Initial Investigation of the Relation between Extended Computer Use and Temporomandibular Joint Disorders

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ABSTRACT

Aim: To determine if temporomandibular joint disorders (TMDs) are associated with extended computer use.

Materials and Methods: People with chronic pain and extensive computer use were recruited by means of a newspaper advertisement. Those who responded to the ad were asked to complete an online survey, which included questions on computer use, medical history, pain symptoms, lifestyle and mood.

Results: Ninety-two people completed the online survey, but none of them responded to all questions in the survey. Of the 88 respondents who reported their sex, 49 (56%) were female. Most of the respondents had used computers for more than 5 hours per day for more than 5 years, and most believed that their pain was linked to computer use. The great majority had pain in the neck (73/89 [82%]) or shoulder (67/89 [75%]), but many (40/91 [44%]) also had symptoms of TMD. About half of the participants reported poor sleep and fatigue, and many linked their pain to negative effects on lifestyle and poor quality of life. Two multiple regressions, with duration of pain as the dependent variable, were carried out, one using the entire sample of respondents who had completed the necessary sections of the survey (n = 91) and the other using the subset of people with symptoms suggestive of TMD (n = 40). Duration of computer use was associated with duration of pain in both analyses, but 6 other independent variables (injury or arthritis, hours of daily computer use, stress, position of computer screen relative to the eyes, sex, and age) were without effect. In these regression analyses, the intercept was close to 0 years, which suggests that the pain began at about the same time as computer use.

Discussion: This web-based survey provides the first evidence that chronic pain in jaw muscles and other symptoms of TMD are associated with long-term, heavy use of computers. However, the great majority of people with these symptoms probably also suffer from pain in the shoulder and neck.

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Over the past 20 years, there has been an enormous increase in the number of work-related musculoskeletal disorders of the upper limb; by 2002, these conditions accounted for two-thirds of reported cases of occupational illness in the United States.[1] This increase in musculoskeletal pain has paralleled the growth in the use of computers. In 1997, for example, 92 million adults in the United States were using a computer, and half

of all employed adults used computers for work-related purposes.[2] By the end of 2005, 240 million personal computers were in use in the United States, and worldwide Internet use had reached 1 billion.[3]

Established risk factors for musculoskeletal pain include computer use for more than 20 hours per week, older age, female sex, history of smoking, high levels of stress and infrequent exercise.[4,5] Pain associated with computer use is most frequently reported in the shoulder and neck region,[6] with lower frequency in the hands,[1] arms[1] and eyes.[7] No reports were found linking computer use with pain in the muscles of mastication or the jaw joints, which are the primary sites of pain in temporomandibular joint disorders (TMDs).[8] However, in 1998, one of the authors (L.P.) began to experience pain of the head and neck that he thought was associated with extensive computer use and new bifocal eyeglasses. The pain was relieved by chewing gum. After extensive investigation by several specialists, an acrylic occlusal splint was made for him, and 6 months later, he was able to manage his pain.

This experience prompted a preliminary investigation to determine if there is a correlation between computer use and the symptoms of TMD. A web-based survey was developed to gather data from people most likely to suffer from computer-related pain.

Materials and Methods

Study Design and Data Collection

Participants were recruited through the following advertisement, which was placed once in the print version the *National Post,* a Canadian newspaper with a circulation of about 231,000 copies per day: "Do you suffer from headaches and/or muscle pain in your neck and shoulders? Do you spend many hours each day in front of a computer? Have you done so for several years? The Department of Psychology of McGill University, in conjunction with the Faculty of Dentistry, is currently studying the effects of long-term computer use on the head, jaw, neck, and shoulders." Interested readers were directed to a website to complete an online questionnaire. The website offered a brief description of the study and its safeguards of confidentiality. Participants received no compensation for completing the questionnaire. This study was approved by the Institutional Ethics Committee of McGill University.

