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Monitoring of students body posture: a longitudinal study.

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ABSTRACT

Introduction: Childhood and adolescence are important periods of growth in which the position is altered to support the new body proportions. **Objective:** To characterize the longitudinal profile of body posture in children and adolescents. **Method:** Body posture of children and adolescents of a Philanthropic Institution was assessed through an initial and one final evaluation after 24 months. The postural evaluation was performed by means of photogrammetry according to the Software Protocol (SAPo v 0.68). For analysis of the variables, the sample was divided into two groups with respect to age, where the first group (GI) was composed of 17 children aged 6 to 7 years and the second group (GII) by individuals from 8 to 10 years. Statistical analysis was performed with the Statistical Package for Social Sciences 15.0 software (SPSS). The significance determination criterion used was the level of 5%. **Results:** 34 students (19 girls and 15 boys) were evaluated. In relation to body posture, when the initial and final evaluation were compared, the variables Q right angle ($p = 0.003$) and horizontal alignment of the pelvis ($p = 0.006$) showed significantly difference to the GI. To GII the variables horizontal alignment of acromions ($p = 0.016$), right frontal lower limb angle (0,019) and left ($p < 0.001$), Q right angle ($p = 0.001$) and left ($p < 0.001$), alignment horizontal pelvis ($p = 0.009$), ankle angle ($p = 0.002$) and left-leg/hindfoot angle ($p = 0.017$) showed greater changes in angular medians. **Conclusion:** Children of GI presented more homogeneous values after the established range, keeping an angular stability for most of the observed postural variables. However, GII presented more significant decreases in asymmetries and body misalignments.

Keywords: growth, child, adolescent, posture, physical therapy

INTRODUCTION

Human posture is a result of the relationship between gravity and the body structure[1] and is characterized as a state of skeletal balance capable of protecting the body against injury or deformity.[2-4] Since the first years of life, the body undergoes changes in posture throughout its development, where some are more evident during the school stage, since in this period occur growth spurts.[5.6]

During body growth there is a quest for structural balance, demanded by the compatibility with the new bodily proportions, and new ways of reacting to gravity are tested, which generates postural changings which constantly varies. This makes it impossible to require stereotyped alignment posture patterns from children.[7,8] With advancing age children tend to have a higher body alignment due to stabilization of body posture and a better projection of the center of gravity.[7,9,10] Adolescents and adults have more defined postural standards, which may or not be considered satisfactory.

Studies that observed the postural alignment of children and adolescents identified significant alterations in the course of growth. Lafond, et al.[10] assessed 1084 individuals aged from 4 to 12 years and it was observed that the postural alignment changes considerably in relation to a vertical reference and is characterized by asymmetries in the segments of the head, shoulders, pelvis and knees. Back, et al.[11] evaluated 44 students from 1st to 4th grade and found that all had some kind of postural misalignment. These authors justify their findings by affirming that this fact is a physiological and natural consequence of growth, and may also be associated with daily postural habits. [10,11]

Investigations of body posture through photographs have produced satisfactory results.[12] Photography, in addition to practicality, ensures greater accuracy of results, especially when combined with software for measurement and analysis of angles and distances.[13] The Postural Assessment Software (PAS), reliable and validated tool, allows the quantitative analysis of body posture through the demarcation of anatomical points.[14,15]

The use of software to perform the analysis of posture of children and adolescents is increasing.[2,10] However, alignment reference values and postural symmetries for children and adolescents are still scarce, and most of the time, based on the posture of the adult population, although it is known that the

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developing musculoskeletal system has its own characteristics and transitional postures.[9,10] Also, longitudinal follow up of the posture of this population are tight. Therefore, the objective of this study is to classify the body mass index (BMI) and characterize the evolution of the longitudinal profile of the body postural alignment of children and adolescents.

METHOD

This is a longitudinal, observational, quantitative and descriptive study. The follow-up of variations in the body posture of schoolchildren attending a Philanthropic Institution was carried out, through evaluations obtained in a 24 month interval. The participants' initial age ranged from 6 to 10 years.

The study included all schoolchildren who regularly attended the Institution and carried out the two evaluations in the expected interval, during the years of 2012 to 2015. The participant's responsibles signed the Free and Informed Consent Form and children with comprehension skills, signed the Term of Assent. Those who had any cognitive or musculoskeletal changes that limited the proposed investigation were excluded. This study was approved by the Ethics and Research Committee of the Federal University of Santa Maria (CAAE protocol nº 0369.0.243.000-11), in December 2001.

