

Prevalence of musculoskeletal pain and its association with inadequate school furniture*

Prevalência de dor musculoesquelética e sua associação com a inadequação do mobiliário escolar

Mirelle de Oliveira Saes¹, Cristina Dutra Ribeiro¹, Ana Luisa Muccillo-Baisch², Maria Cristina Flores Soares²

*Recebido da Universidade Federal do Rio Grande, Rio Grande, RS, Brasil.

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ABSTRACT

BACKGROUND AND OBJECTIVES: Inadequate school furniture is a factor contributing to musculoskeletal pain onset in students. This study aimed at estimating the adequacy of school desks and chairs with regard to students' anthropometric characteristics and its possible association with musculoskeletal pain in different parts of the body.

METHODS: A survey was carried out with 625 students and the furniture of 69 classrooms. The simplified Nordic Questionnaire for Analysis of Osteomuscular Symptoms was used for the analysis of musculoskeletal symptoms, and parameters recommended by standard NBR 14006 (Brazilian Association of Technical Standards) were used to analyze furniture.

RESULTS: This study has shown that 87.2% of chairs and 45.6% of desks were totally inadequate. There has been significant association between inadequate desks and neck/cervical (12.6%; $p=0.05$) and dorsal (15.1%; $p=0.00$) musculoskeletal pain. Similar result was found with regard to inadequate chairs (neck/cervical: 17.5%; $p=0.02$; dorsal: 23.8%; $p=0.00$).

CONCLUSION: The high levels of inadequate school chairs and desks demand a review of these items of furniture which are used by students for long periods of time every day. It is recommended that public authorities be informed of this situation and request that school furniture be urgently brought into line with prevailing legislation. Our results stress the need for further care to be taken with regard to school students' health.

Keywords: Adolescent, Back pain, Children, Pain, School health.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A inadequação do mobiliário escolar é um fator que contribui para o surgimento de dor musculoesquelética em estudantes. O objetivo deste estudo foi estimar a adequação das mesas e cadeiras escolares em comparação com características antropométricas dos alunos e sua possível associação com dor musculoesquelética em diferentes regiões do corpo.

MÉTODOS: Foi realizado um levantamento de 625 alunos do ensino e mobiliário em 69 salas de aula. Utilizou-se o Questionário Nórdico de Sintomas Osteomusculares simplificado para análise de sintomas musculoesqueléticos, e para análise do mobiliário escolar utilizou-se os parâmetros recomendados pela norma NBR 14006 (Associação Brasileira de Normas Técnicas).

RESULTADOS: Esta análise mostrou que 87,2% das cadeiras e 45,6% de mesas eram totalmente inadequadas. Foi encontrada associação significativa entre mesas inadequadas e dor musculoesquelética no pescoço/região cervical (12,6%; $p=0,05$) e na região dorsal (15,1%; $p=0,00$). Resultado semelhante foi encontrado em relação à inadequação das cadeiras (pescoço/região cervical: 17,5%; $p=0,02$; região dorsal: 23,8%; $p=0,00$).

CONCLUSÃO: Os altos níveis de mesas e cadeiras escolares inadequadas exigem uma revisão desses itens de mobiliário que são usados por alunos por longos períodos todos os dias. Recomenda-se que as autoridades públicas sejam informadas da situação e solicitem que o mobiliário escolar seja urgentemente adequado à legislação vigente. Os resultados encontrados neste estudo sublinham a necessidade de mais cuidado a ser tomado em relação à saúde dos alunos da escola.

Descritores: Adolescente, Crianças, Dor, Dor nas costas, Saúde escolar.

INTRODUCTION

School furniture is an essential element in the education process. Despite this, little attention has been paid to related ergonomic questions. Improper classroom chairs and desks affect performance at school and contribute to the appearance of musculoskeletal complaints, especially in the spine¹⁻³.

Classroom furniture is being highlighted as an important factor underlying the onset of musculoskeletal pain (MSP) among school children, given that they remain in a sitting position for some 30% of the day for at least nine years^{4,5}.

1. Universidade Federal do Rio Grande, Programa de Pós-Graduação em Ciências da Saúde, Pelotas, RS, Brasil.

2. Universidade Federal do Rio Grande, Programa de Pós-Graduação em Ciências da Saúde e Instituto de Ciências Biológicas, Rio Grande, RS, Brasil.

