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Relationship between postural changes and physical and functional variables in schoolchildren aged 6-12 years

Relação entre as alterações posturais com variáveis físicas e funcionais em escolares de 6 a 12 anos

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Abstract –The aim of this study was to evaluate the prevalence of postural changes and their relationship with BMI, pain, postures adopted in activities of the daily living (ADL), physical activity practice, gender and age (6 to 12 years). This study is characterized as cross-sectional, quantitative and descriptive. The convenience sample consisted of 840 schoolchildren. Regarding the sample characteristics, 477 (56.79%) were female aged 6-12 years (average=8.90±1.71years). Evaluations were carried out at the school premises and a questionnaire was used to collect data on gender, age, pain report, practice of out-of-school physical activities and postures adopted in ADLs. Body mass, height and posture were evaluated. Some schoolchildren (43.21%) reported not practicing physical activity outside of school, 544 (64.76%) correctly carried their backpack and 51.9% adopted correct postures to study and watch TV. Musculoskeletal pain was reported by 62.73%, and shoulders were the most affected. BMI indicated 55.6% of the sample with leanness/normal weight and 44.40% with overweight/obesity. Postural changes were present in 97.02% of students and the region with the highest number of alterations was the upper limbs. Girls presented greater number of trunk alterations (p=0.001), as well as those who did not practice physical activity (p=0.02) and alterations in the lower limbs for younger students (p=0.02) and female students (p=0.01). This study identified high prevalence of postural changes in schoolchildren.

Key words: Child; Pain; Posture.

Resumo – *O objetivo é avaliar a prevalência de alterações posturais e suas relações com o índice de massa corporal (IMC), dor, posturas adotadas em atividades de vida diária (AVDs), prática de atividades físicas, sexo e idade (6 a 12 anos). Caracteriza-se como transversal, quantitativa e descritiva. A amostra de conveniência foi constituída por 840 escolares. Quanto as características dos escolares, 477 (56,79%) eram do sexo feminino, na faixa etária de 6 a 12 anos (Média=8,90±1,71 anos). As avaliações foram realizadas nas dependências das escolas e um questionário foi aplicado para coleta dos dados: sexo, idade, relato de dor, prática de atividades físicas fora da escola e posturas adotadas nas AVDs. Verificou-se a massa corporal, estatura e a avaliação da postura. Alguns escolares (43,21%) relataram não praticar atividade física fora da escola, 544 (64,76%) carregavam corretamente a mochila e 51,9% adotava posturas corretas para estudar e assistir televisão. A dor musculoesquelética foi relatada por 62,73%, sendo os ombros a região mais acometida. O IMC indicou 55,6% com magreza/eutrofia e 44,40% com sobrepeso/obesidade. As alterações posturais foram apresentadas por 97,02% dos escolares e a região com maior número de alterações foi o membro superior. O sexo feminino apresentou maior número de alterações no tronco (p<0,001), os que não praticavam atividade física (p<0.02) e também nos membros inferiores para os escolares mais novos (p<0.02) e do sexo feminino (p<0.01). Este estudo identificou uma alta prevalência de alterações posturais em escolares.*

Palavras-chave: *Criança; Dor; Postura.*

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INTRODUCTION

Many postural alterations have their origins in the period of body growth and development, that is, in childhood and adolescence[1], since during this phase, individuals are subject to risk behaviors that may impair postural alignment. The adoption of inadequate postures, low level of regular physical activity, overweight and obesity among others[2], as well as inadequate posture at the school environment due to inadequate furniture, prolonged sitting time and backpack use in an asymmetrical manner/or with excess weight stand out[3].

The high incidence of postural changes in childhood and adolescence, estimated at 20%[4] is a public health problem, so they should be fully investigated in childhood and adolescence.

Moreover, these alterations can cause musculoskeletal pain (MP) or functional disabilities[5]. The literature reports that the prevalence of MP in schoolchildren is high and is becoming worse, and may have an impact on the health care delivery, functionality and participation of the individual in society [6].

