

## Primed for Injury

What happens when the digital generation becomes the next generation of office workers?



Tomorrow's office worker is today's student. Observing this digital generation of children, teens, and young adults and its use of computers, games, handheld electronic organizers and games, mobile phones, and television remotes, the question arises: What impact are these behaviors having—and will have—on the next generation of office workers? What is the potential for a future increase in computer-related injuries as the first members of the digital generation enter the workforce?

Considering the serious and costly effects of computer-related workplace injuries, answering these questions becomes all the more urgent. In 1999, work-related musculoskeletal disorders (MSDs) accounted for 34 percent of all occupational injuries and illnesses. Estimates for workers' compensation costs associated with MSDs range from \$15 billion to over \$45 billion, according to OSHA. OSHA also estimates that the indirect costs from lost productivity and employee turnover and training are as much as \$100 billion.<sup>1</sup> The dollar costs are high; so is the loss of good employees and their ability to work productively.

### How is the digital generation using computers?

Computer use is a part of nearly every child's experience. Even before children reach school age, they use computers for education and entertainment. Peruse the software aisles of any computer store, and you will see significant investment in programs aimed to prereading, preschool children.

The computer, along with pencils, paper, and books, is a primary school tool. The U.S. Department of Education mandated through its Goals 2000 Program that all U.S. public school classrooms have Internet-accessible computers by the year 2000, ensuring that all students have equal access to computers.

In elementary school, computers are a key part of the curriculum. Keyboarding classes rotate with physical education and music classes. Computer use at home and school increases with age. In a survey of 228 elementary schools in Oregon, teachers reported that

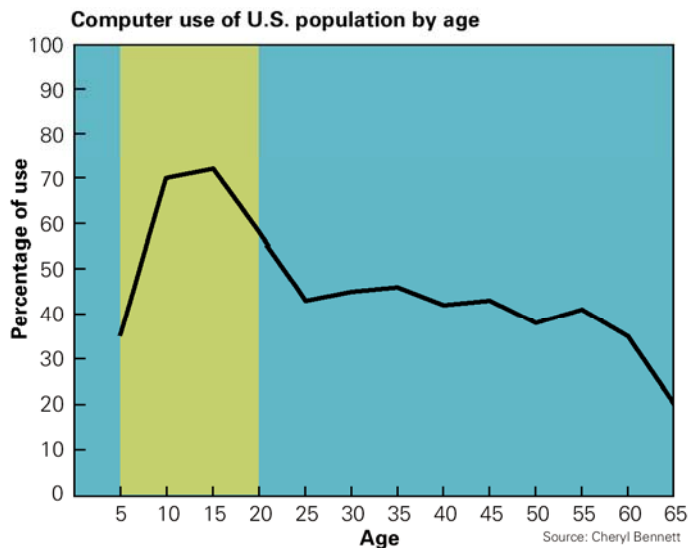


Figure 1.

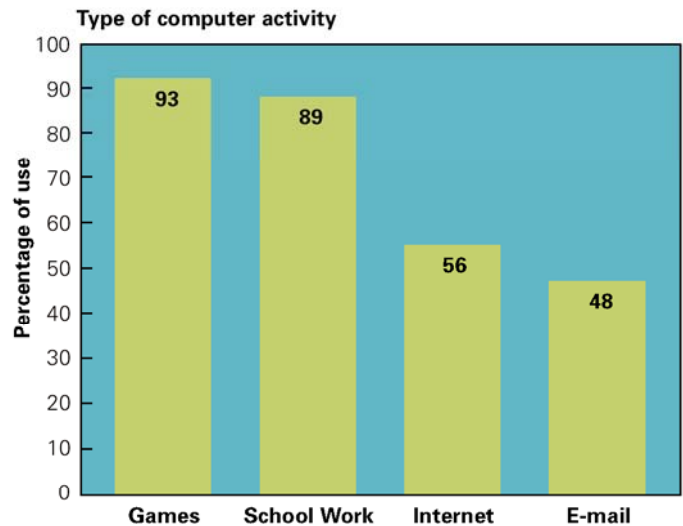


Figure 2. A CNN/USA Today poll asked high school students to rate the type of computer activity and percentage of time they spend doing it. Total computer use averaged 4 hours a week; 44% used a computer daily. Source: Jones and Orr

younger elementary students used computers between 15 and 30 minutes a day. Older elementary students increased their use up to 45 minutes a day.<sup>2</sup>

In 2000, 70 percent of U.S. households with children aged 2 to 17 had computers; 50 percent of those homes were connected to the Internet. Children in those households averaged 97 minutes of computer use a day.<sup>3</sup> The computer has also blossomed into a primary means of communication among teens and young adults, thanks to the Internet, email, and instant messaging. A 2000 study of Australian students aged 10 to 17 found that, on average, computer use ranged from just under 17 hours a week up to 80 hours a week.<sup>4</sup> Electronic gaming, either through game consoles or the computer and the Internet, is increasing, particularly among boys and young men. In another study of Australia's youth, over 13 percent of boys and four percent of girls aged nine to 11 spent more than 20 hours over a two-week period playing electronic games.<sup>5</sup> In the U.S. in 2003, the yearly average number of hours playing electronic games was 75; this accounts for all ages of users.<sup>6</sup> It is safe to assume that the amount of computer use and electronic gaming will continue growing, due to decreased computer and game console costs, increased broadband cable access, and the popularity of instant messaging.