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Correspondence to:

Mirelle de Oliveira Saes
Rua Visconde Paranaguá 102
96203-900 Rio Grande, RS, Brasil.
E-mail: mirelle_saes@gmail.com

Remaining seated for long periods of time in improper positions can lead to the weakening of muscles in the rear dorsal and lumbar region and place strain on intervertebral discs, causing harmful effects to the spine^{6,7}. The literature reports an increase in the number of school children with musculoskeletal lesions, strains and altered posture that can be associated with remaining in a sitting position for prolonged periods of time and with adopting improper sitting postures⁸. A study undertaken with American school children with 6 – 8 years of age has found that 58% of them reported having taken time off school at least once a month because of pain associated with discomfort caused by the length of time spent in a sitting position⁷.

In Brazil, a study with 93 students with 11 years of age, found that 54% reported musculoskeletal pain in the cervical region of the spine during activity in school desk⁹. However, the national literature has focused its studies on the prevalence of musculoskeletal disorders and associated factors among students, and research regarding the adequacy of school furniture remains weak¹⁰. Classroom furniture therefore plays an important role in maintaining good sitting posture. Studies show high prevalence of classrooms with furniture that is inadequate for students' anthropometric characteristics, thus resulting in bad sitting positions, discomfort and difficulty in learning and concentrating¹⁰⁻¹³.

Some studies have found that musculoskeletal structures most frequently affected by MSP associated with inadequate school furniture are the spine and the shoulders^{14,15}.

The use of ergonomically adapted furniture has been recommended in order to reduce MSP prevalence among school children. Studies confirm that the use of ergonomic furniture reduces musculoskeletal symptoms when compared to furniture that is not adapted to school children¹⁶.

Within this context, furniture is one of the determining factors for a satisfactory ergonomic environment, apart from being of great importance in the teaching process by helping preventing altered postures, pains and the possible onset of disorders, as well as by helping performance, safety and comfort and by influencing students' productivity and learning¹⁶⁻¹⁸.

The purpose of this study was to estimate the dimensions of the adequacy of classroom chairs and desks in relation to anthropometric characteristics of state school students, as well as to investigate the association between inadequate furniture and the presence of MSP in different regions of students' bodies. Once these data have been obtained, they can be used to inform the design of school health promotion programs with regard to the ergonomics of classroom furniture.

METHODS

This was a cross-sectional study with 1st to 9th grade school children at four municipal schools in Rio Grande-RS, Brazil. Sixty-nine classrooms were assessed as to the adequacy of chairs and desks in relation to students. Study data were collected between June and December 2010.

For the purposes of studying prevalence, sample size was calculated using 30% MSP prevalence, 5% alpha error and a 4% margin of error, thus resulting in 504 students. After adding 10%

to account for losses, total sample size was 554 students. The following were established for the purposes of studying association: 80% statistical power, 5% alpha error, relative risk greater than or equal to 1.45 and 28% prevalence among unexposed students (excess backpack weight variable), thus totalling 474 students. After adding 10% for losses and 15% for the control of confounding factors, total sample size needed was identified as 599 students.

The number of children and adolescents to be assessed in each school was defined based on the proportion enrolled at each school. The number of students defined for each school was then divided by the number of available grades. Resulting number of students by grade was then distributed between the total number of students comprising the classes in each grade, always ensuring that the sample had a similar number of boys and girls.

A questionnaire containing closed questions was used to collect data: demographic characteristics (gender, age, skin colour); MSP-related aspects (regions of the body: neck and cervical region; shoulders; arms; elbows; forearms; wrists, hands and fingers; dorsal region; lumbar region; hips/lower limbs).

MSP assessment was conducted with the aid of a human body diagram and questions of interest to the study were adapted from the simplified Nordic Questionnaire for Analysis of Musculoskeletal Symptoms¹⁹. MSP assessment was performed during the seven days prior to the study itself. The visual analog scale was used to quantify MSP among students.

The assessment of classroom furniture was restricted to sets of chairs and desks as per NBR Standard 14006 (Brazilian Association of Technical Standards), which states: "a chair/desk set is comprised of a desk and a chair, which are independent of each other; whereby the desk is comprised of a desktop, frame (base), storage space, and the chair is comprised of backrest, seat and frame"²⁰. Furniture of the four schools assessed was the same.

School furniture adequacy was assessed using NBR 14006 recommendations and considering students' height. Nine items relating to the desks were analysed (minimum width of the desktop and legroom; height of the desktop; minimum height for leg movement, for positioning the knees and for positioning obstacles in the leg movement area; minimum depth of the desktop, minimum depth of the space for positioning the legs and for moving them), as well as nine characteristics of the chairs (minimum width of the seat and backrest; height of the seat, height of the upper edge of the backrest and height of the front edge of the seat; maximum height of the gap between the seat surface and the base of the backrest; depth of the seat; angle between the seat and the backrest; inclination of the seat)²⁰.

