ORIGINAL RESEARCH

Influence of nutritional status and physical activity on the posture of children and adolescents

Influência do perfil nutricional e da atividade física na postura de crianças e adolescentes

Influencia del perfil nutricional y actividad física en la postura de niños y adolescentes

Jerusa Jordão Coelho[1], Maylli Daiani Graciosa[1], Daiane Lazzeri De Medeiros[2], Letícia Miranda Resende Da Costa[2], Micheli Martinello[3], Lilian Gerdi Kittel Ries[4]

ABSTRACT | The purpose of this study was to verify the effect of nutritional status and physical activity on the posture of children and adolescents. Sixty individuals from both genders aged between 5 years and 14 years were evaluated. The posture was assessed by photogrammetry. The physical activity level was determined through the Physical Activity Questionnaire for Children (PAQ-C). The nutritional status classification was made using the body mass index for age and gender. The results showed that the physical activity variable had an effect on the shoulder and body asymmetry angles (p<0.05). The active group presented greater asymmetry in the shoulder and body asymmetry angles compared to the sedentary group (p<0.05). The nutritional status did not affect any postural angle (p>0.05). There was no interactive effect between the evaluated variables on the postural angles (p>0.05). The development of preventive and interventionist actions, such as controlled physical activity and nutritional monitoring, is important for the postural alignment of school children and school adolescents.

Keywords | body mass index; motor activity; posture.

RESUMO | O objetivo do estudo foi verificar o efeito do perfil nutricional e da atividade física na postura de crianças e adolescentes. Foram avaliados 60 indivíduos de ambos os sexos, com idade entre 5 e 14 anos. A postura foi avaliada por meio da fotogrametria. Para determinar o nível de atividade física foi utilizado o Questionário de Atividade Física para Crianças (PAQ-C). A classificação do perfil nutricional foi realizada por meio do Índice de Massa Corporal por idade e com relação ao sexo. Os resultados mostraram que a atividade física exerceu efeito sobre os ângulos assimetria do ombro (AO) e assimetria corporal (ACO) (p<0,05). O grupo ativo apresentou maior assimetria nos ângulos de AO e ACO comparado ao grupo sedentário (p<0,05). O perfil nutricional não influenciou nenhum ângulo postural (p>0,05). Também não houve efeito interativo entre os parâmetros avaliados sobre os ângulos posturais (p>0,05). É importante o desenvolvimento de ações preventivas e intervencionistas, como atividade física controlada e acompanhamento nutricional, no alinhamento postural de crianças e adolescentes em idade escolar.

Descritores | postura; atividade motora; índice de massa corporal.

RESUMEN | El objetivo del estudio fue verificar el efecto del perfil nutricional y de la actividad física en la postura de niños y adolescentes. Fueron evaluados 60 individuos de ambos sexos, con edades entre 5 y 14 años. La postura fue evaluada por medio de fotogrametría. Para determinar el nivel de actividad física fue utilizado el Cuestionario de Actividad Física para niños (PAQ-C). La clasificación

Study conducted at the Universidade do Estado de Santa Catarina (UDESC), Laboratory of Postural Development and Control (LADESCOP) – Florianópolis (SC), Brazil.
[1]Physical Therapy student at the UDESC – Florianópolis (SC), Brazil.
[2]Master's degree student in the Physical Therapy Postgraduation Program at the UDESC – Florianópolis (SC), Brazil.
[3]Master's degree in Human Movement Sciences at the UDESC – Florianópolis (SC), Brazil.
[4]Professor of the Physical Therapy Postgraduation Program at the UDESC – Florianópolis (SC), Brazil.

