Cumulative Trauma Disorder Risk for Children Using Computer Products: Results of a Pilot Investigation with a Student Convenience Sample

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SYNOPSIS

Objectives. Cumulative trauma disorder is a major health problem for adults. Despite a growing understanding of adult cumulative trauma disorder, however, little is known about the risks for younger populations. This investigation examined issues related to child/adolescent computer product use and upper body physical discomfort.

Methods. A convenience sample of 212 students, grades 1–12, was interviewed at their homes by a college-age sibling or relative. One of the child's parents was also interviewed. A 22-item questionnaire was used for data-gathering. Questionnaire items included frequency and duration of use, type of computer products/games and input devices used, presence of physical discomfort, and parental concerns related to the child's computer use.

Results. Many students experienced physical discomfort attributed to computer use, such as wrist pain (30%) and back pain (15%). Specific computer activities—such as using a joystick or playing noneducational games—were significantly predictive of physical discomfort using logistic multiple regression. Many parents reported difficulty getting their children off the computer (46%) and that their children spent less time outdoors (35%).

Conclusions. Computer product use within this cohort was associated with self-reported physical discomfort. Results suggest a need for more extensive study, including multiyear longitudinal surveys.

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INTRODUCTION

Cumulative trauma disorder (CTD) is physical injury resulting from the cumulative effects of repetitive stressful movements or postures. Areas commonly involved are the hand, wrist, shoulder, and neck, resulting in disorders such as carpal tunnel syndrome and neck tension syndrome.[1] CTD is a common problem among adults, frequently the result of work-related activities.[2] Individuals employed in clerical and computer work (jobs requiring light physical activity), are at high occupational risk for such disorders.[3,4] The U.S. Bureau of Labor Statistics estimates that nearly 700,000 workdays are lost annually because of such work-related disorders, costing employers $15–$20 billion in workers' compensation annually.[5,6]

Given the prevalence of CTD, its potentially disabling effects, and the significant social and economic costs of this problem, considerable efforts have been made to inform and educate consumers, establish policies, and redesign products, with many efforts directed specifically at computer users.[7–9] However, despite growing awareness and understanding of adult CTD, very little is known about the potential risks of computer-related CTD for adolescents.

The majority of studies looking at adolescent upper extremity musculoskeletal problems are related to sports injury.[10–14] Several studies have looked at other health-related computer use issues, such as epileptic seizures[15] and visual accommodation.[16] One case report on computer games and repetitive strain injury was found.[17] Two studies examined student computer workstation setup in schools and related health risks.[18,19] Other studies have considered the psychosocial aspects of computer game use, such as increased aggression, social isolation, and addiction.[20–23] Generally, none of the studies on adolescents to date have adequately examined usage habits, prevalence of symptoms, or specific causal models of upper extremity musculoskeletal disorders and computer product use.

In an effort to better understand the potential CTD risk for children and adolescents, a questionnaire was administered to a sample of students to ascertain patterns of use, self-reported physical discomfort, and behavior changes. The principal hypothesis the questionnaire examined was if increased computer use and computer-related game exposure was related to higher self-reported upper body physical discomfort.

METHODS

Procedure

To assist with data collection, San Francisco State University undergraduate students volunteered to interview a younger sibling or relative in grades 1–12 and that child's parent. The volunteers were enrolled in a cross-cultural health class, and collected data as an alternative to a writing assignment or for extra credit. To reduce completion bias, if collection was not possible, the student could do an alternate writing assignment. Before collecting data, the interviewers were familiarized with the questionnaire and instructed in data collection procedures. The questionnaire was described as an instrument to assess adolescent/family computing habits. The confidential nature of the process was emphasized to reduce any reporting bias. The students then conducted interviews in person or via telephone within a two-week period. Although this procedure provided a convenience sample that could not be considered representative of U.S. children, for a pilot study it proved to be a cost-effective approach for reaching a diverse age range of children and their parents.

Questionnaire

A structured 22-item questionnaire was developed that included 16 items for the interviewed child and six items for the child's parent (Figure). The main outcome variables included six dichotomous (present/absent) CTD-related physical complaints: wrist discomfort, neck discomfort, back discomfort, headache, eye strain, and fatigue. The main predictor variables included items from four relevant areas: (*a*) somatic factors (age, gender, glasses, level of activity); (*b*) psychosocial factors (depression, social withdrawal, hyperactivity, aggression); (*c*) environmental factors (time using computer alone, parental control of access); and (*d*) behavioral factors (input devices, nature of use, and duration of use). Many of the questionnaire items possessed strong face validity and focused on well-defined objective attributes, such as wearing glasses. It contained no personally identifying information. The University Committee for the Protection of Human Subjects approved both the questionnaire and protocol.