For college students, the computer is an essential tool. Many universities now require a computer—and computer literacy—for enrollment. Cyber cafes are gaining popularity as the place where students gather to socialize, collaborate, compose, and research. The common element in these activities is the use of a computer. In a survey of computer use among college students, participants reported working on a computer an average of three hours a day.<sup>7</sup> The percentage of time that college students spent on the computer increases as the semester progressed: Deadlines on assignments and papers caused students to spend longer periods of consecutive time at the computer.<sup>8</sup>

Figure 1 demonstrates the spike in computer use during the teen years; figure 2 breaks down use during those years into specific types of computer activity.

### What are the risks?

The potential for an increase in computer-related injuries such as repetitive motion and MSDs may become greater among a younger population. While children tend to move more frequently than older

children and adults, which can prolong the onset of injury, even young bodies have thresholds. Research into children's resilience and susceptibility to MSDs is a budding area of research. But computer use promotes sedentary posture, and sedentary behaviors can lead to health risks.

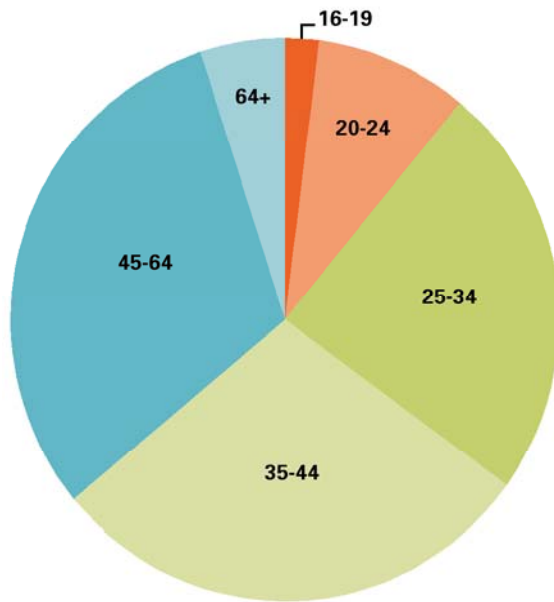
If it takes ten years for repetitive strain injuries to set in, as Alan Hedge, professor of ergonomics at Cornell University, believes, teenagers who have been using computers since the age of six will be "primed to experience some injuries" as they age and continue using computers.<sup>9</sup>

Just what does "primed for injury" mean? And as the first generation of people raised with computers and other information technology tools enters the workforce, are their bodies already exhibiting signs of injury most often associated with an aging workforce?

Young people are not immune to the computer-related injuries more often associated with adult workers. Businesses, aware that injuries result in attrition and costs, invest in ergonomically designed furniture and training. Unfortunately, the same cannot always be said for schools and universities. As a result, students experience a number of computer-related musculoskeletal symptoms and disorders.

MSD occurrences among a computer-using adult workforce signals the potential MSDs that young people may experience through the cumulative time they spend using computers.<sup>10</sup> Assuming a direct correlation between computer use and injury, however, is not easy or always accurate. A number of factors can enter into a young person experiencing MSDs. For example, extracurricular activities such as playing a sport or an instrument can contribute to MSDs. So can stress or work. The Bureau of Labor Statistics documents in great detail the incidence of MSDs among the workforce. But unless a student works, MSDs are not captured or reported by the Bureau.

There are a few numbers we can start with, however. In 2002, half a million people took time away from work to recover and treat work-related MSDs of the lower back and upper extremities. (Figure 3) Of that total, 9,000 were aged 16 to 19, and a little over 47,000 were aged 20 to 24.<sup>11</sup> In the U.S., 52,000 teenagers and young adults under the age of 30 receive disability payments through the Social Security Administration because of MSDs.<sup>12</sup> Cheryl Bennett, a researcher at the Lawrence Livermore National Laboratory and a leading proponent



**Figure 3.** In 2002, 500,000 people missed work to recover or treat MSD-related injuries, including a measurable group of high school and college-aged workers.

Age	Number of People
16-19	9,000
20-24	47,000
25-34	122,000
35-44	146,000
45-64	156,000
64+	20,000

OSHA reports workers' compensation costs for the total group ranged from \$15 million to \$45 million.