Correspondence to: Jerusa Jordão Coelho – CEFID – Rua Pascoal Simone, 358 – CEP: 88080-350 – Florianópolis (SC), Brazil – E-mail: jerusa.jordao@hotmail.com
Presentation: Sep. 2012 – Accepted for publication: apr. 2013 – Financing source: none – Conflict of interest: nothing to declare – Approval at the Ethics Committee n. 165/2011.

del perfil nutricional fue realizada por medio del Índice de Masa Corporal por edad y con relación al sexo. Los resultados mostraron que la actividad física ejerce un efecto sobre los ángulos de asimetría del hombro (AH) y asimetría corporal (ACO) (p<0,05). El grupo activo presentó mayor asimetría en los ángulos AH y ACO comparado al grupo sedentario (p<0,05). El perfil nutricional no influenció ningún ángulo postural (p<0,05). También no hubo efecto interactivo entre los parámetros evaluados sobre los ángulos posturales (p<0,05). Es importante el desenvolvimiento de acciones preventivas e intervenciones, como la actividad física controlada y acompañamiento nutricional, en el alineamiento postural de niños y adolescentes en edad escolar.

Palabras clave | postura; actividad motora; índice de masa corporal.

INTRODUCTION

A good posture is a state of skeletal and muscular balance that is capable of protecting the body structures against injuries or deformities[1,2]. In childhood, the balance between these structures is subject to modifications due to daily life habits[3]. The period of body growth and development that happen in childhood and adolescence are extremely important because many postural problems originate in these stages of life[4,5].

One of the possible factors associated with postural changes in children and adolescents is excess of body weight[6]. In the last few decades, indices of childhood overweight and obesity have grown rapidly and in a concerning manner[7]. The increase of these indices is associated with unhealthy eating habits and not a very active lifestyle[8-10], in which activities like playing videogames and watching television are predominant[11,12]. Incorrect habits in this period help acquire inappropriate postures that may result in serious damage[13] and may interfere in the recent and future health of these individuals[14]. Thus, it is important to identify inappropriate habits and postures adopted by these children and adolescents for prevention, pain decrease, and to provide an incentive to maintain a healthy posture[2].

It is known that obesity overloads mechanical structures, especially the joints, due to the wearing suffered by the body for a long period[6]. Obesity predisposes an individual to the alteration of the valgus knee for the realignment of the extremity due to fat accumulation in the medial region of the knees, which causes a knee hyperextension because of the internal rotation of the femur[15]. Furthermore, it is associated with head protraction[1] and instabilities of feet joints[16]. These changes can cause compensations in other areas of the body[16] and result in pain, lack of mobility, and body biomechanical inefficacy[15].

A good posture in childhood and adolescence has great importance, given that the incorrect alignment of the body segments is a risk factor for injuries in sports practice[17]. Some studies have reported the existence of an association of excess body weight with postural change. However, in the researched literature, there was no study verifying the association of nutritional status with physical activity and posture at the same time.

In addition, the majority of researches are limited to the evaluation of the lower limb alignment through angles that indicate rotations, valgus and varus deformities, and pelvis positioning[16,18,19]. Body alignment analysis may provide subside in order that postural changes will work globally in the clinical practice.

Thus, it is relevant to understand the possible factors that may cause postural deviations in children and adolescents, in order that interventions directed towards their prevention and treatment may be prepared. It is believed that a sedentary lifestyle and obesity may influence postural alignment. Therefore, the objective of this study was to verify if nutritional status and physical activity have an effect on the posture of children and adolescents.

METHODOLOGY

A transversal study was intentionally carried out with 60 children and adolescents of both genders in the municipality of Florianópolis, Santa Catarina, Brazil. Subjects presented a mean age of 10±2 years (44 children aged 5 to 11 years and 16 adolescents aged 12 to 14 years), mean height of 1.44±0.15 m, and a mean body mass index (BMI) of 40.20±13.44 kg. Twenty-five (41.67%) subjects were male. The inclusion criteria included school children and adolescents aged 5 to 14 years, with different nutritional statuses. The exclusion criteria included systemic or neurological diseases, physical therapy and/or orthopedic treatment, pathologies associated with posture, and injuries or musculoskeletal deformities that were evident in the inspection.

This study was approved by the Research and Ethics Committee of Universidade do Estado de Santa Catarina, under approval number 165/2011.

