MUSCULOCKELETAL DEFORMITIES AND BACK PAIN IN SCHOOLCHILDREN

Danijela Domljan[1], Zoran Vlaović[2], Ivica Grbac[3]
University of Zagreb Faculty of Forestry, Zagreb, CROATIA,
[1]domljan@sumfak.hr; [2]vlaovic@sumfak.hr; [3]ivica.grbac@zg.t-com.hr

Abstract: *Sitting is the most common body position of every schoolchild during classroom activities. The problems related to prolonged sitting develop when children start going to school, mostly because today children have to sit in classrooms for about 5-10 hours. An increasing number of schoolchildren in the world suffer from musculoskeletal problems and back pain (MSD/BP), which has become an international problem in schools. The aim of this paper is to investigate if the children in Croatian elementary schools suffer from MSD/BP. The research was conducted at elementary schools in Zagreb County, Croatia. The purpose of the questionnaire was to obtain information about the children's attitude towards school furniture and the pain that develops while sitting. The survey included 255 schoolchildren from the 5th to 8th classes. The results showed that pupils sometimes feel fatigue and pain (54%) while sitting. They feel pain in the neck (57%), back (45%), shoulders (26%), spine (muscles) (25%), and in other parts of the body. These results may lead to conclusion that MSD/BP can also be found in schools in other Croatian counties, as well as in the world. When designing classroom furniture, the opinion of youth about the available furniture must be taken into account, as well as the pain and fatigues detected among pupils.*

Keywords*: sitting, schoolchildren, elementary school, musculoskeletal discomfort, back pain, school furniture design*

1. INTRODUCTION

Generally speaking, human body is created for perpetual motion, not for resting [1]. As a result, none of the body positions is comfortable over a longer period of time and fatigue occurs. If a body position is not changed soon, pains can occur [2]. If the pains endure, they can create difficulties at work. A modern man spends one half of his/her life sitting passively, one fourth lying and only the remaining fourth in motion [3]. The physical and psychical disorders occurring while sitting represent one of the alarming problems of modern civilization.

Today, as a result of the development of information technologies, new educational methods and newly created habits of the modern society, as early as in the preschool age, children spend a growing amount of time sitting in front of TV sets and computers, in cars etc., in the positions they copy from grownups. In most of the schools (so called "traditional schools"), children spend in classrooms as much as 92% of their time in static sitting, 3% in dynamic sitting, only 3% active sitting or walking, and 2% standing [4]. In order to maintain the "still", static and upright position of the body, a child, particularly the one of a younger age, becomes restless and fidgety in order to find an appropriate position [5]. Body fatigue occurs when the organism simply collapses in an anomalous position due to muscle fatigue. It results in pains in the back, jugular spine,

head and legs. Scientific literature has been paying more and more attention to these pains, calling them officially musculoskeletal discomfort and back pain (MSD/BP) [6].

1.1. Musculoskeletal Discomfort and Back Pain (*MSD/BP)*

In the past few decades, the emergence of MSD/BP has attracted attention of numerous physicians and psychologists [7]. It was observed that, in addition to the above mentioned anomalous posture of children in classrooms, children complain more and more about these pains. This "problem" would perhaps not be noticed to this extent, if it were not for numerous research of office sitting throughout the world, where a substantial growth of MSD/BP disorder has been recorded.
The musculoskeletal discomfort and back pain at school-age children worries not only the World Health Organization, but also the interdisciplinary experts studying school environment.
It is estimated that more than 80% of the population complain about the pains in some moment of their lives and at least 7% of workers see their general practitioners because of various back pains, primarily lumbar pains [8].
The data about the health condition of school age in Croatia, based on the results of medical examinations, indicate a number of disorders occurring in school age [9]. Among other things, Dr. Kuzman says that more than one third of schoolchildren and students have poor posture and that more than 40% of elementary-school children have markedly deformed feet; also, structural deformities of spine, disturbances of refraction, high blood pressure and dislalia have been detected.

