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COLLEGE STUDENTS AND COMPUTERS: ASSESSMENT OF USAGE PATTERNS AND MUSCULOSKELETAL DISCOMFORT

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Time pressure from deadlines, awkward body postures and long-duration, continuous computer use are associated with musculoskeletal disorders (MSDs) in workers using computers. Few studies have examined computer-use-related MSDs in college students. This study investigated computer use patterns of college students, and made comparisons to a group of computer-using professionals. 234 students completed a web-based questionnaire on computer use habits and discomfort students associated with computer use. As a group, students reported their computer use to be at least 'Somewhat likely' 18 out of 24 h/day, compared to 12 h for the professionals. Students reported more uninterrupted work behaviours than the professionals. Younger graduate students reported 33.7 average weekly computing hours, similar to hours reported by younger professionals. Students generally reported more frequent upper extremity discomfort than the professionals. Frequent assumption of awkward postures was associated with frequent discomfort. Results signal a need for intervention prior to entry into the workforce.

INTRODUCTION

Background

Since 1985, worldwide personal computer use has grown from 6.5 users per 1,000 people in 1985 to 663 per 1,000 in 2002 (Computer Industry Almanac 2003). No longer just used in office settings, computers are becoming ubiquitous. Computer use may actually be more prevalent among some groups of non-workers, namely students, than among some adults who use computers for work. To illustrate this point, a study at the University of Massachusetts revealed that the proportion of students with no experience with computers fell to almost zero over a five year period in the early 1990s (Kuenzi 1999-2000).

As computers expand our horizons, research and reports show some negative effects associated with computer use, in the form of musculoskeletal discomfort and disorders (MSDs). Among these are carpal tunnel syndrome, tendonitis, and tension neck syndrome. Risk factors that are singularly identified to contribute to MSDs are repetition, duration, force and posture, and there is strong evidence that jobs that impose combinations of these factors increase workers' risk for developing MSDs (Bernard 1997).

Numerous studies of adult workers have found associations between computer use and musculoskeletal discomfort (Hunting *et al.* 1981, Starr *et al.* 1982, Läubli and Grandjean, 1984, Kadefors *et al.* 1999, Forman *et al.* 1999, 2001, 2002, Kitahara *et al.* 2000, Sjøgaard *et al.* 2000, Birch *et al.* 2000, Jensen *et al.* 2000, Thorn *et al.* 2002). Repeatedly, temporal and postural factors have been associated with musculoskeletal symptoms and/or disorders in workers who use computers. Some interventions in the office worker population have been shown to be effective in reducing VDT user discomfort (Tittiranonda *et al.* 1999, Aaras *et al.* 1998).

The number of studies investigating children and their computer use is limited, but growing. Harris and Straker (2000) found that 60% of a sample of 271 students, aged 10-17 years, reported discomfort with using their laptop computers. There was a statistically significant association found between mean maximum time on task and discomfort while using the computer. In a survey of 382 high school students, 28% reported hand discomfort after using the computer, 40% reported neck/back pain, and 41% reported general body pain (Jones and Orr 1998). Jones and Orr further concluded that since high school students are establishing their lifestyle activities and patterns, the increased computer use at a younger age may increase the prevalence and trauma associated with computer use as students become older. Another study emphasized the importance of educating students about MSD and teaching students about healthy computing. 'Students are at risks for RSIs (repetitive strain injuries) because of student behavior, laboratory arrangements, a lack of emphasis on posture in the curriculum, and the attitudes/perceptions of faculty and administrators' (Royster and Yearout, 1999).

An as yet understudied segment of the student population that may have an elevated risk for developing MSDs, in association with computer use, is college students. The National Center for Education Statistics reported the fall enrollment in post-secondary institutions in 1999 to be over 14 million, with enrollment expected to exceed 17 million by 2011 (Papadakis 2000). Only a few studies have investigated college students' computer use, from an ergonomics perspective.

Katz *et al.* (2002) attained a 96% response rate and found 53% of a university class of graduating seniors experienced symptoms in the upper extremity (UE) when using a computer. Symptoms of UEMSDs were associated with being female, a computer science concentration, and self-reported computing for more than 20 hours per week (Katz *et al.* 2000).