Body mass and height were used to measure the BMI, which was applied to evaluate the nutritional status in the anamnesis. From the BMI per age and gender, subjects were classified into the following groups: low weight, eutrophic, overweight, and obese[20]. Additionally, the participants were divided into obese (obese and overweight), and non-obese (low weight and eutrophic) groups.

The Physical Activity Questionnaire for Children (PAQ-C)[21] was used to investigate the level of physical activity in children and adolescents and was performed in the seven days before the questionnaire had been answered. Each question was scored from one to five, (1) meaning very sedentary and (5) meaning very active, and the final score was achieved by calculating the mean of the questions[22]. From the classification, subjects were divided into two groups: active (score higher than or equal to three) or sedentary (score lower than three)[22].

A SANYO digital camera (model VPC-HD 2000) was used for the photogrammetry, positioned parallel to the floor, leveled at a 0.85 cm height and at a 3 m distance from the assessed participant. All recordings were executed by the same photographer in the frontal and sagittal planes; they were analyzed by two trained evaluators for further reliability analysis.

Participants were wearing bathing clothes, and they remained in the orthostatic position with their arms comfortably positioned along the body and feet on a 30×40 cm sheet. Later, the outline of the feet was marked with a pen, which was used as a pattern for the next photos. The positioning place was marked with a masking tape at a standard distance of 3 m from the camera and the subject.

For the calibration, a vertically positioned plumb line was used as reference, in which there were two reflexive markers with a 100 cm distance between both. The postural analysis was done by the Postural Analysis Software (SAPO)[23,24].

In order to mark the anatomical points, spherical markers of 1 cm fixed bilaterally were used as a reference for tracing the angles, positioned by only one investigator. The marked points were as follows: spinous process of the 7th cervical vertebrae (C7),

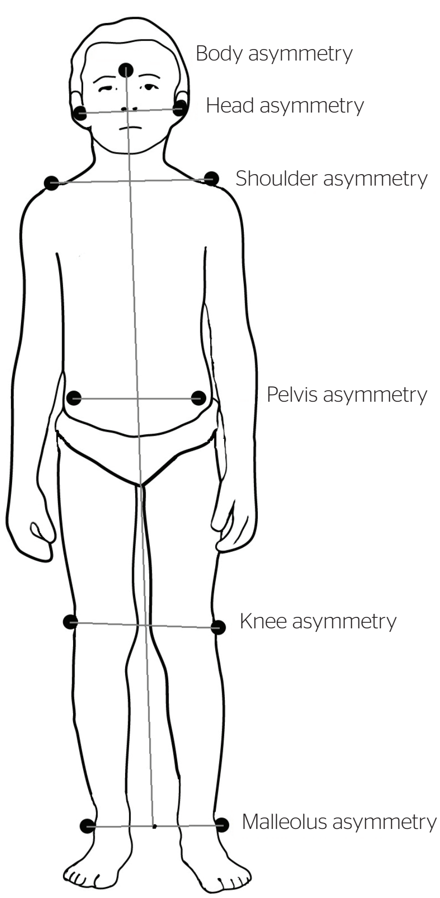

Figure 1. Analysis of the asymmetry of the anatomical marks in the frontal plane

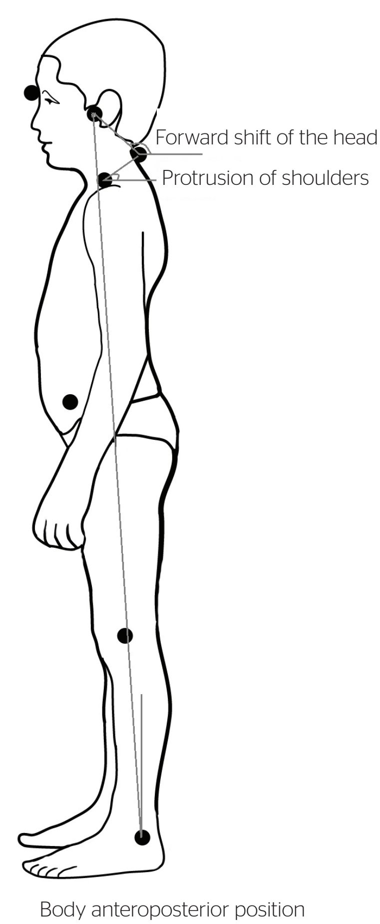

Figure 2. Analysis of the asymmetry of the anatomical marks in the sagittal plane