So, what is the cause of the growing and more frequent occurrence of musculoskeletal discomforts and bodily pains at elementary school children? The list of the main causes includes age, sex, hereditary diseases in the family, physical and sports (in)activity, body position while sitting, the amount of time spent in front of a computer or TV set, psycho-social factors, and inadequately designed school furniture [6].

1.2. Impact of School Furniture Design on MSD/BP

Although it is believed that, in addition to the existing weakness of children's musculoskeletal system, school activities are not the only factor responsible for real, fixed bodily deformities and pains, the manner of school activities can contribute to the development of poor posture. In this respect, in addition to lack of exercise, the major contributor is lengthy sitting on an inadequately designed and dimensioned school chair and at an equally poorly designed school desk.
The results of the research of the matching of the functional dimensions of school chairs with anthropometrical size of the elementary-school children in Zagreb County [10] confirm that the school chairs are not suitable for children. The research also confirmed the hypothesis that almost no part of the measured schoolchild population uses chairs of adequate dimensions. It is clear that the bodies of the users – schoolchildren – will inevitably suffer consequences.

The deterioration of spine that takes place at school age is a significant cause of sitting problems and one of possible causes of serious diseases and chronic diseases later in life, when many people perform their office work inefficiently due to pains [11]. The World Health Organization and International Labour Organization estimate that approximately

160,000,000 workers contract occupational diseases or have their diseases deteriorated by their work every year [12]. As there is no organized monitoring of this group of diseases in the Republic of Croatia, there is a need for special prevention and monitoring programs. One such special program should relate to protection of school-age children who are more and more exposed to musculoskeletal deformities.

2. THE AIM OF THE RESEARCH

There has been no systematic research that would analyze schoolchildren's opinion about the existing furniture and equipment used in classrooms, their needs and requirements in classes and their pains and problems, which can contribute to the optimal design of school furniture.
The goal of this research was to determinate whether schoolchildren feel pain and in what part of the body when they use the existing school chairs and desks and thus confirm whether the available design and structure of the classroom furniture are the potential cause of future occupational diseases.

3. MATERIALS AND METHODS

3.1. Respondents and Surveyed Schools

The questionnaire was filled out by 255 children [Nm=127 (49.8%); Nf=128 (50.2%)] from the fifth to eighth grades of four elementary schools in Zagreb County [N5=56 (22%); N6=75 (29.4%); N7=71 (27.8%); N8=53 (20.8%)]. The schools differed by the number of children in classes, pedagogical approaches, conducting of classes, and classroom equipment. However, despite these differences, they all had "traditional" furniture for schools [13].
The questions processed in this research are a part of a wider survey (adapted from [14]) carried out in order to obtain information on children's behaviour and attitudes towards school environment and furniture. The research results indicate pains in individual body parts when using the existing furniture during classes.

3.2. Permission for Carrying Out the Research

With a help of headmasters of the schools which took part in the survey, permission was requested for carrying out of the research. All the children who voluntarily took part in it and their parents gave the permission. It was explained to all the participants that the research is voluntary and that any child can withdraw at any stage.

3.3. Statistical Analysis

Data analysis was performed using SPSS (13.0) for Windows. Depending on a question, the arithmetic mean (mean value) and percentage of respondents who chose that answer were specified for every answer. The data are given for the total sample (in Figures) and by sex and grade of the schoolchildren (in Tables).

4. RESULTS

The results of the children's answers are shown in tables, by grade (the 5th, 6th, 7th and 8th grades, separately) and sex (boys, girls). All the tables show the total number of respondents by groups observed (Freq.). For the result of every answer, the table shows the percentage of respondents (Col Pct), calculated 95%-interval of reliability, and results of the X^2 test (chi-squared test) made for all the observed groups of respondents by grade and sex if only one answer was possible. All the analyses where $p<0.05$ are considered statistically significant and are designated with bold characters and italics.