Source: Bureau of Labor Statistics

of student/computer-related injury research, notes another problem with a younger population receiving Social Security benefits due to MSDs: Our Social Security system is not equipped to offer disability payments to young people who have never been employed.<sup>13</sup>

### How are computers used in school?

**Elementary School**—In 2001, the Johns Hopkins University's Center for Information Technology and Health Research sponsored a symposium on children and technology that addressed various facets of this question: If information technology (IT) is growing in the 21st century, will physical and mental health effects from IT use also increase?<sup>14</sup>

Among the presenters at the symposium was Alan Hedge. He notes the great variation in size among elementary students, yet sees very little variety in the size of the furniture available for these children. A study of third, fourth, and fifth graders from 11 schools pointed out a "striking misfit" between the users and their gear, says Hedge. Monitors and keyboards are often set too high, so children's necks are strained as they view monitors and their wrists and arms are angled sharply, thus straining muscles and tendons. The same situations apply at home, where furniture and computers are typically sized and arranged for adult-sized bodies.<sup>15</sup>

Medical professionals report an increase in complaints from children about back, neck, and shoulder pain linked to two factors: backpacks overloaded with books and improperly designed computer workstations. Carrying over 15 percent of one's body weight in a backpack alters posture and gait when walking; more than ten percent can cause detrimental effects.<sup>16</sup> "If we don't start paying attention to these issues in children, we may be creating a generation of adults with even greater back and neck problems than we're seeing today," states Dr. Jerome McAndrews, spokesman for the American Chiropractic Association.<sup>17</sup>

Adding to the problem is the promotion of computers in school without adequate ergonomics training and appropriate furnishings. Monies are allocated for equipment, but those dollars do not include the cost of training on proper use of equipment nor for the furniture that can offer a more healthful posture for varying sizes of students.

Dr. Dieter Breithecker, in a study on development of posture and exercise in German schools, says: "What is taken for granted today

for every office place or work—that it must provide the ergonomic surroundings for maintaining the health and psycho-physical well being of the employee—is neglected in schools for economic reasons and ignorance. However, the school is a 'place of work' not only for teachers but for the children as well."<sup>18</sup>

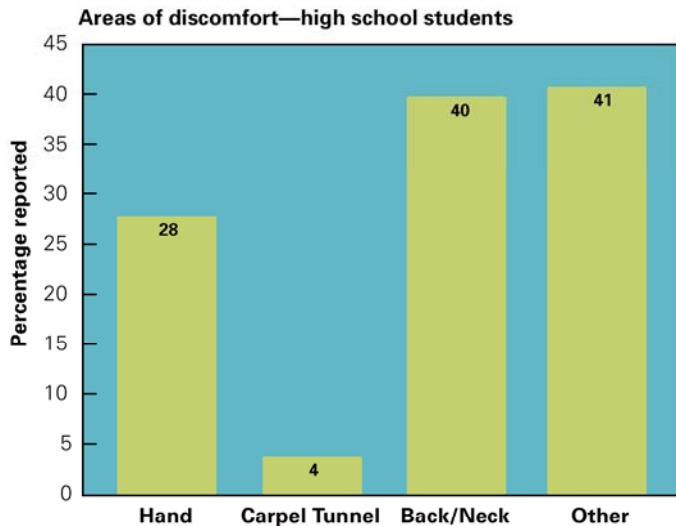
While furniture and equipment are often cited as significant contributors to MSDs, the very nature of using a computer calls for sedentary posture. That is also the case for hours spent playing video and computer games. Sedentary posture and repetitive activity will take their toll on the muscles and tendons in the body. Moving the body, shifting postures, and taking breaks are ways to eliminate discomfort.

**Middle School**—Karen Jacobs, ergonomist and clinical professor at Boston University's Sargeant College of Occupational Health, found that more than 40 percent of sixth- and seventh-graders complained of musculoskeletal pain after completing one week of a computer class. Her research was based on the self-reporting of 341 students.<sup>19</sup>

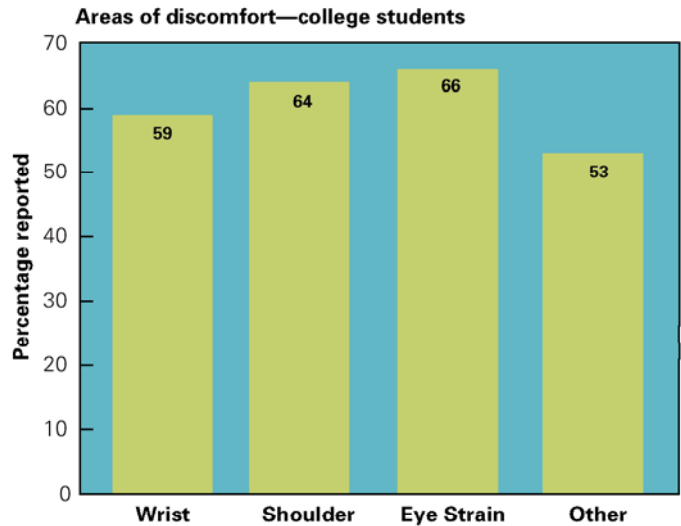
In a study of Australian sixth-grade students, 60 percent of those tested reported discomfort associated with computer use. The results of early research such as these studies indicate that children are at least as much at risk as adults.<sup>20</sup>