Data collection took place at the schools during the period in which students were in attendance, in a reserved place previously defined by school administrators. Two evaluators received training in data collection from the study coordinator. One of them was responsible for the first stage of data collection which involved verifying anthropometric variables. Following this, the other evaluator applied the data collection tool.

The frequency distribution of items relating to the school furniture was performed initially. Given that no furniture was found to be compliant with the standards used as reference, desks and

chairs were categorized according to their inadequacy: partially inadequate (up to four inadequate items) or totally inadequate (five or more inadequate parameters).

Data were entered in a database set up beforehand using Epi-Info 6.04 and were analysed using STATA 10.0. Frequency distribution of different variables was then calculated and their association with MSP in the most prevalent regions was obtained using the Chi-square test. Values with $p < 0.05$ were considered significant. The study complied with the directives of National Health

Council Resolution 196/96 and was approved prior to being conducted by the Federal University of Rio Grande Health Research Ethics Committee report number 20/2010. All school children were authorized to take part in the study by means of a Free and Informed Consent Term (FICT) signed by their parents and/or guardians.

RESULTS

The study sample was comprised of 625 school children aged 6-18 years, of whom 56.3% were girls and 72.3% were white-skinned. Average height of the sample was 1.45cm, and average body weight was 43.3kg.

All furniture assessed had inadequate items; 87.2% of the chairs and 45.6% of the desks were totally inadequate. The analysis of the adequacy of school desks / chairs can be found in tables 1 and 2.

With regard to desks, the height of desktops and their depth were found to be 100% inadequate in all analyses. Items found to be adequate in 100% of the schools assessed were: minimum height for knee and leg movement.

With regard to chairs, minimum height of the gap between the seat and the base of the backrest and the height of the front edge of the seat were found to be inadequate in 100% of the schools assessed. Minimum seat width, minimum backrest width and backrest inclination were found to be adequate in all analyses.

Furthermore, the inadequacy of school chairs was higher among female adolescents ($n=310$; $p < 0.00$) and those aged between 6 and 10 years ($n=278$; $p < 0.00$). The inadequacy of the table was higher for girls ($n=150$; $p=0.260$) and among students with 11-18 years of age ($n=180$; $p < 0.00$).

Data were also analysed taking into consideration the six body regions with the highest MSP prevalence (Table 3). Greater MSP prevalence was found in the neck/cervical region ($p=0.05$) and lumbar region ($p < 0.00$) in students using totally inadequate desks. It should be highlighted that the association between MSP in the neck/cervical region and totally inadequate desks was found to be at the limit of significance.

Significantly higher MSP prevalence was found in the neck/cervical region ($p=0.02$) and lumbar region ($p < 0.00$) in relation to totally inadequate chairs.

When evaluating mean musculoskeletal pain, the following re-

Table 1. Prevalence of adequacy of school desks. Rio Grande/RS/Brazil

Desk dimensions	Adequate (%)	Inadequate (%)
Desktop – minimum width	63.2	36.8
Legroom – minimum width	63.0	37.0
Desktop – height	-	100.0
Leg movement – minimum height	100.0	-
Knee movement – minimum height	100.0	-
Leg movement – minimum height of obstacle position	8.2	91.8
Desktop – minimum depth	-	100.0
Legroom – minimum depth	69.4	30.6
Leg movement – minimum depth	86.9	13.1

Table 2. Prevalence of adjusting chairs of schools. Rio Grande/RS/Brazil, 2010

Chair dimensions	Adequate (%)	Inadequate (%)
Minimum backrest width	100.0	-
Seat height	12.6	87.4
Maximum height of the space between seat and base of backrest	-	100.0
Height of the upper edge of the backrest	7.0	93.0
Height of the front edge of the seat	-	100.0
Effective seat depth	12.6	87.4
Angle between seat and backrest	91.8	8.2
Seat inclination	100.0	-
Minimum backrest width	100.0	-

Table 3. Association between furniture and the occurrence of musculoskeletal pain in different body regions of schoolchildren ($n=625$) of public education. Rio Grande/RS/Brazil, 2010