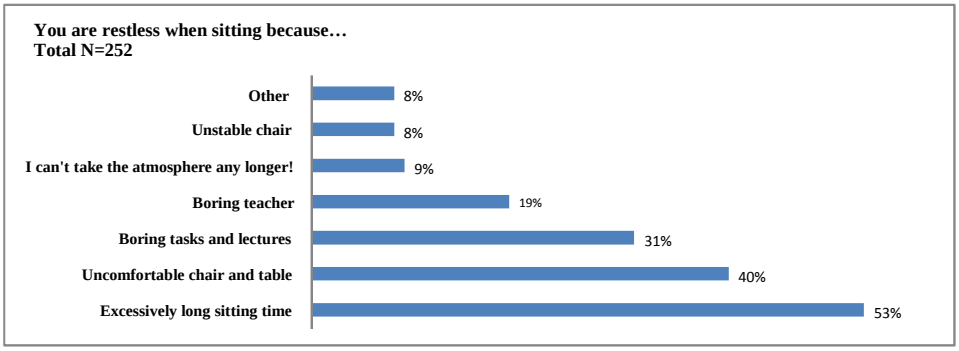

Figure 1: The distribution of the answer of all respondents (total N=255) to the question: *"You are restless during classes because…"*

Table 1: The answers to the question "*How many hours during a day do you sit in the classroom (on average)*?" distributed by grades and sex of the respondents

Hours spent sitting (average, in classroom)		Class				Sex	
		5	6	7	8	Boys (m)	Girls (f)
Answers	Freq	**56**	**75**	**71**	**53**	**127**	**128**
2 hours	Col Pct	0.00%	0.00%	1.41%	1.89%	0.00%	1.56%
	-95% IP	0.0%	0.0%	1.3%	1.8%	0.0%	0.4%
	+95% IP	0.0%	0.0%	3.3%	5.8%	0.0%	4.4%
3 hours	Col Pct	5.36%	1.33%	1.41%	3.77%	3.15%	2.34%
	-95% IP	0.7%	1.3%	1.3%	1.3%	0.03%;	0.4%
	+95% IP	10.7%	3.3%	5.3%	9.3%	6.0%	4.4%
4 hours	Col Pct	23.21%	5.33%	9.86%	15.09%	18.11%	7.03%
	-95% IP	12.0%	0.06%	3.0%	5.4%	11.3%	2.6%
	+95% IP	34.0%	9.9%	17.0%	24.6%	24.7%	11.4%
5 hours	Col Pct	37.50%	33.33%	21.13%	30.19%	32.28%	28.13%
	-95% IP	25.3%	22.4%	11.5%	17.7%	23.9%	20.2%
	+95% IP	50.7%	43.6%	30.5%	42.3%	40.1%	35.8%

6 hours	Col Pct	12.50%	37.33%	39.44%	18.87%	25.98%	31.25%
	-95% IP	4.2%	26.1%	27.7%	8.4%	18.4%	23.0%
	+95% IP	21.8	47.9%	50.3%	29.6%	33.6%	39.0%
7 hours and more	Col Pct	21.43%	22.67%	26.76%	30.19%	20.47%	29.69%
	-95% IP	10.3%	13.5%	16.7%	17.7%	13.0%	22.1%
	+95% IP	31.7	32.5%	37.3%	42.3%	27.0%	37.9%
Mean =5.6 / hours		**5.2**	**5.7**	**5.8**	**5.5**	**5.4**	**5.7**
χ2 test		***χ2 =29.6799; DF=15; p=0.0131***				***χ2 =11.5100; DF=5; p=0.0422***	

Table 2: The answers to the question *"Sitting makes you tired, so you start feeling pain during sitting?"* distributed by grades and sex of the respondents

