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ORIGINAL RESEARCH

Postural analysis of cervical spine and shoulder girdle of children practitioners and non-practitioners of the Pilates method

Análise postural da coluna cervical e cintura escapular de crianças praticantes e não praticantes do método pilates

Análisis postural de la columna cervical y cintura escapular de niños practicantes y no practicantes del método pilates

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ABSTRACT | Was compared the postural pattern related to the cervical spine and shoulder girdle, practitioners and students not Pilates practitioners. This was a cross-sectional and quantitative study. The study evaluated a convenience sample consisting of 39 students, divided into Pilates group (PG) composed of 21 students and inactive group (IG) consisting of 18 students. Postural assessment was made of the same through the SAPO software. There were significant differences between the groups on the variables related to the horizontal alignment of acromions (p=0.02), horizontal asymmetry of the scapula (p=0.003), vertical alignment of the body in the right side view (p=0.0003), and asymmetry in frontal plane (p=0.0003). Pilates practitioners students had better shoulder and scapula alignment and better body alignment and the center of gravity when compared to non-practitioners.

Keywords | Physical Therapy Specialty; Child; Posture.

RESUMO | Comparou-se o padrão postural relacionado à coluna cervical e cintura escapular de estudantes praticantes e não praticantes do método pilates. Trata-se de um estudo transversal e quantitativo. O trabalho avaliou uma amostra de conveniência formada por 39 estudantes, divididos em grupo pilates (GP), composto por 21 escolares, e grupo inativo (GI), composto por 18 escolares. Foi realizada avaliação postural dos mesmos por meio do software Sapo. Houve diferença significativa entre os grupos nas variáveis relacionadas ao alinhamento horizontal dos acrômios (p=0.02), assimetria horizontal da escápula (p=0.003), alinhamento vertical do corpo em vista lateral direita (p=0.0003) e assimetria no plano frontal (p=0.0003). Os estudantes praticantes do pilates obtiveram melhor alinhamento de ombro e escápula e melhor alinhamento corporal e do centro de gravidade quando comparados aos não praticantes.

Descritores | Fisioterapia; Criança; Postura.

RESUMEN | Se comparó el estándarpostural relacionado a la columna cervical y cintura escapular de estudiantes practicantes y no practicantes del método pilates. Se trata de un estudio trasversal y cuantitativo. El estudio evaluó una muestra de conveniencia formada por 39 estudiantes, divididos en grupo pilates (GP), compuesto por 21 estudiantes, y grupo inactivo (GI), compuesto por 18 estudiantes. Se realizó la evaluación postural mediante el software Sapo. Hubo diferencia significativa entre los grupos en las variables relacionadas a la alineación horizontal de los acromiones (p=0.02), asimetría horizontal de la escápula (p=0.003), alineación vertical del cuerpo en

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vista lateral derecha (p=0.0003) y asimetría en el plano frontal (p=0.0003). Los estudiantes practicantes de pilates obtuvieron mejor alineación del hombro y escápula y mejor alineación corporal y del centro de gravedad cuando comparados a los no practicantes.

Palabras clave | Fisioterapia; Niños; Postura.

INTRODUCTION

The term posture is defined as the dynamic relation of body segments, mainly the musculoskeletal part, which adapts in response to a received stimulus[1]. In this sense, posture is also employed to describe the alignment of body, as well as its orientation in space[2]. Thus, proper posture is of paramount importance to avoid muscle imbalances and, thus, have lower probability of injuries or deformities[3]. The main risk factor for spinal disorders is inadequate postural habits during performance of daily life activities[4].

In children, incorrect postural habits, due to long periods in sitting posture, oversized seats, inadequate or poorly executed exercises, and heavy backpacks, result in postural disorders since the early years of schooling[5]. Furthermore, the children's body mechanics is in process of growth and their musculoskeletal structures are under development, being more susceptible to deformation[6]. Correct posture in infancy or early detection of postural disorders enable body alignment as an adult, since that period is essential for an individual's musculoskeletal development, with greater possibilities for prevention and treatment of such postural alterations, especially concerning the spinal column[7]. According to Peliteiro et al.[8], postural evaluation can provide early diagnosis for such individuals.

In the context of postural re-education, it is known that the Pilates Method contributes positively to postural alignment of the body[6], as this technique is based on exercises that combine strength, stretching, and breathing, which presuppose improvement in posture, in addition to physical and mental conditioning. In fact, a study confirms that the Pilates method contributes positively to body posture in young, healthy women[9]; however, its effect on healthy children in school age is scarce.

Considering the scarcity of studies concerning the practice of the Pilates method on the postural profile of children, this study aimed to compare the postural pattern related to cervical spine and shoulder girdle of students practitioners and non-practitioners of the Pilates method.

