Original Article

Study of postural misalignments between sex, school cycle and physical activity

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ABSTRACT

This study aimed to characterize and compare postural behaviour between gender, school cycles and PA levels in 213 students, aged between 10 and 20 years, from Escola Básica e Secundária de Santa Maria. Postural assessment was made through visual scan analysis in a symmetrograph and the Adams test. PA level assessment was made using the IPAQ. Postural behaviour presented high percentages of imbalances in both sexes, with the highest prevalence in the head lateral flexion, shoulders level asymmetry, scoliosis, gibbosity, forward head and protracted shoulders. Lumbar scoliosis was significantly related to pelvic asymmetry ($p < .001$), protracted shoulders were related to forward head ($p = .010$) and dorsal hyperkyphosis ($p = .048$) and lumbar hyperlordosis was more prevalent in subjects with pelvic anteversion ($p < .001$). Dorsal hyperkyphosis manifested in males with a markedly higher prevalence than females ($p = .006$). Postural imbalances were present at all ages, with pelvic anteversion decrease ($p = .028$) with school cycles progression. Our sample proved to be physically active with 73.9% categorized with high and moderate levels of PA. Higher PA levels where related to forward head lower percentages ($p = .006$). It should be highlighted the importance of postural assessment school students.

Keywords: Postural behaviour; Misalignments; Adolescents; Youngsters.

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INTRODUCTION

Postural behaviour is defined as a position of the body in each activity. It is described by joints and/or body segments relative positions and the balance between the muscles that move those (Kisner *et al*., 2007). The ideal postural alignment results from the minimal tension in the body's structures, leading to an optimal movement efficiency (Patel, 2005). Changes in the optimal bones positions due physical activities may cause muscle shortening overloads in the musculoskeletal system (Pinto and López, 2001). The physical activity (PA) is defined as any body movement by the skeletal muscles. That requires energy expenditure and include working, domestic tasks and leisure physical activities (WHO, 2014). Upon that, occupational physical activity might be associated with postural behaviour.

The XXI century is characterized by the raise of new technologies. The new technology use has been related with the decrease of PA levels (WHO, 2010; Baptista *et al*., 2011). The postural habits and patterns of human being starts in the earliest ages. The spine, the scapular and pelvic alignments are the most affected. The postural changes in the musculoskeletal system may lead to degenerative pathologies and if not earlier detected and corrected, may physically limit the individuals (Minghelli, 2008). In both sexes, postural misalignments are present at all school ages (Ferronatto *et al.,* 1998; Santos *et al.*, 2009; Klusener *et al*., 2014; Alves *et al*., 2020), with a higher prevalence of forward head posture, protracted shoulders and scoliosis (Pinto and Lópes, 2001; Minghelli *et al*., 2009; Peliteiro *et a*l., 2010; Noll *et al*., 2012). Females are more prone to dorsal hyperkyphosis (Verderi, 2003; Braz *et al*., 2007; Moreira *et a*l., 2013), scoliosis (Braz *et al*., 2007; Minghelli, 2008; Noll *et al*., 2012), lumbar hyperlordosis and pelvic anteversion (Minghelli *et a*l., 2009; Peliteiro *et al*., 2010).

Hypotrophy and muscle imbalance from being physical inactivity are assumed as causes for postural misalignments and decline in musculoskeletal system functionality (Braccialli and Vilarta, 2000; WHO, 2010; Johnson, 2016). Higher levels of PA may be related with postural misalignments due to incorrect movement patterns hypersolicitation. Sports practice may overuse certain body segments and joints and contribute to develop postural misalignments and asymmetries (Bastos *et al*., 2009; Meliscki *et a*l., 2011; Santos *et al*., 2016; Forte *et al*., 2017).

The school environment is an external factor that may contribute to postural changes in children and adolescents. Moreover, children spent the most part of the time in school and the bone structures development period might be affected by postural behaviour at school and PA (Ferronatto *et a*l., 1998; Braccialli and Vilarta, 2000; Pinto and Lópes, 2001; Minghelli *et al*., 2009; Alves *et al*., 2020). The students have long daily inactivity periods in the classroom, without the necessary ergonomic adaptation of school environment and with the adoption of incorrect and vicious postures of their body segments (Verderi, 2003; Tobar, 2004; Santos *et al.,* 2009; Lafeta *et al*., 2013; Alves *et al*., 2020). The weight carried in the schoolbag is often excessive (Barbosa *et al.,* 2019) and its transportation is also mostly done asymmetrically (Sedrez *et al*., 2014). Thus, the school cycles may change postural behaviour and alignment.

