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Posture and musculoskeletal pain in eutrophic, overweight, and obese students. A cross-sectional study

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Abstract—Childhood obesity increases susceptibility to musculoskeletal injuries. The purpose of this study was to describe the prevalence of overweight and obesity and to identify differences in posture and musculoskeletal pain among eutrophic, overweight, and obese students. Participants were 420 students, 252 (60%) were females and 168 males (40%), with a mean age of 11.1 (± 2.3) years. The posture of all participants was qualitatively assessed; the quantitative postural evaluation was performed using the Postural Assessment Software (PAS/SAPo) for a population subsample of 99 participants. An adapted version of the Nordic Musculoskeletal Questionnaire was used for pain assessment. Data were analyzed descriptively and via statistical tests (significance level of $p < 0.05$). The target population exhibited 22.1% of overweight individuals and 14.1% of obese. Compared to the eutrophic students, the postural evaluation showed a higher knee valgus angle, higher incidence of thoracic kyphosis, and greater prevalence of lumbar hyperlordosis in overweight and obese students ($p \leq 0.05$). No association between overweight and pain complaints was detected ($p = 0.994$).

Keywords: obesity, posture, musculoskeletal pain, photogrammetry

Resumo—“Postura e dor musculoesquelética em estudantes eutróficos, com sobrepeso e obesos. Um estudo transversal.” A obesidade infantil aumenta a susceptibilidade a lesões musculoesqueléticas. Os objetivos deste estudo foram descrever a prevalência de sobrepeso e obesidade e identificar as diferenças na postura e dores musculoesqueléticas entre os estudantes eutróficos, com sobrepeso e obesos. Dos 420 alunos avaliados, 252 (60%) eram do sexo feminino e 168 (40%) do sexo masculino, com idade média de 11,1 ($\pm 2,3$) anos. A postura de todos os indivíduos foi avaliada qualitativamente. Para uma subamostra ($n=99$), a avaliação postural quantitativa foi realizada pelo Software de Avaliação Postural (PAS/SAPo). Uma versão adaptada do Questionário Nórdico de Sintomas Osteomusculares foi usada para avaliação da dor. Os dados foram analisados de forma descritiva e por testes estatísticos com nível de significância de 5%. Os resultados mostraram que a prevalência de sobrepeso foi de 22,1 % e de obesidade foi de 14,1%. Avaliação postural indicou maiores ângulos de valgo de joelho, maior incidência de cifose torácica e hiperlordose lombar em estudantes com sobrepeso e obesidade em relação aos eutróficos ($p \leq 0,05$). Não houve associação entre excesso de peso e dor ($p = 0,994$).

Palavras-chave: obesidade, postura, dor musculoesquelética, fotogrametria

Resumen—“La postura y dolor musculoesquelético en estudiantes de peso normal, con sobrepeso, y con obesidad. Un estudio transversal.” La obesidad infantil aumenta la susceptibilidad de sufrir lesiones musculoesqueléticas. Los objetivos de este estudio es describir la prevalencia de sobrepeso y de obesidad e identificar las diferencias de postura y dolores musculoesqueléticos entre los estudiantes eutróficos, con sobrepeso y obesos. De los 420 estudiantes evaluados, 252 (60%) eran del sexo femenino y 168 (40%) del sexo masculino, con edad media de 11,1 ($\pm 2,3$) años. La postura de todos los individuos fue evaluada cualitativamente. Para un submuestreo ($n=99$), una evaluación de la postura cuantitativa fue realizada por un Programa de Evaluación Postural (Software de Avaliação Postural PAS/SAPo). Una versión adaptada del Cuestionario Nórdico Estandarizado fue utilizada para la evaluación del dolor. Los datos han sido analizados de forma descriptiva y por testes estatísticos con nivel de significancia del 5%. Los resultados han demostrado que la prevalencia de sobrepeso fue de 22,1% y de obesidad fue de 14,1%. La evaluación de la postura ha indicado ángulos más grandes de genu valgum (valgo de rodilla), mayor incidencia de cifosis torácica e hiperlordosis lumbar en estudiantes con sobrepeso y obesidad en relación a los alumnos eutróficos ($p \leq 0,05$). No hubo asociación entre el exceso de peso y el dolor ($p = 0,994$).