Questionnaire

The online questionnaire (available at www.psych.mcgill.ca/misc/tmj/questionnaire.html) consisted of 32 questions covering the following domains:

- demographic characteristics (3 questions): age, sex, occupation
- computer use (5 questions): years of computer use, hours of use per day, time of day when the computer was most frequently used, eye level while in front of the monitor, change in pain during extended periods away from the computer
- medical history (9 questions): previous injuries (whiplash, head or neck injury, severe blows to the head or jaw, symptoms of arthritis, family history of arthritis), use of reading glasses, current pain medications, visits to health care professionals, diagnostic tests
- pain symptoms (12 questions): general (e.g., head) and specific (e.g., temple) locations of pain, duration of pain, frequency of pain throughout the day, alleviation of pain by eating, other symptoms
- lifestyle and mood (2 questions): changes in lifestyle, mood and level of stress since the onset of pain symptoms
- relation between pain and computer use (1 question): perceived connection between pain symptoms and computer use.

Statistical Analysis

The effects of several potential confounding variables (age, sex, psychological stress, and history of head or neck injury or arthritis [referred to hereafter as "injury or arthritis"]) were examined, and the associations between each of these and the key dependent variable (duration of pain, in years) were analyzed. A correlation analysis, χ^2 contingency analysis or *t* test for independent samples was used, depending on the nature of the variables in each analysis. Multiple regression analysis was performed for the dependent variable (duration of pain) using data from the whole sample and from the subgroup with symptoms of TMD (i.e., pain in the face, jaws or ears [or any combination]; pain in specific areas, such as the jaw joint or cheekbones; pain when moving the jaw from side to side; stiffness of the jaw upon waking; or any combination of these symptoms).[9]

Results

Characteristics of Participants

The study attracted 92 participants, but none of them answered every question. Of the 88 participants who reported their sex, 49 (56%) were female and 39 (44%) were male. Age ranged from younger than 20 years to older than 60, but most participants were 51–60 years of age (**Fig. 1**).

For the 2 largest age groups, there was a nonsignificant tendency toward overrepresentation of females in the younger age group (41–50 years) and overrepresentation of males in the older age group (51–60 years) ($\chi^2_{5df} = 7.87$, $p < 0.10$).

Data for current occupation (n = 87 responses) was grouped into 3 categories: professional (59 respondents [68%]), clerical and client service (14 responses [16%]) and other (14 responses [16%]). None of the participants were employed in a trade.

Table 1 Computer usage and pain experienced by respondents

Computer use					
Duration of computer use No. (%) of respondents (n = 86)	1–3 yr 4 (5)	3–5 yr 10 (12)	5–10 yr 23 (27)	> 10 yr 49 (57)	
Computer use/day No. (%) of respondents (n = 91)	1–3 h 9 (10)	3–5 h 20 (22)	5–10 h 24 (26)	> 10 h 38 (42)	
Period of use No. (%) of respondents (n = 90)	Constant 65 (72)	Morning 8 (9)	Afternoon 4 (4)	Evening 13 (14)	
Location of computer use[a] No. (%) of respondents (n = 91)	Home 76 (84)	Work 77 (85)			
Level of eyes relative to screen No. (%) of respondents (n = 73)	Top 40 (55)	Middle 29 (40)	Bottom 4 (5)		
Pain					
Duration of chronic pain No. (%) of respondents (n = 88)	< 0.5 yr 4 (5)	0.5–1 yr 16 (18)	1–3 yr 21 (24)	3–5 yr 16 (14)	> 5 yr 33 (38)
Period of maximum pain[a] No. (%) of respondents (n = 88)	Constant 25 (28)	During day 27 (31)	Morning 12 (14)	Afternoon 17 (19)	Evening 7 (8)

[a]*For these questions, participants were permitted to choose more than one response.*