Therefore, physical education (PE) programs with student's postural assessment may earlier detect postural misalignments (Verderi, 2003; Braz *et al*., 2007; Moreira *et a*l., 2013). Thus, PE teachers assume an important role in public health, collaborating with health professionals. Moreover, PE teachers may develop exercise programs based on student`s postural misalignments (Alves *et al*., 2020). Postural assessment is also important in all cycles due to the transformations inherent to the growth processes (Klusener *et al*., 2014). There also seems to be a trend that postural habits acquired during childhood and adolescence may remain until adulthood (Sedrez *et al*., 2014).

The postural alignment is possible to assess with different methods, such as photogrammetry, tomography, X-ray, visual scan analysis, questionnaires, symmetrographs, plumb lines, scoliometers and goniometers (Verderi, 2003; Alves *et al*., 2020). In several studies assessing PA, the questionnaires are used in large samples. Questionnaires are low cost instruments. However, problems related to objectivity due to the difficulty of the subjects to remember the exact performed activities, as well as the tendency to overestimate the time and intensity variables are some limitations (Maia and Oliveira, 2001; Cafruni *et a*l., 2012).

To date, no study was founded assessing the student's postural misalignments and physical activity. So far, the literature presents scarce information about the postural misalignments by physical activity levels and sex. Upon that, the aim of this study was to assess significant differences in children posture in spine, scapular and pelvic alignment by visual scan, between sex, school cycles and PA levels. It was hypothesised that postural behaviour varies according to sex, schooling cycle and different PA levels.

MATERIAL AND METHODS

Participants

The sample of this study was composed with 213 students, 124 males and 89 females, with an average age of 14.30 ± 2.65 years. The 2nd cycle group covers the ages between 10 and 12 years, the 3rd cycle between 13 and 16 and the secondary between 17 and 20. The sample was representative of the respective local school population. All assessments were carried out at the Escola Básica e Secundária de Santa Maria in PE classes. An informed written consent from the parents or guardians were provided beforehand. An explanation about the purpose and the methodology of this research, as well as the importance of assessing the student's posture was given. The study was approved by the Education Regional Direction with process number DSP/15-29. All procedures were in accordance with the Helsinki Declaration for Research on Humans.

Visual scan analysis

The field test was conducted through visual scan analysis with a symmetrograph. The symmetograph had a transparent acrylic plate with 2 m high and 1 m wide, embedded in a wooden frame. A 0.1m quadricular grid metric was designed in the acrylic plate. The construction of this instrument was based on Kendall *et al*. (2005). For the foot placement, a wooden base with 0.6 x 0.6 m was fixed on the symmetrograph, without any foot references. The participants were asked to position themselves exactly in the middle.

The subjects were barefoot. The males wear shorts or a bathing suit. The females wear a two-piece bathing suit or top and shorts (Kendall *et al*., 2005), with full body digital image recorded in the posterior view of the frontal plane (Figure 1 at left), and in the right lateral view of the sagittal plane (Figure 1 at right). A Sony digital camera (Sonny, Cyber-shot DSC-W810, Tokyo, Japan) was fixed on a tripod at 2.65 m distance from the symmetrograph and heighted 0.85 m from the ground (Santos *et al*., 2005). The levelling of these two instruments was carried out through an air bubble level.

In the frontal plane posterior view the earlobes, shoulders and posterior superior iliac spines, the spinal apophyses of the C3 to L5 vertebrae with the intergluteal fold horizontal alignment were assessed. In the sagittal plane right lateral view the alignment between the external auditory canal, clavicular acromion, dorsal and lumbar cervical vertebrae, the femoral trochanter, the anterior iliac spines and the pubic symphysis verticality. These parameters defines a standard postural model. Any mismatch in this anatomical reference alignment implied a postural misalignment. The Adams test allowed to assess the student's thoracolumbar curves with a trunk flexion, with palms held together, knees extended and the feet together. The evaluator was in a posterior position. The test was considered positive when, in the tangential view of the back, there was visualization of gibbosity or thoracolumbar curves.