Palabras clave: obesidad, postura, dolor musculoesquelético, fotogrametría

Introduction

The number of people who are overweight or obese has increased worldwide (Wills, 2004). Brazilian population is experiencing a transition process in their nutritional status, in which malnutrition declines and prevalence of overweight and obesity increases (Brazilian Institute of Geography and Statistics [IBGE], 2010). According to IBGE (2010), the excess weight in adult men jumped from 18.5% (1974-75) to 50.1% (2008-09). The rate of weight increase from 28.7% to 48.0% for men outpaced the rate for women. This situation also affects children and adolescents. Obese children have a higher chance of developing hypertension, respiratory, dermatological, endocrine, and orthopedic disorders in addition to maintaining obesity throughout adulthood (Dietz, 1998; Fisberg, 2006; Moser, Milano, Brito, Titski, & Leite, 2011; Reilly, 2006; Wearing, Hennig, Byrne, Steele, & Hills, 2006;).

The mechanical overload caused by overweight also leads to greater susceptibility to musculoskeletal injuries (Calvete, 2004; Campos, Silva, & Anhesim, 2004). One of the consequences of this overload is improper posture. Initially compensatory, improper posture progresses to a fixed posture with muscle adaptations and retractions of joint capsules and ligaments that may result in musculoskeletal pain (Bell et al., 2011; Levangie & Norkin, 2005; Pinto, Holanda, Radu, Villares & Lima, 2006; Taylor et al., 2006).

Posture changes during the process of development during childhood and adolescence. Functional changes as a result of poor posture, negatively impact the health of children (Calvete, 2004). Some authors have evaluated the association between obesity and the presence of postural changes (Arruda, 2009; Cicca, João, & Sacco, 2007; Detsch et al., 2007; Kussuki, João, & Cunha, 2007; Mac-Thiong, Berthoulaud, Dimar, Betz, & Labelle, 2011; Pinto et al., 2006; Silva et al., 2011; Taylor et al., 2006). Others have reported musculoskeletal pain in this population (Bell et al., 2011; Pinto et al., 2006; Silva et al., 2011; Stovitz, Pardee, Taylor et al., 2006; Vazquez, Duval & Schwimmer, 2008).

The association between obesity and postural changes had already been observed previously. However, some of the previous studies have limitations, including small sample size (Arruda, 2009; Cicca et al., 2007; Kussuki et al., 2007; Martinelli et al., 2011; Pinto et al., 2006; Silva et al., 2011), limited range of age or imbalance between sexes of participants (Arruda, 2009; Cicca et al., 2007; Detsch et al., 2007; Kussuki et al., 2007), or lack of a reference group for comparison (Martinelli et al., 2011). Furthermore, the type of posture classification used varies among studies, including analysis of postural changes using anteroposterior and lateral views (Detsch et al., 2007) and qualitative and quantitative analysis. Thus, it is clear that there is a great heterogeneity in the assessed samples and the measurement techniques used and, consequently, in the results. This demonstrates that this matter requires further investigation.

When subjective (or qualitative) measurements are compared with direct (or quantitative) measurements, it is observed that more accurate data are obtained from direct measurements (Juul-Kristessen, Fallentin, & Ekdahl, 1997). However, quantitative methods are more complex, time consuming and can only assess certain parts of the body.

The Postural Assessment Software (PAS/SAPo) is based on photogrammetric measurements developed by Ferreira (2005). This method was validated (Ferreira, Duarte, Maldonado, Burke, & Marques, 2010), including intra- and inter-rater reliability for the target population (Sato, Martins, Minatel, Moreira, & Coury, 2009). However, it is important to note that the analysis generated by SAPo cannot assess the posture of the spine and therefore requires a complementary qualitative evaluation.

Given this background, the purpose of this study was: (1) to describe the prevalence of overweight and obesity among students; and (2) to identify alterations in posture using qualitative and quantitative evaluations, and (3) to register complaints of musculoskeletal pain among eutrophic students and overweight students (including both overweight and obese) from a sample of female and male students with ages of 6 to 18 years.

Methods

Participants and study location

This is an observational cross-sectional study. The number of potentially eligible participants was 1039 and comprised all students enrolled in elementary school in two public schools in the State of São Paulo (Brazil). While the two schools were in different neighborhoods, the socioeconomic profiles of the students (that is, a low socioeconomic profile) were similar. All students from both schools were invited to participate in the study; however, only those with an informed consent form signed by their parents could participate.

