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Effects of a muscular stretching and strengthening school-based exercise program on posture, trunk mobility, and musculoskeletal pain among elementary schoolchildren – a randomized controlled trial

Efeitos de um programa escolar de exercícios de alongamento e fortalecimento muscular sobre a postura, mobilidade do tronco e dor musculoesquelética em escolares do ensino fundamental – ensaio clínico randomizado controlado

Efectos de un programa escolar de ejercicios de estiramiento y fortalecimiento muscular sobre la postura, movilidad del tronco y dolor musculoesquelético en escolares de la enseñanza fundamental - ensayo clínico randomizado controlado

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Abstract

Introduction: The exercise benefits for the most prevalent postural changes require proper investigation, with large samples, control group, and concealed allocation. **Objective:** To assess the effects of a muscular stretching and strengthening school-based exercise program on posture, trunk mobility, and musculoskeletal pain among elementary schoolchildren. **Method:** Three hundred students from three schools in Brazil were evaluated. Stretching and strengthening exercises, twice a week, for eight weeks in group sessions were provided by one physiotherapist. The control group did not undergo any intervention. Head, back and shoulder posture were qualitatively evaluated. Head and trunk alignment were evaluated using the Posture Assessment Software. Cervical, thoracic, low back and upper limb pain were assessed for the last seven days. The trunk mobility was recorded through the flexibility of the posterior chain. Posture, pain and trunk mobility were recorded at baseline and after the intervention. Groups were compared using χ^2 test, two-way MANOVA, and two-way ANOVA, with α set at 5%. **Results:** Shoulder posture showed significant results (P = 0.04), the intervention group showed the lower worsening rate. In the quantitative evaluation, a statistically significant difference was observed between assessments (P < 0.01 for head and trunk; ES = 0.53) but not between groups. The intervention group had a higher percentage of improvement in the overall musculoskeletal pain (P = 0.04; ES = 0.54). Mobility decreased an average of 1.8° in the control group and increased 5.0° in the intervention group, without statistical significance. **Conclusion:** The program was effective in reducing pain level and shoulder misalignment at the intervention group.

Keywords: Prevention and control. Exercise therapy. Musculoskeletal pain. School health services. Spinal curvatures.

Resumo

Introdução: *Os benefícios do exercício para alterações posturais requerem investigação adequada, com amostras grandes, grupo controle e alocação aleatorizada.* ***Objetivo:*** *Avaliar os efeitos de um programa de exercícios de alongamento e fortalecimento muscular em ambiente escolar na postura, mobilidade de tronco e dor musculoesquelética em escolares do ensino fundamental.* ***Método:*** *Foram avaliados trezentos estudantes de três escolas públicas no Brasil. Exercícios de alongamento e fortalecimento em grupo, duas vezes por semana, durante oito semanas foram oferecidos por um fisioterapeuta. O grupo controle não realizou intervenção. As posturas da cabeça, coluna e ombros foram avaliadas de forma qualitativa. Os alinhamentos da cabeça e tronco foram avaliados pelo Software de Avaliação Postural. Dores cervical, torácica, lombar e nos membros superiores foram avaliadas nos últimos sete dias. A mobilidade do tronco foi avaliada pela flexibilidade da cadeia posterior. As medidas foram registradas na linha de base e após a intervenção. Os grupos foram comparados usando o teste* χ^2*, MANOVA e ANOVA two-way, com* α *de 5%.* ***Resultados:*** *A postura do ombro mostrou resultados significativos (P = 0,04), o grupo intervenção apresentou menor taxa de piora. Na avaliação quantitativa, houve diferença estatisticamente significante entre avaliações (P < 0,01 para cabeça e tronco, ES = 0,53), mas não entre grupos. O grupo intervenção teve maior percentual de melhora na dor (P = 0,04; ES = 0,54). A mobilidade do tronco diminuiu 1,8° no grupo controle e aumentou 5,0° no grupo intervenção, sem significância estatística.* ***Conclusão:*** *O programa foi eficaz em reduzir o nível de dor e desalinhamento do ombro no grupo intervenção.*

Palavras-chave: *Prevenção e controle. Terapia por exercício. Dor musculoesquelética. Serviços de saúde escolar. Curvaturas da coluna vertebral.*