Growth was measured by verifying weight and height, with the participant standing and barefoot. An anthropometric balance of the Filizzolla brand was used with a stadiometer graduated in centimeters. From the BMI, age and sex, the BMI of low weight, eutrophic and overweight children (overweight or obese) was characterized according to the linear growth curves recommended by the World Health Organization.[16]

Postural evaluation was performed through photogrammetry by two trained evaluators. The data were processed by the Postural Assessment Software (PAS, v 0.68 SAPo®),[17] a tool used in many studies.[18-21] The pictures were taken with Sony digital camera, 14.1 megapixel resolution, positioned 1 meter parallel from the floor, on a tripod. The subject was placed three meters away from the camera, in the anterior, posterior and left views in bathing suits. To calibrate the photograph, a plumb line was fixed to the ceiling of the room with two points marked 100 cm apart. To ensure the same base of support in the photographs, a black rubber mat was used in which the contour of the feet was drawn with chalk. The anatomical references were manually palpated and demarcated with styrofoam balls, as recommended in the protocol.[17]

The variables of body posture were selected for the analysis, in the anterior, posterior and profile views, considered with levels of acceptable reliability, very good or excellent, according to Souza et al. [14] Thus, we evaluated the following: horizontal alignment of the head, acromions and anterior superior iliac spine (ASIS), the tuberosity of the tibia and pelvis; Vertical alignment of the acromial and vertical head of the body, angles between acromion and EIA, frontal of the lower limbs (LL), right and left Q, knee angle, ankle and right and left leg/hindfoot, difference in limb length and asymmetries in the frontal and sagittal planes.

For the analysis of the variables, the sample was divided into two groups, considering the age of the first evaluation, in which the first group, Group I (GI), was composed of 17 children aged 6 and 7 years and the second, Group II (GII), by individuals from 8 to 10 years. Statistical analysis was processed by Statistical Package for Social Science 15.0 (SPSS) software. For the detection of differences between two means, paired t test was used for the variables of normal distribution and the Wilcoxon for non-parametric test on those in which the normality hypothesis was rejected. Significance was considered in the case of $p<0.05$.

RESULTS

Thirty-four schoolchildren, 19 girls and 15 boys participated in this longitudinal study. The mean age, weight, height and Body Mass Index (BMI) for the initial and final evaluations are presented in Table 1.

In the BMI classification, in the first evaluation, 23 (73.54%) schoolchildren were eutrophic, four (8.82%) were underweight and seven (17.64%) were overweight. In the second evaluation, 24 months later, 24 (70.58%) were eutrophic, one (2.95%) underweight and nine (26.47%) were overweight. When comparing the variations between the first and second evaluation, from the 23 eutrophic, two regressed to low weight, six evolved to overweight and the other 15 maintained eutrophy. Four schoolchildren in low weight were identified, in which three became eutrophic and only one passed to the classification overweight. Still, from the seven participants who were overweight in the first evaluation, six of them remained with this classification and the other one became eutrophic.

Table 2 presents the body posture variables for the GI, in which a significant difference was observed between the medians of the evaluations in the anterior view for the variable

Table 1. Schoolchildren profile in the first evaluation and after 24 months.

Variables	Evaluations (n=34)	
	EvI	EvF
	Mean ± SD	Mean ± SD
Age (years)	7.73 ± 1.50	9.73 ± 1.50
Weight (Kg)	26.72 ± 5.95	34.94 ± 8.95
Height (m)	1.27 ± 0.09	1.37 ± 0.11
BMI (Kg/m²)	16.35 ± 1.93	18.15 ± 2.51
BMI rating	**%**	
Low weight	8.82	2.94
Eutrophic	73.52	70.58
Overweight	17.64	26.47

EvI: Initial Evaluation; EvF: Final Evaluation; BMI: Body Mass Index; SD: Standard Deviation.

Table 2. Variations of body posture in the first evaluation and 24 months after, in the anterior view, left and posterior profile for the group of schoolchildren aged 6 and 7 years.

Variables	GI ASSESSMENT (n=17)		
	EvI Median (Min-Max)	EvF Median (Min-Max)	p
Previous View			
Align horiz of head(°)	1.60 (0.7-4.7)	1.6 (0.3-3.1)	0.468
Align horiz of acromions (°)	1 (0.9-3.0)	0.9 (0.3-3.1)	0.523
Align horiz of ASIS(°)	1.30 (0.8-2.6)	1.1 (0.4-1.8)	0.266
Â acromions and ASIS(°)	1.70 (0.6-3.7)	1.8 (0.9-2.9)	0.642
Â front of RLL(°)	2.2 (1.4-3.3)	2.8 (0.9-2.9)	0.343
Â front of LLL(°)	3.1 (1.1-7.5)	2.9 (1.2-6.1)	0.981
Diff. lenght MMII(°)	0.7 (0.1-1.4)	1.2 (0.3-1.5)	0.887
Horiz align tuber of tibias(°)	2.9 (1.5-5.5)	2.3 (0.0-4.7)	0.115
Â Q R(°)	21.9 (12.1-32.4)	7.9 (3.1-10.0)	0.003*
Â Q L(°)	15.6 (5.2-27.2)	6.1 (3.7-13.2)	0.097
Asymmetry in the frontal pl. (%)	17.5 (4.5-25.9)	4.0 (1.3-12.2)	0.185
Left Side View			
Vert align of acromions-head (°)	9.5 (4.4-25.6)	13.2 (4.7-20.6)	0.339
Vert align of the body(°)	2.5 (1.5-3.2)	2.1 (0.6-2.4)	0.109
Horiz align of the pelvis(°)	17.4 (15.8-27.4)	16.3 (9.6-18.5)	0.006*
Â do knee(°)	4.8 (3.3-7.7)	2.8 (1.25-6.3)	0.177
Â of ankle(°)	87.1 (83.4-88.4)	88.9 (84.8-90.0)	0.068
Sagital Asymmetry pl.(%)	25.5 (17.1-34.8)	24.0 (20.1-37.5)	0.060
Posterior view			
Â leg /hindfoot R(°)	11.9 (8.6-20.2)	10.8 (4.6-17.5)	0.570
Â leg /hindfoot L(°)	16.4 (10.5-19.2)	7.3 (1.7-15.8)	0.061