Inclusion criteria were: being regularly enrolled in the target elementary schools, and bringing the consent form signed by their parents or legal representative on the day of the evaluation. Exclusion criteria were: a BMI (body mass index) classified as underweight (below the 15th percentile of the WHO charts for BMI for age) (De Onis, Onyango, Borghi, Siyam, Nishida, & Siekmann, 2007); and diseases, disorders, or disabilities of the musculoskeletal or neurological system reported by students, teachers or guardians or observed by the evaluators.

The sample consisted of 420 elementary school students (1st to 8th grade) who were evaluated between the years 2007 and 2010.

Equipment and instruments

Personal data such as identification, age and grade were collected in a standardized form. The presence of musculoskeletal pain was assessed using an adapted version of the Nordic Musculoskeletal Questionnaire - QNSO (Pinheiro, Tróccoli & Carvalho, 2002). This instrument includes a picture of a body contour that allowed the student to report location of any pain experienced during the past seven days. However, additional data contained in the QNSO (symptoms during the last 12 months, pain interference in daily activities, and whether medical treatment had been sought) were not collected.

Body mass was measured using a high accuracy four cells digital anthropometric scale (G Life ®, 180 kg; maximum sensitivity, 100 g). Height was measured using a millimeter

tape (sensitivity: 5 mm). A turntable, digital camera (SONY Handycam® DCR-SR85), and a tripod (Wiefeng WT3111 Tripod) were also used for the purpose of taking pictures of the participants' full body.

Postural evaluation

Two types of postural evaluations were performed: a qualitative and a quantitative evaluation. Postural Assessment Software (PAS/SAPo) was used to quantitatively assess posture. This software is available at the website: <http://puig.pro.br/sapo/>. In the literature, it is possible to identify Brazilian studies using this method to improve the quality of postural evaluations such as Guimarães, Sacco, and João (2007) and Iunes, Castro, Salgado, Moura, Oliveira, and Bevilaqua-Grossi (2005).

The quantitative postural evaluation required the use of reflective markers consisting of polystyrene spheres 2 cm in diameter that were coated with reflective material. A plumb line was positioned next to the participant to enable calibration of the photographic recording using the vertical as reference. A turntable was used to prevent the individuals to move so that photos were taken in the different views (anterior, posterior, and lateral) using the digital camera fixed on a tripod.

Qualitative postural evaluation was performed by a physiotherapist using reference points provided in the literature (Kendall, McCreary, Provance, Rodgers, & Romani, 2007). According to Kendall et al. (2007), the plumb line represents the line of gravity. Thus, in the mid sagittal plane, from the center of the heel, the gravity vector extends upward between the lower limbs, the midline of the pelvis, spine, sternum and skull. The left and right halves must be symmetrical. In the side view, the projection represents the line of gravity in the frontal plane. The gravity line extends slightly in front of the lateral malleolus, slightly anterior to the axis of the knee joint, slightly behind the axis of the hip joint, then passes through the bodies of the lumbar vertebrae, approximately through the middle of the trunk and shoulder and, finally through the middle the external auditory canal.

Based on the structures mentioned above and relative to the plumb line, the presence of postural changes was determined from the photographic records. The aspects evaluated were: lateral tilt and forward head, shoulder anteriority, cervical lordosis, thoracic kyphosis, and lumbar lordosis.

The intra-rater reliability of postural qualitative evaluation was tested in 10 participants, five normal and five overweight students. The results indicated that, in general, the intra-rater reliability was 80%. More specifically, the results were: 80% reliability for the evaluation of the lateral tilt of the head, 80% for the forward head evaluation, 90% for the shoulder anteriority evaluation, 100% for cervical lordosis, 60% for thoracic kyphosis, and 70% for lumbar lordosis.

Procedures

The evaluation was conducted with children in bathing suits and no shoes. For quantitative postural analysis, reflective markers were placed by a physiotherapist trained in the

following anatomical landmarks: tragus, glabella, acromion, anterior superior iliac spine (ASIS), greater trochanter, knee joint line, patella, anterior tibial tuberosity (ATT), lateral malleolus, medial malleolus, the C7 spinous process, the point between the second and third metatarsals, the inferior angle of the scapula, and the midline of the leg (Ferreira et al., 2010). Each patient was then positioned on the turntable, next to a plumb line, with the feet aligned and separated using the width of the hips as the separation distance.