Jacobs sees injury risk progressing as children age. Middle school demands get greater, backpacks get heavier, and more time is spent on the computer. It is this combination of factors—computers and the video games and the sedentary behaviors—that is cause for alarm, says Jacobs. And it is the heavy backpacks and the contact stress and back pain young people experience from them. "Behavior is what we need to change," says Jacobs. "We can't wait to have all the quantitative data. We need to start building awareness of prevention measures."<sup>21</sup>

**High School**—A study of 382 high school students reveals some compelling statistics about the prevalence of computer-related injury among this population. (Figure 4) Participating students were in business classes, such as journalism or computer programming, which required more computer use than other courses. Results were gathered through self-reporting and articulated in terms such as pain in the back, neck, and other areas of the body. While students used computers in class, nearly half also used them in their work outside of school. Students, on average, used the computer 2½ hours per day,



**Figure 4.** 382 high school students identified areas of discomfort during or after computing (could select more than one). The 4% of self reported and medically reported carpal tunnel syndrome is significantly higher than the 1.5% reported in the adult population. Source: Jones and Orr



**Figure 5.** 300 college students identified areas of “little to moderate” discomfort experienced during or after computing (could select more than one). Over half the test group used computers for homework, just under half for entertainment. Source: Burke

and over a third of the test group self-reported discomfort in the back, neck, and hands.<sup>22</sup>

In discussion of the study, the authors point out that the self-reporting of carpal tunnel syndrome increased when combining school, at-home, and work activities. Computer use in school had the least reporting of discomfort after use, while computer use at home and repetitive activities at work (e.g., fast-food service, computer work) showed the greatest risk. Students may spend more consecutive time on the computer at home, as opposed to school, where use may be limited to a portion of a class period. The study also points to the fact that increased computer use adds to risk factors such as repetitive motion disorders, which may or may not be caused by computer use.<sup>23</sup>

Experts agree that the greater the amount of consecutive time spent using a computer or playing a video game, the greater the chance of discomfort or injury. Couple the increasing academic requirements of high schoolers, many that require computer use, with the increasingly popular communications methods such as instant messaging, and the result is increased consecutive time at the computer—and increased MSD risk potential.

**College**—The trend toward increased consecutive computing time continues in college. Online research establishes the computer as an information output source, says Dr. Jack Dennerlein, of Harvard University’s Department of Environmental Health. His concern is that while experts study postures and body injury from computer use, it is most often while one is inputting information. However, a great deal of time is spent using a computer and not using a keyboard. What happens when users aren’t inputting information? What are they doing with their arms? What are the effects of mouse use over an extended period of time? What implications does this have on potential injury? Dennerlein and others are conducting research to answer these questions.<sup>24</sup>

Some college students are taking charge of dealing with computer-related injuries. (Figure 5) Students at Harvard started the RSI Action group as a way to provide preventative education about repetitive stress injuries (RSIs) to the general public and to students at Harvard. The group provides advocacy and support for Harvard students with RSI. According to the group’s website, 90 percent of those who access the site are from outside Harvard.<sup>25</sup>

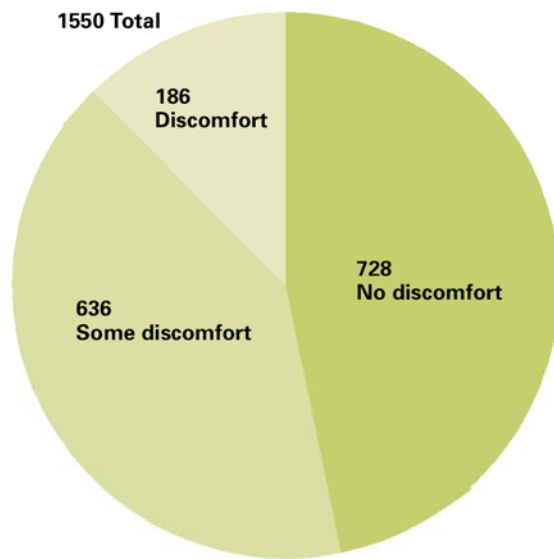
Students lead and maintain Stanford University-based studentErgonomics. Like Harvard’s RSI Action, studentErgonomics raises awareness and provides education about computer-related repetitive strain injuries. It targets high school and college students across the country.<sup>26</sup>