Another study by Katz’s group investigated how UE disorders affected a small sample of 16 symptomatic graduate and undergraduate students (Cortés *et al.* 2002). The students reported that computers have an essential role in their academic, social, and personal lives. From the medical community, most students reported that they were told to discontinue computer use, and students felt that this suggestion was not realistic. Suggestions were made for complete ergonomic evaluations of computer workstations, along with providing checklists of information in labs and examples of ergonomic adaptations of current workstations or equipment for students to try (Cortés *et al.* 2002).

Specific aims of the current study

The specific aims of the current work were to 1) develop, among different groups of college students, profiles of computer use patterns and musculoskeletal discomfort specifically associated with computer use, 2) compare student patterns with similarly obtained patterns from professionals that use computers, and 3) identify associations between patterns of use and musculoskeletal discomfort. Based on the existing relevant literature, an investigational model of student computer use and musculoskeletal discomfort was developed to guide the design of the current study (see figure 1).

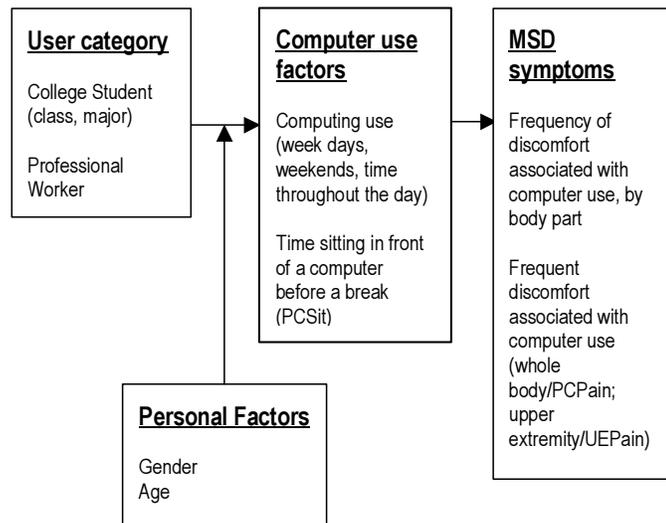


Figure 1. Graphical representation of research development.

METHODS

The surveys and protocols for this study and the study of the PW were approved by the appropriate human subjects protection review boards of the authors’ institutions. All participants were required to provide informed consent prior to participating in the studies.

Subjects

Students from North Carolina State University, The Ohio State University, and The University of South Florida, were recruited to participate in a survey. Convenience sampling was utilized. Students received no compensation for their participation. 267 surveys were completed, for a response rate

of 38%. Due to duplication, neglect, or errors in responses, 26 responses were excluded from the analyses.

Survey instrument

The questionnaire used in the study was based on one used to study professional workers who use computers for work (Sommerich 2002). The questions focused on computer use in relation to location, duration, frequency, posture, and discomfort. Demographic information collected from the students included age, gender, class standing, major, and a question on when they began using computers. The survey instrument is replicated in the thesis by Noack (2003).

Variables

When just considering the student data, the independent variables were Class (graduate or undergraduate), Major (Engineering, v. Humanities), and Gender. Due to the potential association between age and MSD, when making statistical comparisons between the CS and PW, only data from subjects under 35 years of age were utilized for both groups. The dependent variables of interest were based on questions about the participants’ computer use: frequency, duration, posture, discomfort, demographic information, and previous computing experience. Some of these responses were evaluated qualitatively in descriptive statistics, while others were formally addressed via statistical analyses.

Statistical analysis

The survey produced ratio and ordinal data. JMP (SAS, Cary NC) was used for analysis. Throughout the analysis, a probability of less than 0.05 indicated a significant effect. The Wald Chi-Squared test was used for the analysis that tested the effects of the independent variables.

RESULTS

Descriptive statistics are presented first, followed by statistical analyses of musculoskeletal discomfort and potential risk factors. The most important findings are the similarities between college students and professional workers, in terms of hours of computer use, frequency of musculoskeletal discomfort associated with computer use, and working in awkward postures which showed a relationship to discomfort. Please reference the thesis by Noack (2003) for a more complete analyses.