The evaluator moved the platform for the photographic record of the different plans. The digital camera was positioned three meters away from the participant, on a tripod approximately one meter from the ground, so that the image of the individual could occupy the center of the visual field of the camera. The recordings were made in the frontal and sagittal views from the anterior, posterior, and both the right and left sides.

All photos were submitted to procedures of calibration, alignment, and identification of the vertical reference (plumb line). This reference line was placed slightly forward of the participants' lateral malleolus in the side views and of the midpoint between the two legs in the front and back views, as suggested by Kendall et al. (2007). After this, the qualitative analysis of posture was performed in each patient.

Quantitative evaluation followed the guidelines of PAS/SAPo. The photos were aligned and calibrated. The reflective markers were identified and the protocol of measures of the PAS/SAPo was used, providing the following parameters: horizontal alignment of the acromions, horizontal alignment of the ASIS, angle between acromions and ASIS, vertical alignment of the trunk, horizontal alignment of the pelvis, hip angle, knee angle, valgus knee, quadriceps angle (Q), ankle dorsiflexion, valgus ankle, horizontal alignment of the head, vertical alignment of the head, and projection of the center of gravity in the frontal and sagittal planes.

The PAS/SAPo results presented in this study are in degrees. Negative values indicate deviations to the left and positive values indicate deviations to the right for the parameters: horizontal alignment of the acromions, horizontal alignment of ASIS, angle between the acromions and ASIS. In these cases, 0° is the expected value for participants without postural changes.

For parameters such as hip angle, knee angle, valgus knees, and valgus ankle, positive values indicate flexion and negative values indicate extension. For the quadriceps angle (Q), normality is expected at 15° for girls and 12° for boys. For ankle dorsiflexion, the normal angle is 90°.

For the vertical alignment of the trunk, negative values indicate extension and positive values indicate trunk flexion. For the horizontal alignment of the pelvis, negative values indicate anteversion and positive values indicate retroversion. For vertical alignment of the head, negative values indicate forward head and positive values indicate head retraction.

The horizontal alignment of the head is a measure used only for comparing evaluations. In this case, high angles represent greater cervical spine extension.

In this study, the manual palpation of all anatomic landmarks necessary for quantitative evaluation in PAS/SAPo demanded around 40 minutes per participant and the number of students to

be evaluated was relatively large. This procedure was performed only for a sub-sample of students ($n=99$, or 24% of the total sample). There were no selection criteria for determining the sub-sample composition. The first 99 participants in the study comprised the sub-sample.

Data analysis

The body mass index (BMI) was calculated by dividing body mass (kg) by height squared (m). From the BMI values, age, and gender, students were classified into two groups: eutrophic and overweight (overweight and obesity), as defined by the World Health Organization (WHO) (De Onis et al., 2007). According to WHO, the BMI classification of children and adolescents must use specific charts that consider age and gender of the child. These charts can be accessed on the WHO website: http://www.who.int/growthref/who2007_bmi_for_age/en/. For WHO classification, overweight children are those with BMI above the 85th percentile; obesity signifies a BMI above the 97th percentile.

The QNSO data were grouped in conditions of presence or absence of musculoskeletal pain in any region of the body.

Statistical analysis was performed with SPSS for Windows (version 20.0). The chi-square test (χ^2) was used to test the association between groups (eutrophic and overweight) and between dependent variables from qualitative postural analysis (categorical) and the presence of musculoskeletal pain (dichotomous).

For the continuous dependent variables from the quantitative postural evaluation (PAS/SAPo), tests of normality and homogeneity of variance were employed—the Shapiro-Wilk test and Levene’s test, respectively. Since postural changes depend on age and sex (Lueder & Rice, 2008; Mac-Thiong et al., 2004; Penha et al., 2005), these covariates were included in the multivariate analysis (MANCOVA). Multivariate analysis allows us to identify whether significant differences exist between factors of interest when the dependent variables are combined. Additionally, the covariate analysis uses the relationship between the dependent variable and an intervening variable (age) to adjust the score of the dependent variable (Carter et al., 2011). The dependent variables resulting from the evaluation by PAS/SAPo were grouped in segments (head, trunk, and lower limbs) for the multivariate analysis. The significance level of 5% ($p<0.05$) was adopted.