glabella, tragus, acromion, iliac spine, anterosuperior, lateral epicondyle of the femur, and lateral mallelus.

The angles analyzed in the frontal plane were as follows: head, shoulder, pelvis, knee, and malleolus asymmetries. They were determined by the intersection of the straight traces joining the anatomical point marked in the right of its correspondent to the left and by the straight line traced in the horizontal position, parallel to the floor and perpendicular to the plumb line. Besides these two, body asymmetry (BA) was analyzed, which was measured through the free angle formed by the line that passes the glabella marker and mean point between the malleoli with a parallel trace to the plumb line that passes the mean point between the malleoli[3]. Figure 1 shows an analysis of the asymmetry of the anatomical marks in the frontal plane.

In the sagittal plane, the following aspects were analyzed: forward shift of the head (free angle formed by the trace through the tragus marker up to the C7 marker and by a perpendicular trace to the plumb line that passes in the C7 marker); shoulder protrusion (free angle formed by the line that passes the C7 marker up to the acromion marker and a perpendicular trace to the plumb line that passes the acromion marker); and anteroposterior position of the body (free angle formed by the line that passes the tragus markers up to the external malleolus and a parallel trace to the plumb line that passes the external malleolus)[3]. Figure 2 shows an analysis of the asymmetry of the anatomical marks in the sagittal plane.

STATISTICAL ANALYSIS

All measures were applied by two investigators and the mean of the measures obtained from both investigators were finally used in the analysis. The inter-evaluator reliability was assessed through the intraclass correlation coefficient (ICC – two-way random).

Descriptive data have been reported with 95% confidence intervals for the means (CIM 95%). The one-way analysis of variance (ANOVA) was used to find the joined influence of the nutritional status (non-obese/obese) and physical activity (active/sedentary) variables in measures of every postural angle. Normality of the residues and homoscedasticity were verified applying the Kolmogorov-Smirnov and Levene tests, respectively. Differences in the mean postural angles between the groups with non-obese and obese nutritional statuses and between the sedentary and active groups were analyzed with the Student's t-test for independent samples.

The program used was the Statistical Package for the Social Sciences (SPSS), version 17.0 for Windows, and all procedures adopted a 5% significance level (0.05), with a bicaudal distribution.

RESULTS

With regard to nutritional status, out of the 60 evaluated subjects, 41.67% (n=25) were obese. With regard to the level of physical activity, 50% (n=30) were sedentary.

The most practiced physical activities were volleyball and soccer, practiced at least twice a week.

High inter-evaluator reliability was obtained in all measures of the postural angles (all ICC>0.97; $p<0.00$), considering the arithmetic mean between them.

Table 1 shows the results of the ANOVA analyses. In the one-way analysis, the physical activity (PA) variable had an effect on the shoulder asymmetries (SA) and BA ($p<0.05$).

The active group presented higher asymmetry in the SA and BA angles compared to the sedentary group ($p<0.05$), as seen in Table 2. The nutritional status did not influence any postural angle ($p>0.05$). There was also no interactive effect between the variables on postural angles ($p>0.05$).

DISCUSSION

The evaluation of body segment alignment and posture alterations through photogrammetry has been a more reliable method to gather data when compared to visual observation, and it can quantify the morphological variables associated with posture[24,25].

Some authors report that obesity[18,19] and sedentary lifestyle[26] may have a negative influence on posture. Results of the present study did not confirm the initial thesis. The existence of the nutritional status influence on postural alignment was not seen in this study, and physical activity had an isolated effect on the increase of SA and BA.