Resumen

Introducción: *Los beneficios del ejercicio para las alteraciones posturales requieren investigación adecuada, con muestras grandes, grupo control y asignación aleatorizada.* ***Objetivo:*** *Evaluar los efectos de un programa de ejercicios de estiramiento y fortalecimiento muscular en ambiente escolar en la postura, movilidad de tronco y dolor musculoesquelético en escolares de la enseñanza fundamental.* ***Método:*** *Se evaluaron trescientos estudiantes de tres escuelas públicas en Brasil. Los ejercicios de estiramiento y fortalecimiento fueron ofrecidos por un fisioterapeuta,en grupos, dos veces por semana por ocho semanas. El grupo control no realizó intervención.*

Las posturas de la cabeza, columna y hombros fueron evaluadas de forma cualitativa. Los alineamientos de la cabeza y el tronco fueron evaluados por el software de evaluación postural. Los dolores cervical, torácico, lumbar y los miembros superiores se han evaluado en los últimos siete días. La movilidad del tronco fue evaluada por la flexibilidad de la cadena posterior. Las medidas se registraron en la línea de base y después de la intervención. Los grupos fueron comparados usando la prueba $\chi 2$, MANOVA y ANOVA de dos vías, con α del 5%. ***Resultados:*** *La postura del hombro mostró resultados significativos (P = 0,04), el grupo intervención presentó menor tasa de empeoramiento. En la evaluación cuantitativa, hubo diferencia estadísticamente significativa entre evaluaciones (P < 0,01 para cabeza y tronco, ES = 0,53), pero no entre grupos. El grupo de intervención tuvo un mayor porcentaje de mejora en el dolor (P = 0,04; ES = 0,54). La movilidad del tronco disminuyó 1,8° en el grupo control y aumentó 5,0° en el grupo intervención, sin significancia estadística.* ***Conclusión:*** *El programa fue eficaz en reducir el nivel de dolor y desalineación del hombro en el grupo de intervención.*

Palabras clave*: Prevención y control. Terapia por ejercicio. Dolor musculoesquelético. Servicios de salud escolar. Curvaturas de la columna vertebral.*

Introduction

Several studies have demonstrated a high prevalence of low back pain in schoolchildren [1-3], varying from 8% to 74% [4]. Children have reported pain and discomfort in different daily activities. This discomfort must not be underestimated as it may result in disability, decreased attention, absence from classes, and need for medication [5]. Back pain in childhood is an important predictor of back pain in adulthood, a fact that highlights the need for early initiatives to prevent the development of musculoskeletal pain in adulthood [3, 4].

In addition, several authors have found a high prevalence of postural changes among individuals from 6 to 18 years old. The most frequent postural deviations are deficits in the formation of the foot longitudinal arch, knee hyperextension and valgus, hip medial rotation, pelvic anteversion, lateral pelvic tilt, abdominal protrusion, lumbar hyperlordosis, winged scapula, protruding shoulders, thoracic hyperkyphosis, and shoulder asymmetry [6-12]. Although some of these postural changes are consequences of the age and not necessarily will be prevalent in adult age.

Proper posture involves minimal muscular effort and assists in the protection of internal structures. Postural deviation generates overload on the musculoskeletal system and may lead to disorders, discomfort, and disability [8, 13]. Kjaer et al. [14] showed, through analysis of magnetic resonance imaging (MRI), degenerative disc findings are relatively common in children, and some are associated with low back pain (LBP). Corrêa and Bérzin [15] found high levels of muscular activity in the suboccipital and upper trapezius muscles in children with head anteriorization.

Postural changes are related to muscular and connective tissue adaptations, but it is not clear if it can be reversed through strengthening and stretching exercises [13]. Few prospective studies assess the effect of exercise on posture [13, 16], mainly in children and adolescents [15, 17]. Corrêa and Bérzin [15] evaluated the effects of exercises on head, neck, and shoulder posture in a small sample (n = 19). Espinoza-Navarro et al. [17] applied an exercise program for postural changes among 120 children during an 8-month period, improving postural variables; however, this study assessed only preschool children. The concealed allocation was not performed in these studies, and only the study by Espinoza-Navarro et al. [17] had a control group for comparison with the intervention group.

Some authors have evaluated the effectiveness of exercise programs for low back pain [18-20] and obtained positive results. The most common intervention made at schools are based on teacher guidance and supervision regarding postural care, changes in class organization to allow body movement, pauses to avoid long periods in the sitting position, incentives for students to perform physical activity, adaptations to furniture, reduction in the weight of backpacks, and use of lockers at schools [1, 21-23].

The exercise benefits for the most prevalent postural changes require proper investigation, i.e.

with large samples, control groups, and concealed allocation into intervention and control groups. This study is a randomized controlled trial that aimed to assess the effects of a muscular stretching and strengthening school-based exercise program on posture, trunk mobility, and musculoskeletal pain among elementary schoolchildren. The hypothesis is that the program proposed will decrease the proportion of schoolchildren with postural deviations, increase trunk mobility and decrease musculoskeletal pain.