Results

Table 1 shows the demographic and physical characteristics of the sample population. Gender, age, grade, body weight, height, and BMI are shown separately by groups and for the total sample.

The mean age of the participants was 11.1 years (± 2.3 years) and the gender distribution was similar between groups. The prevalence of overweight found in this study was 22.1% and obesity was 14.1%. Among males, the prevalence of overweight was 20.2% and obesity was 16.1%; for girls the prevalence was 23.4% and 12.7%, respectively. The association between gender and overweight was not significant ($\chi^2=0.002$, $p=0.967$).

Table 2 shows the results of qualitative analysis in both groups and in the total sample. Table 2 shows that the overweight group had a higher prevalence of thoracic hyperkyphosis and lumbar hyperlordosis ($p\leq 0.05$).

Results of the quantitative posture analysis of the trunk, lower limbs, head and projection of the center of gravity in the frontal and sagittal planes are shown in Table 3. Multivariate analysis found a significant difference between groups only for

Table 1. Characteristics of the sample evaluated in relation to gender, age, grade, body mass, height and body mass index (BMI), separated by group and for the total sample.

	Eutrophic (n=268; 63.8%)	Overweight (n=152; 36.2%)	Total (n=420; 100%)
Gender [n(%)]			
Female	161 (63.9)	91 (36.1)	252 (100.0)
Male	107 (63.7)	61 (36.3)	168 (100.0)
Age (years)			
mean(SD)	11.1 (2.3)	11.2 (2.2)	11.1 (2.3)
Grade [n(%)]			
1st grade	10 (62.5)	6 (37.5)	16 (100.0)
2nd grade	27 (73.0)	10 (27.0)	37 (100.0)
3rd grade	35 (70.0)	15 (30.0)	50 (100.0)
4th grade	15 (60.0)	10 (40.0)	25 (100.0)
5th grade	41 (59.4)	28 (40.6)	69 (100.0)
6th grade	52 (65.8)	27 (34.2)	79 (100.0)
7th grade	50 (54.9)	41 (45.1)	91 (100.0)
8th grade	38 (71.7)	15 (28.3)	53 (100.0)
Body mass (kg)			
mean (SD)	39.4 (10.6)	53.6 (14.8)	44.5 (14.1)
Height (m)			
mean (DP)	1.5 (0.2)	1.5 (0.1)	1.5 (0.1)
BMI (kg/m ²)			
mean (DP)	17.5 (1.8)	23.2 (3.8)	19.5 (3.8)

Table 2. Prevalence of postural changes in the qualitative analysis for the each group and the entire sample [n (%)].

Postural change	Eutrophic (n=268)	Overweight (n=152)	p	Total (n=420)
Cervical hyperlordosis	43 (16.1)	44 (28.9)	0.260	87 (20.7)
Thoracic hyperkyphosis	98 (36.6)	72 (47.4)	0.030	170 (40.5)
Lumbar hyperlordosis	101 (37.7)	82 (53.9)	0.005	183 (43.6)
Lateral tilt of the head	33 (12.3)	27 (17.8)	0.152	60 (14.3)
Forward head	51 (19.0)	54 (35.5)	0.730	105 (25)
Shoulder anteriority	49 (18.3)	41 (27.0)	0.151	90 (21.4)

Table 3. Results in degrees of quantitative postural evaluation of the trunk, legs, head and projection of the center of gravity for the different groups [mean (SD)].