The school period is the moment that students are forming their habits, attitudes and posture evaluation constitutes a fundamental stage in the diagnosis and treatment of joint, bone and muscle alterations, as well as in the identification of factors causing body misalignment[7]. Posture evaluation, associated to Body Mass Index (BMI) and MP, as well as students' daily posture habits, will lead to the early detection of problems that may affect health and quality of adult life, increasing the possibilities of interventions, contributing to the health promotion of these students and minimizing the risk of future changes.

The aim of this study was to evaluate the prevalence of postural alterations and their relationship with BMI, MP, postures adopted in activities of the daily living (ADL), physical activity, sex and age among schoolchildren aged 6-12 years from Uberaba / MG.

METHOD

PROCEDURES

This research is characterized as cross-sectional, exploratory, quantitative, and descriptive, approved by the Research Ethics Committee of the "Triângulo Mineiro" Federal University (UFTM), under protocol No. 1731.

The sample consisted of 840 schoolchildren, 477 (56.79%) females aged 6-12 years (average age of 8.90±1.71 years), with 341 (40.6%) aged 6-8 years, 340 (40.47%) aged 9-10 years, and 159 (18.93%) aged 11-12 years, enrolled in two public schools in the city of Uberaba. Schools selected were located in areas covered by municipal basic health services, and participated in the "Physiotherapeutic and nutritional assessment in schoolchildren" extension project of the "Triângulo Mineiro" Federal University (UFTM). All schoolchildren invited to participate in the study were provided with

free and informed consent forms, which were forwarded to their parents.

Evaluations were carried out on school premises. Initially, the questionnaire was used in classroom, monitored by students participating in the project, to collect data on gender, age, pain report, practice of out-of-school physical activities and postures adopted in ADL.

The presence of MP was evaluated using a human body illustration based on the map of Corlett and Bishop[8], where students were instructed to indicate where pain occurred (five regions): arms, spine (cervical, dorsal and lumbar), shoulders, hands and lower limbs.

The practice of out-of-school physical activities was self-reported, and students were asked to respond if they practiced regular physical activities (at least once a week) in addition to those practiced in physical education classes offered in schools.

Postures adopted in ADL were identified using questionnaire with illustrations, created specifically for the study. ADL included study at home and at school (6 illustration options), watching television (5 options), and use of computers and video games (6 options). Each student selected the illustration that most closely resembled his/her posture. In addition, the illustration that most closely resembled the way that the school backpack was carried was selected among 10 options.

In this analysis, the correct posture for the performance of ADL was considered sitting, with lumbar region supported and feet properly positioned on the floor or other surface. Incorrect study postures were those without lumbar support, excessive spine flexion and without foot or hand support. Incorrect positions to watch television were considered lying down and sitting without lumbar spine and feet support. For use of computers and video games, postures considered incorrect were those without lumbar support, excessive column flexion, without feet support and low or very distant chairs.

The correct way to carry the backpack was considered at the top of the waist, supported by two straps behind the back. Unsatisfactory techniques were unilateral, with very low or very high strips (relative to the waist), or when the material was carried using hands without backpack on one side of the body.

Students were then referred one by one to a large, airy and well lit room in which body mass, height and postural assessment were assessed.

The body mass was verified with student barefoot, wearing light clothes, using digital electronic scale with capacity of 150 kg and sensitivity of 50 g. Height was measured using portable stadiometer with student barefoot, and neck, buttocks and heels in line. Body mass index (BMI) values were calculated based on height and body mass. Nutritional status was assessed using the BMI Z score index, according to standards established by the World Health Organization[9].

In clinical practice, the most commonly used noninvasive method for postural assessment is visual observation. It is a qualitative and subjective method based on the observation of the individual positioned or not in

the silometer. Posture inspection was performed by the evaluator's view of differences and asymmetries[10] and exclusively depends on the evaluator's ability and experience to interpret the results, leaving room for errors[11].

However, considering that routine exams are essential for early diagnosis of deformities during growth[1] and the need to use low-cost, easy-to-apply technologies to diagnose and control posture changes [10,11], the present study used the traditional method of postural evaluation proposed by Kendall, Mc Creary and Provance[10] and Magee[12], performing adequate training for four evaluators to guarantee inter-rater reliability, through the application to in 10 students, being careful not to include them in the sample.