Methods

Participants

The sample was composed of 303 elementary schoolchildren from three public schools (1st to 8th grade) in a Brazilian town (São Carlos, São Paulo). The schools were from different neighborhoods but the students' socioeconomic profiles were similar (low and medium class). All students were invited to join the study, but only those who delivered the free informed consent form, signed by their parents, were included.

The inclusion criteria were attendance at the elementary school and delivery of the consent form signed by their parents. The exclusion criteria were the presence of disease, dysfunction or disability of the musculoskeletal or neurological systems, any exercise intolerance, or attendance at less than 50% of the exercise sessions.

Three subjects in the sample were excluded due to musculoskeletal disease. The remaining 300 students were allocated into the intervention or control groups through random number generation.

The group composition was unbalanced, with 188 students allocated to the intervention group and 112 to the control group. This procedure was chosen to avoid great loss of subjects in the experimental group and to decrease the number of subjects exposed to the control condition [24].

This study was performed in accordance with the National Health Board, Resolution 196/96 regarding ethics issues, and was approved by the Ethics Committee of the Federal University of São Carlos (CAAE 0124.0.135.000-08, Opinion N.039/2009). The identification number of the randomized controlled trial at Clinical Trials is NCT02255695.

Data collection

Demographic data

Personal data were collected using a standardized form. Body mass was measured using a digital anthropometric scale with four cells of high accuracy (maximum of 180 kg, sensitivity of 100 g) (Slim, G Life®, São Paulo, SP, Brazil), and height was measured with a millimeter tape (sensitivity of 5 mm).

Pain evaluation

The presence of pain was evaluated by self-report. The Nordic Musculoskeletal Questionnaire was used to provide the level of musculoskeletal pain from the previous 7 days [25]. The presence of overall musculoskeletal pain (pain at any region), back pain (cervical, thoracic and/or low back) and upper limb pain was recorded. The pain intensity was recorded by an 11-point scale. The child was asked to score the intensity from 0, which was the lack of pain, to 10, which was compared with the highest pain the children had ever experienced.

Postural evaluation

Two types of postural evaluation were performed: qualitative and quantitative. The choice of using both approaches was an effort to overcome the limitations intrinsic to both assessments, which are complementary and help elucidate better the effects of the exercise program on this population. The students were assessed before and immediately after the intervention. The evaluations were performed in the school, in a private room by only one trained physiotherapist. This physiotherapist had previous experience with the evaluation and the therapy techniques and worked for one year with children and adolescents. The evaluation was performed with the students in swimwear and barefoot.

Qualitative postural evaluation

For the qualitative postural evaluation, a form containing corporal diagrams and the most prevalent postural changes was used. The main postural changes considered were anteriorization/retraction of the head, cervical hyperlordosis, thoracic hyperkyphosis, lumbar hyperlordosis, and protraction/retraction of the shoulders. The presence or absence of the aforementioned postural changes were recorded in a standardized sheet. The presence of postural changes was considered asymmetries to be corrected in the exercise program.

The qualitative postural assessment was performed by a physiotherapist using the technique by Kendall et al. [8], in which the plumb line represents the line of gravity. Thus, in the midsagittal plane, it extends from the center of the heel upward between the lower limbs, and through the pelvic midline, spine, sternum, and skull. The left and right halves must be symmetrical. On the side view, the projection represents the line of gravity in the frontal plane. It extends slightly forward to the lateral malleolus, slightly anterior to the knee joint axis, slightly posterior to the hip joint axis, through the bodies of the lumbar vertebrae, through approximately half of the trunk, through the middle of the shoulder, and through the middle of the external auditory canal.

The following equipment was used: gyratory platform, digital camera (Handycam DCR-SR85, SONY®, Tokyo, Japan), tripod (Tripod WT3111, Wiefeng® Ningbo-Zhejiang, China), and a plumb line.

Each subject was positioned over the gyratory platform to avoid repositioning for the photographic record, next to the plumb line, with the feet aligned and separated by hip width. The evaluator moved the platform for the photographic record across the different planes. The digital camera was positioned 3 meters from the subject, on a tripod 1 meter tall, so that the subject's image occupied the center of the camera's visual field. The photographs were taken in the frontal and sagittal planes with anterior, posterior, and lateral views.