Postural change	Eutrophic (n=74)	Overweight (n=25)	p	Total (n=99)
Trunk [°]				
Horizontal alignment of the acromions	0.9 (1.8)	0.7 (2.2)	0.899	0.8 (1.9)
Horizontal alignment of the ASIS	0.5 (2.3)	-0.2 (2.1)	0.235	0.3 (2.3)
Angle between acromions and ASIS	-0.4 (2.8)	-0.9 (2.7)	0.308	-0.5 (2.8)
Vertical alignment of the trunk	-2.4 (3.1)	-3.6 (3.7)	0.129	-2.7 (3.3)
Horizontal alignment of the pelvis	-12.9 (5.9)	-14.0 (4.9)	0.511	-13.2 (5.6)
Legs [°]				
Right hip angle	-5.0 (6.5)	-7.4 (6.1)	0.206	-5.6 (6.5)
Left hip angle	-7.0 (5.2)	-8.1 (5.8)	0.861	-7.3 (5.3)
Right knee angle	3.6 (6.6)	0.9 (7.6)	0.319	2.9 (7.0)
Left knee angle	0.6 (5.3)	-1.1 (8.1)	0.889	0.2 (6.3)
Right valgus knee	-1.1 (2.9)	-3.5 (2.1)	0.001	-1.7 (2.9)
Left valgus knee	-0.4 (3.3)	-3.2 (2.4)	0.000	-1.1 (3.3)
Right quadriceps angle (Q)	18.7 (9.0)	18.8 (7.7)	0.908	18.7 (8.7)
Left quadriceps angle (Q)	20.8 (8.4)	19.7 (8.1)	0.427	20.5 (8.3)
Right ankle dorsiflexion	83.9 (3.5)	84.8 (4.0)	0.364	84.2 (3.6)
Left ankle dorsiflexion	84.9 (3.0)	85.7 (4.9)	0.986	85.1 (3.5)
Right valgus ankle	11.9 (10.1)	9.2 (8.1)	0.352	11.2 (9.6)
Left valgus ankle	12.3 (9.9)	10.0 (7.3)	0.509	11.7 (9.3)
Head [°]				
Horizontal alignment of the head	0.7 (3.0)	0.9 (3.9)	0.542	0.8 (3.2)
Vertical alignment of the head	16.7 (10.6)	15.3 (12.9)	0.621	16.4 (11.2)
Projection of the center of gravity				
Frontal plane	1.1 (9.6)	4.7 (6.4)	0.094	2.1 (9.0)
Sagittal plane	44.9 (20.8)	44.4 (17.3)	0.924	44.7 (19.9)

ASIS = anterior superior iliac spine.

the valgus knee, both the right ($F=10.97$; $p=0.001$) and left knees ($F=15.16$; $p=0.000$). The overweight group showed greater angles than the eutrophic group (see Table 3). The MANCOVA indicated significant differences between gender for the vertical alignment of the trunk ($F=4.65$; $p=0.034$), right hip angle ($F=7.37$; $p=0.008$), right knee angle ($F=8.18$; $p=0.005$), right Q angle ($F=4.05$; $p=0.047$), left ankle dorsiflexion ($F=6.23$; $p=0.014$), and horizontal alignment of the head ($F=4.92$; $p=0.029$). The MANCOVA analysis showed that the trunk tended to be more extended for girls than boys. Girls also showed greater hip extension and right ankle dorsiflexion. The Q angles of the girls were bilaterally higher than the angles of the boys. The boys had greater head tilt and greater right knee flexion.

The age covariate was significant for the following variables: vertical alignment of the trunk ($F=6.83$; $p=0.01$), left knee angle ($F=4.51$; $p=0.036$), horizontal and vertical alignment of the head ($F=24.62$; $p=0.000$). Therefore, the older the child was, the greater the degree of misalignment. No statistically significant difference was found between groups for the projection of the center of gravity in the frontal and sagittal planes (Table 3).

No association was found between the presence of pain and the groups ($p=0.994$); the presence of pain was almost identical in frequency between the two groups (55.2% in the eutrophic group, 55.3% in the overweight group). When considering the genders separately, there was also no significant association between groups ($\chi^2=0.048$, $p=0.827$ for boys and $\chi^2=0.027$, $p=0.869$ for girls). However, the prevalence of musculoskeletal pain was significantly higher in girls (61.1%) than in boys (46.4%), with $\chi^2=8.789$ and $p=0.003$, independent of body mass.

Discussion

The purpose of this study was to describe the prevalence of overweight and obesity and to identify differences in posture and reporting of musculoskeletal pain among eutrophic and overweight students. The findings indicate that the prevalence of overweight was 36.2%. There was a higher prevalence of thoracic kyphosis, lumbar hyperlordosis, and valgus knees among students who were overweight. No association existed between

the presence of pain and whether or not a child was overweight.

The prevalence of overweight in this study was similar to that shown in the study by Detsch et al. (2007) and in Brazilian national data (IBGE, 2010). Detsch et al. (2007) found a 21.8% prevalence of overweight/obesity among girls ($n=495$) in their study in South of Brazil. Similarly, Brazilian national data provided by IBGE indicate that 33% of children 5-9 years are above the recommended weight. Children 10-19 years had overweight prevalence of 19.4% (girls) to 21.7% (boys). Obesity was found in 33.5% of children and adolescents (IBGE, 2010).