Min: Minimum; Max: Maximum; Â: Angle; Align: alignment; Horiz: horizontal; Vert: vertical; RLL: right lower limb; LLL: lower left limb; Dif: difference; Tuber: tuberosities; pl: plan; ASIS: anterior-superior iliac spines, C7: seventh cervical vertebra; R: right; L: left; SD: standard deviation. * level of significance p<0.05.

Q right angle (p=0.003) and in the left lateral view for the horizontal alignment of the pelvis (p=0.006). In table 3, the same postural variables were presented for the GII, in which in the anterior view a significant difference was found for the horizontal alignment of the acromion (p=0.016), the frontal angle of the lower right limb (0.019) and left (p<0.001) and the Q right (p=0.001) and left angle (p<0.001). On the left side the horizontal pelvic alignment (p=0.009) and the ankle angle (p=0.002) had a significant difference. In the posterior view only the left leg and hindfoot angle had significance (p=0.017).

DISCUSSION

Through the follow-up of children and adolescents attending the Philanthropic Institution, it was observed that most of them obtained a classification of BMI within normality during the evaluations. It should be noted that none of the participants classified as underweight in the first evaluation remained in the second in this classification and also that the highest percentage of overweight individuals was found in the final evaluation.

The variables horizontal alignment of the pelvis and Q angle presented a decrease in the angular medians when compared to the initial and final evaluation for GI and GII. The horizontal alignment angle of the pelvis indicates anteversion or retroversion, if there is asymmetry. In this study, there was a decrease of the angular values for this variable in the GI and GII with the growth, indicating the search for a pelvic stabilization with the age advancing.

For some authors the anteversion/retroversion are physiological changes that occur in the period of growth. This is explained by weakness of the rectus abdominis and paravertebrae, since this muscle acts more effectively from 10 or 12 years of life.[6.11]

The Q angle, formed by a line between the anterior-superior iliac spine and the center of the patella, according to PAS protocol [17] indicates a patellar misalignment (patella lateralized or medialized). This misalignment can occur due

Table 3. Variations of body posture in the first evaluation and 24 months after, in the anterior view, left and posterior profile for the group of schoolchildren aged 8, 9 and 10 years.

Variables	GII ASSESSMENT (n=17)		
	EvI Median (Min-Max)	EvF Median (Min-Max)	p
Previous view			
Align horiz of head-C7(°)	1.5 (1.3-4.4)	1.4 (0.7-2.9)	0.205
Align horiz of acromions (°)	1.9 (1.2-2.9)	0.8 (0.4-2.0)	0.016*
Align horiz of ASIS (°)	2.1 (1.0-3.0)	1.0 (0.5-2.5)	0.344
Â acromions and ASIS (°)	2.4 (0.9-4.2)	1.7 (0.6-3.0)	0.093
Â front of RLL (°)	3.9 (2.4-5.3)	2.2 (1.3-2.6)	0.019*
Â front of LLL (°)	4.7 (3.7-6.8)	2.0 (0.6-4.0)	<0.001*
Diff. lenght MMII (°)	0.5 (0.3-1.2)	1.1 (0.5-2.1)	0.332
Horiz align tuber of tibias (°)	2.7 (1.2-4.8)	2.3 (1.2-4.0)	0.955
Â Q R(°)	23.4 (13.7-28.7)	4.7 (2.0-11.0)	0.001*
Â Q L(°)	24.1 (17.8-32.7)	3.7 (2.6-7.1)	<0.001*
Asymmetry in the frontal pl.(%)	10.1 (5.6-38.2)	5.3 (2.1-11.2)	0.050*
Left Side View			
Vert align of acromions-head (°)	12.5 (8.1-16.1)	17.5 (7.8-23.7)	0.619
Vert align of the body (°)	1.5 (0.9-2.6)	1.5 (0.6-2.0)	0.393
Horiz align of the pelvis (°)	17.8 (15.9-23.4)	14.2 (10.6-15.5)	0.009*
Â of knee(°)	4.2 (2.5-10.4)	5.7 (1.3-7.8)	0.394
Â of ankle(°)	85.5 (83.1-86.9)	88.2 (87.1-91.1)	0.002*
Sagital Asymmetry pl.(%)	23.6 (20.6-31.3)	23.1 (8.6-25.6)	0.076
Posterior view			
Â leg /hindfoot R (°)	12.7 (7.4-16.0)	10.0 (3.4-15.6)	0.492
Â leg /hindfoot L(°)	13 (8.9-16.7)	7.3 (1.7-15.8)	0.017*

