



Original Article

Monitoring the prevalence of postural changes in schoolchildren

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Abstract. [Purpose] The aim of this study was to identify whether postural changes are prevalent with advancing age using a photogrammetric method performing one-year follow-up study. [Subjects and Methods] Thirty-eight schoolchildren were evaluated in 2011 and 2012 in this cohort study. The subjects underwent a postural evaluation, which involved palpation of reference anatomic points, placement of reflexive markers over the anatomic points, image acquisition, and point digitalization using the Digital Image-based Postural Assessment evaluation software. For data analysis, descriptive statistics and inferential statistics were analyzed by McNemar's test. [Results] The results showed a significant increase in postural change prevalence for the lumbar spine in the sagittal plane (from 42.2% to 81.6%) and the knees in the frontal plane (from 39.5% to 63.2%) and a significant decrease in the prevalence of scoliosis (from 68.5% to 42.2%). [Conclusion] The findings indicate an increase in the prevalence of postural changes in schoolchildren from Teutônia, RS, Brazil, in 2012 compared with 2011. The development of longitudinal investigations for long-term monitoring of the evolution of posture and of schoolchildren habits's representing a viable alternative to subsidize health actions.

Key words: Posture, Schoolchildren, Assessment, Prevalence

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INTRODUCTION

The theme of body posture in relation to school has been of interest to several researchers, in regard to postural changes^{1,2)} and/or back pain risk factors³⁻⁵⁾ and back care programs⁶⁾ and in regard to knowledge concerning the prevalence of postural changes in different cities⁷⁾.

Regarding the prevalence of postural changes in school children, the results of studies have differed, possibly as a result of differences in methodology or differences intrinsic to the studies themselves. Body posture is influenced by socioeconomic, morphological, environmental, and behavioral factors, separately or in combination^{1,8,9)}, and this can generate different results even for a population of students with similarities in age and body mass index (BMI), hindering comparison of different places and environments. Furthermore, the method utilized for postural assessment can lead to different results. Regarding this issue, the majority studies have assessed posture by observation, which is dependent on the subjectivity and experience of the evaluator and does not allow for quantification of postural changes¹⁰⁾. Nevertheless, this issue can be easily resolved by utilizing quantitative methods accessible to schools, such as computerized photogrammetry, which provides reliable and accurate information, enabling detection of subtle changes during assessments¹¹⁾.

Considering the postural defects that occur in school-age children, which remain during adulthood, the period during which they go to school is the most important period for musculoskeletal development, and for a better prognosis in treatment of postural changes, periodic assessment is necessary in this population^{7,12)}. However, to the best of our knowledge, there are

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no longitudinal studies describing the evolution of the postural framework of students throughout their school years in Brazil as assessed by quantitative methods without subjective assessment by an evaluator. This is an important gap, as body posture is not static and tends to change over time, mainly during the growth stage^{7, 13}. From this perspective, we aimed to identify postural changes that are prevalent with advancing age using photogrammetry, by performing a one-year follow-up study.

SUBJECTS AND METHODS

This was a cohort study with a comparative design performed in October and November in 2011 and 2012. The select the sample, the school that the study would focus on was selected at random from among 11 schools in Teutônia, Rio Grande do Sul, Brazil. For the evaluation in the first year, schoolchildren were drawn from four separate physical education classes. For the second year, the evaluation was limited to the schoolchildren evaluated in the previous year. The sample size was determined based on the population proportion formula¹⁴, using the population of based schoolchildren (N=1,720) a significance level of 95%, sampling error estimated on 10% over 10% of thoracic kyphosis proportion. Based on this, a study sample of 34 schoolchildren was necessary. Taking into consideration potential losses, 70 schoolchildren were invited to participate.

The inclusion criteria for eligible participants were as follows: enrolled in the fifth to eighth grade of elementary school in the first year evaluation, able to stand on his/her feet independently, and presentation of parental consent. The exclusion criteria were as follows: did not participate in all postural evaluations or presented with chronic musculoskeletal diseases. This study was approved by the Ethics Committee of the Federal University of Rio Grande do Sul, (number 19832), in accordance with the ethical standards of the Declaration of Helsinki (1975, revised in 1983). All subjects signed an informed consent form.

The subjects were submitted to a postural evaluation, which consisted of palpation of reference anatomic points (APs), placement of reflective markers over the APs, image acquisition, and digitalization of points with DIPA (Digital Image-based Postural Assessment) postural evaluation software^{10, 15}. All the evaluation protocols were performed by only one researcher, and each subject was evaluated twice, once in 2011 and once in 2012. For the evaluation, the schoolchildren wore swimwear, were barefooted, and, if necessary, tied back their hair.