METHODOLOGY

This is a controlled clinical trial, which included a convenience sample of students aged from 9 to 14 years, enrolled in three fifth grade classes of a public elementary school in the rural area of the state of Rio Grande do Sul, Brazil. From this sample, we recruited two groups of students: the Pilates group, which practiced Pilates-based exercises (PG), composed of 21 students (6 boys and 15 girls), and the inactive group (IG), composed of 18 students (5 boys and 13 girls), which practiced neither regular physical exercise nor physical education at school.

The PG was selected by means of an university extension project carried out at the same school, which had as its objective inserting the practice of the Pilates method among students. This group practiced the method, at the school, from April to November 2014, with frequency of two times a week and duration of 1 hour per session. The students practiced a protocol with exercises based on the Pilates method, with floor Pilates and accessories, consisting of three stages, according to the protocol by Araújo et al.[10], adapted by the researchers, and the level of difficulty increased gradually according to the evolution of the students. The IG practiced no physical education at school, since some public schools in the country offer do not offer the discipline in the early years of elementary school, and neither practiced any regular physical exercise, according to their answers to a simple questionnaire applied by the researchers.

Thus, the inclusion criteria of this study were: practicing only the Pilates method at school for at least four months with minimum frequency of 75% (PG), and practicing neither regular physical exercise nor physical education at school (IG). The exclusion criteria were: the practice of other modalities of physical exercises by the students, in addition to Pilates (PG), as well as the practice of any physical exercise and school physical education (IG), and any physical and/or cognitive inability that prevented the students from participating in the study (PG and IG).

The ethical precepts were respected, in accordance with the Declaration of Helsinki (2008). The legal guardians of each student signed a free and informed

consent form, authorizing the participation of the students in the study. The project was approved by the Ethics and Research Committee, University of Pampa, under number 457,088, November 13, 2013.

The students were submitted to an anthropometric evaluation (body weight and height, to determine body mass index - BMI), as well as to a postural assessment, with a Sony 16.1 MP digital camera model DSC-W690 on a tripod at the height of 90 cm above the floor and at the distance of 300 cm from the child. The student, wearing a bathing suit, was asked to remain in standing position, parallel to a plumb line and perpendicular to the camera, in anterior view, posterior view, and right and left lateral views. To allow a subsequent software calibration, styrofoam balls were fixed to the plumb line, at a distance of 100 cm between them. The data were recorded by means of Photogrammetry and analyzed in the Postural Evaluation Software - SAPO[3]. The specific anatomical points[11] (Figure 1) were positioned over styrofoam balls of 1 cm and 2 cm in diameter and fixed with double-sided adhesive tapes.

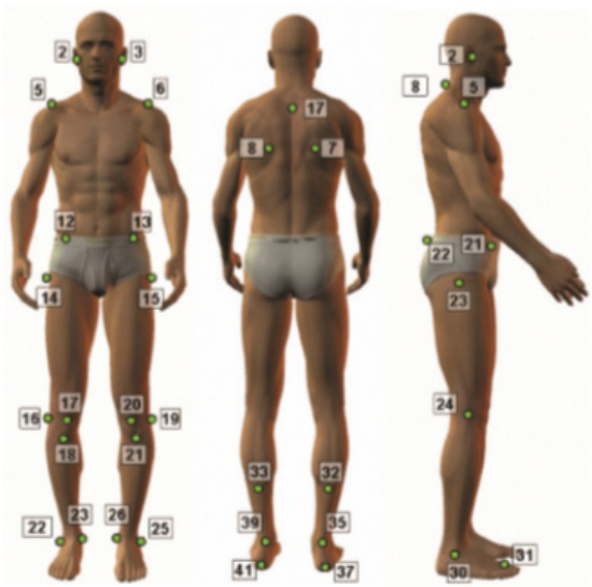

Figure 1. Bone references of the protocol of the postural evaluation software SAPO. Anterior view - 2, 3 left and right tragi; 5, 6 left and right acromia; 12, 13 right and left antero-superior iliac spine; 14, 15 right and left greater trochanter; 16, 19 lateral projection of the right and left knees articulation line; 17, 20 right and left patellar center; 18, 21 right and left tibial tuberosities; 22, 25 lateral malleoli; 23, 26 medial malleoli; Posterior view - 7, 8 lower angle of right and left scapulae; 17 third thoracic vertebra; 32, 33 medial point of leg, 35, 39 intermalleolar line; 37, 41 Achilles tendon bilaterally; Lateral view - 2 tragus; 8 seventh cervical vertebra; 5 acromion; 21 antero-superior iliac spine; 22 postero-superior iliac spine; 23 greater trochanter; 24 projection of the knee articulation line; 30 lateral malleolus; 31 region between the second and third metatarsi

The marking of anatomical points and the photographic record were carried out by two previously trained evaluators, and the angles analyzed[11] are presented in Chart 1. Analysis and interpretation of results were carried out by the same researcher, previously trained. Evaluation of postural deviations in SAPO was conducted by a blind evaluator.