Studies that observed the influence of obesity on posture, evaluated other parameters and analyzed their results with another methodology[16,18,19]. The most seen alterations were knee valgus[16,18,19] and pelvic anteversion[16]. No alterations associated with knees and pelvises were found in the present study. However, the analysis was limited to the symmetry evaluation between the

Table 1. Values of confidence intervals of means 95%CIM and one-way analysis of variance (ANOVA) for the postural angles

Angles	95%CIM	p-value		
		NS	PA	Interaction (NS×PA)
Head asymmetry	1.951–2.881	0.208	0,711	0.23
Shoulder asymmetry	1.357–2.112	0.591	0.029*	0.29
Pelvis asymmetry	1.548–2.148	0.749	0.768	0.14
Knee asymmetry	1.433–2.081	0.397	0.081	0.51
Malleolus asymmetry	1.321–1.874	0.417	0.586	0.43
Body asymmetry	0.526–0.817	0.400	0.044*	0.48
Forward shift of the head	42.480–45.188	0.336	0.670	0.26
Protrusion of shoulders	152.695–57.870	0.508	0.511	0.95
Anteroposterior position of the body	3.135–3.685	0.526	0.928	0.67

NS: nutritional status; PA: physical activity; *Statistically significant

Table 2. Comparison between the means of scores obtained in the evaluation of postural angles according to the studied parameters

Angles	NS			PA		
	Normal (n=35)	Obese (n=25)	p-value	Sedentary (n=30)	Active (n=30)	p-value
Head asymmetry	2.66±1.95	2.07±1.53	0.21	2.39±1.63	2.45±1.98	0.90
Shoulder asymmetry	1.81±1.69	1.63±1.07	0.65	1.29±1.01	2.18±1.71	0.02*
Pelvis asymmetry	1.81±1.16	1.91±1.19	0.75	1.76±1.09	1.93±1.24	0.58
Knee asymmetry	1.63±1.08	1.93±1.47	0.37	1.48±1.11	2.03±1.35	0.09
Malleolus asymmetry	1.50±1.06	1.74±1.09	0.40	1.50±1.05	1.70±1.10	0.47
Body asymmetry	0.72±0.60	0.61±0.51	0.45	0.52±0.38	0.83±0.67	0.03*
Forward shift of the head	44.40±5.65	43.05±4.60	0.33	44.28±5.86	43.39±4.60	0.51
Protrusion of shoulders	154.57±10.31	156.29±9.71	0.52	156.15±10.26	154.41±9.87	0.51
Anteroposterior position of the body	3.49±1.19	3.30±0.87	0.52	3.39±1.25	3.43±0.86	0.89

NS: nutritional status; PA: physical activity; *Statistically significant

right and left sides. Other investigations associated with posture and obesity in the upper limbs should be developed in order to investigate possible alterations, given that the majority of studies found were focused on the lower limbs.

The postural alterations are not exclusive to obese subjects although they have been seen more frequently in these subjects because of increased mechanical needs and actions performed with excess of body mass[27].

Although there are very few specific studies with regard to obesity in the musculoskeletal system, a reason for the lack of influence on the nutritional status may be the chronological age of the sample. Since the evaluations were performed during the growth period, it can be suspected that the excess of weight could not have resulted in biomechanical wearing or overloads that altered the assessed parameters. However, such variables were not evaluated herein, so this suspicion cannot be confirmed. Further researches should try to understand the formation process of this wearing, as well as the minimum period needed for their appearance due to excess of weight. The extended age range was presented as a limitation; therefore, investigations with a bigger sample and stratification in subgroups are necessary.

With regard to the effect of physical activity on postural alignment, active individuals were more asymmetric in all analyzed parameters, but with a statistic significance only on the level of the shoulders and on the general analysis of the body in the frontal plane. This result was not expected since the prediction of the study was that a sedentary lifestyle might have influenced the acquisition of postural changes. However, it is possible that such a result was observed due to a practiced physical activity, given that volleyball was the most frequent physical activity practiced by the subjects in this study.