For image acquisition, a 12.1 megapixel Sony digital camera (Cyber-shot, Sony Brazil Ltda., São Paulo, SP, Brazil), was used that was coupled to a tripod at a height of 0.95 m, with the tripod located a horizontal distance of 2.80 m from the subjects, as per the recommendation of Furlanetto et al^{10, 15}. For vertical reference, two reflective markers were used, which were attached to a plumb line and located 1 m apart. The horizontal reference was assumed to be perpendicular to the plumb line. For image acquisition, the subject was positioned so that the reflective markers stayed approximately on the same plane as the plumb line, maintaining in this way an equal distance from the camera to the point and to the plumb line. Images were acquired without altering the level of zoom in all cases^{9, 14}. With the subject orthostatic, images were acquired (1) in the sagittal plane from a position perpendicular to the right side of the subject for evaluation of anteroposterior changes and (2) in the frontal plane from a position behind the subject for evaluation of latero-lateral changes.

The APs, indicated by reflective markers, were marked before image acquisition and corresponded to the following anatomic points: in the sagittal plane, the APs marked on the ear lobe, acromion, umbilicus, top of the posterior iliac spine, top of the anterior iliac spine, top of the greater trochanter, lateral condyle of the knee, fossa anterior to the external malleolus, and spinous processes of the vertebrae C7, T6, L4, and S2 vertebrae; and in the frontal plane, the APs were marked on the acromion, inferior angles of the scapula, top of the posterior iliac spine, and heel, all of which were demarcated bilaterally, and the spinous processes of the C7, T2, T4, T6, T8, T10, T12, L2, L4, and S2 vertebrae.

After image acquisition, images were transferred to a computer (Sony notebook, HD 500GB, 4GB RAM), where they were digitalized and analyzed with the DIPA software^{10, 15}, which provides quantitative information on the subject's posture in the sagittal and frontal planes, in addition to a posture classification¹⁰. Table 1 presents the classifications that can potentially be given by DIPA in each evaluated region.

The DIPA software was used as recommended by studies of Furlanetto et al.^{10, 15}, in which it was developed and validated, with strong and significant correlation found with all the variables studied.

The statistical analysis was performed using the IBM SPSS Statistics (version 19.0). Descriptive statistics were used to analyze data, and the results are presented in frequency tables for each variable in the sagittal plane (body balance, aligning knees, cervical spine, dorsal spine, lumbar spine) and frontal plane (body balance, presence of scoliosis, aligning shoulders, aligning knees). Inferential statistics by McNemar's test were also used to compare the results from 2011 and 2012 to variables in the sagittal plane (body balance, aligning knees, cervical spine, dorsal spine, lumbar spine) and frontal plane (body balance, presence of scoliosis, aligning shoulders, aligning knees). The significance level adopted was 0.05.

RESULTS

Of the 70 schoolchildren invited to participate, 65 were evaluate in 2011, and 38 were reevaluate in the 2012. The sample loss was due to absenteeism because of a school trip, changing schools, absence for other reason, or inability to leave class for evaluation because of a test. Based on this, the sample comprised 38 schoolchildren evaluated in 2011 and 2012 who were 11 to 16 years old; of them, 13.2% were 11, 18.4% were 12, 31.6% were 13, 26.3% were 14, 7.9% were 15, and 2.6% were

Table 1. Classifications of subject posture in the sagittal and frontal planes, provided by DIPA, used in this study

Plane	Evaluated region	Classification
Sagittal	Body balance	Normal, with change (anterior imbalance, posterior imbalance)
	Aligning knees	Normal, with change (in flexion, in extension)
	Cervical spine	Normal, with change (in anterior position, retroverted)
	Dorsal spine	Normal kyphosis, with change (hyperkyphosis, kyphosis rectified)
	Lumbar spine	Normal lordosis, with change (hyperlordosis, lordosis rectified)
Frontal	Body balance	Normal, with change (right imbalance, left imbalance)
	Aligning knees	Normal, with change (valgus, varus)
	Aligning shoulders	Normal, presence of imbalance
	Presence of scoliosis	Normal posture, with change (dorsal scoliosis, lumbar, in dorsal and lumbar)

