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The association between children's computer use and musculoskeletal discomfort

Karen Jacobs[a,*] and Nancy A. Baker[b]
[a]*Boston University, Sargent College of Health and Rehabilitation Science, Department of Occupational Therapy, 635 Commonwealth Ave., Boston, MA 02215, USA*
[b]*University of Pittsburgh, Pittsburgh, PA, USA*

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Abstract: As American children spend more time working at computers, they may be putting themselves at risk for musculoskeletal disorders and other conditions that can result from overuse. There is little research that describes the home computer use of American middle school children or that describes the prevalence of musculoskeletal discomfort in this population.
This study provides a general description of the computer set-up and home use of 152 6th grade children and looks at the association between overall musculoskeletal discomfort and various ergonomic variables.
Method: 152 6th grade children completed the Musculoskeletal Discomfort Questionnaire and a survey of home computer use.
Results: More than half of the children reported some musculoskeletal discomfort within the last year. This pain could be made worse by computer use. Students reported that they had three computers in their house, and that they generally did not have furniture specifically designed for computer use. There was a significant association between the number of hours on the computer and overall musculoskeletal discomfort ($r = 0.19,\ p = 0.05$). The odds ratios between having furniture designed for the computer and touch typing and musculoskeletal discomfort were borderline significant, but suggested that students without proper furniture were more likely to have musculoskeletal discomfort (OR = 1.89, 95% CI = 0.94–3.84) and that those who could touch type were less likely to have musculoskeletal discomfort (OR = 0.54, 95% CI = 0.26–1.10), OR).
Conclusion: American children are reporting moderate amounts of musculoskeletal discomfort and this discomfort can be associated with computer use. Risk factors associated with computer use and discomforts are similar to those reported in the adult literature. Further study is necessary to understand the similarities and differences between adult and children computer use and how to protect both from developing musculoskeletal discomfort.

Keywords: Ergonomics, youth, interactive media

1. Introduction

It is estimated that over 12.5 million of all American elementary school children use a computer at school and over 30 million have a computer in their home [1]. This number is expected to continue to increase over the next few years [2]. Although in recent years there have been studies on the effect that computer use has on children's cognitive skills and social skills, there have been very few studies on the effects of computer use on a child's physical well being [3]. Research on the designs of computer workstations for adults has suggested that a poorly set-up computer workstation is associated with increased musculoskeletal discomfort and musculoskeletal disorders [4]. This raises concerns on the effect of computer workstation design on children's musculoskeletal health.

Although many middle schools offer computer classes, there is no established standard for the design of computer workstations in the classroom [5] and no suggestions at all about home computer set-up. Fur-

*Address for correspondence: Karen Jacobs, 5 Possum Hollow Road, Andover, MA 01810, USA. Tel.: +1 978 688 1554; Fax: +1 978 687 6395; E-mail: kjacobs@bu.edu.

thermore, while much emphasis has been placed upon the ergonomic fit between adult workers and their computer workstations, few researchers have focused on children's positioning at computers. Although the risks associated with prolonged adult computer use and improper positioning at computer workstations are frequently cited in professional literature [6–8]; it is unclear whether children face similar hazards. Some researchers [2] have suggested that children are at an even greater risk than adults because computers and peripherals are designed for adults' larger proportions.

Much of the present research on computer use and children have evaluated whether the school furniture is the correct size for children and whether this leads to poor posture in children [5,9,10]. Less research has been conducted to discover if this poor posture has lead to musculoskeletal discomfort. Aagraard-Hansen and Storr-Paulsen [11] reported that there was no difference in pain reports for children who had ergonomically designed desks and chairs, even though the children reported that they preferred the ergonomic designed furniture to the typical furniture. Harris and Straker [12] reported that 60% of their sample of 314 students, aged 10 to 17 years, reported increased discomfort when they used their laptop computer. Most of the discomfort was reported in the neck, upper back, wrist, and knees. Thus, there is minimal research, which examines the association between computer use and musculoskeletal discomfort in children [13]. Because of the prevalence of computer use and the potential hazards associated its use, it is important to begin to determine the incidence and prevalence of computer-related musculoskeletal discomfort in school aged children and to describe their use of computers at home.