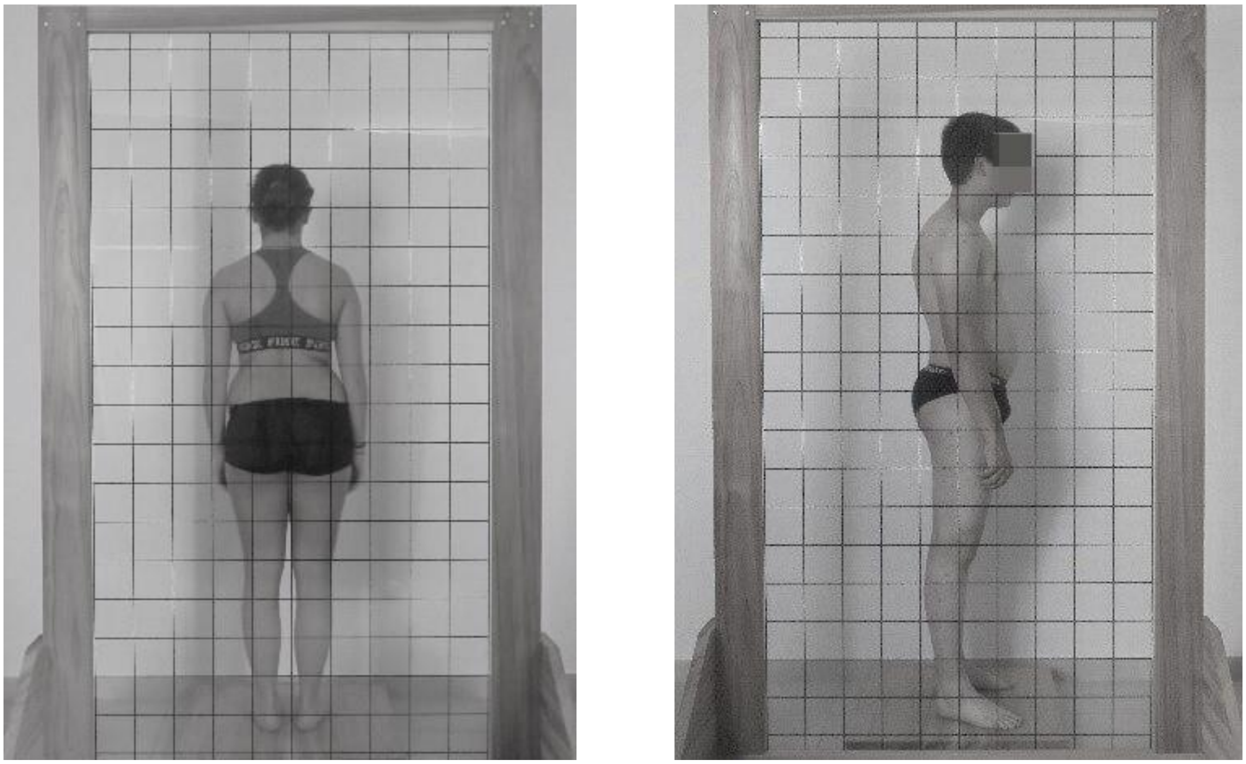

Figure 1. Visual scan analysis of the full body digital image in the frontal plane posterior view (left) and in the sagittal plane right lateral view (right).

Physical activity level assessment

The PA level was assessed with the IPAQ - International Physical Activity Questionnaire (short-form), for estimating physical activity at school, in sports and in leisure time, regarding the last 7 days. The student's PA levels classification was performed according to the scoring and classification protocol. The questionnaires were filled out in the classroom, with teacher's supervision. In order to minimize the inaccuracies in the answers, a detailed prior explanation was carried out, allowing a greater degree of confidence in the obtained results.

Analysis

Descriptive statistics was used to characterize the different variables involving central tendency and dispersion parameters (mean and standard deviation). Regarding inductive statistics and given that these variables show a normal distribution verified through asymmetry and kurtosis parameters, we used parametric statistics in the scalar variables. The Chi-Square test was used for the postural behaviour comparison between gender, school cycles and physical activity levels, as well as for the behaviour of the scapular and pelvic girdles with the spine. The level of significance considered for the differences found between the variables was $p < .05$. The computer program selected for the statistical analysis was the Statistical Package for Social Sciences (SPSS) - version 22.0.

RESULTS

Postural misalignments in all participants were observed. In the posterior view of the frontal plane, the highest prevalence were found in cervical scoliosis (51.6%), left shoulder elevation (46.5%) and in dorsal scoliosis (39.9%). In right lateral view of the sagittal plane the most prevalent misalignments were the forward head posture (76.1%), protracted shoulders (41.3%) and pelvic anteversion (39.4%). In the posterior view of the frontal plane, lumbar scoliosis was significantly related to the posterior superior iliac spines misalignment (X2 = 72.419; $p < .001$); whereas, in the right lateral view of the sagittal plane, forward head was associated with protracted shoulders (X2 = 13.294; $p = .010$), protracted shoulders was related to dorsal hyperkyphosis (X2 = 9.562; $p = .048$) and lumbar hyperlordosis was more prevalent in the subjects with pelvic anteversion (X2 = 59.597; $p < .001$) (Table 1).

Table 1. Summary of misalignments and comparisons of postural behaviour between gender.