Volleyball practice can create possible postural changes such as SA[28]. In sports practice, there is a constant repetition of asymmetric movements, especially of the upper limbs, which can cause osteomioarticular imbalances and predispose the appearance of posture changes. However, more studies are necessary to confirm this hypothesis since physical activity associated with posture has not been much investigated yet.

Olympic gymnastic athletes presented a tendency to decrease postural alterations, such as valgus knee, trunk rotation, and hip medial rotation when compared to a group of non-athletes[29]. However, an increase in the pelvic anteversion was noticed. Such results are contradictory and make it difficult to comprehend the effects of sports practice on posture, therefore, they do not show if this activity acts positively or negatively on posture.

Exercise practice is considered a category of planned and repetitive physical activity[14], which can or cannot change the body symmetry. The practiced activity can suffer an influence of some factors, such as time, kind and level of practice, besides the musculoskeletal balance. Thus, it is important to carefully prepare the tasks during the physical activity, since posture alterations may be attributed to how the exercises were performed.

Therefore, it is very important to include exercises that improve physical fitness since the lack of practice stimulation repels children and adolescents from several physical activities and games and conducts them to inactivity[30].

CONCLUSION

The nutritional status did not influence the evaluated postural parameters. The effect of physical activity on BA determines a careful planning in how to perform the exercises. The development of preventive and interventionist actions, such as controlled physical activity and nutritional monitoring, is important to prevent future complications and to ensure a good postural alignment in school children.