RESULTS

Participants

Study participants included 212 students from grades 1 through 12, with a mean age of 12.4 years (range 5–

Figure. SFSU Computer Usage Questionnaire

STUDENT QUESTIONS

1. Is there a computer located in your home? 0___No 1___Yes
2. Age _____years old
3. Gender 0___Male 1___Female
4. Grade level ___ (if not in grades 1–12, please do not continue)
5. How many years have you used a computer (such as a PC or MAC)? ___Years
6. About how many hours do you use a computer on 1 typical weekday? ___Hours
7. About how many hours do you use a computer on 1 typical Saturday? ___Hours
8. Percent time computer is used for: Homework __% + Entertainment __% = 100%
9. Do you do any of the following? [MARK ALL THAT APPLY]
   a. ___ Use computers at home
   b. ___ Use computers at school
   c. ___ Use computers at friends' homes
   d. ___ Play video arcade games
   e. ___ Play home video games, like Nintendo
   f. ___ Play handheld games, like Game Boy
10. About how many hours in total are all computer products (computers, arcade games, video games, handheld games) used on 1 typical Saturday? ___Hours
11. When you use a computer, which of the following activities is it used for? [MARK ALL THAT APPLY and indicate how much of the time is for that purpose, for example, 20% e-mail, 80% educational games = 100%.]
    a. ___ E-mail Percent Time _____
    b. ___ Chat Percent Time _____
    c. ___ Surfing Percent Time _____
    d. ___ Educational games Percent Time _____
    =100%

12a. List educational games/websites you use? (includes computer, arcade, handheld)

12b. List noneducational games/websites used? (includes computer, arcade, handheld)

13a. Do you play the games: [MARK ALL THAT APPLY]
   a. ___ Alone
   b. ___ With other live players
   c. ___ With other networked players

13b. Which of those three is the most common?
   a. ___ Alone
   b. ___ Others/Live
   c. ___ Others/Networked

14. Games are played with: [MARK ALL THAT APPLY]
   a. ___ Mouse
   b. ___ Keyboard
   c. ___ Joystick
15. Do you ever experience any of the following during or immediately after your computer/computer game use [MARK ALL THAT APPLY]
   a. ___ Headache
   b. ___ Backache
   c. ___ Wrist/hand
   d. ___ Eyestrain (fuzzy vision after use)
   e. ___ Neck discomfort
   f. ___ Fatigue
16. Do you wear glasses/contacts? 0___No 1___Yes

Figure (*continued*). SFSU Sibling Computer Usage Questionnaire

PARENT QUESTIONS

17. Do you ever use the computer as a reward/punishment for the child, such as the child can use the computer if homework gets done? 0___No 1___Yes
18. Do you ever have difficulty getting the child off the computer, such as getting him/her to stop playing computer games, using chat room? 0___No 1___Yes
19. Do you ever notice behaviors in your child that may be related to the use of computers/playing computer games? [MARK ALL THAT APPLY]
    a. ___ Irritability, easily angered, aggressive speck or behavior
    b. ___ Depression, sadness, moodiness
    c. ___ Hyper, restless, fidgety
    d. ___ More socially withdrawn, communicating less with family/friends
    e. ___ Less interest in outdoor or physical activity
    f. ___ What positive changes do you see from computer use?
20. Do you use any type of software, such as the Surf Guard software, to prevent Internet access to inappropriate materials? 0___No 1___Yes
21. Do you limit the child's computer time? 0___No 1___Yes
22. About how many hours in total are all of these computer products (computers, arcade games, video games, handheld games) used on one typical Saturday? ___Hours

18 years); 52% of the students were female. One parent of each participating child was also interviewed. Questionnaire completion rate was approximately 94%.

Desktop computer use

The hypothesized relationship between use and discomfort is reported here beginning with desktop use. Students reported using desktop computers on average for 4.4 years (range 1–12 years). Computers were used 2.0 hours per day during the week (range 0–6 hours) and 2.4 hours per day on the weekend (range 0–10 hours; very high use, such as 10 hours, was uncommon and may reflect exaggerated self-reporting). Most of the students had computers available for use at home (96%). Home was the most common place of use (95%), followed by school (85%) and friends' homes (60%). Students were asked to indicate to what extent the computer was used for homework (37%) and entertainment (63%; no significant difference by gender). Finally, students reported the percentage of time the computer was used for e-mail, chat, surfing, educational games, and noneducational games (Table 1). Females were significantly more likely to use e-mail and educational games (p=0.004; p=0.016). Males were significantly more likely to use noneducational games (p=0.002).