All photos were calibrated and aligned with the vertical reference (plumb line). This reference line was moved slightly forward to the lateral malleolus on the side views and the midpoint between the two legs on the front and back views. After this, qualitative analysis of posture was performed.

The intra-rater reliability of postural qualitative assessment was tested in 10 subjects, and the results indicated that the intra-rater reliability was good.

Quantitative postural evaluation

Postural Evaluation Software (PAS/SAPO) was used for quantitative postural evaluation. PAS/SAPO [26] evaluates posture based on photogrammetric measures. The method was validated [27] and its intra- and inter-rater reliability were evaluated in the population of interest [28]. In the literature, identifying studies using this methodology to improve the quality of postural assessment is possible [29, 30].

For this assessment, besides the equipment described for the qualitative evaluation, reflective markers were used. They consisted of polystyrene spheres, 2 cm in diameter and coated with reflective material.

The attachment of the reflexive markers and the evaluation followed the guidelines of PAS/SAPO. The photos were aligned and calibrated. The protocol for measurements by PAS/SAPO was used, with the following parameters: horizontal alignment of the acromion, horizontal alignment of the anterior superior iliac spines (ASIS), the angle between the acromion and the ASIS, vertical alignment of the trunk, horizontal alignment of the pelvis, horizontal alignment of the head, and vertical alignment of the head.

The PAS/SAPO results presented in this study are represented in degrees. Negative values indicate deviations to the left, and positive values indicate deviations to the right for the parameters of horizontal alignment of the acromion, horizontal alignment of the ASIS, and the angle between the acromion and the ASIS.

For the vertical alignment of the trunk, negative values indicate extension and positive values indicate trunk flexion. For the horizontal alignment of the pelvis, negative values indicate anteversion and positive values indicate retroversion. For the vertical alignment of the head, negative values indicate forward head and positive values indicate head retraction. For the horizontal alignment of the head, positive values indicate lateral flexion to the right and negative to the left. For all the variables, 0° is the expected value for subjects without postural changes.

In this study, the manual palpation of all anatomical landmarks necessary for quantitative evaluation in PAS/SAPO required approximately 40 minutes per subject, and the number of students to be evaluated was relatively large. Therefore, only some of the subjects (n = 51) were evaluated: 27 in the control group and 24 in the intervention group.

Trunk mobility evaluation

For the trunk mobility evaluation, the posterior chain flexibility was assessed by a photogrammetric technique [31]. Before the collection, the students stretched their hamstring muscles three times for 30 seconds each. A digital line was drawn joining the markers attached to the ASIS and the greater trochanter, and another the line joining the marker fixed on the spinous process of the C7 vertebra to the one fixed on the ASIS. Then, the angle formed between the lines was measured. Two photographs were taken, one in the upright position and the other in the maximum trunk flexion. The trunk mobility was estimated by the difference between the values obtained in the two photographs. This procedure was performed using PAS/SAPO software.

Intervention

The control group received no intervention. The intervention group participated in an exercise program for eight weeks during physical education classes. The training was held twice a week, and each session lasted 50 minutes. These parameters were established according to the scientific basis [8, 16, 19, 32-34]. A physiotherapist, accompanied by a physiotherapy and physical education student, administered the training sessions. The same physiotherapist conducted all of the exercise sessions, only alternating the assistant, to ensure the treatment reproducibility. The same exercise program was conducted with the control group after completion of the study, thus fulfilling the precepts of ethics in human research.

The exercise program was designed to restore muscular balance through flexibility, endurance, and muscular strength [8, 32, 33]. During the sessions, the physiotherapist explained the importance and purpose of each exercise to the students to ensure the correct execution.

As the program was implemented in groups of 10 students, the treatment of several postural changes was included in the intervention program. To promote flexibility, stretching exercises were applied for the rotator neck muscles, lateral neck flexors, levator scapulae, upper trapezius, erector spinae, major and minor pectoralis, rhomboids, spinal lateral flexors, column rotators, piriformis, hamstrings, quadriceps, and hip adductors and abductors [8, 16, 32-34]. The stretching exercises were static and maintained for 30 seconds each.

Strengthening exercises were applied for developing strength, endurance, and control of the cervical spine deep flexor muscles, stabilizers of the glenohumeral joint and scapula, abdominals, spine extensors, and hip extensors [8, 16, 19, 32-34].

The structure of the exercise sessions was a warm-up, followed by strengthening and finally stretching, as recommended in the literature [35-38]. The exercise program was the same for all subjects and groups of treatment. As the children performed the session with colleagues from the same classroom, it was impracticable to individualize the treatment. Therefore, we tried to ensure that all the possible posture changes were addressed. Table 1 shows the distribution of activities performed during one session.