Students were instructed to remain for a few minutes in the relaxed posture of feet, with upper limbs along the trunk and barefoot, keeping body mass equally distributed.

Each school was evaluated only once and individually. The scapular belt and the antero-posterior iliac spine, deviations in knee and ankle, occipital-chest-buttock alignment, neck alignment and lateral deviations of the spine were verified[10,12].

All schoolchildren were instructed by the project team on the correct postures to be adopted in their activities. Figures, images and simulations were used as didactic resources for this orientation, seeking the participatory character of children. Parents of students who were identified with high number of postural alterations and / or presence of musculoskeletal pain were instructed to seek the Basic Health Unit located in the area covered by schools.

For inferential analysis, musculoskeletal alterations were grouped into changes on shoulder (shoulder protrusion, shoulder height difference, and shoulder shrinkage), lower limbs (knee hyperextension, popliteal fossa height difference, knee valgus, knee varus, and flat feet), and trunk (head protrusion, head tilt, hyperkyphosis, hyperlordosis, and scoliosis), considering the presence of none, one, and two or more changes in these regions. Analyses were also performed using total postural changes, considering no, up to two, and three or more changes.

BMI results were used to classify students into two categories: thinness/normal weight (thinness and thinness with normal weight group) and overweight/obesity (overweight and obesity group).

This procedure has already been described in a study previously published by part of our research team[13].

Analyses were performed using the SPSS v. 20 software. For descriptive analysis of data, gross values and percentages were used. For inferential statistics, the Chi-square test was used. The significance level was 5%.

RESULTS

A total of 363 schoolchildren (43.21%) reported not practicing out-of-school physical activities, and 544 (64.76%) reported carrying the school backpack correctly.

In terms of postures adopted in the different activities, 436 (51.9%) reported adopting correct postures for studying and watching television. However, 587 (69.88%) reported adopting incorrect postures when using the computer or playing video games.

MP was reported by 527 schoolchildren (62.73%), with shoulders being the most affected region (191 cases, 22.74%), followed by hands (104 cases, 12.39%) and back and arms (81 cases, 9.64%).

BMI classification found that 467 (55.6%) of students presented thinness/normal weight, while 373 (44.40%) were overweight/obese.

Postural alterations were found in 97.02% of students, with 627 presenting three or more alterations, observed in all body segments evaluated. The region with the highest number of alterations was the upper limbs. These results are presented in Figure 1.

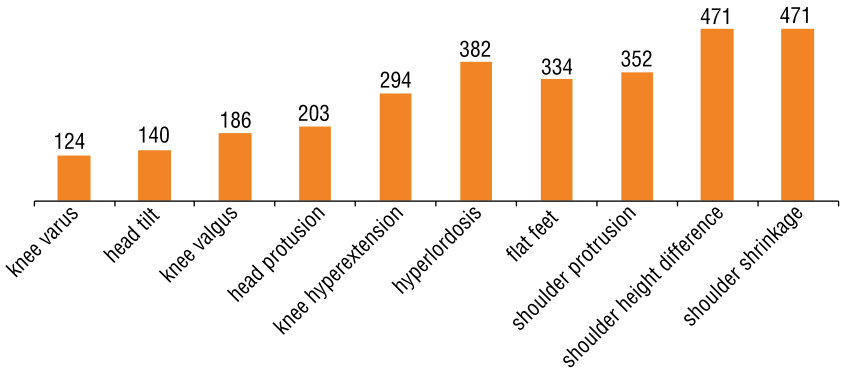

Figure 1. Postural changes assessed.

The results of analyses between postural trunk changes and age, gender and practice of physical activity are in Table 1.