Computer game use

In addition to playing games on the computer, students also reported whether they played home video games [such as Nintendo (71%) and video arcade games (63%)] and handheld games [such as Gameboy (50%)]. Males were significantly more likely to play home video games and video arcade games (p=0.001;

Table 1. Percent of time spent on each computer activity, comparison by gender

Computer activity	*Percent of time on each activity*	*Male Mean/SD*	*Female Mean/SD*	*Two-tailed significance*
Chat	13.5	13.7/21.6	13.3/21.5	0.906
E-mail	15.3	1.2/15.2	19.3/23.2	0.004
Surfing	17.3	18.6/22.4	16.0/20.4	0.393
Educational games	20.6	15.4/23.8	24.8/30.4	0.016
Non-educational games	33.3	39.9/32.9	26.5/27.6	0.002

Table 2. For each physical location, percent of students who reported computer-related discomfort, by gender

Physical location or symptom	*Percent reporting discomfort by location*	*Male Mean/SD*	*Female Mean/SD*	*Two-tailed significance*
Head	18.9	22.0/41.6	15.5/36.3	0.225
Neck	30.8	36.8/48.6	23.3/42.7	0.101
Eye	37.7	34.0/47.6	41.8/49.6	0.246
Wrist	29.7	32.0/46.9	28.2/45.2	0.549
Back	14.6	14.0/34.9	15.5/36.3	0.768
Fatique	30.5	26.2/44.3	36.1/48.4	0.232

p=0.001), but no difference was found in the use of handheld games (p=0.131). When asked how they most typically played games—either alone, with others, or networked—89% reported that they played alone at times, 65% played with others at times, and 16% played networked games. The most common input device used by children was the mouse (79%), followed by the keyboard (43%) and joystick (27%).

Students estimated time spent on all computer-related activities, including nongame purposes (such as e-mail) and games (such as arcade games, home video games, desktop computer games, and handheld games). They reported an average of 3.3 hours of use for all devices on a typical Saturday. (Saturday was selected because game device use was expected to be higher on a nonschool day.) For comparison, four approximately equal-sized age groups were created: 5–9, 10–12, 13–15, and 16–18. The hours spent in all related activities by age group on a typical Saturday were: 2.8, 3.9, 3.6, and 2.9. These differences were not significant.

Self-reported physical complaints

Students reported on physical complaints they believed to be related to computer product use. On average, 27% of the students reported some type of physical complaint ranging from 14% reporting back discomfort to 38% reporting eyestrain (Table 2). There were no significant differences in complaints by gender. Complaints were then examined across the four age groupings; that also did not produce significant differences. Finally, physical complaints were analyzed in relation to hours of computer product use on Saturdays. Students were placed into one of three levels—no use, moderate use, and high use—and then comparisons for the presence of physical discomfort were made across levels. Significant differences were found for back and eye discomfort based on usage level (Table 3). It should be noted that we did not expect these physical complaints, with the possible exception of eyestrain, to result in medical assessment or care. Therefore, information on impairment and medical care was not collected.

Table 3. Presence of physical discomfort across levels of Saturday computer use

	Level of use					
Physical location or symptom	*No use Mean/SD (n = 22)*	*Moderate use Mean/SD (n = 132)*	*High use Mean/SD (n = 44)*	*SS*	*F*	*Probability*
Head	0.05/0.21	0.22/0.42	0.20/0.40	0.57	1.83	0.16
Neck	0.13/0.35	0.32/0.47	0.29/0.46	0.45	1.08	0.34
Eye	0.14/0.35	0.37/0.49	0.44/0.50	1.37	3.03	0.05
Wrist	0.18/0.40	0.30/0.46	0.24/0.45	0.33	0.83	0.44
Back	0.0/0.00	0.11/0.32	0.34/0.481	2.17	9.26	0.001
Fatigue	0.27/0.46	0.34/0.48	0.18/0.39	0.56	1.35	0.26

NOTES: Duncan test for significant differences between Groups 1–3, p=0.05

Back—Groups 1 and 2 were significantly different from Group 3

Eye—Group 1 was significantly different from Groups 2 and 3

SS = statistically significant

Physical complaints related to multiple predictors

A logistic regression analysis was done to consider the best predictors of physical complaints based on different somatic, psychosocial, behavioral, and environmental factors. The specific predictors selected were: (*a*) somatic factors (glasses); (*b*) psychosocial factors (depression, social withdrawal, hyperactivity, aggression); (*c*) behavioral factors (input device choices [mouse, joystick, keyboard], game device choices [home computer video games, handheld games], hours of computer use on Saturday, percent time playing noneducational games); and (*d*) environmental factors (time using computer alone, parental control of computer access). The best predictors for each of the six physical complaints are shown in Table 4.

Parents' general observations

Parents commented on several issues related to their child's computer use. They estimated the amount of time the child spent involved in all computer-related activities on a typical Saturday. Saturday was chosen because this is a day the parents are more likely to be home with the child to observe computer use. The average time reported was 3.0 hours, compared with the childrens' self-estimate of 3.3 hours. Although close, the difference was statistically significant (p=0.01). In addition, the following items were reported: 51% imposed limits on computer use, and 46% had trouble getting their children off the computer. Positive benefits—including academic support, improvements in self-esteem, and reduction in boredom—were reported by 48% of the parents.

