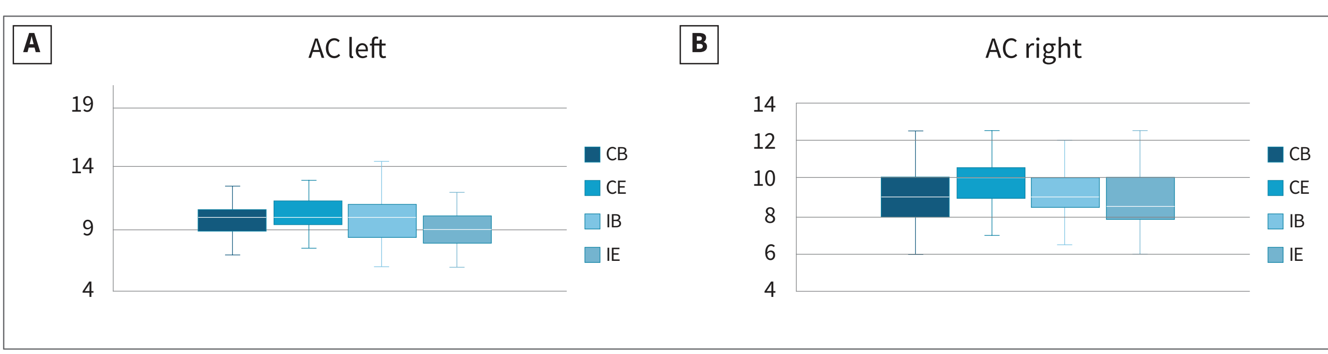

Figure 3: Acromio-clavicular distance on the left side (**A**) and on the right side (**B**) in the intervention and control group at the beginning and the end of the programme.

Legend: AC – acromio-clavicular distance; CB – control at the beginning; CE – control at the end; IB – intervention group at the beginning; IE – intervention group at the end.

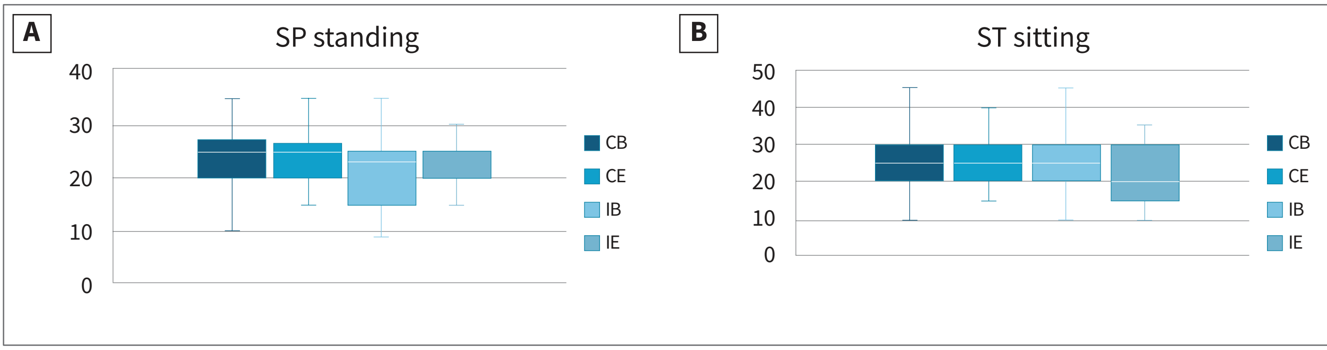

Figure 4: Spine-pelvis angle in a standing position (**A**) and in the sitting position (**B**) in the intervention and control group at the beginning and the end of the programme.
Legend: SP – spine-pelvis angle; CB – control at the beginning; CE – control at the end; IB – intervention group at the beginning; IE – intervention group at the end.

4 Discussion

The results of our study confirmed the high prevalence of BP among primary school children. Among the children included in the study, 36% reported a history of back pain, which is consistent with findings from other studies on similar age groups (22,23) and suggesting the importance of early prevention programmes.

Actually, the incidence of pain was significantly reduced among children who were included in the programme. The absolute reduction in the risk of pain at the end of the programme was 20%. However, in the subgroup of children who reported pain at the start of the study, the absolute risk reduction between the control and test groups was as high as 52%, demonstrating both the preventive and therapeutic value of the systemically introduced programme. A similar study with an eight-week exercise programme for 12-13 year olds with known BP in the last three months also had a 40% absolute risk reduction six months after the programme was implemented (24).