Table 1. Bivariate analysis between postural trunk changes and age, gender and practice of physical activity

	Trunk alterations				
	0 Number (%)	1 Number (%)	2 or more Number (%)	Total Number (%)	p
Age (years)					0.22
6-8	107 (31.38)	140 (41.06)	94 (27.57)	341 (100)	
9-10	97 (28.53)	155 (45.59)	88 (25.88)	340 (100)	
11-12	61 (38.36)	61 (38.36)	37 (23.27)	159 (100)	
Gender					<0.01*
Female	121 (25.37)	221 (46.33)	135 (28.30)	477 (100)	
Male	144 (39.67)	135 (37.19)	84 (23.14)	363 (100)	
Physical activity					0.02*
No	97 (26.72)	160 (44.08)	106 (29.20)	363 (100)	
Yes	168 (35.22)	196 (41.09)	113 (23.69)	477 (100)	
Total	265	356	219	840	

Greater number of changes were observed for female students (p=0.00006) and for those who did not practice physical activity (p=0.02).

The results of analyses between postural lower limb changes and age, gender and practice of physical activity are shown in Table 2.

Table 2. Bivariate analysis between postural lower limb changes and age, gender and practice of physical activity.

	Lower limb alterations				
	0 Number (%)	1 Number (%)	2 or more Number (%)	Total Number (%)	p
Age (years)					<0.01*
6-8	78 (22.87)	126 (36.95)	137 (40.18)	341 (100)	
9-10	109 (32.06)	127 (37.35)	104 (30.59)	340 (100)	
11-12	53 (33.33)	54 (33.96)	52 (32.70)	159 (100)	
Gender					0.01*
Female	117 (24.53)	186 (38.99)	174 (36.48)	477 (100)	
Male	123 (33.88)	121 (33.33)	119 (32.78)	363 (100)	
Physical activity					<0.01*
No	83 (22.87)	141 (86,5)	139 (10,74)	363 (100)	
Yes	157 (32.91)	166 (34.80)	154 (32.29)	477 (100)	
Total	240	307	293	840	

Greater number of alterations were observed for younger schoolchildren (p=0.002) and female students (p=0.01). Regarding the practice of physical activity, 32% of those who practice and 22.87% of those who do not practice did not present any changes (p=0.006).

The results of analyses of total postural changes with age, gender and practice of physical activity are shown in Table 3.

Table 3. Bivariate analysis between total postural changes and age, gender and practice of physical activity

	Total alterations			
	0-2 Number (%)	3 or more Number (%)	Total Number (%)	p
Age (years)				0.06
6-8	95 (27.86)	246 (72.14)	341 (100)	
9-10	89 (26.18)	251 (73.82)	340 (100)	
11-12	29 (18.24)	130 (81.76)	159 (100)	
Gender				0.04*
Female	108 (22.64)	369 (77.36)	477 (100)	
Male	105 (28.93)	258 (71.07)	363 (100)	
Physical activity				0.02*
No	77 (21.21)	286 (78.79)	363 (100)	
Yes	136 (28.51)	341 (71.49)	477 (100)	
Total	213	627	840	

*p<0.05 (Chi-square test).

Greater number of total changes were observed for female schoolchildren (p=0.04) and who did not practice physical activity (p=0.02).

DISCUSSION

The postural evaluation of students revealed that 97.02% had at least one postural alteration. These results corroborate previous studies. Santos et al.[11] assessed the posture of 247 elementary school students aged 6-12 years and found that 20% of them had three to four postural changes, while only 2% had no alterations.

The shoulder area presented the highest number of alterations, with 72.9% of schoolchildren with at least one of them, 41.90% presented protrusion and 56.07% had drop or retraction. Santos et al.[11] also found that the most frequent alterations were shoulder drop (50.2%), shoulder protrusion (39.7%) and winged scapula (40.5%). Rodrigues and Yamada[3] evaluated 513 schoolchildren aged 11-15 years and found that the most frequent alteration was shoulder elevation (77.78%) and shoulder protrusion (61.60%), which indicates the presence of shoulder imbalance and inadequate posture of students, with kyphotic positioning of the thoracic spine.