This article presents preliminary descriptive information on a 6th grade cohort currently being studied prospectively through the 6th, 7th and 8th grades. The purpose of the overall research program is as follows:

- To describe the incidence of musculoskeletal discomfort reported by middle school children;
- To document how and where middle school children use the computer at home;
- To examine the association between different ergonomic, work practice, and demographic variable and musculoskeletal discomfort; and
- To describe the results of an intervention aimed at increasing the children's knowledge and implementation of ergonomic principles related to computer use.

This article will provide information on the first three purposes from the pre-intervention cohort of 6th graders.

2. Method

2.1. Participants

Participants were recruited in fall 1999, from a population of 6th grade students in a public middle school in Massachusetts in the United States. The sample was homogenous for age and socioeconomic background. One hundred and fifty-two 6th grade students agreed to participate in this three-year study.

2.2. Instruments

Two instruments have been used in this study to collect health and comfort data on the incidence and prevalence of computer-related musculoskeletal discomfort.

2.2.1. Demographic survey

Students completed a short answer questionnaire on computer use (type of activity, time at home) and computer set-up. There were also questions that examined sports and playing a musical instrument.

2.2.2. Musculoskeletal Disorder Questionnaire (MDQ)

Students completed 33 questions, along with schematic drawings of the neck, back, shoulders, elbows, and wrists/hands that describe potential areas of musculoskeletal pain and discomfort. Musculoskeletal discomfort was operationalized as a participant's self-reports of pain, numbness, or discomfort in five body parts (neck, back, shoulder, elbow, and wrist/hand), experienced within the last year, but not due to trauma. The reports were further modified by the intensity of the discomfort, and whether the participants viewed computer use as making the discomfort worse. The MDQ is a combination of the Scandinavian Musculoskeletal Questionnaire [14] and the musculoskeletal questionnaire used by Bernard et al. [15,16].

Table 1
Prevalence of pain reports by body part and the distribution of intensity in those who had pain ($N = 152$)

Intensity	Neck ($n = 142$)		Shoulder ($n = 139$)		Elbow ($n = 139$)		Wrist/Hand ($n = 139$)		Back ($n = 136$)		Overall ($n = 131$)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
None	93	66.4%	117	84.2%	127	91.3%	111	79.9%	105	75.0%	55	42.0%
Mild	5	3.5%	16	11.5%	7	5.0%	22	15.8%	16	11.8%	61	46.6%
Moderate	27	19.0%	6	4.2%	4	2.8%	4	2.9%	12	8.8%	10	7.6%
Severe	15	10.6%	0	0.0%	0	0.0%	0	0.0%	2	1.5%	5	3.8%

Table 2
The impact of computer use on individuals who reported discomfort in a body part

	Neck ($n = 48$)		Shoulder ($n = 22$)		Elbow ($n = 11$)		Wrist/Hand ($n = 29$)		Back ($n = 31$)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Pain got										
Better	3	6.3%	3	13.6%	1	9.1%	1	3.4%	1	3.2%
Worse	17	35.4%	5	22.7%	6	54.5%	15	51.7%	13	41.9%
No different	28	58.3%	14	63.6%	4	36.4%	13	44.8%	17	54.8%

2.3. Procedure

A convenience sample of 152 6th grade students was recruited to participate in this research. Students were recruited from the daily 45-minute computer classes that are offered over a six-week period throughout the school year. At each change of terms, 6th grade students enrolled in the computer class were recruited. Students were only allowed to participate after informed consent had been received from both the student and parent or legal guardian. After recruitment, the principle investigator (PI) asked the participants to complete a demographic survey and the Musculoskeletal Disorder Questionnaire (MDQ).

2.4. Statistical analysis

The musculoskeletal discomfort scores for each body part were summed to form a score for that body part. These were then combined to form an overall musculoskeletal discomfort score. The higher the score, the greater the discomfort. Many of the questions on the demographic survey were combined to create composite scores. The biomechanical composite score combined "yes/no" questions concerning the computer set-up and the participants' reports of awkward postures. The sports composite score added the number of sports that the individual participated in, while the instrument composite score summed the number of instruments the participant played. The number of rooms composite indicates the number of rooms in the participant's house that had a computer in it (choices were living room, computer room, parent's room, other room). The computer activity composite shows the number of activities the participant engaged in while on the computer. From these composites and other variables, simple descriptive statistics were generated. These describe the prevalence of musculoskeletal discomfort in this population. They also provide a sketch of the computer station set up, and the use of the computers by these students in their homes. Pearson's correlation coefficients were used to examine the association between musculoskeletal discomfort and the composite scores, and odds ratios with Mantel-Haenszel test for significance and 95% confidence intervals were used to examine the simple dichotomous demographic variables.