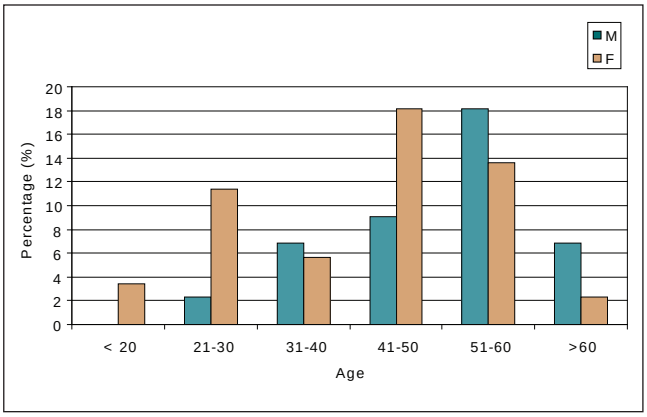

Figure 1: Age distribution of study participants by sex (n = 88).

Computer Use

Most of the participants had used computers for at least 5 years, and more than half had used computers for more than 10 years. The majority of participants used a computer for more than 5 hours per day at home, at work or both (**Table 1**).

Seventy-two percent of the respondents reported using the computer "constantly"; of the remainder, 9% used the computer in the morning, 4% in the afternoon and 14% in the evening. Slightly more than half of the participants (55%) viewed the computer screen with their eyes level with the top third of the monitor; 40% of participants viewed the middle of the screen, and only 5% had their eyes level with the bottom third (**Table 1**).

Pain

Thirty-eight percent of the participants reported having experienced pain for more than 5 years; 28% had constant pain, and few had maximum pain in the evening (**Table 1**).

The most frequently reported locations of pain were the neck (82%), shoulder (75%) and head (47%); more than a quarter of 89 respondents (28%) reported jaw pain. The frequencies of face and ear pain were much lower (12% and 15%, respectively). Two participants reported pain in the neck region only, 6 reported pain in the shoulders only and 1 experienced pain in the jaw alone. However, most respondents reported pain at several locations (**Table 2**). For instance, of the 73 respondents who reported neck pain, 54 also had pain in the shoulder, 34 had head pain, 22 had jaw pain, 12 had ear pain and 10 had face pain.

Seventy-seven percent of the participants believed that there was a link between symptoms of pain and computer use, and 73% reported that the pain decreased when they were away from the computer for an extended period. Among the 41% of respondents who reported that the pain decreased after eating, only 22% experienced frequent jaw pain.

Participants were also questioned about other physical symptoms that they had experienced. Several of these were related specifically to the jaw (**Table 3**). Among the most frequent symptoms were bruxism (reported by 32%), noises in the jaw joint (28%), sore or sensitive teeth (22%) and stiffness of the jaw upon waking (13%). The most

Table 2 Frequency of pain in specific locations and combinations of locations (n = 89 responses)

Site	No. (%) of respondents	+Head	+Neck	+Shoulders	+Face	+Jaw	+Ears
Head	42 (47)	–					
Neck	73 (82)	34	–				
Shoulders	67 (75)	27	54	–			
Face	11 (12)	8	10	5	–		
Jaw	25 (28)	15	22	18	5	–	
Ears	13 (15)	7	12	6	3	9	–

Table 3 Other symptoms experienced by participants

Type of symptoms[a]	No. (%) of respondents
Physical (n = 92)	
Joint noises	
Neck	49 (53)
Jaw	26 (28)
Bruxism	29 (32)
Stiffness of jaw upon waking	12 (13)
Locking or slipping of jaw	8 (9)
Difficulty opening or closing mouth	4 (4)
Sore or sensitive teeth	20 (22)
Sinus pain	20 (22)
Tinnitus	19 (21)
Loss of hearing	9 (10)
General (n = 92)	
Difficulty sleeping	42 (46)
Fatigue	45 (49)
Nervousness	10 (11)
Anger	8 (9)
Depression	14 (15)
Effects on lifestyle (n = 92)	
Missed work	9 (10)
Decreased quality of life	26 (28)
Less physical activity	35 (38)
Less social interaction	10 (11)
Less interest in regular leisure pursuits	20 (22)
Loss of appetite	7 (8)
Overall feeling of malaise	18 (20)

[a]*Participants were permitted to choose more than one response in each category.*

frequent of the general symptoms were fatigue (49%), difficulty sleeping (46%) and depression (15%) (**Table 3**).