The nature of the intervention did not allow the participants and therapists to be blind to the allocation of subjects into groups. In addition, the condition of human resources for the research did not allow for evaluator blinding.

Table 1 – Distribution of the exercises performed during one session

Activity	Duration	Description	Reps/duration and series (initial)	Increasing the load
Warming up	10 minutes	Jokes or sports that involve aerobic component. Usually chosen by the children between the options offered by the therapist. Examples: football, catch-up	--	--
Strengthening	20-25 minutes	Concentric exercises: dorsal bridge, abdominal, nod (fit the chin on the neck), push-up, bicycle	3 sets of 10 reps	Increments of five repetitions in each set
		Isometric exercises: ventral bridge, bird dog, superman, superman variation with arm abducted	3 sets of 5 seconds	Increments of five seconds in each set
Stretching	15-20 minutes	Stretching specific muscles	3 sets of 30 seconds	---

Data analysis

Data analysis followed the principles of intention-to-treat analysis so that the control group subjects who participated in any session were included in the analysis and kept in the group to which they were originally allocated (control).

Body mass index (BMI) was calculated by dividing body mass (kg) by height squared (m^2), and the students were classified into four groups: underweight, healthy weight, overweight, and obese [39] to characterize the sample.

The primary outcome was the qualitative postural variables and the secondary outcomes were quantitative postural variables, trunk mobility, and musculoskeletal pain. The pre- and post-exercise data from the qualitative postural analysis and pain assessment were analyzed by calculating the difference between the initial and final scores. Thus, a new variable emerged, with three categories: worsening, improvement, and no change. Worsening indicated that a certain postural deviation was detected only in the post-intervention assessment. Improvement indicated that a postural deviation was detected in the pre-intervention and was not detected in the post-intervention assessment. No change indicated that the presence or absence of a postural change was maintained between pre- and post-evaluations. These data were analyzed by chi-squared test to find the association between categorical dependent variables in the intervention and control groups.

Multivariate analysis (two-way MANOVA) with mixed design was used for analyzing the quantitative data from the SAPO. Data were grouped into two segments (head and trunk) to identify statistically significant differences between the groups, and between the pre-and post-exercise assessments for quantitative postural data. To analyze the trunk mobility, a two-way ANOVA between the groups and time was done. Effect sizes (ES) and 95% confidence intervals (CI) were calculated. The level of significance for all tests was set at 5% ($P < 0.05$), and all tests were performed using SPSS (version 20.0, IBM, New York, United States). The clinical significance estimated was higher than the minimum detectable difference (MDD).

Results

The subjects were recruited from December 2008 to March 2012. Of the 303 students who presented the consent form signed by their parents, three were excluded due to severe musculoskeletal disorders (n = 2 with severe scoliosis and n = 1 with osteochondrosis). Therefore, three hundred students were assessed at baseline and randomly allocated to the control (n = 112) and intervention groups (n = 188). The loss of follow-up was 53 students of 300 included.

The subjects of the intervention group were from 3 schools (centers) and performed the treatment sessions in groups of 10 students. Of the 188 students in the intervention group, 35 did not attend the post-intervention assessment due to absence from school and were considered lost of follow-up. Of the 153 students reassessed, 76 participated in less than 50% of sessions (minimum criteria for inclusion in the analysis), so they were excluded from the analysis.

The subjects of the control group were also from the three schools assessed. Of 112 subjects initially evaluated, 18 did not attend the post-intervention assessment. Eight other subjects, although allocated to the control group, participated in the intervention, attending one exercise session. However, to follow the intention-to-treat analysis, they were kept in the control group for data analysis (Figure 1).

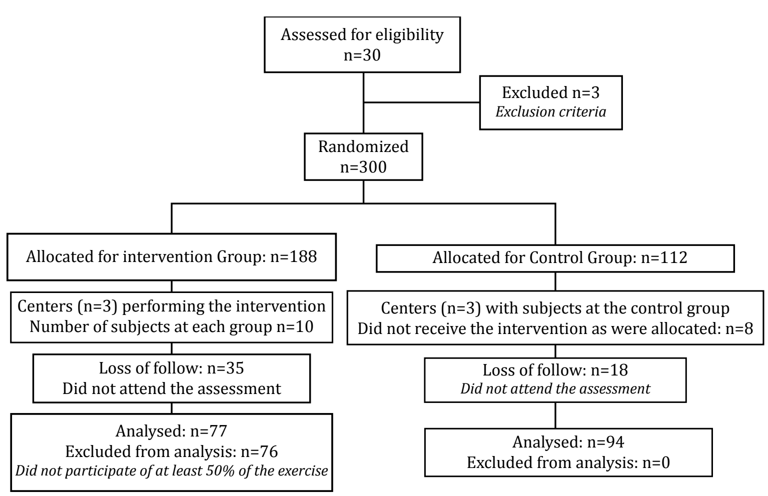

Figure 1 – Flowchart of participants during the study phase.