Demographics

Basic demographic information (age, gender, and race/ethnicity) is provided in table 1, for all participants. As a point of interest, almost half of the CS (45%) began using computers prior to starting high school, while this was the case for only 11% of the PW. When the data were reduced to just those subjects under 35, there remained 201 students (mean age of 23.6 years, s.d. 3.6; 121 females and 80 males) and 60 professionals (mean age of 30.5 years, s.d. 2.9; 30 females and 30 males).

Table 1. Demographic information for the CS and PW: age, gender, and race/ethnicity. Number of responses to each question provides sample size information.

	College Students n=234	N for CS	Professional Workers n=302	N for PW
Mean age, years (sd)	25.2 (6.4)	219	44.4 (9.9)	300
Gender, n (%)	M: 87 (37%) F: 147 (63%)	234	M: 181 (61%) F: 118 (39%)	299
Race/ethnicity, n (%)	Caucasian: 179 (76%) Asian: 31 (13%) Other: 27 (11%)	232	Caucasian: 272 (90%) Asian: 8 (3%) Other: 23 (7%)	297

Computer use practices

All groups of respondents reported average weekly computer use that exceeded 20 hrs (Table 2). 102 students reported using both desktop (DPC) and notebook (NPC) computers. 91% of the PW were classified as ‘heavy users’, meaning that they used their computers for work on all, or at least the vast majority, of days they worked. Both CS and PW were asked about the likelihood of using a computer during specific time periods throughout the day. For each two hour time period, the response choices were the same as those listed in figure 2. Figure 3, depicting *Very likely* responses, shows that the professional workers appear to concentrate their computer use during normal business hours, while the college students’ computing hours shift towards the evening hours. A composite score, PCSit, which increased as the likelihood of sitting at the computer for longer periods of time, was greater for graduate students than for undergraduates (p=.004); and was greater for college students than for the professionals (p<.0001).

Table 2. Weekday and weekend hours of computer use reported by participants.

	Undergrad.	Graduate	PW
Weekday, hrs			
All S	20.4 (10.9)	25.3 (12.8)	26.6 (9.0)
S <35 yrs	20.4 (11.2)	25.7 (12.8)	29.3 (9.4)
Weekend, hrs			
All S	6.2 (4.1)	7.6 (5.5)	5.3 (6.4)
S <35 yrs	6.2 (4.2)	8.0 (5.7)	6.4 (7.4)

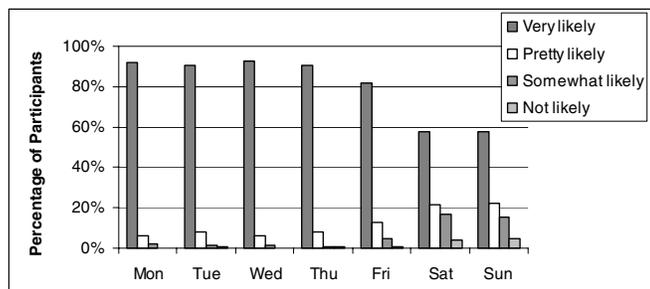


Figure 2. Graphical representation of reported daily computer use for CS and PW participants.

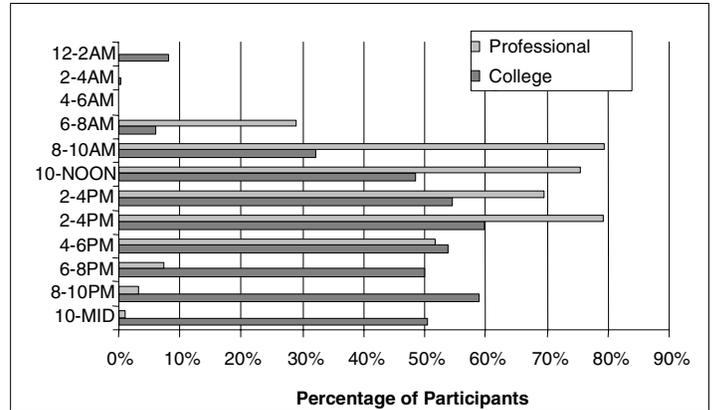


Figure 3. Graphical representation of reported computer use during the day for PW and CS participants.