	Postural Variables	Misalignments	Total (%)	Gender		p
				Male	Female	
Posterior View of the Frontal Plane	Head positioning	Right lateral flexion	39.9%	41.9%	37.1%	
		Left lateral flexion	35.2%	33.9%	37.1%	.773
	Scapular girdle	Higher right shoulder	28.6%	31.5%	24.7%	
		Higher left shoulder	46.5%	44.4%	49.4%	.559
	Cervical Spine	Cervical scoliosis	51.6%	54.0%	48.3%	.410
	Dorsal spine	Dorsal scoliosis	39.9%	51.6%	46.1%	.425
	Lumbar spine	Lumbar scoliosis	29.6%	32.3%	25.8%	.312
	Pelvic girdle	Right Pelvic tilt	31.9%	30.6%	33.7%	
		Left pelvic tilt	7.0%	8.1%	5.6%	.742
	Adams test	Positive right	33.3%	33.1%	33.7%	
		Positive left	32.4%	33.1%	31.5%	.970
Right Lateral View of the Sagittal Plane	Head positioning	Forward head posture	76.1%	79.8%	85.4%	
		Posterior head posture	1.4%	0.8%	2.2%	.286
	Scapular girdle	Protracted shoulders	41.3%	43.5%	38.2%	
		Retracted shoulders	0.4%	0.0%	1.1%	.385
	Cervical Spine	Cervical rectification	24.9%	27.4%	21.3%	
		Cervical hyperlordosis	4.7%	5.6%	3.4%	.396
	Dorsal spine	Dorsal rectification	0.9%	1.6%	0.0%	
		Dorsal hyperkyphosis	29.6%	42.7%	10.1%	<.001 **
	Lumbar spine	Lumbar rectification	4.7%	7.3%	2.2%	
		Lumbar hyperlordosis	24.9%	24.2%	25.8%	.265
	Pelvic girdle	Pelvic anteversion	39.4%	37.1%	42.7%	
		Pelvic retroversion	0.9%	0.8%	1.1%	.680

(**). Statistically significant differences between variables p < .01.

The Chi-Square Test revealed significant differences between gender comparisons with a higher prevalence of dorsal hyperkyphosis in males ($p < .001$), between schooling cycles with a higher prevalence of pelvic anteversion in the 2nd cycle group ($p = .028$) and between PA levels, with low-level subjects showing a higher forward head posture prevalence ($p = .006$) (Table 2 and Table 3).

Table 2. Comparisons of postural behaviour between school cycles.

	Postural Variables	Misalignments	School Cycle			p
			2nd Cycle	3rd Cycle	Secondary School	
Posterior View of the Frontal Plane	Head positioning	Right lateral flexion	37.3%	41.0%	40.5%	
		Left lateral flexion	39.2%	41.0%	26.6%	.169
	Scapular girdle	Higher right shoulder	29.4%	32.5%	24.1%	
		Higher left shoulder	45.1%	47.0%	46.8%	.684
	Cervical Spine	Cervical scoliosis	51.0%	47.0%	57.0%	.444
	Dorsal spine	Dorsal scoliosis	52.9%	47.0%	49.4%	.799
	Lumbar spine	Lumbar scoliosis	33.3%	31.3%	25.3%	.561
	Pelvic girdle	Right Pelvic tilt	31.4%	33.7%	30.4%	
		Left pelvic tilt	3.9%	9.6%	6.3%	.708
	Adams test	Positive right	41.2%	28.9%	32.9%	
		Positive left	35.3%	31.3%	31.6%	.395
Right Lateral View of the Sagittal Plane	Head positioning	Forward head posture	76.5%	83.1%	84.8%	
		Posterior head posture	3.9%	0.0%	1.3%	.358
	Scapular girdle	Protracted shoulders	51.0%	36.1%	40.5%	
		Retracted shoulders	0.0%	0.0%	1.3%	.332
	Cervical Spine	Cervical rectification	21.6%	25.3%	26.6%	
		Cervical hyperlordosis	3.9%	2.4%	7.6%	.537
	Dorsal spine	Dorsal rectification	2.0%	1.2%	0.0%	
		Dorsal hyperkyphosis	17.6%	28.9%	36.7%	.162
	Lumbar spine	Lumbar rectification	2.0%	8.4%	3.8%	
		Lumbar hyperlordosis	33.3%	18.1%	26.6%	.167
	Pelvic girdle	Pelvic anteversion	58.8%	32.5%	34.2%	
		Pelvic retroversion	0.0%	1.2%	1.3%	.028 *

(*). Statistically significant differences between variables, p < .05.

Table 3. Comparisons of postural behaviour between Physical Activity levels.