Feeling tired / pain during sitting?		**Class**				**Sex**	
		5	**6**	**7**	**8**	**Boys (m)**	**Girls (f)**
Answers	**Freq**	**56**	**75**	**71**	**52**	**126**	**128**
Yes, often	Col Pct	21.43%	14.67%	23.94%	21.15%	19.84%	20.31%
	-95% IP	10.3%	6.9%	14.1%	9.9%	13.0%	13.0%
	+95% IP	31.7%	23.1%	33.9%	32.1%	27.0%	27.0%
No	Col Pct	33.93%	26.67%	19.72%	25.00%	33.33%	18.75%
	-95% IP	21.6%	17.0%	10.7%	13.2%	24.8%	12.2%
	+95% IP	46.4%	37.0%	29.3%	36.8%	41.2%	25.8%
Sometimes	Col Pct	44.64%	58.67%	56.34%	53.85%	46.83%	60.94%
	-95% IP	32.0%	47.9%	44.5%	40.5%	38.3%	52.6%
	+95% IP	58.0%	70.1%	67.5%	67.5%	55.7%	69.4%
χ^2 test		χ^2 =5.4527; DF=6; p=0.4872				***χ^2 =7.5485; DF=2; p=0.0230***	

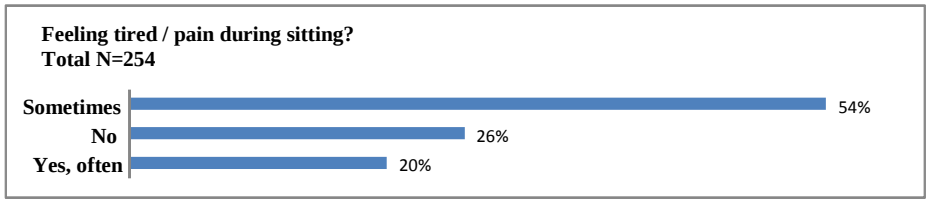

Figure 2: The distribution of the answer of all respondents (total N=255) to the question: *"Sitting makes you tired, so you start feeling pain during sitting?"*

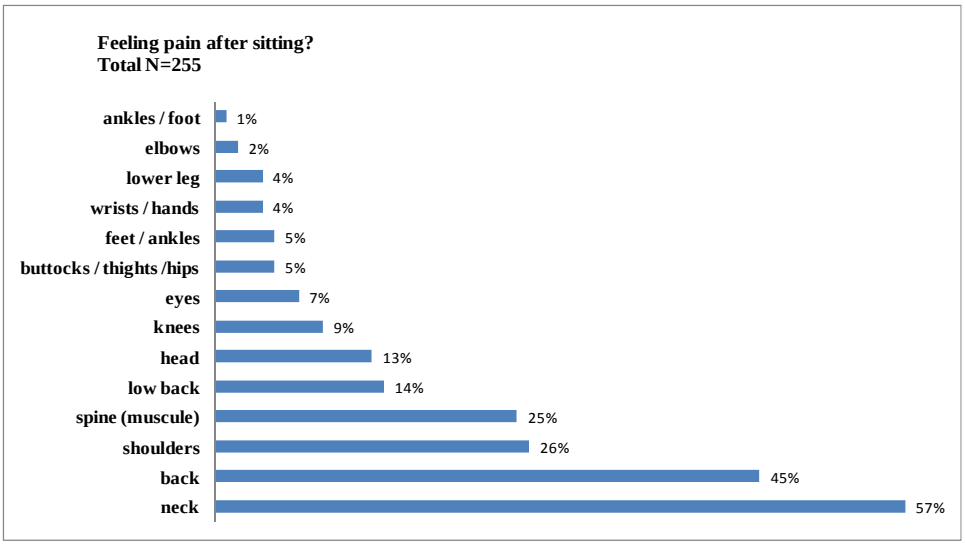

Figure 3: The distribution of the answer of all respondents (total N=255) to the question: *"Where do you mostly feel pain after sitting and where is this pain strongest?"* (multiple answers are allowed)

Table 3: The distribution of the answer of all respondents to the question: *"Where do you mostly feel pain after sitting and where is this pain strongest?"* (multiple answers are allowed)