Respondents also reported that the pain had a significant effect on their life, in particular, by reducing physical activity (38%) and quality of life (28%) (**Table 3**).

Thirty participants reported injuries or pre-existing musculoskeletal disease: of these, 9 (30%) had whiplash, 14 (47%) had other head or neck injury, 20 (67%) had had a severe blow to the head or jaw, and 13 (43%) had arthritis. Among these 30 participants, 14 had just 1 pre-existing condition, 9 had 2 pre-existing conditions, 4 had 3 pre-existing conditions, and 3 had all 4 pre-existing injuries or conditions.

Data from the entire sample of people who completed the necessary survey questions (n = 91) were used to analyze whether duration of pain, the key dependent variable, was related to any of the 6 independent variables: prior injury or arthritis, hours of daily computer use, presence of significant stress, position of computer screen relative to the eyes, sex and age. The results of this analysis indicated that duration of pain was not significantly related to any of the independent variables ($p > 0.05$ in all cases). Nevertheless, all 6 potential confounding variables were included in the multiple regression analyses, described below.

Two multiple regressions were performed to predict the duration of pain, one with data for all 91 participants and the other with data for the 40 (44%) participants who met the specific criteria for TMD. All 6 independent variables were included in each analysis. The 2 analyses produced similar results, and the overall regressions were significant: for the analysis with 91 participants, $F_{7,68df} = 4.62$, $p < 0.001$; for the analysis with 40 participants, $F_{7,28df} = 6.34$, $p < 0.001$. Duration of computer use was significantly associated with duration of pain (**Table 4**), and the coefficients relating these 2 variables were 0.83 for all participants and 0.75 for those with TMD. These values suggest a direct linear dependence of pain on years of computer use. Moreover, in both regression analyses the intercepts were close to zero (0.2 and

Table 4 Nonstandardized regression coefficients from multiple regression analyses

Variable	Coefficient	*p*
All participants (*n* = 91)[a]		
Independent variables		
Injury or arthritis	−0.56	0.09
Hours of daily computer use	0.16	0.36
Stress	−0.36	0.37
Eye level not at top of monitor	0.17	0.58
Sex	−0.09	0.80
Age	0.01	0.91
Key independent variable		
Years of computer use	0.83	< 0.001
Participants meeting criteria for TMD (*n* = 40)		
Independent variables		
Injury or arthritis	−0.45	0.10
Hours of daily computer use	0.17	0.26
Stress	−0.11	0.70
Eye level not at top of monitor	0.28	0.30
Sex	−0.15	0.61
Age	−0.01	0.96
Key independent variable		
Years of computer use	0.75	< 0.001

[a]*Number of participants who completed the necessary sections of the survey for this analysis.*

0.4 years, respectively), which indicates that the pain began at about the same time as computer use. When the analyses were repeated without the independent variables, the results were similar.

Discussion

This study is the first to show an association between long-term computer use and TMD. More than a quarter of the survey respondents reported chronic pain of the jaws, and 44% had other symptoms commonly associated with TMD (e.g., ear and face pain, joint noises, sore teeth and sore sinuses).[10] The duration of pain was strongly associated with duration of computer use for the whole population and for the subgroup with symptoms of TMD.