	Postural Variables	Misalignments	Physical Activity Level			p
			High	Moderate	Low	
Posterior View of the Frontal Plane	Head positioning	Right lateral flexion	41.9%	41.6%	35.5%	
		Left lateral flexion	40.5%	31.2%	33.9%	.405
	Scapular girdle	Higher right shoulder	27.0%	27.3%	32.3%	
		Higher left shoulder	47.3%	49.4%	41.9%	.920
	Cervical Spine	Cervical scoliosis	52.7%	45.5%	58.1%	.327
	Dorsal spine	Dorsal scoliosis	54.1%	44.2%	50.0%	.473
	Lumbar spine	Lumbar scoliosis	29.7%	32.5%	25.8%	.693
	Pelvic girdle	Right Pelvic tilt	29.7%	33.8%	32.3%	
		Left pelvic tilt	6.8%	10.4%	3.2%	.517
	Adams test	Positive right	27.0%	31.2%	43.5%	
		Positive left	36.5%	29.9%	30.6%	.247
Right Lateral View of the Sagittal Plane	Head positioning	Forward head posture	74.3%	87.0%	85.5%	
		Posterior head posture	0.0%	0.0%	4.8%	.006 **
	Scapular girdle	Protracted shoulders	41.9%	35.1%	48.4%	
		Retracted shoulders	0.0%	1.3%	0.0%	.392
	Cervical Spine	Cervical rectification	28.4%	20.8%	25.8%	
		Cervical hyperlordosis	4.1%	6.5%	3.2%	.748

Dorsal spine	Dorsal rectification	2.7%	0.0%	0.0%	
	Dorsal hyperkyphosis	27.0%	27.3%	33.9%	.325
Lumbar spine	Lumbar rectification	6.8%	1.3%	8.1%	
	Lumbar hyperlordosis	28.4%	26.0%	19.4%	.269
Pelvic girdle	Pelvic anteversion	33.8%	46.8%	37.1%	
	Pelvic retroversion	0.0%	0.0%	3.2%	.105

(**). Statistically significant differences between variables, p < .01.

DISCUSSION

This study aimed to assess significant differences in children posture in spine, scapular and pelvic alignment by visual scan, between sex, school cycles and PA levels. It was hypothesized that postural behaviour varies according to sex, school cycle and different PA levels. The main findings were that lumbar scoliosis was related with the posterior iliac crests misalignment, forward head was associated with protracted shoulders and the later ones with dorsal hyperkyphosis and lumbar hyperlordosis presented higher prevalence in the subjects with pelvic anteversion.

The option for visual scan analysis in a symmetrograph was due to that it is a non-invasive method, with immediate feedback in Physical Education classes and with easy application in larger samples (Alves *et al*., 2020). The Adams test is unanimously recognized as primary basis for detecting scoliosis and gibbosity (Minghelli, 2008; Ferreira *et al*., 2009). The choice of the IPAQ questionnaire was due to its ease of application, being also widely used in PA epidemiological studies with larger samples (Gordia *et al*., 2010) and presents reliability and scientific validation in youngsters (Guedes *et al*., 2005).

The importance of gender study is related to the fact that females are more prone to postural misalignments than males (Braz *et al*., 2007; Minghelli *et al*., 2009; Peliteiro *et al*., 2010; Noll *et al*., 2012; Moreira *et al*., 2013; Verderi, 2003), despite being verified in both sexes. Postural assessment is also important in all school cycles due to the transformations inherent to the growth processes (Klusener *et al*., 2014). High prevalence of misalignments is common in all school cycles (Ferronatto *et al*., 1998; Santos *et al*., 2009; Klusener *et al*., 2014).There also seems to be a trend that postural habits acquired during childhood and adolescence may remain until adulthood (Sedrez *et al*., 2015).