Table 2. Prevalence of postural changes in the sagittal plane in 2011 and 2012: (a) body balance, (b) aligning knees, (c) cervical spine, (d) dorsal spine, and (e) lumbar spine

(a)			(b)		
Body balance	2011	2012	Aligning knees	2011	2012
	N (%)	N (%)		N (%)	N (%)
Normal	0 (0)	0 (0)	Normal	26 (64.8)	24 (63.1)
Imbalance	38 (100)	38 (100)	Change	12 (35.2)	14 (36.9)
(c)			(d)		
Cervical spine	2011	2012	Dorsal spine	2011	2012
	N (%)	N (%)		N (%)	N (%)
Normal	13 (34.2)	9 (23.6)	Normal	14 (36.8)	8 (21)
Change	25 (65.8)	29 (76.4)	Change	24 (63.2)	30 (79)
(e)					
Lumbar spine	2011	2012			
	N (%)	N (%)			
Normal	22 (57.8)	7 (18.4)			
Change	16 (42.2)	31 (81.6)*			

*p value lower than 0.05

Table 3. Prevalence of postural changes in the frontal plane on 2011 and 2012: (a) body balance, (b) aligning knees, (c) aligning shoulders, and (d) presence of scoliosis

(a)			(b)		
Body balance	2011	2012	Aligning knees	2011	2012
	N (%)	N (%)		N (%)	N (%)
Normal	16 (42.1)	20 (52.6)	Normal	23 (60.5)	14 (36.8)
Imbalance	22 (57.9)	18 (47.4)	Change	15 (39.5)	24 (63.2)*
(c)			(d)		
Aligning shoulders	2011	2012	Presence of Scoliosis	2011	2012
	N (%)	N (%)		N (%)	N (%)
Normal	23 (60.5)	24 (63.1)	Normal	12 (31.5)	22 (57.8)*
Imbalance	15 (39.5)	14 (36.9)	Change	26 (68.5)	16 (42.2)

*p value lower than 0.05

16 in the second year of evaluation.

The results showed that there was a significant increase in the prevalence of postural change in the lumbar spine in the sagittal plane (Table 2) and in the knees (Table 3) and a significant decrease in scoliosis prevalence in the frontal plane (Table 3).

DISCUSSION

This study aimed to identify postural changes that are prevalent with advancing age. After one year, a significant increase in the prevalence of postural change in the lumbar spine and knees and a significant decrease in the prevalence of scoliosis were identified.

The lumbar region is one of the regions most affected by problems related to postural change and musculoskeletal pain^{16, 17}. Positional and structural factors have been suggested as possible causes of bad posture⁷. It is believed that merely adequate postural habits during the performance of activities of daily live (ADL) can minimize postural defects developed during the school years, which tend to remain over the course of one's life^{5, 12, 18}.

From this perspective, the school environment has a lot to do with this process, and the it appears that the school environment presents many ergonomic problems unfavorable to healthy postural habits. The relation between the school environment and changes in lumbar lordosis, for example, is well documented: the excessive weight of school supplies has been known to cause lumbar hyperlordosis^{17, 18}; the relaxed resting position when sitting, placing support on the ischial tuberosity and the posterior surface of the sacrum and coccyx, is associated with lumbar rectification^{19, 20}; and spending extended periods in a sitting posture is associated with an increase of lumbar flexion²¹⁻²³. It is also documented that there is a relation between ADL outside of school and postural changes in schoolchildren, such as in the case of adoption of the prone position while sleeping^{17, 24}.

Regarding the increase in knee alterations in the frontal plane when comparing the evaluation years, it is believed that this can be attributed to schoolchildren's stage of growth^{25, 26}. As is known, postural changes are multifactorial, and mainly in this stage of life, it is possible verify transient postural alignments to provide dynamic changes in postural alignments to children during development²⁷⁻²⁹.

An interesting finding was the significant decrease in the prevalence of scoliosis in the evaluated schoolchildren. A possible explanation for this could be the distribution of the evaluated age group. In the second year of evaluation, the largest part of the sample comprised 12-, 13-, and 14-year-old schoolchildren who were 11 or 12 years old, which is when the first growth spurt tends to occur, at the time of the first evaluation. It is well documented that idiopathic scoliosis, which is the most common type of scoliosis, is closely related to growth spurts^{12, 13}. In this period, there are many postural transformations in the search for a compatible balance with the body's new proportions; once this stage is over, postural changes tend to stabilize. Furthermore, this period of large bone growth coincides with fluctuation of circulating hormones, including estrogen, which interacts with growth hormone and other growth factors (bone acquisition and bone remodeling), which are considered potential etiologic factors of idiopathic adolescent scoliosis^{13, 30}.