Experts are also paying attention to this population and a potential problem with MSDs. One group of researchers surveyed 512 college students at a university in the western U.S. regarding four areas of computer use: duration of computing, computer-related symptoms or discomfort, training on workstation design, and the design of a computer work area at home. Seventy percent of the students reported upper back and neck pain. This group reported that discomfort lasted up to two days, although the range was zero to 150 days. Students missed up to 21 days of school due to their injuries and up to 30 days of work. Of this group, 3.5 percent had a diagnosis of carpal tunnel syndrome confirmed by a physician. This is strikingly higher than the 1.47 percent figure from a 1995 study of U.S. workers.<sup>27</sup>

This study also highlighted the disparity between time spent training on proper ergonomic posture and time spent computing. Ninety-five percent of this group used a computer at home, but only 10 percent received any home training on ergonomics. Training increases to 26 percent in school and to 60 percent at work.<sup>28</sup>

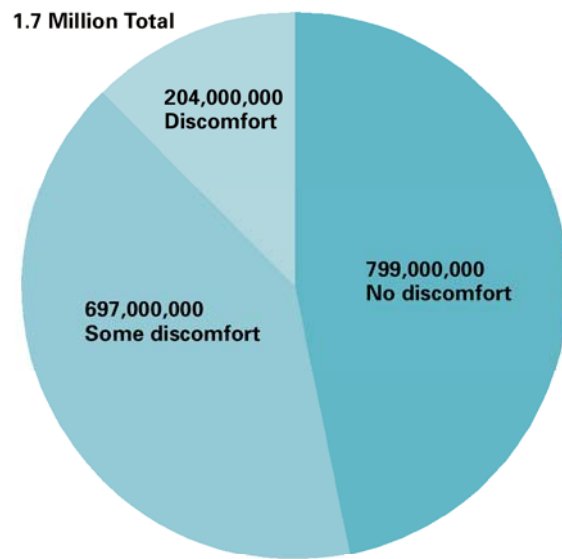
Dr. Benjamin Amick, from the University of Texas School of Public Health, has coined the phrase “binge computing,” which addresses one of the problems with computer-related injuries: working at the computer for an extended time without a break. Binge computing is not an unusual occurrence in college, especially when the semester end nears, along with deadlines for term papers. Amick says binge computing and its related injuries is an “emerging problem in college kids.”<sup>29</sup>

Amick, along with Dr. Jeffrey Katz of Harvard University, surveyed senior undergraduates of a private university, asking students if they experienced pain, numbness, tingling, or other discomfort in their hands, wrists, or arms when using a computer. (Figure 6) Answers were sorted into three groups: 1) never, 2) yes, with computer use of several hours, and 3) yes, with computer use of one hour or less. Of the student group surveyed, 47 percent reported never having symptoms; 41 percent reported symptoms after several hours; and 12 percent reported symptoms after one hour or less. The researchers divided the third response further to analyze amount of use and



**Figure 6.** One out of eight graduating seniors (12.5%) at an undergraduate college experienced musculoskeletal discomfort after computing for one hour or less. 41% reported some discomfort; 47% no discomfort.

Source: Katz, Amick



**Figure 7.** What are the implications of this study for a broader undergraduate population? If we apply these same statistics to an undergraduate population of 1.7 million, we can speculate that up to 800,000 experience some discomfort after several hours and 200,000 experience discomfort frequently when computing. Source: Katz, Amick

discomfort. Of the 12 percent, 6.9 percent experienced symptoms after one hour of computing, 3.2 percent after several minutes, and 2.5 percent with virtually all computer-related activities.<sup>30</sup>

The figures speak for themselves: One out of eight students experience symptoms after computing for one hour or less. Projecting results from the Katz study to a national undergraduate population of 1.7 million students, suggests about 800,000 undergraduates in the U.S. have some discomfort and 200,000 of them have frequent symptoms.<sup>31</sup> (Figure 7) The implications of this finding are significant, particularly when considering that many of the college graduates in this country will become employed and use computers in their work.

Louis Freund of the Silicon Valley Ergonomics Institute, quoted in *USA Today*, speaks of a population in its thirties showing up as “ergonomic casualties.” In the same article, author Stephanie Amour writes that ergonomists see trouble in the number of ergonomic ailments in the tech industry. This is a sign that “younger workers who have grown up using computers are increasingly vulnerable to injuries.”<sup>32</sup>

How will these new professionals affect future injury rates, compensation costs, and loss of productivity and time away from work?