Feeling pain after sitting / where?		Class				Sex	
		5	6	7	8	Boys (m)	Girls (f)
Answers	**Freq**	**56**	**75**	**71**	**53**	**127**	**128**
Head	Col Pct	14.29%	16.00%	9.86%	7.55%	10.24%	14.06%
	-95% IP	4.9%	7.7%	3.0%	0.7%	4.8%	8.0%
	+95% IP	23.1%	24.3%	17.0%	15.3%	15.2%	20.0%
Neck	Col Pct	42.86%	36.00%	54.93%	52.83%	41.73%	50.78%
	-95% IP	30.0%	25.1%	43.4%	39.6%	33.4%	42.3%
	+95% IP	56.0%	46.9%	66.6%	66.4%	50.6%	59.7%
Back	Col Pct	16.07%	20.00%	15.49%	28.30%	21.26%	17.97%
	-95% IP	6.4%	10.9%	6.7%	15.9%	13.9%	11.3%
	+95% IP	25.6%	29.1%	23.3%	40.1%	28.0%	24.7%
Shoulders	Col Pct	7.14%	1.33%	4.23%	1.89%	1.57%	5.47%
	-95% IP	0.3%	-1.3%	0.6%	1.8%	0.4%	1.2%
	+95% IP	13.7%	3.3%	8.6%	5.8%	4.4%	8.8%
Spine (muscule)	Col Pct	7.14%	8.00%	4.23%	0.00%	3.94%	6.25%
	-95% IP	0.3%	1.9%	-0.6%	0.0%	0.6%	1.9%
	+95% IP	13.7%	14.1%	8.6%	0.0%	7.4%	10.1%

Elbows	Col Pct	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	95% IP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Low back	Col Pct	1.79%	4.00%	4.23%	1.89%	5.51%	0.78%
	-95% IP	1.7%	0.4%	0.6%	1.8%	1.9%	-0.7%
	+95% IP	5.7%	8.4%	8.6	5.8%	10.1%	2.7%
Wrists / hands	Col Pct	1.79%	4.00%	2.82%	1.89%	3.94%	1.56%
	-95% IP	1.7%	0.4%	1.0%	1.8%	0.6%	0.4%
	+95% IP	5.7%	8.4%	7.0%	5.8%	7.4%	4.4%
Buttock / thighs / hips	Col Pct	0.00%	4.00%	0.00%	1.89%	1.57%	1.56%
	-95% IP	0.0%	0.4%	0.0%	1.8%	0.4%	0.4%
	+95% IP	0.0%	8.4%	0.0%	5.8%	4.4%	4.4%
Knees	Col Pct	1.79%	5.33%	0.00%	3.77%	5.51%	0.00%
	-95% IP	1.7%	0.06%	0.0%	1.3%	1.9%	0.0%
	+95% IP	5.7%	9.9%	0.0%	9.3%	10.1%	0.0%
Lower legs	Col Pct	3.57%	0.00%	0.00%	0.00%	1.57%	0.00%
	-95% IP	1.1%	0.0%	0.0%	0.0%	0.4%	0.0%
	+95% IP	9.1%	0.0%	0.0%	0.0%	4.4%	0.0%
Ankles /feet	Col Pct	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	95% IP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Feet / ankles	Col Pct	3.57%	1.33%	1.41%	0.00%	1.57%	1.56%
	-95% IP	1.1%	1.3%	1.3%	0.0%	0.4%	0.4%
	+95% IP	9.1%	3.3%	3.3%	0.0%	4.4%	4.4%
Eyes	Col Pct	0.00%	0.00%	2.82%	0.00%	1.57%	0.00%
	-95% IP	0.0%	0.0%	1.0%	0.0%	0.4%	0.0%
	+95% IP	0.0%	0.0%	7.0%	0.0%	4.4%	0.0%

5. DISCUSSION AND CONCLUSIONS

According to recent researches, the existing designs of children's workplaces in schools, often even fifty-odd year old, do not fully meet the requirements of modern generations of elementary school children. Also, their functional dimensions do not suit the anthropometric size of pupils [13]. Children have difficulties in getting used to the furniture, particularly due to the fact that its design and size poorly fit the modern approach to work tasks. Children become restless and fidgety and feel pain in some parts of the body. As other reasons for this, some experts also mention the population growth in the past fifty years and the fact that school furniture poorly fits the size of children [15].