The results of this study indicate that there was a higher prevalence of thoracic kyphosis, lumbar hyperlordosis, and increased valgus knee angle in overweight students. Other studies evaluating the posture of students also found a higher prevalence of thoracic hyperkyphosis (Arruda, 2009) and lumbar hyperlordosis (Detsch et al., 2007; Kussuki et al., 2007; Arruda, 2009). Several authors report that these changes are compensatory postures, caused by excess of abdominal mass and anterior displacement of the center of gravity (Arruda, 2009; Brandalize & Leite, 2010; Detsch et al., 2007). The postures represent a compensatory attempt to improve the function or normalize appearance (Levangie & Norkin, 2005).

Several authors also found a higher prevalence of valgus knee in children who are overweight (Cicca et al., 2007; Pinto et al., 2006; Silva et al., 2011). Pinto et al. (2006) analyzed 49 girls 7-14 years by observational postural analysis in São Paulo/SP and reported that 55% of overweight children had valgus knees, compared with only 2% of the eutrophic population.

The presence of valgus knee associated with overweight may be related to the increased overload in the lower limbs. Moreover, the accumulation of fat in the inner thighs causes the spacing of the malleoli, promoting the opening of the medial compartment and a higher pressure in the lateral compartment of the knee. With time and development, there is an unequal growth between the two compartments, leading to the installation of a fixed valgus deformity (Brandalize & Leite, 2010).

The results of this study indicate no association between overweight and musculoskeletal pain. Likewise, Stovitz et al. (2008), after evaluating 135 children aged 5-18 years in California (USA), described the presence of pain as not being associated with BMI. In Brazil, Silva et al. (2011) evaluated 51 children (33 obese and 18 non-obese) also found that the overall prevalence of pain was not associated with BMI for boys, only for girls. However, the authors did not provide any explanation for this result.

From a biomechanical point of view, it is plausible to associate overweight with the presence of musculoskeletal pain, since obese children and adolescents have biomechanical modifications that may result in excessive joint forces (Stovitz et al. 2008). Although several authors have found an association between musculoskeletal pain and overweight (Pinto et al., 2006; Taylor et al., 2006; Bell et al., 2011; Silva et al. 2011), the evidence in the literature is not conclusive. A review of epidemiological studies on lower back pain reported that only 32% of the 65 studies analyzed showed a statistically positive association. Therefore, there is insufficient evidence to determine whether a causal relationship exists between body weight and pain (Lebeouf-Yde, 2000).

This study confirmed that postural changes are dependent on both age and sex, as was described by several authors in earlier studies (Lueder & Rice, 2008; Mac-thiong et al., 2004). With respect to gender, other studies found differences in the prevalence of postural variations between boys and girls (Juskeliene, Magnus, Bakketeig, Dailidienė & Jurkuvenas, 1996; Penha, Casarotto, Sacco, Marques, & João, 2009; Penha et al., 2005; Poussa et al., 2005). According to the literature, the differences in the prevalence of postural variations arising during development of children are likely due to differences in musculoskeletal development and flexibility between genders.

The results obtained in this study show that the higher the age, the greater the degree of misalignment. Lafond, Descarreaux, Normand, and Harrison (2007) found similar results. In a sample of 1084 children aged from 4-12 years, these authors found that postural changes during childhood are characterized by an increase in misalignment in the sagittal plane with increases in age.

The type of experimental design used (cross-sectional) is one limitation of this study. This type of study design does not allow researchers to understand causal relationships. On the other hand, a representative sample, such as the one in this study, can be difficult to recruit in quantitative longitudinal studies.

A quantitative posture evaluation was performed for only 24% of the total study sample, which reduces the degree to which the results are representative. However, there was no prior selection of students to be evaluated by SAPO, which reduces the chance of bias in the choice of participants. Qualitative postural evaluation is the most widely used in clinical settings and, in the present study, was assessed as reliable (intra-rater reliability). Quantitative evaluation with PAS / SAPO, despite being regarded as the most reliable in the literature does not allow the evaluation of posture of the spine.

Conclusion

The results indicate a high prevalence of overweight and obesity (36%) and the association of postural changes with overweight. This finding calls for attention when associated with posture consequences in children and adolescents. The results of this study indicate the need for treatment and preventive measures that can be implemented early in the school environment.

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