REFERENCES

1. Kussuki MOM, João SMA, Cunha ACP. Caracterização postural da coluna de crianças obesas de 7 a 10 anos. Fisiot Mov. 2007;20(1):77-84.
2. Penha PJ, João SM, Casarotto RA, Amino CJ, Penteado DC. Postural assessment of girls between 7 and 10 years of age. Clinics. 2005;60(1):9-16.
3. Ries LGK, Martinello M, Medeiros M, Cardoso M. Peso da mochila escolar, sintomas osteomusculares e alinhamento postural de escolares do ensino fundamental. Ter Man. 2011;9(43):190-6.
4. Bunnell WP. Selective screening for scoliosis. Clin Orthop Relat Res. 2005;(434):40-5.
5. Nissinen MJ, Heliövaara MM, Seitsamo JT, Könönen MH, Hurmerinta KA, Poussa MS. Development of trunk asymmetry in a cohort of children aged 11 to 22 years. Spine. 2000;25(5):570-4.
6. Lemos LFC, David AC, Teixeira CS, Mota CB. Obesidade infantil e suas relações com o equilíbrio corporal. Acta Fisiatr. 2009;16(3):138-41.
7. Pinto MCM, Oliveira AC. Occurrence of child obesity in preschool children in a São Paulo day-care center. Einstein. 2009;7(2 Pt 1):170-5.
8. Silva LR, Rodacki ALF, Brandalize M, Lopes MFA, Bento PCB, Leite N. Alterações posturais em crianças e adolescentes obesos e não-obesos. Rev Bras Cineantropom Desemp Hum. 2011;13(6):448-54.
9. Nunes MMA, Figueiroa JN, Alves JGB. Excesso de peso, atividade física e hábitos alimentares entre adolescentes de diferentes classes econômicas em Campina Grande (PB). Rev Assoc Med Bras. 2007;53(2):130-4.
10. Reilly JJ. Physical activity, sedentary behaviour and energy balance in the preschool child: opportunities for early obesity prevention. Proc Nutr Soc. 2008;67(3):317-25.
11. Cardon G, Van Cauwenberghe E, De Bourdeaudhuij I. What do we know about physical activity in infants and toddlers: A review of the literature and future research directions. Sci & Sports. 2011;26(3):127-30.
12. Lazzoli JK, Nóbrega ACL, Carvalho T, Oliveira MAB, Teixeira JAC, Leitão MB, et al. Atividade física e saúde na infância e adolescência. Rev Bras Med Esporte. 1998;4(4):107-9.
13. Zapater AR, Silveira DM, Vitta A, Padovani CR, Silva JCP. Postura sentada: a eficácia de um programa de educação para escolares. Ciênc & Saúde Col. 2004;9(1):191-9.
14. Mello ED, Luft VC, Meyer F. Obesidade infantil: como podemos ser eficazes? J Pediatr. 2004;80(3):173-82.
15. Wearing SC, Hennig EM, Byrne NM, Steele JR, Hills AP. The impact of childhood obesity on musculoskeletal form. Obes Rev. 2006;7(2):209-18.
16. Martinelli AR, Purga MO, Mantovani AM, Camargo MR, Rosell AA, Fregonesi CEPT, et al. Análise do alinhamento dos membros inferiores em crianças com excesso de peso. Rev Bras Cineant Des Hum. 2011;13(2):124-30.
17. Calvete SA. A relação entre alteração postural e lesões esportivas em crianças e adolescentes obesos. Motriz. 2004;10(2):67-72.
18. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, et al. Orthopedic complications of overweight in children and adolescents. Pediatrics. 2006;117(6):2167-74.
19. Pinto ALS, Holanda PMB, Radu AS, Villares SM, Lima FR. Musculoskeletal findings in obese children. J Paediatr Child Health. 2006;42(6):341-4.
20. Center for Disease Control and Prevention – National Center for Chronic Disease Prevention and Health Promotion (EUA). Nutrition and Physical Activity. Body mass index-for-age (children). Atlanta: CDC. [cited on: 8 May 2012]. Available at: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/tool_for_schools.html
21. Kowalski KC, Crocker PRE, Faulkner RA. Validation of the Physical Activity Questionnaire for older children. Pediatr Exerc Sci. 1997;9(2):174-86.
22. Silva RCR, Malina RM. Nível de atividade física em adolescentes do Município de Niterói, Rio de Janeiro, Brasil. Cad Saúde Pública. 2000;16(4):1091-7.
23. Ferreira EAG. Postura e controle postural: desenvolvimento e aplicação de método quantitativo de avaliação postural. [dissertation] São Paulo: Faculdade de Medicina da Universidade de São Paulo; 2006.
24. Ferreira EAG, Duarte M, Maldonado EP, Burke TN, Marques AP. Postural assessment software (PAS/SAPO): validation and reliability. Clinics. 2010;65(7):675-81.

25. Sacco ICN, Alibert S, Queiroz BWC, Pripas D, Kieling I, Kimura AA. Confiabilidade da fotogrametria em relação a goniometria para avaliação postural em membros inferiores. Rev Bras Fisioter. 2007;11(5):411-7.

26. Albuquerque PL, Quirino MAB, Santos HH, Alves SB. Interferência da prática de atividade física habitual na postura de jovens. Ter Man. 2010;8(37):198-203.

27. Campos FS, Silva AS, Fisberg M. Descrição fisioterapêutica das alterações posturais de adolescentes obesos. Braz Pediatr News. 2002 [cited on: 15 April 2012]. Available at: http://www.portalsaudebrasil.com/artigospsb/obes167.pdf

28. Siqueira T, Costa LL, Fernandes WVB. Análise das alterações posturais em atletas de voleibol feminino nas categorias infantil e infanto-juvenil. Ter Man. 2010;38(8):332-8.

29. Guimarães MMB, Sacco ICN, João SMA. Caracterização postural da jovem praticante de ginástica olímpica. Rev Bras Fisioter. 2007;11(3):213-9.

30. Berleze A, Haeffner LSB, Valentini NC. Desempenho motor de crianças obesas: uma investigação do processo e produto de habilidades motoras fundamentais. Rev Bras Cineantropom Desemp Hum. 2007;9(2):134-44.