Restlessness was identified in this research, too. Schoolchildren do not sit peacefully. On the contrary, they start fidgeting after a while. As the reasons for this, they mostly

mention excessive time they have to spend sitting (55%), uncomfortable chairs and desks (40%) and boring classes (31%) (Figure 1). The research of Cardon et al. [4] has proven that children that do not have sufficient freedom of movement („traditional school" vs. „moving school") exhibit boredom, feel more pains; they are more dissatisfied and have poorer results and achievements.
On average, children sit for 5 hours while attending classes (mean = 5.6) (Table 1). All schoolchildren (total) sometimes feel tired while sitting (54%) and they start feeling pain (Figure 2). However, if the structure of individual answers is analyzed, we can see there is a significant difference ($p<0.05$) between boys and girls in manifesting pain (Table 2): while 33.33% of boys claim they do not have pain, girls exhibit it more often and sometimes (60.94%) regardless of their age. Exhibiting pain by sexes has been also researched by other authors [7]. They have noticed that this percentage is higher among girls probably owing to the fact that, due to the cultural heritage and traditional upbringing, men are not allowed to express emotions and pain. All generations are equally distributed by age, with the 6th-grade children reporting somewhat larger discomforts (sometimes 58.67%) (Table 2).
The schoolchildren mostly complain about pain in the neck (57%), back (45%), shoulders (26%) and the whole spine (25%), but also in other parts of the body (Figure 3). This indicates that pupils in other schools might also suffer pains. Interestingly, schoolchildren of both sexes, and even by grades, do not have relevant pains in the lower parts of the body and legs (feet, upper leg, lower leg, knees…), compared to more marked pains in the upper parts of the body, particularly in the neck and back, almost equally in all grades (Table 3).
Murphy et al. [14] have proved by PEO observation that most of the moves that schoolchildren make while sitting are in the neck (flexion >20˚, n=42; rotation>45˚, n= 33) and when they move backwards and forwards (trunk flexion >20˚, n=21).
The above mentioned results lead to the conclusion that, due to frequent motions and inadequate relation of dimensions of the body, furniture and environment, a child's body makes certain efforts which manifest themselves as pain. Also, the upper parts of the body are exposed to a higher load so the writing or reading position is not appropriate compared to the angle of the head, neck and shoulders, which also can result in pain.

The pain and uncomfortable sitting observed in the results of this survey of Zagreb County schoolchildren indicate that this phenomenon can also be found in other Croatian counties. A child spends more than 5 hours a day sitting at his/her place in the classroom, on a chair and at a desk (Table 1). The question is to what extent the exposure to the harmful impact of an inadequately designed workplace contributes to occurrence of occupational diseases later in life. Under the recommendations of the International Labour Organization, exposure to harmful impact of a workplace is directly responsible for occurrence of occupational diseases. The length and/or level of exposure to a certain harmful impact of a workplace or working environment also contribute to it [12].

The results indicate that Croatia is among the countries where systematic prevention should be carried out in order to prevent office workers from contracting occupational diseases. Although further extensive research of this problem is required to confirm this, the already obtained results are sufficient to indicate the need for designing different and modern workplaces for schoolchildren that would be stimulating and meet the modern requirements for healthy growth and development of every child [16].

It is proposed that designing of a new and different workplace for schoolchildren be initiated – a workplace the functional dimensions of which would match the anthropometric dimensions and allow free movements of the body, thus reducing lengthy static positions of children's bodies and potential pains and discomforts. An optimal design of workplaces would prevent occupational diseases which can be observed in all employees (both children and adults) who spend lengthy periods of time at their work.

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