The significant increase in postural change prevalence in the knees and the lumbar spine in teenagers, and the slight increase in changes in the cervical and thoracic region signal that the school period is a risky stage for the spine health of schoolchildren, since the ADL performed routinely by schoolchildren contribute to maintenance of inadequate posture³¹. These findings underscore the importance of conducting Back Schools programs in the school environment once the root of the problem is addressed, since they are effective in modifying postural habits^{6, 22, 32}.

Beyond Back Schools, there is a broader need to incorporate new public policies in the school environment in order to avoid further progression of postural changes like those found in this study. It should be emphasized that, besides the knowledge about the prevalence of postural change, it is also necessary to comprehend the relationship between this prevalence and the environment, in other words, how the everyday habits adopted by schoolchildren cause postural problems. The development of longitudinal investigations, rather than transversal studies, would allow for long-term monitoring of the evolution of posture and of schoolchildren habits, representing a viable alternative to subsidize the health actions to this public.

Against the background presented, we concluded that the prevalence of postural changes in the lumbar spine and knees increased significantly in one year, while the prevalence of scoliosis decreased significantly when comparing the years 2011 and 2012.

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REFERENCES

- 1) Widhe T: Spine: posture, mobility and pain. A longitudinal study from childhood to adolescence. *Eur Spine J*, 2001, 10: 118-123. [[Medline](#)] [[CrossRef](#)]