Participants, who were recruited through an advertisement printed in a nationally distributed newspaper, answered an online questionnaire about their computer use, pain and other symptoms. The study yielded useful data, but the method of recruitment limited broad application of the findings. The advertisement appeared in only one newspaper and was probably read by only the wealthiest segment of the English-speaking Canadian population. This factor may explain why none of the participants worked in a trade. Furthermore, the participants were self-selected, and computer literacy was a requirement for participation, given the online questionnaire. Also, all of the participants had to be suffering from chronic pain, although potential participants were not informed that TMD symptoms were of particular interest. Therefore, it is extremely unlikely that the study sample was representative of the general Canadian population; however, it may well be typical of the many computer users who suffer from chronic musculoskeletal pain.

Over the past 2 decades, a surge in musculoskeletal disorders of the upper limb has accompanied the widespread increase in the use of computers. One report indicated that although muscular pain accounted for only 18% of all occupational illnesses in 1982, this proportion had risen to nearly two-thirds in 2002.[1] In fact, Schlossberg and others,[11] in an investigation of the risk factors associated with upper extremity and neck pain among engineering graduates, found that 60% of study participants experienced symptoms with computer use and that 12.6% experienced symptoms after 1 hour or less of computer work.

Previous studies have determined that the odds ratios for neck and shoulder pain were significantly higher among females and that they increased with age.[2,12,13] Some authors have suggested that smaller female stature and decreased strength of the shoulder muscles may explain the higher risk among females.[12,13] LeResche[14] reported that TMDs tended to be 1.5–2 times more frequent among women and that prevalence was greatest between 35 and 45 years. In the study reported here, the great majority of participants were between 40 and 60 years of age, with a slight preponderance of females overall and overrepresentation of females in the younger age groups; however, for the entire study sample, there was no relation between duration of pain and either sex or age. In this analysis, it is unlikely that the lack of significance was due to the small sample size, because the regression coefficients were very small.

It appears that the cumulative effects of daily computer use are more important than the daily duration of computer use.[11] Schlossberg and others[11] found that computer use of 20 hours or more per week and duration of use of 8 years or more were strongly correlated with computer-related pain (in the upper extremity or neck). The multiple regression analyses reported here showed that only years of computer use was significantly associated with duration of pain in both the entire study sample and the subset of participants with symptoms of TMD. In addition, these results indicated that the associated neck pain began at the same time as computer use.

This study was initiated because one author found that jaw pain diminished when he stopped using a computer and that it returned when he resumed heavy computer use. Almost 80% of survey respondents stated that there was a link between their pain and computer use. Schlossberg and others[11] reported similar findings: 90% of participants in their study attributed the onset of pain to computer activity.

Most of the respondents to the current survey reported that their pain declined when they stopped using the computer for long periods of time. In a workstation improvement program in the United States, taking breaks never or infrequently was associated with an increased odds ratio for neck and shoulder discomfort.[8] This result suggests that taking breaks will reduce pain, and other data suggest that short breaks do not reduce productivity.[4]

In the current study, 41% of participants experienced pain relief after eating. This finding is similar to results reported by Dao and others,[6] who found that pain levels declined after chewing gum in 32% of patients with TMD-related myalgia. However, in the same study,[6] pain increased after chewing in 48% of the patients, which indicates the possibility that patients with myofascial pain can be divided into 2 subgroups, differentiated by response to exercise.

Burgess-Limerick and others[15] studied height of the computer monitor and head and neck posture and showed that lower placement of the computer monitor (35° to 44° below the ear–eye line) may be beneficial and may increase the time to fatigue the neck muscles. Izquierdo and others[16] found that pain declined with a downward gaze toward the monitor of 14° or more. Most of the participants in the study reported here (55%) had their eyes level with the top third of the screen, which corresponds to a viewing angle of less than 17°.[15]

This study has confirmed that computer users are likely to suffer from musculoskeletal pain. In addition, the longer the duration of computer use in years, the more likely that the participant will have had pain for a similar period. This study presents the first evidence that chronic pain in the jaw muscles and other TMD symptoms are significantly associated with the long-term use of computers.

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