The difference in shoulder levels could be explained by the presence of laterality, which would lead to dominant shoulder depression[12]. In addition, shoulder asymmetry could also be related to inadequate backpack support, as in the case of single-shoulder support, causing asymmetric, which would cause postural adjustments and compensatory actions. However, although 35.24% of students in the present study reported not carrying the backpack correctly, no significant results were found between the way school materials were carried and postural changes. It is important to highlight that these results may be related to other factors related to school material, in addition to the way they are carried, such as weight, size, shape and time of transportation. In this sense, Lemos et al.[14] found that postural changes begin to occur when load is greater than 10% of body weight.

Thus, alterations found in the present study may be associated to the backpack weight, a variable that was not analyzed, which characterizes a study limitation. These are important variables that should be evaluated in future works.

High prevalence of trunk abnormalities was found in 68.45% of students in the present study, with 24.17% having head protrusion, 16.67% head inclination, 14.64% hyperkyphosis, 39.52% hyperlordosis and 4.29% scoliosis. Other studies have also found prevalence of alterations in this region. Santos et al.[11] reported pelvic tenderness (21.5%) and anteversion (19%), head protrusion (11.7%) and tilt (15.4%), thoracic kyphosis (9.7%), and lumbar hyperlordosis (26.3%). In a study by Rodrigues and Yamada[3], 29.2% of students presented head inclination and 24.6% showed hyperkyphosis. Borges et al.[15] observed incidence of 76.92% of head misalignment and 46.15% of scoliosis. Pereira and Figueirôa[16] found that the frequency of scoliotic posture in schoolchildren aged 9-14 years who attended the basic cycle of a municipal school in Salvador, Bahia, was 35.2%. Vieira et al.[17] found prevalence of early signs of scoliosis in 26.3% of the 377

schoolchildren aged 5-6 years of both sexes. Souza et al.[18] investigated the prevalence of idiopathic scoliosis in schoolchildren aged 10-14 years from the public school system, with prevalence of 4.3%.

Differences between scoliosis rates found are probably related to the methodological criteria used for detection, namely, postural evaluation, anterior flexion test, photogrammetry, Cobb radiography and angle. However, it is important to highlight that physical examination constitutes an important part of scoliosis diagnosis, since this disease in most cases is painless. Physical examination favors early diagnosis and allows effective treatment, usually without the need of surgical treatment, which presents risks to the patient, in addition to high cost[18].

Regarding thoracic hyperkinesia, some authors have related it to scapular instability. It may also be associated with periods of rapid growth, such as during pubertal outbreak, which is very significant in women, since they have a trend to adopt this posture as a way to hide breast development[19]. In addition, the prepubertal stage and puberty are periods of life during which posture undergoes a series of adjustments and adaptations due to body changes. Between 7 and 12 years of age, posture undergoes great transformation to achieve balance compatible with new body proportions. The fact that girls go through this phase before boys explains these results, where girls showed more changes in this region (p=0.00006). In this sense, Santos et al.[11] observed significant association of trunk changes with gender, with greater effects on girls. Another variation that contributed to this result was scoliosis, since in the study by Pereira and Figueirôa[17], the presence of scoliotic posture was significantly more frequent in females, and Souza et al.[18] observed scoliotic posture in about 85% of women, especially in the age group of 9-13 years.

The association between postural changes and age of schoolchildren indicated statistically significant number of alterations in lower limbs in younger schoolchildren. In this sense, it is important to evaluate postures adopted in activities in which students spend much of their time such as studying, watching TV and using computer or video game. In the present study, postures adopted by schoolchildren were not significantly associated with postural alterations. Debs et al.[20], also did not detect correlations between postural habits investigated, such as material transportation, sitting during class, sleeping posture, place to perform the school task, bad positioning in the sitting posture and the habit of sleeping in networks with changes vertebral column.

However, these relationships have been described in several works in literature. Sedrez et al.[21] demonstrated that thoracic kyphosis was associated with inadequate posture when sitting down to write and sit on a bench and use the computer for four hours or more. Although the findings of this study do not allow affirming that there is a cause/effect relationship of postural alteration with postures adopted by students, preventive actions are necessary in the school environment to improve these inappropriate habits in order to avoid their associations with future alterations. Further

longitudinal studies should be carried out to explore this issue.