Chart 1. Angles of the protocol of the postural evaluation software SAPO

Anterior view	Head	Angle 1 - Horizontal alignment of head: 2-3 and the horizontal.
	Trunk	Angle 2 - Horizontal alignment of acromia: 5-6 and the horizontal.
		Angle 3 - Horizontal alignment of the antero-superior iliac spines: 12-13
		Angle 4 - Angle two acromia and two antero-superior iliac spines: 5-6; 12-13
	Lower limbs	Angle 5 - Frontal angle of the right lower limb: 14-16-22 (external angle).
		Angle 6 - Frontal angle of the left lower limb: 15-19-25 (external angle).
		Angle 7 - Difference in the length of lower limbs: D(12;23)-D(13;26).
		Angle 8 - horizontal alignment of the tibiae tuberosities: 18-21 and horizontal.
		Angle 9 - Right Q-angle: angle between 12-17 and 17-18.
		Angle 10 - Left Q-angle: angle between 13-20 and 20-21.
Side view	Head	Angle 11 - Horizontal alignment of head (C7): 2-8 and horizontal.
		Angle 12 - Vertical alignment of head (acromion): 5-2 and vertical.
	Trunk	Angle 13 - Vertical alignment of trunk: 5-23 and vertical.
		Angle 14 - Angle of hip (trunk and lower limb): 5-23-30.
		Angle 15 - Vertical alignment of body: 5-30 and vertical.
		Angle 16 - Horizontal alignment of pelvis: 21-22 and horizontal.
	Lower limbs	Angle 17 - Angle of knee: 23-24-30.
		Angle 18 - Angle of ankle: 24-30 and horizontal.
Posterior View	Trunk	Horizontal asymmetry of scapula in relation to T3
	Lower limbs	Angle 19 - Angle right leg/rearfoot: 32-35-37.
		Angle 20 - Angle left leg/rearfoot: 33-39-41.

We used the statistical program Instata and the data were presented through descriptive analysis, as mean and standard deviation or as absolute and relative frequency. The Kolmogorov-Smirnov test was used to determine the normality of the data. Thus, the student t-test for independent samples was used for the continuous variables that presented parametric distribution and

the Mann-Whitney test was used when the variables presented a nonparametric distribution. The Mann-Whitney test was used for the following variables: horizontal alignment of head, horizontal alignment of acromia, and horizontal alignment of head, right and left profile, in the intergroup comparison. We considered $p<0.05$ as statistically significant.

RESULTS

We analyzed the postural profile concerning cervical spine and shoulder girdle in a sample consisting of 39 students, 21 in the PG (10.38±0.58 years and BMI=18.74±4.51 Kg/m^2) and 18 in the IG (10.68±1.3 years and BMI=17.57±1.61 Kg/m^2).

Values for the cervical spine and shoulder girdle postural profile of PG and IG students are presented in Table 1. There was significant difference between groups for variables related to horizontal alignment of acromia (p=0.02), horizontal asymmetry of scapula (p=0.003), vertical alignment of body in right side view (p=0.0003), and asymmetry in frontal plane (p=0.0003), showing that for PG students, compared to IG students, the left acromion is less elevated, the left scapula is less abducted, and there is better alignment of body and center of gravity.

Table 1. Comparison of cervical spine and shoulder girdle postural profile between practitioners and non-practitioners of the Pilates method

	PG	IG	P
N	21	18	
Anterior view			
Horizontal alignment of head:	0.9±3.0	8.4±42.2	0.14
Horizontal alignment of acromia:	1.1±1.9	-10.4±42.0	0.02*
Posterior View			
Horizontal asymmetry of scapula	-4.6±20.0	-25.6±21.8	0.003*
Right Side View			
Horizontal alignment of head:	49.9±18.5	42.1±8.2	0.08
Vertical alignment of head	6.5±11.0	8.3±13.7	0.65
Vertical alignment of trunk:	-1.1±3.9	-0.9±3.0	0.87
Vertical alignment of body:	1.4±1.7	3.5±1.6	0.0003*
Left Side View			
Horizontal alignment of head:	49.0±19.0	44.1±6.2	0.39
Vertical alignment of head	6.6±8.8	1.5±8.3	0.07
Vertical alignment of trunk:	1.1±3.2	-0.3±4.5	0.25
Vertical alignment of body:	2.8±2.5	2.3±1.8	0.50
Center of gravity			
Asymmetry in frontal plane	7.9±11.6	-11.6±12.9	0.0003*
Asymmetry in sagittal plane	38.7±12.9	43.9±14.7	0.24

Asymmetries in frontal and sagittal planes are presented in percentiles, and other variables are presented in degrees, PG=Pilates Group, IG=Inactive Group, N=number of individuals in each group, *Values<0.05 indicate significant difference

DISCUSSION

This study analyzed the postural profile concerning cervical spine and shoulder girdle in a sample consisting of 39 students, aged from 9 to 14 years, and observed postural alterations in these segments, which is consistent with the findings of Detsh et al.[12]. Furthermore, this study showed that practitioners of the Pilates method presented better alignment of shoulder and scapula, as well as better alignment of body and center of gravity, when compared to non-practitioners.