### How can we reduce the risks?

People involved in education—from students to parents to educators, from administrators to taxpayers—need to understand the ramifications of MSDs and how they can be prevented. The same principles and actions that motivate businesses to train employees and purchase ergonomically designed furniture should apply to the education arena, as well. Educating students and their teachers on ergonomics, proper posture, and other healthful behaviors is essential. There is also a need to continue research that will assess the risks and injuries related to computer use among a school-aged population.

Spreading the word about health risks among a younger population is critical to raising awareness. Bennett, who in addition to her ergonomics research at Lawrence Livermore National Laboratory also chairs the Ergonomics for Children and Educational Environments International Ergonomics Association Technical Committee, sees the need for research focused on the student population. Even the

ergonomics guidelines in existence today for proper computer use are established to the scale and size of adults.<sup>33</sup>

Alan Hedge has created ergonomic guidelines specific to the great variation in body sizes of students, with particular focus on elementary and middle school populations. The Cornell University Ergonomics website (CU-Ergo) includes detailed training on ergonomics, with illustrations and photographs demonstrating proper and improper postures. It also offers tips on design of workstations and information on computer-related injuries.

Applying learning from office and work situations can be helpful in an analysis of educational settings. We know, for example, that computer-related injuries can pose a significant problem in the workplace. For three years, 632 newly hired workers were tracked to determine the prevalence and risk of musculoskeletal symptoms and disorders of the hands or arms and necks or shoulders.<sup>34</sup> Of the study population, 252 were aged 20 to 29 and 236 were aged 30 to 39, and 552 members (87 percent) had either two- or four-year college degrees. These workers computed for at least 15 hours a week in their work. The conclusions were staggering: More than half of these workers experienced upper extremity musculoskeletal symptoms. A large number of the symptoms met the criteria for MSDs. Neck and shoulder injuries exceeded those of the hands and arms. These numbers are especially meaningful when considering injury rates among college students and the potential and actual injury rates among a younger group of workers.

It is difficult to argue with the intentions of local school systems and the U.S. Department of Education to have computers in every classroom. The Internet has opened a new avenue for information sharing and learning. Knowing how to use a computer is an essential skill for students now and in the future. But the availability of dollars for computers may not be matched by a commitment to train educators and students in computer-related ergonomics. As awareness of potential health risks grows, schools may factor into their budgets all of the items necessary to support healthful classrooms, including training, furniture, and computers.

Legislation passed in New Jersey in 2003 signals a growing understanding of the importance of ergonomics in the school.

---

An Ergonomics in Education Study Commission, composed of medical and ergonomics professionals, educators, and administrators, will determine how best to integrate ergonomics into the curricula.<sup>35</sup> It will examine ergonomic issues such as design standards for equipment and furniture, training and ergonomics programs, and computer-related injuries. Cheryl Bennett calls the legislation a “triumph” for the human factors/ergonomics discipline.<sup>36</sup> Karen Jacobs is working to pass similar legislation in Massachusetts.<sup>37</sup>

In lieu of similar legislation throughout the country, there are other ways to achieve an awareness of healthful computer use. Future teachers can be taught about MSDs and how to protect against them—curricula can include ergonomic training applied to students in a school environment.

An educated student body and faculty will have advantages outside of the school setting. Awareness of ergonomics should promote more healthful use of computers and other equipment in the home, too. Students will be armed with the knowledge to help and teach parents about the ergonomic risks of improper computer use, heavy backpacks, and sedentary behavior.

One recent study conducted among college students highlights the effectiveness of ergonomic training. After volunteering to be part of an ergonomics design team and receiving training on computer-related MSDs and ergonomics, students were able to identify and offer solutions for computer workstations, including placement of computers and other equipment and healthful behaviors when computing. Scores from the students’ post-training tests were significantly higher than pre-training test scores.<sup>38</sup>

The same seriousness with which we address computer-related injuries in the workplace and provide ergonomic training to mitigate them should be applied to a younger population of students, who, one day, will be part of the workforce. Taking the necessary measures to ensure that people who use computers remain healthy and injury free, whether they are children, teens, young adults, or near-retirement workers, will yield benefits for everyone.