Regarding postural assessment, we verified misalignments in the entire sample. In the posterior view of the frontal plane, scoliosis was the most prevalent imbalance, being more evident in the upper levels of the spine (Tobar, 2004; Braz *et al*., 2007; Minghelli, 2008; Lafeta *et al*., 2013). This fact may be related to the body changes inherent to the pubertal growth spurt (Martelli *et al*., 2006), insufficient muscle strength to balance external loads (Barbosa *et al*., 2019) or with the maintenance of incorrect postures that involve prolonged trunk lateral flexion (Kendall *et al*., 2005). Misalignment of the shoulders level was the second most prevalent imbalance, with left shoulder elevation predominance (Pinto and Lópes, 2001; Minghelli *et al*. 2009; Biava and Lima., 2011; Preto *et al*., 2015) possibly due to the dominant side hyperfunction (Peliteiro *et al*., 2010; Hall, 2016) and insufficient muscle strength to balance external loads. Lumbar scoliosis was statistically related with posterior iliac crests misalignment. In the sagittal plane right lateral view, forward head posture was the most evident misalignment (Lafeta *et al*., 2013; Silva *et al*., 2017), possibly related with the prolonged mobile phone usage time (Jung *et al*., 2016), standing in low tables or highchairs (Braccialli and Vilarta, 2000) or as a compensation for excess weight carried in the backpack (Braccialli and Vilarta, 2000; Oshiro *et al*., 2007; Barbosa *et al*., 2019). Protracted shoulders was the second most common postural misalignment in our study (Pinto and Lópes, 2001; Santos *et al*., 2009; Biava and Lima, 2011), although these results are inferior to the majority of the literature (Ferronatto *et al*., 1998; Minghelli *et al*., 2009; Peliteiro *et al*., 2010; Lafeta *et al*., 2013). The percentage of protracted shoulders was higher in subjects who manifested forward head posture. The high prevalence of dorsal hyperkyphosis (Ferronatto *et al*., 1998; Noll *et al*., 2012; Lafeta *et al*., 2013), possibly related with the high prevalence of forward head posture (Johnson, 2016), was significantly higher for subjects who manifested protracted shoulders. Lumbar hyperlordosis was observed with inferior percentual values comparatively to other consulted studies (Minghelli *et al*., 2009; Peliteiro *et al*., 2010; Noll *et al*., 2012; Lafeta *et al*., 2013). Pelvic anteversion was the third most prevalent imbalance in the sagittal plane, despite showing a lower prevalence than that we found in the bibliography (Pinto and Lópes, 2001; Minghelli *et al*., 2009; Peliteiro *et al*., 2010), being significantly higher for subjects who revealed hyperlordosis (Minghelli *et al*., 2009).

Between sexes, hyperkyphosis was significantly more pronounced in males than females. Although there hasn't been no statistically significant differences, the shoulders horizontal misalignment was predominant in both sexes and may be related to the dominant side hyperfunction (Kendall *et al*., 2005; Hall, 2016). Scoliosis was more evident in males, contrary to the majority of the consulted literature that advocates a higher prevalence of female scoliotic postures (Braz *et al*., 2007; Minghelli, 2008; Noll *et al*., 2012), possibly related with males collaboration in tasks inherent to the rural environment. The female group had lumbar hyperlordosis and pelvic anteversion (Minghelli *et al*., 2009; Peliteiro *et al*., 2010) highest prevalence.

Amongst school cycles, the significantly pelvic anteversion higher prevalence in the 2nd cycle group is considered normal at these ages, appearing as a compensatory mechanism to ensure the lack of stability and balance due to body changes inherent to the growth process (Kendall *et al*., 2005; Peliteiro *et al*., 2010; Klusener *et al*., 2014). Although there hasn't been no statistically significant differences, scoliosis was also more prevalent in the 2nd cycle, suggesting that this asymmetry prevalence is more marked in the period of growth that follows childhood (Preto *et al*., 2015). The tendency to forward head posture and dorsal hyperkyphosis was more evident depending on the progression in schooling cycles.

Regarding to PA, most of the sample most of the sample was categorized with high and moderate levels. Forward head posture was significantly more prevalent in the moderate and low activity level groups. Although there hasn't been no statistically significant differences, the high scoliotic postures prevalence in the high and moderate group may be related to the fact that most of the PA is performed within the scope of collaboration in rural environment tasks or with a postural adaptation due to the sports practice specificity, not properly compensated in the training process of the young athletes (Bastos *et al*., 2009; Meliscki *et al*., 2011; Santos *et al*., 2016; Forte *et al*., 2017). The prevalence of hyperkyphosis was more evident with PA level decrease, while lumbar hyperlordosis was more prevalent in the high and moderate levels. The higher level of activity had no supremacy in any variable, with the greatest tendency towards alignment to be seen in the moderate and low level groups.

The great prevalence of misalignments found in the entire sample emphasizes the need for student's postural assessment in PE Classes. The result of this study showed significantly higher prevalence of dorsal hyperkyphosis in males, higher pelvic anteversion in the 2nd cycle group and lower forward head posture prevalence in high-level PA subjects. Although the present study was based on data collected from students at a public school, the results may be affected by specific conditions and the geographical location, should be taken into account in the generalization in the Portuguese student population. It is also admitted, due to the methodological requirement for the acquisition of the photographic images, that this fact may have led to changes in the subjects postural behaviour patterns. The PA assessment was done through the application of a questionnaire where, necessarily, we will take into account the subjectivity inherent to the students own answers. For futures studies it is of relevant interest to investigate the validation of a functional movement test screen for the school population, as well as the establishment of "*healthy zones*" for postural misalignments (stipulating a boundary between normal and pathological asymmetries). We also suggest conducting the same study but with a longitudinal character and the assessment of the subjects biological age.