Regarding postural pattern, a study analyzed the effects of Pilates on biomechanical patterns during a functional task of shoulder flexion, and the results indicated that the program was effective in stabilizing the posture when the shoulder flexion movement was performed. This finding suggests the relation between the practice of the method and the prevention of disorders that involve the neck-shoulder segments[13]. This positive effect of Pilates on the shoulder complex was also evidenced in this study, in which practitioners of the method presented a better alignment in this segment, when compared to non-practitioners.

The better alignment of body and center of gravity in Pilates practitioners in this study can be explained by the fact that the exercises of this method influence the postural control and stimulate the function of the core muscles and stabilizers of the vertebral column[14]. In this sense, Pilates requires activation and coordination of multiple muscle groups at the same time, emphasizing

the strengthening of the core muscles, coordination of breathing, movement and positioning of body[15], thus developing stabilization and flexibility[16]. Therefore, the method seeks body symmetry, since it works on trunk movements seeking to combine balance, flexibility, and muscle strengthening[17].

Considering that the function of the force center (powerhouse) is to promote the support of the spine and internal organs, stabilize the torso, and maintain correct posture to reduce the energy expenditure during movement and the risk of lesions[18], strengthening the core muscles is important to promote postural correction and alignment, a principle addressed by Pilates. In this context, the core muscles form a complex known as pelvic-lumbar complex, which includes the paravertebral, abdominal, pelvic floor, hip adductors, glutes muscles, and diaphragm[19]. Among them, the posterior abdominal muscles and the transversus abdominis are important stabilizers of the lumbar spine, in which they generate an intra-abdominal pressure with minimum load to the lumbar spine[20]. Thus, through this function, there is a decrease in axial compression and shear stress, promoting greater stability to the vertebral column[21].

Additionally, in the center of force, there is also the center of gravity, corresponding to where the movements are initiated. Therefore, strengthening these muscles, through Pilates, leads to prevention and rehabilitation of musculoskeletal and postural disorders[21]. These factors corroborate the data from this study, in which there was better alignment of trunk and center of gravity in Pilates practitioners.

During the growth phase of a healthy child, the body gradually reaches adult form, being especially altered during puberty because of hormonal changes, musculoskeletal development, and rapid growth spurt; therefore, bad postural habits and postural alterations tend to occur more frequently in this phase[22,23]. Complementarily, in addition to hormonal influences, there are environmental and behavioral influences, which can be aggravating factors in relation to postural alterations in these children, such as overweight and inadequate transport of school materials, ergonomic conditions relating to furniture that is inappropriate to school needs, and the maintenance of incorrect postures adopted during classes and in periods out of school[24].

From this perspective, it is relevant to adopt measures for early detection and correction of postural alterations, through integrated action of educators, students, parents, physical therapists, and government[23], considering this crucial phase of postural development in children. Thus, one of the posture re-education methods most widely used today is the Pilates method[25]; however, its utilization for children in schools is still scarce. The study of Andeo et al.[26] proposed introducing a variety of Pilates-based exercises to physical education teachers who work in primary schools to be adapted for their classes, to develop biopsychosocial skills and promote the health of students; however, the study does not report the effects of this practice.

Studies have demonstrated positive effects from the practice of the Pilates method on the posture and stabilization of trunk in young adults[16,27,28,29], as well as in young women with postural alterations[30]. Moreover, the practice of the method was effective for a better alignment of head, shoulders and scapulae of a teenager with clinical diagnosis of scoliosis[31]. In particular, Pata et al.[32] and Kaesler et al.[33] indicated that an exercise program based on the Pilates method was effective in improving postural stability in seniors. Although studies point to a positive effect of the Pilates method on the postural pattern and stability in different populations, its effects are still scarce for children in school age. This fact demonstrates the relevance of this study, since better posture profile was found on practitioners of the method, when compared to non-practitioners.

As limitation of the study, we reiterate that it was not possible to determine if the group of practitioners of the Pilates method already had better postural alignment prior to the evaluation, when compared to the non-practitioners.

CONCLUSION

Considering the data obtained in this study, we could observe that the students practitioners of the Pilates method presented better alignment of shoulder and scapula, as well as better alignment of body and gravity center, when compared to the non-practitioners.

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