A total of 171 subjects were included in the analysis. No adverse or side effects were observed in the intervention and control groups. In Table 2, the sample characteristics at baseline are shown for both groups. The groups were similar at baseline regarding the variables of gender, age, grade, weight, height, BMI classification, and manual preference.

Table 2 – Sample characteristics at baseline for the control and intervention groups and for the total sample

Characteristics	Control n = 94	Intervention n = 77	Total n = 171
Gender			
Male	32/94	24/77	56/171
Female	62/94	53/77	115/171
Age (years)			
Mean(SD)	11.5(1.8)	11.5(1.5)	11.5(1.7)
Grade			
1st grade	2/94	0/77	2/171
2nd grade	2/94	2/77	4/171
3rd grade	5/94	2/77	7/171
4th grade	2/94	4/77	6/171
5th grade	29/94	28/77	57/171
6th grade	25/94	16/77	41/171
7th grade	19/94	13/77	32/171
8th grade	10/94	12/77	22/171
Body Mass (kg)			
Mean(SD)	45.5(13.2)	47.1(15.3)	46.2(14.2)
Height (m)			
Mean(SD)	1.5(0.1)	1.5(0.1)	1.5(0.1)
Classification BMI			
Underweight	13/94	2/77	15/171
Healthy weight	45/94	44/77	88/171
Overweight	17/94	15/77	32/171
Obesity	14/94	10/77	24/171
Manual Preference			
Right	87/94	66/77	153/171
Left	7/94	11/77	18/171

Table 3 shows the results of the qualitative postural analysis and musculoskeletal pain in the intervention and control groups. A statistically significant association for the posture of the shoulders between pre- and post-intervention (*P* = 0.04) was observed. The intervention group experienced a lower worsening rate for shoulder posture than did the control group. Although no significant difference was identified (anteriorization/retraction of the head, *P* = 0.72, *ES* = 0.21; cervical hyperlordosis, *P* = 0.93, *ES* = 0; thoracic hyperkyphosis, *P* = 0.14, *ES* = 0.47; lumbar hyperlordosis, *P* = 0.40, *ES*=0.19; presence of back pain, *P* = 0.91, *ES* = 0; presence of pain in the upper limbs, *P* = 0.76, *ES* = 0.14; intensity of back pain, *P* = 0.10, *ES* = 0.5; and intensity of upper limb pain, *P* = 0.81, *ES* = 0.14), the worsening rate was lower and the rate of improvement was higher for the intervention group compared with the controls for all other variables. The intervention group showed greater improvement for the musculoskeletal pain than the control group (*P* = 0.04, *ES* = 0.54).

Table 3 – Posture and pain expressed in frequencies [n(%)] and confidence intervals (95% CI).

	Control (n=66)						Intervention (n=54)					
Variables [n(%)]	- -	95%CI	= =	95% CI	+ +	95% CI	- -	95% CI	= =	95% CI	+ +	95% CI
Postural Change												
Head anteriorization/ retraction	5(7.6)	3.3-16.5	53(80.3)	69.2-88.1	8(12.1)	6.3-22.1	3(5.6)	1.9-15.1	42(77.8)	65.1-86.8	9(16.7)	9.0-28.7
Cervical Hyperlordosis	10(15.2)	8.4-25.7	41(62.1)	50.1-72.9	15(22.7)	14.3-34.2	7(13.0)	6.4-24.4	34(63.0)	49.6-74.6	13(24.1)	14.6-36.9
Thoracic Hyperkyphosis[a]	7(10.6)	5.2-20.3	57(87.7)	76.1-92.7	1(1.5)	0.3-8.1	4(7.4)	2.9-17.6	45(83.3)	71.3-91.0	5(9.3)	4.0-19.9
Lumbar hyperlordosis[b]	11(17.2)	9.6-27.4	50(78.1)	64.2-84.5	3(4.7)	1.6-12.5	5(9.3)	4.0-19.9	45(83.3)	71.3-91.0	4(7.4)	2.9-17.6
Shoulder anteriorization/ retraction *	14(21.2)	13.1-32.5	43(65.2)	53.1-75.5	9(13.6)	7.3-23.9	3(5.6)	1.9-15.1	44(81.5)	69.2-89.6	7(13.0)	6.4-24.4