3. Results

3.1. Descriptive data

3.1.1. Musculoskeletal discomfort

More than half of all students reported musculoskeletal pain in at least one body part (see Table 1). Table 2 provides the frequency of participants who reported that computer use made a body part discomfort worse.

3.1.2. Computer use

Most participants reported computers in three rooms (95%). One hundred and twenty-seven (88.2%) of participants reported that there was a computer in their parents' room, 108 (75%) of participants reported that there was a computer in their living room, and 106 (73.6%) of participants reported that their was a computer room in their house.

Table 3 reports the frequency of different activities that were done on home computers and the number of different activities students engaged in. Students pri-

Table 3
Students activities on the computer

	Freq.	%
E-mail to friends	96	67%
Surfs the Internet	92	64%
Do homework	54	38%
Word processing	107	74%
Playing games	52	36%
Does 1 thing	7	5%
Does 2 things	37	27%
Does 3 things	65	47%
Does 4 things	25	18%
Does 5 things	3	2%
Does nothing	2	1%

marily played games, sent e-mail, and did word processing activities.

Table 4 provides a list of questions included in the biomechanical composite of the home computer set-up and how the students answered these questions. The mean score on the biomechanical composite was 3.28 ($sd = 1.47$). Table 4 also lists how students answered questions concerning touch-typing, parental limitations on computer use, input devices, and whether they played computer games for more than an hour.

Only 50 students (33%) reported that they played one or more instruments. More students played sports, 53 (35%) reported playing one sport, 31 (20%) reported playing 2 or more sports.

Table 5 demonstrates the amount of time that participants reported they spent on the computer.

3.2. Associations

In general there was very little association between the composite variables and severity of musculoskeletal discomfort in this cohort (see Tables 6 and 7). However, the number of hours spent on the computer showed a moderate, significant association with overall musculoskeletal pain ($r = 0.19$, $p = 0.05$). Two of the dichotomous variables had a borderline significance; the ability to touch type was protective (OR = 0.54, 95% CI = 0.26–1.10), while participants who did not have furniture designed for computer use were 1.89 times more likely to report overall musculoskeletal discomfort (OR = 1.89, 95% CI = 0.94–3.84).

4. Discussion

This data suggests that more than half of these 6th grade children experienced some sort of musculoskeletal discomfort in at least one body part. This pain could be exacerbated by computer use. While the individual reports of discomfort were mostly quite mild, some children experienced moderate to severe discomfort, particularly in the neck. This discomfort did not seem to be associated with participation in sports or with playing an instrument, both activities that have been reported to be associated with musculoskeletal aches and pains.

This data also suggests, that at least for these children, computers are ubiquitous in the home. Most children reported having three computers in the house, and only 5 percent reported they had 2 or less. Children are therefore being exposed to computers and computer use more and more in the home environment. What is disturbing about this report is that the home computer environment often is not set up with ergonomic computer workstation equipment. More than half of the children reported that they did not have furniture specifically designed for the computer. In this sample, students who reported that did not have furniture specifically designed for the computer were 1.89 times more likely to report musculoskeletal discomfort than those who did have specific furniture. These results suggest that like adult users, the physical set-up of the computer workstation may be an important predictor of musculoskeletal discomfort. The students reported poor keyboard and monitor placement, and 86% reported that their heels did not touch the ground during computer use. Proper chair height (i.e., with the heels touching the ground) has often been cited in the adult literature as of prime importance in protecting computer users from musculoskeletal disorders.

These students report that they do a variety of tasks while on the computer. The most popular activities were word processing, surfing on the web and sending/answering e-mails. Most students reported that their parents had placed no strictures on when and how much they could use the computer. In general, these students reported that they usually spent less than an hour at one sitting on the computer, but at least one third spent greater than an hour on the computer at a sitting. Prolonged time on the computer has been reported in the adult literature as one of the more consistent biomechanical variables associated with musculoskeletal discomfort [4]. This association was also present for these students. The more time they spent per sitting on the computer, the greater overall musculoskeletal discomfort they reported.