CONCLUSION

We were able to verify a high number of postural behaviour asymmetries in students, with the highest prevalence found in forward head posture, protracted shoulders, shoulders horizontal misalignment, scoliosis and pelvic anteversion. We observed a significant prevalence of hyperkyphotic postures in males, with a more marked female tendency towards hyperlordosis and pelvic anteversion. With the school cycles progression, we noticed a significant pelvic anteversion prevalence decrease and a tendency to forward head and dorsal hyperkyphosis increasing. Most students showed moderate to high levels of PA, although about half did not seem to comply with the recommendations for performing at least 60 minutes of moderate to vigorous daily physical activity. The lower level of activity was only significantly related to forward head posture higher prevalence, with a more relevant tendency towards alignment verified in the moderate and low activity groups.

AUTHOR CONTRIBUTIONS

Conceptualization (J.P.G., P.F. and E.C.). Formal analysis (J.P.G., P.F. and E.C.). Methodology (J.P.G., P.F. and E.C.). Supervision (P.F. and E.C.). Writing—original draft (J.P.G.).Writing—review and editing (J.P.G., P.F. and E.C.).

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors. All procedures were in accordance with the Helsinki Declaration for Research on Humans.

REFERENCES

Alves M, Marinho D, Carneiro D, Alves J, Forte P, Nevill A, Morais J. (2020). A visual scan analysis protocol for postural assessment at school in young students, Int. J. Environ. Res. Public Health, 17; 2915: 6-7. https://doi.org/10.3390/ijerph17082915

Baptista F, Silva A, Santos D, Mota J, Santos R., Vale S., Ferreira J., Raimundo A, Moreira H. (2011). Physical Activity Green Book, Lisbon: Instituto do Desporto de Portugal, 13-15.

Barbosa J, Marques M, Izquierdo M, Neiva H, Barbosa T, Velez R, Martinez A, Hermoso A, Jimenez R, Marinho D. (2019). Schoolbag weight carriage in portuguese children and adolescents: a cross-sectional study comparing possible influencing factors. BMC Pediatr, 19;157: 3-4. https://doi.org/10.1186/s12887-019-1519-2

Bastos F, Pastre C, Júnior J, Vanderlei L, Filho G, Hoshi R, Padovani C. (2009). Correlation of the postural standard in young track and field practitioners, Rev. Bras. Med. Esporte, 15; 6: 434-435. https://doi.org/10.1590/s1517-86922009000700006

Biava J, Lima D. (2011). Postural education at school: an integrative approach to the educational development program. Available at: https://www.researchgate.net/publication/284644282_educacao_postural_na_escola_uma_abordagem_integradora_do_programa_de_desenvolvimento_educacional_-_pde; accessed on 01.10.2018.

Braccialli L, Vilarta R. (2000). Aspects to be considered in the development of prevention and orientation programs for postural misalignments, Rev. Paul. Educ. Fís., 14; 1: 17-24.

Braz H, Borges M. (2007). The relevance of postural assessment in schools, Coleção Pesquisa em Educação Física, 6; 2: 27-30.

Cafruni C, Valadão R, Mello D. (2012). How to assess physical activity, Revista Brasileira de Ciências e da Saúde, 10; 33: 62-63. https://doi.org/10.13037/rbcs.vol10n33.1555

Ferreira D, Suguikawa T, Pachioni C, Fregonesi C, Camargo M. (2009). School scoliosis screening: measure for early diagnosis, Rev. Bras. Crescimento Desenvolvimento Hum., 19; 3: 364-365.

Ferronatto A, Candotti C, Silveira R. (1998). The incidence of changes in static scapular waist balance in children between 7 and 14 years, Revista Movimento, 5; 9: 25- 29.

Forte P, Morais J, Barbosa T, Reis A. (2017). Prevalence of postural changes in youth soccer players: a descriptive study, Rev. Ed. Física, 86; 2: 83-85.

Gordia A, Quadros T, Campos W, Petroski E. (2010). Physical activity level in adolescents and its association with sociodemographic variables, Rev. Port. Cien. Desp., 10; 1:177.

Guedes D, Lopes C, Guedes J. (2005). Reproducibility and validity of the international physical activity questionnaire in adolescents, Rev. Bras. Med. Esporte, 11; 2: 157.

Hall S. (2016). Basic Biomechanics, Rio de Janeiro: Guanabara Koogan, 338-340.

Johnson J. (2016). Postural Correction: Hands-On Guide for Therapists", Human Kinetics, 5, 20-21.

Jung S, Lee N, Kank K, Kim K, Lee D. (2016). The Effect of Smartphone Usage Time on Posture and Respiratory Function, J. Phys.Ther. Sci., 28; 1:187-188.

Kendall F, McCreary E, Provance P, Rodgers M, Romani W. (2005). Muscles Testing and Function with Posture and Pain, Lippincott Williams & Wilkins, 52-69.