(To be continued)

(Conclusion)

	Control (n=66)						Intervention (n=54)					
Variables [n(%)]	- -	95%CI	= =	95% CI	+ +	95% CI	- -	95% CI	= =	95% CI	+ +	95% CI
Presence of any musculoskeletal pain*	6(9.1)	4.2-18.4	49(74.2)	62.6-83.3	11(16.7)	9.6-27.4	6(11.1)	5.2-2.2	29(53.7)	40.6-66.3	19(35.2)	23.8-48.5
Presence of back pain	9(13.6)	7.3-23.9	41(62.1)	50.1-72.9	16(24.2)	15.5-35.8	6(11.1)	5.2-2.2	34(63.0)	49.6-74.6	14(25.9)	16.1-38.9
Presence of pain in the upper limbs	7(10.6)	5.2-20.3	51(77.3)	65.8-85.7	8(12.1)	6.3-22.1	5(9.3)	4.0-19.9	40(74.1)	61.1-83.9	9(16.7)	9.0-28.7
Intensity of back pain	19(28.8)	19.3-40.6	31(47.0)	35.4-58.8	16(24.2)	15.5-35.8	12(22.2)	13.2-34.9	19(35.2)	23.8-48.5	23(42.6)	30.3-55.8
Intensity of upper limbs pain	8(12.1)	3.3-16.5	49(74.2)	65.6-83.3	9(13.6)	7.3-23.9	5(9.3)	10.4-30.8	40(74.1)	46.0-71.3	9(16.7)	9.0-28.7

Note: (- -) worsening; (= =) maintenance and (+ +) improvement between pre- and post-intervention; * chi-squared test significant (P < 0.05); [a]n = 65 for control group; [b]n = 64 for control group.

Table 4 shows the results of the quantitative postural analysis. The results of multivariate analysis indicated no difference between the groups, either for the head (P = 0.52, ES = 0.17) or the trunk (P = 0.26, ES = 0.2). There was no significant interaction between groups and time for the head (P = 0.59, ES = 0.15) and trunk (P = 0.86, ES = 0.37). However, a statistical difference between pre-and post-exercise for head and trunk was identified (P < 0.01 for both segments, ES = 0.53 for head, and ES = 0.64 for trunk). The univariate tests showed the differences were significant for vertical alignment of the head (P < 0.01), horizontal alignment of the ASIS (P = 0.009), angle between acromion and the ASIS (P = 0.04), and vertical alignment of the trunk (P < 0.01).

Both groups had a decreased angle of vertical alignment of the head and trunk after the intervention. The misalignment assessed by the variable horizontal alignment of the ASIS increased in the control group while it decreased in the intervention group. The angle between the acromion and the ASIS increased in both groups. The minimum detectable difference is also shown in Table 4. These results show only the vertical alignment of the head and trunk showed a difference higher than the minimum detectable.

Table 4 – Quantitative postural assessment obtained by PAS/SAPo. Data are presented as mean and standard deviation [mean(SD)].

	Control (n = 27)			Intervention (n = 24)			MDD
	Pre	Post	CI 95% (pre-post)	Pre	Post	CI 95% (pre-post)	
Head [º]							
Horizontal alignment of the head	1.2(3.5)	0.6(4.2)	-0.7 - 1.9	-0.3(4.3)	0.2(2.9)	-0.8 - 1.8	1.29
Vertical alignment of the head *	14.4(14.9)	6.7(10.9)	3.2 - 12.2	15.1(11.3)	7.4(9.6)	3.7 - 11.7	2.16
Trunk [º]							
Horizontal alignment of acromion	0.8(2.3)	0.7(1.8)	-0.6 - 0.8	1.0(1.9)	0.9(2.8)	-0.7 - 1.2	1.21
Horizontal alignment of the ASIS*	0.5(2.5)	-0.6(2.7)	0.2 - 2.0	1.1(3.0)	0.1(2.3)	-0.2 - 2.1	1.66
Angle between acromion and the ASIS*	-0.2(3.2)	-1.3(3.6)	-0.1 - 2.3	0.0(3.1)	-0.8(3.6)	-1.4 - 1.3	1.64
Vertical alignment of the trunk *	-3.1(2.9)	-0.8(2.8)	-4.9 - (-2.9)	-3.8(3.9)	-2.2(3.0)	-2.9 - (-0.3)	0.45
Horizontal alignment of the pelvis	-10.8(5.5)	-11.5(5.6)	-1.2 - 2.6	-10.7(6.0)	-12.0(4.9)	-17.7 - (-12.1)	2.29

Note: *Statistically significant difference between pre- and post-exercise, but no difference between groups. ASIS: anterior superior iliac spine. MDD: minimum detectable difference.