Adolescents with poor posture are much more likely to develop BP than those with ideal one. Two-dimensional sagittal imaging of 766 adolescents showed a 1.8-fold higher incidence of BP in those with "swayback" and "flatback" postures and a 1.5-fold higher incidence in those with hyper lordotic and kyphotic postures, respectively (25). Our data also show a high prevalence of poor posture among primary school children. More than half of the subjects had a flatback posture, and only 9% of all children had an ideal posture. A similar prevalence of poor posture among Slovenian primary schoolchildren was found in a cross-sectional study of 100 primary schoolchildren in 2011 in Maribor. In a population of children aged 11-15 years, 15% had increased lumbar and 12% cervical lordosis, and 15% thoracic kyphosis. Scoliosis of the lumbar or thoracic region was present in 6% of the pupils, and BP lasting more than one day was reported by 43% of the pupils (26).

Poor posture contributes to many problems with spine or normal function of the respiratory system. It increases the risk of certain chronic diseases, even more so with poor posture in a sitting position (27,28). By becoming more aware, self-correcting and strengthening postural muscles correctly, we can significantly impact our posture (29,30). At the end of the study, there was a marked improvement in sitting and standing posture in the test group, where 72% of the children had ideal posture. In contrast, in the control group, only 16% of students were observed with an ideal posture. Despite the important impact of posture on spinal health and, moreover, the rising incidence of BP among young people, a literature review revealed a lack of concrete studies on the effect of prevention programmes on posture, indicating a great need for research and practical work in this area.

In particular, the results of our study showed a significant effect of regular exercise on overall posture. In the tested group, there was a reduction in AC distance bilaterally and a consequent improvement in RSP. At the same time, exercise had a protective effect on thoracic kyphosis, with significantly less deterioration compared to the control group, as apprised by the TS distance, which worsened in the control group and remained stable in the intervention group. Exercise training also improved pelvic tilt and lumbo-sacral lordosis to a statistically significant degree.

There were no differences in CV angle measurements. In the study, both the test and control groups had a normal CV angle before the start of the programme, which was maintained at the end of the study.

Potential limitations of the study are mainly due to the possible subjectivity of the postural assessment with the pGALS protocol. The bias of the data acquisition and potential measurement errors were reduced by several years of experience of the assessors and the blinding principle of the assessment. We allow for the possibility that other factors not assessed in the study, such as psycho-emotional factors, may have partially influenced the results.

Due to nature of the pilot project the sample size was relatively small; therefore, further studies should be conducted to confirm our results.

In addition, despite systemic supervision by trained teachers, regular professional supervision by health professionals, and systemic verification of programme implementation at school, we have limited oversight of the quantity and accuracy of the programme. Training at school was obligatory and supervised by the teacher, which enforced compliance. Unfortunately, reports of compliance at home are very limited. Exercises at home were encouraged and supervised by signed homework from parents.

The outcomes of our study suggest a significant impact of systematic implementation of uprightness hygiene in schools. An effective prevention programme on a national scale could significantly impact BP prevention and socioeconomic well-being. Conducting the study in several schools and balancing the subject group by gender allows us to apply the results to the whole population of 9 to 10-year-olds. By being aware of the limitations of the developmental characteristics and the specificities of each group, it is also possible to some extent generalise the results to other age groups of children and adolescents. Further long-term research would be needed to understand the programme's effects better. In our study, tracking the impact of the programme in the context of the SARS-CoV2 pandemic has not been possible so far.

From experience gained during this pilot program, we can conclude that effective implementation of a preventive programme needs systemic and regular control, which could be accomplished through the school environment and systematically trained teachers that ensure continuity and quality of the programme. Periodical support and control could be done by interdisciplinary teams of doctors, physiotherapists, and kinesiologists as it was conducted in the pilot. Only a systemic approach with a national strategy would have a long-lasting effect on the population.

5 Conclusion

Poor posture and back pain are growing health and economic challenges that have recently become increasingly prevalent among young people. The presence of BP in childhood significantly impacts the likelihood of LBP in adulthood, which strongly supports the need for a systemic approach and early preventive measures. In our study, we demonstrated that a regular upright hygiene programme significantly improves posture and reduces the incidence of pain in a selected group of primary school children. Implementing such a programme in the regular health education and school curriculum would be an important step towards a systemic solution to the problem.

Conflict of interest

None declared.

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