The prevalence of MP in 62.73% of students in the present study is above percentages described in literature, which range from 12.2% to 40% in national and international studies[22]. Although high number of schoolchildren reported pain in different regions, they were not associated with postural changes. Nonetheless, other studies have reported such associations. Contri and Petrucelli[23] reported that pain is one of the main complications of scoliosis in children at early school grades (2 to 5). Rego and Scartoni[24] found that postural alterations led to pain in students at primary school grades (5 and 6). Debs et al.[20] evaluated the presence of pain using the Adams test and observed statistically relevant predominance in patients whose outcome was positive.

It is noteworthy that although the authors reported that excessive use of the computer is related to moderate and severe pain intensities, they emphasized that these data must be analyzed with caution, since the cross-sectional design does not allow inferring possible causality, and self-report evaluation may present memory bias. They also reported that the subjective character of pain evaluation may generate incorrect information and / or overestimation of responses[25].

However, it should be considered that in the evaluated students, the association between pain and postural changes may manifest in adult life, when corrections would be more difficult to achieve. The large number of students reporting MP suggests the need for a more detailed evaluation of the symptom, such as intensity, type, frequency, triggering factors, among others, to minimize drug interventions, promote health and improve their quality of life. Further studies should be carried out to evaluate pain in a more specific way in order to understand the causes of this complaint in schoolchildren.

The results of the present study indicated higher prevalence of postural changes in trunk, lower limbs and total changes in students who did not practice physical activities. Other studies have found that regular physical activity can protect against scoliosis[26]. However, it this practice should be performed correctly, since physical activity can be both a protection factor and a risk factor for postural changes, since the type of phisical activity, the weekly training volume, the time of practice and the way the activity is practiced influence the type of musculoskeletal response[21].

Although physical activity is a protection factor for the presence of postural alterations, the results should be interpreted with caution, since information was collected through self report, limiting the deepening of this question. No tools were used that could link this discussion to the evaluation of modalities, frequency, classification (light, moderate, heavy, competitive modalities), practice time, way the activity is conducted, etc. Therefore, studies that better evaluate the form of physical activity should be stimulated.

No significant results between obesity and postural changes were found. Souza Júnior et al.[2] also did not observe this relationship. Chan

and Chen[27] reported no evidence for relationship between obesity and the musculoskeletal system in children, but it is assumed that obesity affects the locomotor apparatus, both structurally and functionally, with joint overload and poor joint alignment.

There is consensus that postural evaluation is the precursor to the identification of postural problems that tangle with normal growth patterns. Thus, the sooner the intervention, the greater the chances of success, with great chances of preventing progression and avoiding diseases of the pathology in adulthood[28].

One limitation of the present study was not using objective methods such as biophotogrammetry and radiography for more accurate diagnosis. However, findings may contribute to justify the need to implement primary prevention programs in schools by health and education managers, helping in early detection to reduce the incidence of these diseases. In this perspective, Bung et al.[29], in a retrospective analysis, compared the results of scoliosis diagnoses by school selection with those diagnosed by other means (family, medical service, etc.), concluding that the former were significantly younger, or those requiring surgery were operated earlier and had smaller curves. Only 45% of the patients diagnosed in school selection required surgical treatment, whereas for those diagnosed by other means, the percentage was 75%.

CONCLUSION

This study identified high prevalence of postural changes in schoolchildren. Early identification of body posture changes can be a preventive action in the collective health area, since if not early identified, can result in pathologies. New studies at national level should be encouraged to reinforce the need for inclusion of posture evaluation in schoolchildren.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee –"Triângulo Mineiro" Federal University and protocol No. 1731 and was written in accordance with standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed experiments: DB, KP and IAPW. Performed experiments: DB, KP and IAPW, LGDQ, AES, EPW. Analyzed data: DB, KP and IAPW. Contributed with reagents/materials/analysis tools: DB, KP and IAPW, LGDQ, AES, EPW. Wrote the paper: DB, KP and IAPW, LGDQ, AES, EPW.

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