Kisner C, Colby L. (2007). Therapeutic Exercise: Foundations and Techniques, F.A.Davis Company, 383,390.

Klusener G, Porto D. (2014). Physiotherapy in schools: postural assessment in children from 6 to 11 years old, Revista Inspirar - Movimento & Saúde, 6; 5:10-11.

Lafeta J, Gondin J, Durães G, Junior E, Silveira M. (2013). Biophotogrammetric analysis of the main postural changes of the spine in schoolchildren. Retrieved from: https://www.efdeportes.com/efd177/analise-biofotogrametrica-das-alteracoes-posturais.htm; accessed on 22.12.2017.

Martelli R, Traebert J. (2006). Descriptive study of postural changes in the spine in schoolchildren from 10 to 16 years of age, Rev. Bras. Epidemiol., 9: 1: 92.

Maia J, Oliveira M. (2001). Evaluation of physical activity in epidemiological contexts, Rev. Port. Cien. Desp., 1; 3: 73-77.

Meliscki G, Monteiro L, Giglio C. (2011). Postural evaluation of swimmers and its relation to type of breathing, Fisioter. Mov., 24; 4: 724-725.

Minghelli B. (2008). School screening: the importance of early detection of scoliotic postures in adolescents from Silves schools, Algarve, Revista Portuguesa de Saúde Pública, 26; 2: 65-66.

Minghelli B, Abílio F, Góis A, Timóteo A, Florença H, Lóia N, Jesus T, Serra F, Duarte M. (2009). Prevalence of postural changes in children and adolescents in schools in the Algarve, Saúde & Tecnologia, 4: 36.

Moreira J, Cornelian B, Lopes C. (2013). The importance of good postural positioning in schoolchildren - the role of the physical education teacher, Revista Uningá Review, 16; 3: 46-47.

Noll M, Rosa B, Candotti C, Furlamento T, Gontijo K, & Sedrez J. (2012). Postural changes in elementary school students at a school in Teutônia, R. Bras. Ci. e Mov., 20; 2: 36-38.

Oshiro V, Ferreira P, Costa R. (2007). Postural changes in schoolchildren: a literature review, Revista Brasileira de Ciências e Saúde, 3; 13: 20.

Patel K. (2005). Corrective Exercise: A Practical Approach, Hodder Arnold, 6.

Peliteiro D, Festas C, Lourenço M. (2010). Analysis of postural changes in schoolchildren, Revista da Faculdade de Ciências e Saúde, 7: 364.

Pinto H, Lópes R. (2001). Postural problems in students of the Paranoá high school center – Brasilia. Retrieved from: https://www.efdeportes.com/efd42/postura.htm; accessed on 13.11.2017.

Preto L, Santos A, Rodrigues V, Quitério N, Pimentel M, Manrique G. (2015). Photogrammetry analysis of posture and associated risk factors in schooled children and adolescents, Revista de Enfermagem Referência, 5;7: 38-39. https://doi.org/10.12707/riv14051

Santos C, Cunha A, Braga V, Saad I, Ribeiro M, Conti P, Oberg T. (2009). Occurrence of postural deviations in children of a school of Jaguariúna, São Paulo, Brazil, Rev. Paul. Pediatr., 27; 1: 77-79. https://doi.org/10.1590/s0103-05822009000100012

Santos J, Moro A, Cezar M, Reis P, Luz J, Reis D. (2005). Portland state university postural assessment method description, Fisioterapia Brasil, 6; 5: 392-394.

Santos J, Toledo E, Reis P, Moro A, Gomes A. (2016). Postural profile in young athletes of high performance rhythmic gymnastics in the state of São Paulo, Revista Brasileira de Prescrição e Fisiologia do Exercício, 10; 59: 395.

Sedrez A, Da Rosa M, Noll M, Medeiros F, Candotti C. (2015). Risk factors associated with spinal structural changes in the spine in children and adolescents, Rev. Paul. Pediatr, 1; 33: 75,80. https://doi.org/10.1016/s2359-3482(15)30033-6

Silva P, Bomfim A, Sampaio A, Mota D, Reis E, Pires L. (2017). Postural changes in children attending municipal schools in the city of Salvador - Bahia, Revista Diálogos & Ciência - Faculdade de Tecnologia e Ciências, 2; 40: 48-51.

Tobar N, Postural characteristics of José Maria Obando school children from the city of Popayán, 2004, Retrieved from: https://www.efdeportes.com/efd70/postura.htm; accessed on 19.11.2017.

Verderi E, The importance of postural assessment, 2003, Retrieved from: https://www.efdeportes.com/efd57/postura.htm; accessed on 11.12.2017.

World Health Organization. (2010). Global Recommendations on Physical Activity for Health, Switzerland, WHO Press, 10.