Body region	School Furniture					
	Chair			Desk		
	Partially inadequate	Totally inadequate	p	Partially inadequate	Totally inadequate	p-value
Neck/cervical	9.0	17.5	0.02*	7.9	12.6	0.05*
Shoulders	10.8	13.8	0.44	12.6	9.5	0.21
Wrists/hands/fingers	11.8	15.0	0.41	12.1	12.3	0.94
Dorsal region	9.2	23.8	0.00*	7.6	15.1	0.00*
Lumbar region	10.1	16.3	0.10	10.9	10.9	0.99
Hips/lower limbs	12.3	11.2	0.79	14.4	9.5	0.06

* $p \leq 0.05$

sults were observed: 4.96 in the neck/cervical; 5.15 in shoulders; 4.66 in wrists/hands/fingers; 5.51 in dorsal region; 5.70 in lumbar and 5.34 on hips and lower limbs.

DISCUSSION

Studies have shown that school children spend approximately 40% of their time sitting in positions that lead to rotation and/or flexion of the cervical, dorsal and lumbar regions, thus placing strain on these structures of the spinal column^{9,21-23}.

With regard to the furniture complying with Brazilian standards, we found that the height of the seat and the height of the front edge of the seat were inadequate for 87.4% and 100% of students, respectively. This corroborates results found by Medina, Illada & Domínguez²¹ in a study conducted with 413 state and private school students in Venezuela, where no furniture assessed was adequate with regard to the height of the seat and the height of the front edge of the seat as recommended by standards. The fact of these items being inadequate means that it is impossible for students to put their feet on the floor so that their lower limbs form an angle of 90°, resulting in them having to sit on the edge of the seat thus preventing them from supporting their backs against the backrest. This means that there has to be anterior flexion of the torso when they need to do activities on the desk²¹. Seat inclination was found to be adequate in all evaluated furniture. This result is quite important, given that it is this inclination that enables opposite groups of muscles to be in a balanced and relaxed position, preserving correct lumbar posture²².

The height of desktops was found to be inadequate in 100% of evaluated furniture. Studies report that inadequate desktop height is harmful when performing activities on the desktop and results in improper postures. When the desk surface is high, in addition to having to bend their heads, when students rest their arms on the desk this alters the position of the shoulder girdle and may cause discomfort in this region. When the desk surface is low, students have to bend forward when handling items on the desk and this can contribute to the appearance of alterations in the cervical and thoracic region of the spinal column^{9,15}.

Results show that pain in the cervical and dorsal region of the lumbar spine is associated with inadequate school furniture. Reis et al.²⁴ conducted a study with 800 Brazilian school children aged 7-18 years and identified that the areas most affected by pain due to inadequate furniture were the back, shoulders and the gluteal region²⁵. Inadequate chairs have been closely associated with pain in the cervical, thoracic and lumbar regions of the spinal column¹⁰. Studies report that pain in the dorsal and lumbar regions of the spine is linked to inadequate height and depth of the chair seat^{14,26}. Still with regard to furniture adequacy, 45.6% of students stated that in their view there was a relationship between reported MSP and school furniture. This association was further perceived when students reported MSP in the shoulder region (23.0%), dorsal region (19.0%) and lumbar region (17.3%).

Our findings are in line with studies that report that when furniture is inadequate to students' needs this gives rise to adaptive alterations in the spinal column, leading to inversion of the lumbar curvature, increase in thoracic kyphosis and pelvic tilt^{8,26}.

CONCLUSION

All results found in this study stress the need for further care to be taken with the health of these children. The high levels of inadequate school chairs and desks demand a review of these items of furniture which are used by students for long periods of time every day. It is recommended that public authorities be informed of this situation and request that school furniture be urgently brought into line with prevailing legislation.

Results have shown that school furniture is inadequate to students' anthropometric characteristics, as well as the inherent need to implement public school health promotion programs to encourage students to adopt healthy postural habits at school, focussing on chairs and desks.

Emphasis is given to the importance of using standard guidelines for manufacturing furniture (chairs/desks) adapted to students' different age groups and anthropometric characteristics, with the aim of ensuring correct postures and preventing musculoskeletal disorders.

An aspect that is essential, but which has little coverage in current literature, is the importance of paying more attention to manufacturing low cost desks and chairs, so as to facilitate public service access to them thus making adequate furniture available to state schools and their students.

Findings emphasize the need for deeper analysis of which inadequate parameters have the greatest influence on MSP found among school children, this being a limitation of this study.

Above all, the conclusion can be reached that school furniture is an important issue that needs to be addressed responsibly by those who plan and undertake public education in our country.

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