Min: Minimum; Max: Maximum; Â: Angle; Align: alignment; Horiz: horizontal; Vert: vertical; RLL: right lower limb; LLL: lower left limb; Dif: difference; Tuber: tuberosities; pl: plan; ASIS: anterior-superior iliac spines, C7: seventh cervical vertebra; R: right; L: left; SD: standard deviation. * level of significance p<0.05.

to muscle imbalances, ligament laxity and twisting of the tibia.[22] In 42 children aged 7 to 10 years found an average of 10,8º ± 3.78[23] This value is close to that found in this study.

As for the shoulder drop, we observed a reduction in the GII asymmetries when compared to the initial and final evaluations. The study Santos et al.[24] also identified this postural change to assess 247 children and adolescents in which 50.2% of subjects had sunken shoulders. This difference occurred predominantly in the age group of 7 and 8 years. Still Penha et al.[5] in assess children 7 to 10 years found that 65.1% of the sample at the age of 9 years showed asymmetry of shoulders in the frontal plane. This postural change may be associated with the transport overhead backpacks[24] and also be predictive for the development of scoliosis.[5]

The ankle angle is formed by the point of projection of the knee joint line, the lateral malleolus and a horizontal line, which form a right angle. A reference value of 90º is expected.[25] In GII values were found to tend to approach the angle expected in the final evaluation. This stabilization may be associated with the reduction of the compensatory strategies of the child's body. In a study on the position of the lower limbs of 42 children aged 7 to 10 years the average for the ankle angle was 83,94º[23] this finding is similar to those found in the GII initial assessment.

In the posterior view, the left leg/hindfoot angle presented significant difference with the growth, in which medians were obtained that decrease throughout the evaluations. It is known that the Leg/hindfoot angle greater than 10º characterizes as valgus calcaneus.[26,27] In the study of Marimoto, et al.[28] which evaluated the posture of children aged from 8 to 10 years old found in 94.4% of evaluated valgus calcaneal. Also, in the study by Penha, et al.[2] has established the presence of valgus calcaneal in 76.0% of children aged 8 years and 67.0% in the evaluated aged 9 to 10 years.

The valgus calcaneus is related to the increase of load on the medial aspect of the foot, which allows the occurrence of the flat foot. This is a mechanism that allows redistribution of the child's weight during changes in body proportions and is a temporary condition that rarely persists until the end of adolescence, so it should not be considered as a change in posture unless it is very pronounced.[7]

Asymmetry in the frontal plane decreased significantly with growth in GII. It is suggested that this fact has been due to a better balance of plantar pressures of contact from a natural reorganization of the alignment and the tendency to adapt to the new acquired body proportions.[28]

The frontal angle of the lower limb is formed by the greater trochanter of the femur, lateral projection of the joint line of the knee and lateral malleolus.[17] In this study the mean values found are decreasing with increasing age, but in the searched literature it was not found studies that contradict or confirm these values in school.

The lack of studies that follow longitudinally the modifications of body posture in childhood and adolescence made it difficult to discuss the data, as well as the lack of reference values of some points analyzed by the PAS protocol, generating difficulty in interpretation. As limitations of this study we can cite the sample loss within the range established due to the transition of the selected sample.

CONCLUSION

Children who had their posture initially assessed at 6 and 7 years (GI) presented more homogeneous values after the established interval, showing a stabilization for most of the posture variables studied. The children who performed the first evaluation at 8, 9 and 10 years (GII) had decreases in asymmetries and body misalignments. It is suggested that this fact is linked to body realignment, which generates a new balance compatible with body proportions from growth.

AUTHOR'S CONTRIBUTION

Nichele, L. F. I.: project design, data collection, analysis of results and preparation of the article; Badaró, A. F. V.: project design, data collection, results analysis and article preparation; Turra, P.: project preparation, data collection, results analysis and article preparation.

CONFLICTS OF INTEREST

We declare there is no conflict of interest, potential or apparent, that may have affected the results of the work.

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