For the trunk mobility, the results indicate that the measurement in the control group decreased by an average of 1.8º (CI 95% = -4.6–1.0) and in the intervention group increased by 5.0º (CI 95% = -0.3–10.2) after the intervention. A two-way ANOVA identified no significant difference between groups (P = 0.12, ES = 0.17) and no significant interaction between factors (P = 0.12, ES = 0.17). However, a significant difference was observed between pre- and post-intervention (P < 0.01, ES = 0.99). The 95% confidence interval for the difference between the amplitudes before and after the intervention was -1.6° to 5.2° for the control group and -11.2° to 1.2° for the intervention group.

Discussion

This randomized controlled trial was designed to evaluate the effects of a school-based exercise program of stretching and strengthening in relation to posture, trunk mobility, and musculoskeletal pain in primary schoolchildren. The findings indicated that the exercise program was effective in decreasing the prevalence of musculoskeletal pain and shoulder anteriorization/retraction. The back and head posture showed differences between evaluations, but not between groups; and trunk mobility increased for the intervention group, without statistically significant differences.

Randomized controlled trials testing the effect of school-based exercise programs for correcting posture in schoolchildren were not found in the electronic databases searched. According to Zaina et al. [16] the treatment of some postural deviations, such as thoracic hyperkyphosis, cervical hypo- and hyperlordosis, and shoulder posture, has been neglected. Furthermore, studies with children are scarcer because most of the authors dealt with the correction of these alterations in adults and elderly people. The only two studies found involving children were not randomized controlled trials [15, 17].

Interventions in adults have shown improvement in forward head [15, 30], scapular abduction [15], thoracic hyperkyphosis, low back pain [30, 34] and lumbar hypolordosis [34] through stretching and strengthening exercises. The results of this study also demonstrated that the intervention group had better outcomes related to the shoulder posture after the program.

Regarding head and trunk postures, no statistically significant differences were observed between the groups, only between the evaluations. Only two variables showed a difference higher than the minimum detectable. This fact may be related to the duration of the exercise program. Although the available studies describe interventions of eight weeks [19, 20]; Hrysomallis and Goodman [13] state that the frequency and duration of exercise programs are insufficient to cause muscular changes.

Another factor that may have contributed to these findings is the implementation of the exercise program in groups. Koumantakis et al. [40] reported that certain treatments require more attention and time from the physiotherapist. Thus, some students may not have been adequately trained in groups. Furthermore, in this type of approach, the evolution of the load of the exercises cannot be satisfactory, as the exercises depend on the group's evolution.

Furthermore, in children, the whole body posture is influenced by physical development, which depends on nutritional, congenital and environmental factors. Batistão et al. [41] found postural changes in children are related to factors such as age, gender, body mass index, handedness and physical activity, using logistic regression analysis. These factors may have influenced the results of this study.

The gain in trunk mobility has been indicated as an important component for treating spinal disorders [32]. In this study, the intervention group had increased mobility after the intervention and the control group had a reduction, without statistical significance. This finding may be related to the type of evaluation used. Iunes et al. [30] and Monte-Raso et al. [42] found discrepancies when using the Whistance method to assess the range of motion of the trunk. In both trials, although differences had been detected by other methods, the results from the Whistance method indicated no difference between the groups. Thus, it is suggested that other forms of flexibility assessment could be used in future studies. Another factor that could cause the lack of statistical significance is the small effect sizes.

Other limitation of this study was the lack of evaluator, subjects, and therapist blinding. Although reducing performance bias was not possible in this intervention, as the subjects and therapists could not be blinded, detection bias could be minimized by a blind evaluator.

Finally, some considerations about the postural evaluation must be addressed. The use of a qualitative assessment puts in question the intra-rater reliability. Although the intra-rater reliability showed good results for this study, the evaluator's experience may affect the reliability. The use of a quantitative approach associated, as in this study, can be a good alternative in future studies.

Conclusions

The school-based exercise program of muscular strengthening and stretching, applied in groups, was effective in reducing the prevalence of musculoskeletal pain and having better outcomes for shoulder posture. For other postural deviations, the results were not significant. These findings indicate that future research could test interventions of longer duration and with individual application of the exercises, and could use more sensitive methods for evaluating trunk mobility.

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