Musculoskeletal discomfort

Frequent discomfort associated with computer use was prevalent in both students and professionals (table 3), where “frequent” was defined as occurring “quite often” or “almost always”. Surprisingly, the students reported statistically more frequent discomfort than the professionals in several body parts (regions of the right upper extremity and neck). Frequent eye discomfort and low back discomfort was more prevalent in the professionals.

Table 3. Prevalence of frequent discomfort associated with computer use in participants under 35 yrs of age; ** indicates sig. diff.

Body part	Students	Professionals
Eyes **	1.5	31.0
Headache	12.4	15.5
Neck **	41.3	21.2
Left shoulder	15.4	8.5
Right shoulder **	24.9	7.0
L. forearm/elbow **	21.4	4.2
R. forearm/elbow **	27.4	7.0
Left hand/wrist	7.0	5.6
Right hand/wrist	12.4	14.1
Upper back	12.9	11.3
Lower back **	6.0	19.7
Buttocks	3.0	5.6
Legs	6.0	4.2

Frequent body part discomfort associated with computer use was also described by two composite scores, PCPain and UEPain, which summed the number of body parts and number of upper extremity parts, respectively, that experienced frequent discomfort (Table 4). PCPain and UEPain differed between male and female students, but was not a function of Class or Major. PCPain did not differ between the CS and PW (analysis limited to participants under 35 years of age), but did still differ by Gender (p=.0004). UEPain differed by Category (p=.0008) and Gender (p=.0017), though there was no interaction between these factors.

Table 4. Average PCPain and UEPain scores (s.d.), as a function of gender and study category (possible score ranges are 0-13 for PCPain and 0-8 for UEPain).

	College Students		Professionals	
	Female	Male	Female	Male
PCPain	2.4 (2.5)	1.2 (1.5)	2.3 (2.5)	0.9 (1.2)
UEPain	2.0 (2.0)	1.0 (1.3)	1.2 (1.6)	0.4 (0.8)

Awkward postures

Students reported being aware of assuming awkward postures when using both desktop and notebook computers. Table 5 presents dichotomized data for the CS and PW, which show similar percentages, between the two groups, of those reporting frequent awkward postures (answered either Quite often or Almost always) for DPC and NPC use.

Table 5. Percentage of respondents who were Quite often or Almost always aware of assuming awkward postures while using a computer.

	College Students	Professionals
Desktop PC	30.4%	29.5%
Notebook PC	17.9%	21.3%

Frequent adoption of awkward postures was associated with frequent discomfort, expressed through the PCPain score (p=.009). Figure 4 illustrates that when students are compared on the basis of more frequent or less frequent assumption of awkward postures while using a desktop computer, a greater percentage of the former group experiences frequent discomfort in at least one body part (75% with PCPain >0), when compared with the latter group (56%). Results were similar for notebook use.

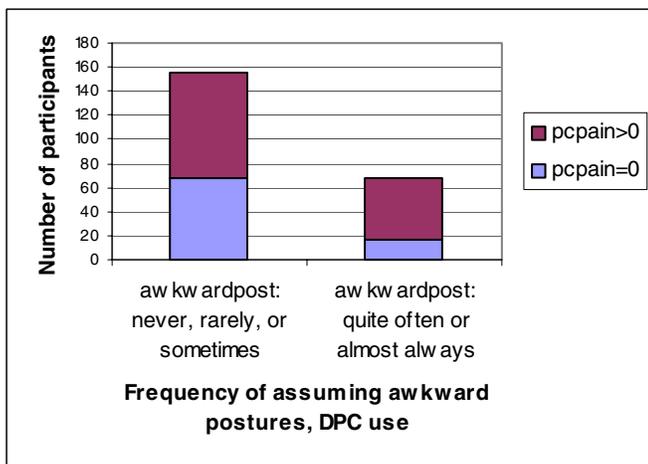


Figure 4. Graphical representation of reported awkward postures with Desktop PC use.