## References

- 1 Occupational Safety and Health Administration (OSHA), “Preventing Work-Related Musculoskeletal Disorders,” February 1999.
- 2 Williams, Inger M., Cook, Tom., and Zigler, Tami, “Computer Ergonomics for Teachers and Students,” (1998/99), Human Factors and Ergonomics Society 44th Annual meeting, held in San Diego, California, July 29-August 4, 2000.
- 3 Straker, Leon, and Pollock, Clare, “Delivering the Power of Computers to Children, Without Harming Their Health,” Proceedings of the 15th Triennial Congress of the International Ergonomics Associations, held in Seoul, Korea, August 24-29, 2003.
- 4 *Ibid.*
- 5 Straker, Leon, and Harris, “Survey of Physical Ergonomics Issues Associated with School Childrens’ Use of Laptop Computers,” *International Journal of Industrial Ergonomics*, 2000, (26) 337-347.
- 6 Plunkett Research, Ltd., “Major Trends Affecting the Entertainment and Media Industry,” *2004 Media and Entertainment Industry Report* ([www.plunketresearch.com](http://www.plunketresearch.com)).
- 7 Peper, Erik, and Gibney, Katherine, “Computer-related symptoms: A Major Problem for College Students,” CTD Resource Network, Inc., [www.tifaq.com](http://www.tifaq.com), accessed March 18, 2004.
- 8 Phone interview with Dr. Jack Dennerlein, Department of Environmental Health, Harvard School of Public Health, July 1, 2004.
- 9 As quoted by Laura Landon in “Poor Computer Setups Injure Children,” May 15, 2004, Lifewise, <http://canoe.ca>.
- 10 Bennett, Cheryl, “Changing Education Ergonomics,” *Proceedings of the XVI Annual International Occupational Ergonomics and Safety Conference*, held in Toronto, Canada, June 10-12, 2002, 3.
- 11 Bureau of Labor Statistics, “Number of nonfatal occupational injuries and illnesses with days away from work involving musculoskeletal disorders by selected worker and case characteristics, 2002 (Table 11), [www.bls.gov](http://www.bls.gov).
- 12 Bennett, C., “Ergonomics in Education,” *Human Factors and Ergonomics Society Bulletin*, February 2004, Volume 47, No. 2.
- 13 *Ibid.*
- 14 “Children and Information Technology: Report of Symposium,” Held at Johns Hopkins University, Bloomberg School of Public Health, and sponsored by the Center for Information Technology and Health Research Department of Environmental Health Sciences, June 11-12, 2001, 1.

- 
- 15 Hickey, Mary, "Mom, My Back Really Hurts: Computer Use and Heavy Backpacks are Taking a Toll on Kids," *Business Week*, August 16, 1999, Issue 3642, 115.
- 16 Hedge, Alan, Barrero, Marisol, and Maxwell, Lorraine, "Ergonomic Issues for Classroom Computing," *Proceedings from the International Ergonomics Association XIVth Triennial Congress and the Human Factors and Ergonomics Society 44th Annual Meeting*, held in San Diego, California, July 29-August 4, 2000.
- 17 Hickey, Mary. "Mom, My Back Really Hurts: Computer Use and Heavy Backpacks are Taking a Toll on Kids," *Business Week*, August 16, 1999, Issue 3642, 115.
- 18 Breithecker, Dieter, "Ergonomics: A Subject for the School as Place of Work?," Federal Working Group on the Development of Posture and Exercise report.
- 19 Phone interview with Professor Karen Jacobs, Boston University's Sargeant College of Occupational Health, July 29, 2004.
- 20 Bennett, Cheryl, "Changing Education Ergonomics," *Proceedings of the XVI Annual International Occupational Ergonomics and Safety Conference*, held in Toronto, Canada, June 10-12, 2002, 3.
- 21 *Ibid.*
- 22 Jones, Chester S, and Orr, Betsy, "Computer-Related Musculoskeletal Pain and Discomfort among High School Students," *American Journal of Health Studies*, 1998, 14 (1), 26-30.
- 23 *Ibid.*
- 24 Phone interview with Dr. Jack Dennerlein, July 1, 2004.
- 25 Harvard RSI Action, [www.rsi.deas.harvard.edu](http://www.rsi.deas.harvard.edu), accessed July 15, 2004.
- 26 Executive Summary: StudentErgonomics, [www.ergonomics@service.stanford.edu](http://www.ergonomics@service.stanford.edu), accessed October 29, 2004.
- 27 Mahan, Shari, and Lutz, Rafer, "Computer Use, Workstation Design Training and Cumulative Trauma Disorders in College Students," *Californian Journal of Health Promotion 2003*, Volume 1, Issue 4, 38-46 (2003).
- 28 *Ibid.*
- 29 As quoted by Jeannie Kever in "Keyed to Ergonomics/Awareness of Kids' Injuries from Computer Use," *Houston Chronicle*, published May 13, 2002, accessed through Boston University's Sargent College of Health and Rehabilitation Sciences Web site, [www.bu.edu/sargent](http://www.bu.edu/sargent), March 29, 2004.
- 30 Katz, Jeffrey, and Amick, Benjamin, et. al, "Prevalence of Upper Extremity Musculoskeletal Disorders in College Students," *American Journal of Medicine* (November 2000), Vol. 109, 586-588.
- 31 *Ibid.*
- 32 As quoted by Stephanie Amour in "Young tech workers face crippling injuries: Long hours, poor ergonomic training leave many in pain," *USA Today*, February 9, 2001.
- 33 Dean, Katie, "Making Johnny Sit Up Straight," *Wired News*, (May 14, 2003), [www.wired.com](http://www.wired.com), accessed May 17, 2004.
- 34 Gerr, Frederic, and Marcus, Michele, et. al (2002), "A Prospective Study of Computer Users: I. Study Design and Incidence of Musculoskeletal Symptoms and Disorders," *American Journal of Industrial Medicine*, 41:221-235, 2002; Marcus, M., and Gerr, F., et al (2002), "A Prospective Study of Computer Users: II. Postural Risk Factors for Musculoskeletal Symptoms and Disorders," *American Journal of Industrial Medicine*, 41:236-249, 2002.
- 35 Dean, Katie. "Making Johnny Sit Up Straight."
- 36 Bennett, Cheryl, "Ergonomics in Education."
- 37 Phone interview with Karen Jacobs, July 29, 2004.
- 38 Robertson, Michelle, and Amick, Benjamin, et. al, "Effects of a participatory ergonomics intervention computer workshop for university students: A pilot intervention to prevent disability in tomorrow's workers," *Work: A Journal of Prevention, Assessment, and Rehabilitation*, March 2002, 305-314.