- 2) Noll M, da Rosa BN, Candotti CT, et al.: Alterações posturais em escolares do ensino fundamental de uma escola de Teutônia / RS *Rev Bras Cienc Mov*, 2012, 20: 32–42.
- 3) Giusti, PH, De Almeida Jr, HL, Tomasi E: Wheight excess of school materials and its risks factors in South Brazil. *Eur. J Phys Rehabil Med*, 2008, 44: 33–38.
- 4) Candotti CT, Noll M, Cruz M: Prevalência de dor lombar e os desequilíbrios musculares em manicures. *Rev. Eletrônica da Esc. Educ. Fis Desportos UFRJ*, 2010, 6: 125–140.
- 5) Noll M, et al.: Back pain and the postural and behavioral habits of students in the municipal school network of Teutônia, Rio Grande do Sul. *J Hum Growth Dev*, 2013, 23: 129–135.
- 6) Geldhof E, Cardon G, De Bourdeaudhuij I, et al.: Back posture education in elementary schoolchildren: a 2-year follow-up study. *Eur Spine J*, 2007, 16: 841–850. [[Medline](#)] [[CrossRef](#)]
- 7) Oshiro V, Gabriele P, Costa R: Alterações posturais em escolares: uma revisão da literatura postural deviations in schoolchildren : a literature review. *Rev. Bras. Cienc Saude*, 2007, 13: 15–22.
- 8) Nissinen MJ, Heliövaara MM, Seitsamo JT, et al.: Development of trunk asymmetry in a cohort of children ages 11 to 22 years. *Spine*, 2000, 25: 570–574. [[Medline](#)] [[CrossRef](#)]
- 9) Kiliç F, Yaman H, Atay E: Investigation of the effects of intensive one-sided and double-sided training drills on the postures of basketball playing children. *J Phys Ther Sci*, 2009, 21: 23–28. [[CrossRef](#)]
- 10) Furlanetto TS, Candotti CT, Comerlato T, et al.: Validating a postural evaluation method developed using a Digital Image-based Postural Assessment (DIPA) software. *Comput Methods Programs Biomed*, 2012, 108: 203–212. [[Medline](#)] [[CrossRef](#)]
- 11) Saad KR, Colombo AS, Ribeiro AP, et al.: Reliability of photogrammetry in the evaluation of the postural aspects of individuals with structural scoliosis. *J Bodyw Mov Ther*, 2012, 16: 210–216. [[Medline](#)] [[CrossRef](#)]
- 12) Braz HM, Borges MD: A relevância da avaliação postural nas escolas. *Coleção Pesqui. em Educ. Fisica*, 2007, 6: 25–32.
- 13) Leboeuf D, Letellier K, Alos N, et al.: Do estrogens impact adolescent idiopathic scoliosis? *Trends Endocrinol Metab*, 2009, 20: 147–152. [[Medline](#)] [[CrossRef](#)]
- 14) Santos GR, Abbud EL, Abreu AJ: Determination of the size of samples: an introduction for new researchers. *Rev Científica Symp*, 2007, 5: 59–65.
- 15) Furlanetto TS, De Oliveira Chaise F, Candotti CT, et al.: Fidedignidade de um protocolo de avaliação postural. *Rev. da Educ. Fis*, 2011, 22: 411–419.
- 16) Detsch C, Luz AM, Candotti CT, et al.: Prevalência de alterações posturais em escolares do ensino médio em uma cidade no Sul do Brasil. *Rev Panam Salud Publica*, 2007, 21: 231–238. [[Medline](#)] [[CrossRef](#)]
- 17) Lemos AT, Santos FR, Gaya AC: Hiperlordose lombar em crianças e adolescentes de uma escola privada no Sul do Brasil: ocorrência e fatores associados. *Cad Saude Publica*, 2012, 28: 781–788. [[Medline](#)] [[CrossRef](#)]
- 18) Neuschwander TB, Cutrone J, Macias BR, et al.: The effect of backpacks on the lumbar spine in children: a standing magnetic resonance imaging study. *Spine*, 2010, 35: 83–88. [[Medline](#)] [[CrossRef](#)]
- 19) Graup S, Dos Santos SG, Moro AR: Estudo descritivo de alterações posturais sagitais da coluna lombar em escolares da rede federal de ensino de Florianópolis. *Rev Bras Oftalmol*, 2010, 45: 453–459. [[CrossRef](#)]
- 20) Yu JS, An DH: Differences in lumbar and pelvic angles and gluteal pressure in different sitting postures. *J Phys Ther Sci*, 2015, 27: 1333–1335. [[Medline](#)] [[CrossRef](#)]
- 21) Beach TA, Parkinson RJ, Stothart JP, et al.: Effects of prolonged sitting on the passive flexion stiffness of the in vivo lumbar spine. *Spine J*, 2005, 5: 145–154. [[Medline](#)] [[CrossRef](#)]
- 22) Noll M, Candotti CT, Vieira A: Escola de educação postural: revisão sistemática dos programas desenvolvidos para escolares no Brasil. *Mov*, 2012, 18: 265–291.
- 23) Yoo W: Comparison of sitting with and without a backrest during computer work. *J Phys Ther Sci*, 2012, 24: 409–410. [[CrossRef](#)]
- 24) Noll M, Tarragô Candotti C, Vieira A, et al.: Back pain and body posture evaluation instrument (BackPEI): development, content validation and reproducibility. *Int J Public Health*, 2013, 58: 565–572. [[Medline](#)] [[CrossRef](#)]
- 25) Dutra DG, Silva PH, de Souza NT: Prevalence of postural changes adolescents Registered in a academy of gymnastics. *Rev Mov*, 2010, 3: 24–28.
- 26) Do Rego AR, Scartoni FR: Alterações posturais de alunos de 5ª e 6ª séries do Ensino Fundamental. *Fit Perform J*, 2008, 7: 10–15.

- 27) Adams MA, Dolan P: Spine biomechanics. *J Biomech*, 2005, 38: 1972–1983. [[Medline](#)] [[CrossRef](#)]
- 28) Santos MM, Silva MP, Sanada LS, et al.: Análise postural fotogramétrica de crianças saudáveis de 7 a 10 anos: confiabilidade interexaminadores. *Rev Bra Fisioter*, 2009, 13: 350–355. [[CrossRef](#)]
- 29) Cil A, Yazici M, Uzumcugil A, et al.: The evolution of sagittal segmental alignment of the spine during childhood. *Spine*, 2005, 30: 93–100. [[Medline](#)]
- 30) Yim AP, Yeung HY, Hung VW, et al.: Abnormal skeletal growth patterns in adolescent idiopathic scoliosis—a longitudinal study until skeletal maturity. *Spine*, 2012, 37: E1148–E1154. [[Medline](#)] [[CrossRef](#)]
- 31) Lee S, Shim J: The effects of backpack loads and spinal stabilization exercises on the dynamic foot pressure of elementary school children with idiopathic scoliosis. *J Phys Ther Sci*, 2015, 27: 2257–2260. [[Medline](#)] [[CrossRef](#)]
- 32) Fonseca CD, Cardoso Dos Santos A, Candotti CT, et al.: Postural education and behavior among students in a city in southern Brazil: student postural education and behavior. *J Phys Ther Sci*, 2015, 27: 2907–2911. [[Medline](#)] [[CrossRef](#)]