DISCUSSION

This study revealed similarities in the amount of time that college students and professional workers use (are exposed to) computers. The study was unique in several ways: it provided information on a much larger set of graduate students than has previously be presented; college student participants

were from public institutions, and so this study complements previous studies of students in private institutions (demonstrating that students at both types of institutions have extensive exposure to computers); computer usage patterns are provided in more detail than in previous studies (by day of the week and hour-to-hour), which illustrates college students, as a group, have less non-computer (“recovery”) time than do professionals who use computers for work.

Musculoskeletal discomfort

The college students in this study reported experiencing frequent musculoskeletal discomfort specifically associated with the activity of using computers. In the current study, the finding that UEPain was greater in college students’ than in the PW was unexpected. Since office workers reported spending more hours using a computer, if a dose-response relationship existed between hours of use and discomfort, one would expect that UEPain would have been higher for the PW. The higher level of UE discomfort reported by college students could be due to the varying work environments, however. Supplying computers for student use is a priority for colleges, but computer labs rarely have computers set up appropriately. They are set-up to maximize the number of computers in the room and, as such provide cramped working conditions that lack adjustability. At one school, the only adjustable workstation was provided for use by students with disabilities (an ADA accommodation). Many universities now require incoming freshman to purchase their own laptops to ease the computer equipment burden, but adding a manual materials handling burden on the students, in addition to an increasing emphasis on use of computers (spending more time using them). Despite the widespread exposure students have to computers, information about healthy computing habits is not readily available to students.

Temporal and postural aspects of computer use

In this study, the primary difference between graduate and undergraduate students was in the number of hours of computer use, although average weekly hours of use by both groups exceeded 20 hours per week, the limiting value that Katz *et al.* (2002) had identified as a risk factor in their research. Unlike that study, however, no relationship could be identified between hours of use and discomfort in the current study. An important association that was identified was the link between awareness of frequent adoption of awkward postures and PCPain. PCPain was also found to correlate with PCSit for the CS and the professionals.

College major was not found to significantly affect any of the variables, which implies that college students’ computer knowledge about MSDs can be addressed at the university level. Simple, low cost solutions are possible with a little ingenuity. Using books as a foot rest, moving the mouse or keyboard closer to the center of use, taking breaks, adjusting the monitor and chair before beginning are only a few quick tips that college students could be informed of with a poster in a computer lab. College students are more likely to enter the workforce with poor computing habits, MSS, or even an MSD, without some intervention. At least with the knowledge about MSDs and MSSs, college students can learn how to set-

up their primary workstation to promote healthier computing, as well as take steps to work healthier in computer labs. With knowledge, a college student experiencing symptoms may find information on elevation of the symptoms before they progress to a permanent problem. Knowledge and proper equipment are two items that could help offset a future workforce's probability of developing computer-related MSDs.

Skepticism about college students as an 'at-risk' population for MSDs and MSSs should begin to dissipate as more evidence reveals the similarities in college students' and professional workers' exposure to computers and reported discomfort. In this study there was only a slight difference between graduate and undergraduate computing hours, and no difference between graduate students and professionals. PCPain was similar between CS and PW, but UEPain was greater in the college students than in the professionals. Since college students have similar computing hours and higher frequency of discomfort, the reporting of college students with MSDs in previous studies is not surprising.

Suggestions for future work

Following a group of college students throughout their academic careers would be a challenging but obvious next step. Research into this younger population could further investigate the natural history of MSDs, because people begin using computers at such an early age, now. Further, professional workers are developing their computing habits at younger ages, in college or at other school levels.

CONCLUSIONS

Efforts to reduce exposures to risk factors associated with MSD should not only include the workforce. This research revealed that risk factors previously identified in groups of professional workers, are also prevalent in the college students' environment, although proper workstation set-up and healthy computing are not yet common place terms in most educational environments. Intervention, in the form of education, at a minimum, should begin much earlier than the workplace, because of the extensive exposure students have to computers during their years in school.

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