## Sources

- Anderen, Joahn Hviid, Thomsen, Jane Froelund, et. al, "Computer Use and Carpal Tunnel Syndrome: A One-Year Follow-Up Study," *Journal of the American Medical Association*, June 11, 2002, 289, 22, pg. 2963.
- Bureau of Labor Statistics, [www.bls.gov](http://www.bls.gov).
- Canadian Broadcasting Company News, "Pain from Computer Use More Common than Thought: Study," April 29, 2002, [www.cbc.ca](http://www.cbc.ca), accessed March 29, 2004.
- Canadian Centre for Occupational Health and Safety (CCOHS), Major Work-Related Factors, [www.ccohs.ca](http://www.ccohs.ca), accessed March 29, 2004.
- Coury, Helenice J.C.G., Porcatti and Isabel A., Alem et. al, "Influence of Gender on Work-Related Musculoskeletal Disorders in Repetitive Tasks," *International Journal of Industrial Ergonomics* 29 (2002), 33-39.
- Evans, Owen, and Patterson, Kim, "Predictors of Neck and Shoulder Pain in Non-Secretarial Computer Users," *International Journal of Industrial Ergonomics* 26 (2000) 357-365.
- Hedge, Alan, "Where are We in Understanding the Effects of Where We Are?" *Ergonomics* (2000), Vol. 43, No. 7, 1019-1029.
- Grossman, Michael, "American's Classrooms: Ergonomics Not Spoken Here," *Ergosolutions*, April 30, 2004.

---

Lewis, R. Jeffrey, and Krawiec, Marianne, et. al, "Musculoskeletal Disorder Worker Compensation Costs and Injuries Before and After an Office Ergonomics Program," *International Journal of Industrial Ergonomics* 29 (2002) 95-99.

Lincoln, Andrew E., and Vernic, Jon S., et. al, "Interventions for the Primary Prevention of Work-Related Carpal Tunnel Syndrome," *American Journal of Preventive Medicine* (2000), Vol. 18, No. 4S, 37-50.

National Center for Educational Statistics (NCES), [www.nces.gov](http://www.nces.gov).

Office Ergonomics Research Committee, Student Ergonomics, [www.oerc.org](http://www.oerc.org), accessed March 23, 2004.

Office of Health and Safety Administration (OHSA), [www.osha.gov](http://www.osha.gov).

Sheedy, James E., "The Bottom Line on Fixing Computer-Related Vision and Eye Problems," *Journal of the American Optometric Association*, Vol., 67, No., 9, September 1996.

Smith, Peter, "Of Icebergs, Ships, and Arrogant Captains," *EDUCAUSE Review*, May/June 2004.

Straker, Leon, and Mekhora, Keerin, "An Evaluation of Visual Display Unit Placement by Electromyography, Posture, Discomfort, and Preference," *International Journal of Industrial Ergonomics* 26 (2000), 389-398.

United States Department of Health and Human Services, National Institute for Occupational Safety and Health, "Musculoskeletal Disorders (MSDs) and Workplace Factors," July 1997, Second Printing, [www.cdc.gov/niosh](http://www.cdc.gov/niosh), accessed March 29, 2004.

Vail, Kathleen, "How Young is Too Young?," (June 2001), Electronic School.com, [www.electronic-school.com](http://www.electronic-school.com).

Warren, Tamara, "Computer Use Begets Injuries on Campuses," *The State News*, February, 12, 1997, [www.statenews.com](http://www.statenews.com), accessed April 20, 2004.