Psychosocial factors reported by parents

Parents also reported on psychosocial factors believed to be related to computer use. Parental input was solicited for these items in the event some children would not understand the questions or might not answer such items honestly. A small percentage of parents reported perceived increases in depression (9%), hyperactivity (15%), and aggression (17%). Larger responses were given for social withdrawal (25%) and reduced physical activity (35%). There were no significant differences by gender, except for hyperactivity, with males perceived as being more hyperactive than the females after computer use (Table 5).

DISCUSSION

There was a high rate of computer product use by both sexes, with students reporting an average of 3.3 hours of use on a typical Saturday. Most of the students had computers at home, and most of the time in use was spent alone and playing games. Physical complaints perceived to be related to computer use were common, ranging from 15% reporting back discomfort

Table 4. Significant predictors of each physical complaint via logistic regression

Neck discomfort	No significant predictors
Fatigue	Aggression (p=0.02; β=0.84; R=0.16)
Eyestrain	Social withdrawal (p=0.04; β=0.3; R=0.09) Computer video game play (p=0.03; β=–0.38; R=–0.10)[a]
Headache	Noneducational games (p=0.03; β=0.02; R=0.12) Hyperactive (p=0.05; β=0.46; R=0.10)
Back discomfort	Social withdrawal (p=0.02; β=0.52; R=0.14) Noneducational games (p=0.03; β=0.02; R=0.14) Hours of weekend computer use (p=0.01; β=–0.27; R=–0.17)[a]
Wrist discomfort	Aggression (p=0.002; β=0.83; R=0.19), Noneducational games (p=0.006; β=0.02; R=0.16), Joystick (p=0.02; β=0.45; R=0.12), Computer video game play (p=0.05; β=0.48; R=0.09) Parental computer control (p=0.05; β=0.38; R=0.09) Depression (p=0.007; β=–1.1; R=–0.15)[a]

NOTE: Logistic backward stepwise regression was used for analysis.

[a]Negative association with the symptom's presence

Table 5. Percent of parents reporting perceived psychosocial changes in child

Psychosocial changes	*Total sample*	*Male Mean/SD*	*Female Mean/SD*	*Two-tailed significance*
Depression	8.5	10.1/30.3	7.3/26.1	0.47
Hyperactivity	15.2	22.2/40.4	10.0/30.1	0.04
Agression	16.5	20.0/40.1	13.6/34.4	0.23
Social withdrawal	24.6	24.3/43.1	25.5/43.8	0.84
Reduced activity	35.2	40.4/49.3	30.9/46.4	0.15

to 38% for eyestrain. There were no significant differences in reported complaints by gender or age, but significant differences were found for level of usage, with higher use related to more reported discomfort. Parents noted a decrease in outdoor activity and difficulty getting their children off the computer products. They also perceived an increase in various psychosocial phenomena, including aggression, depression, and social withdrawal (solitary play was common with computer products). Other research has shown computer use to be related to increases in depression and social isolation, and a reduction in psychological well-being.[24] Also, television viewing and use of computer games are seen as a significant aspect of the increasingly sedentary life-style of American adolescents and a contributor to the epidemic in adolescent obesity.[25,26]

Logistic regression predicting physical discomfort from a variety of variables found wrist pain to have the largest number of significant predictors. This fits with epidemiological findings from adult populations that show hand and wrist pain to be one of the most commonly associated CTD symptoms of computer use.[1] Interestingly, in this sample, the best predictor of wrist pain was aggression (p=0.002). The psychosocial factors—aggression, depression, social withdrawal, and hyperactivity—were significant in five of the six physical complaints. Other researchers have similarly found significant relationships between computer use and changes in psychological well-being,[24] and between psychosocial factors and CTD symptoms.[3,27,28]

The findings of this investigation show that physical and psychosocial changes are perceived by students and parents to be associated with computer use. These changes may presage future problems or at least indicate poor computing habits. This data, however, does not provide sufficient information to draw conclusions about the actual causal relationship between these variables. The reported discomfort could result from excess use, poor computing habits, poor ergonomic design, or other factors. Nor do we know if the self-reported physical discomfort, if actually related to computer use, has any etiological significance in terms of CTD. Additional research is essential to increase our basic understanding. This research should include large prospective longitudinal surveys to explore the frequency, duration, and intensity of use, and relationships between use and symptoms, including symptom intensity, duration, and degree of impairment; electromyographic and other studies to provide insight into possible underlying pathogenic mechanisms; and more complex, theory-based multivariate models to test new hypotheses, because simple biomechanical models have not been able to predict musculoskeletal problems adequately.

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