One interesting finding of this study is that touch-typing may be protective. Individuals who could touch type were 54% less likely to report musculoskeletal

Table 4
Frequency of answers to basic biomechanics and other computer use questions

	Yes	No
Biomechanics composite questions		
User reaches out for keyboard	17 (12%)	121 (88%)
Furniture designed for computer use	68 (47%)	78 (53%)
User squints at computer	18 (12%)	127 (88%)
Keyboard on same surface as monitor	63 (43%)	82 (57%)
Keyboard on a pull out shelf	84 (58%)	61 (42%)
User's heels touch the floor	20 (14%)	123 (86%)
Adjustable chair height	62 (43%)	82 (57%)
Monitor is straight ahead of eyes	94 (70%)	41 (30%)
Other questions		
Uses alternate input devices	98 (72%)	38 (28%)
Parents limit computer use	29 (20%)	115 (80%)
User knows how to touch type	88 (61%)	56 (39%)
User plays games for more than an hour	99 (69%)	38 (28%)

Table 5
Hours spent on the computer per sitting

Hours	Freq.
$<$ 1/2 hours	27 (18.8%)
1/2–1 hr	66 (45.8%)
1–1 1/2 hrs	20 (13.9%)
1 1/2–2 hrs	10 (6.9%)
$>$ 2 hrs	21 (14.6%)

Table 6
Correlations between composite variables and musculoskeletal discomfort

	r	p
Biomechanics	0.04	0.70
Number of rooms w/ computers	0.01	0.88
Number of sports played	-0.13	0.15
Number of instruments played	0.00	0.98
Number of activities done on the computer	-0.05	0.55
Number of hours spent on the computer	0.19	0.05

discomfort than those who did not know how to touch type. It is possible that students who touch type, position themselves in a better posture during computer tasks, or it is possible that those who touch type finish computer tasks more quickly and therefore spend less time on the computer. Whatever the reason, this is a result that requires further study. However, interestingly, many schools are eliminating touch-typing as a skill to be taught middle and high school students. It is possible that touch typing classes may be an important skill for the computer literate, particularly if these classes were combined with training in computer ergonomics.

These results provide some evidence that students are experiencing musculoskeletal discomfort associated with computer use. They suggest that computer use may be having an impact on the health of young users and that it is important that we not only start training students in proper computer ergonomics, but also that we provide them with ergonomically correct computer workstations both at school and home. This present study provides support to the study by Oates et al. [2], which provided a preliminary ergonomic and postural assessment of computer work settings in American elementary schools.

5. Conclusion

In summary, preliminary data analysis suggests that computer use may be associated with musculoskeletal complaints in a population of middle school aged children. The risk factors associated between musculoskeletal discomfort in children and computer use are very similar to those risk factors being cited in the adult literature [4]. However, there has been much less research on children and computer use, so there has been less impetuous to provide ergonomically correct computer workstations for children at school and home. Although there has been significant concern in recent years on the quality of children's interactions with software and the Internet, there has been almost no discussion on the quality of the physical set-up of the child's computer workstation. It is imperative that children be provided with ergonomically correct computer workstations that are designed specifically for their size and abilities. Without intervention in this area, we may be raising children who are more prone to musculoskeletal disorders because they have had a longer exposure period and also, who have no idea how to protect themselves through the use of ergonomically correct computer workstations.

A great deal of further research is necessary to understand how computers are influencing the health of

Table 7
Odds ratios between dichotomous variables and musculoskeletal discomfort

	OR	95% CI	p
Uses alternate input devices	0.72	0.31–1.64	0.62
Parents limit computer use	0.78	0.33–1.83	0.57
User knows how to touch type	0.54	0.26–1.10	0.09
User plays games for more than an hour	1.16	0.54–2.52	0.70
Furniture designed for computer use	1.89	0.94–3.84	0.08

America's children. This study is just a preliminary examination of many questions about children and computer use. Among the research still to be done:

- Further identification of the prevalence of musculoskeletal discomfort and disorders in all ages of children. We need to establish if this prevalence has increased with the addition of computers to children's environments.
- More detailed information about how children use the computer. The types of activities and how long they actually spend.
- More detailed analysis of the biomechanical set-up of computer work stations both at home and at school. How do these biomechanics affect musculoskeletal discomfort? What are the important elements of a good computer workstation for children?
- What kind of education do we need to provide children to teach them how to use computers safely? Will a course in ergonomic strategies help to create good habits in children for all the years they use a computer?

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