International Handbook of Occupational Therapy Interventions

Chapter 6
Ergonomic Interventions for Computer Users with Cumulative Trauma Disorders

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The number of computer keyboard workers with cumulative trauma disorders is as much as 12 times that of non-keyboard users.

(Weiss and Chan, 2008)

Abstract This chapter examines ergonomic interventions for computer users who experience cumulative trauma disorders (CTDs) in the workplace. CTDs are defined. The complex nature of these disorders and the need for holistic and comprehensive evaluation is discussed. Statistics of prevalence and incidence are reviewed. The role of occupational therapy in the management of these disorders is examined. Examples of interventions for these disorders are cited, and a systematic review of the effectiveness of the ergonomic interventions is provided. Finally, recommendations for occupational therapy practice and further research are provided.

Keywords Computers • Cumulative trauma disorders • Ergonomics • Musculoskeletal disorders

Definition

Cumulative trauma disorders (CTDs) are disorders that are caused, precipitated, or aggravated by repeated exertions or movements of the body (Loy, nd). Work-related CTDs are complex in terms of etiology, pathophysiology, prevention, and effectiveness of interventions.

Background

A combination of factors can result in CTDs. Factors reported in the literature include ergonomic and environmental (prolonged positioning in awkward postures, repetitive movements, force, sustained exertion, temperature, lighting, mechanical

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stress), personal and psychosocial (gender, age, health habits, work style, medical conditions, anxiety, anthropomorphics, attitude, and work ethics), and work and organizational (work load, time pressures, job stress, social support, control over job tasks, role conflict, job security, social context, and supervisors' and managers' knowledge of assistive technologies and ergonomic principles; or legislation regarding work accommodations) (Cook and Polgar, 2008; Foye et al., 2002; Hamilton et al., 2005; Nieuwenhuijsen, 2004; Trujillo and Zeng, 2006; Weiss and Chan, 2008).

Many issues complicate the attribution of CTDs to computer use among individuals. Other work tasks can cause or contribute to the problem, such as the use of the telephone, filing, lifting and carrying tasks, resistive activities such as turning a stiff doorknob, and writing. Time use, rigor, vigor, and repetitive or resistive characteristics vary among individuals in relation to hobbies and leisure pursuits. Home maintenance activities such as laundry, washing dishes, and yard work are other potential contributing factors (Cook and Polgar, 2008; Hamilton et al., 2005).

Purposes

Occupational therapists (OTs) have training and skills to observe in the workplace, holistically, the ergonomic and environmental factors, the psychosocial issues, and individual characteristics. The aim is to provide a complete evaluation and intervention plan to prevent and heal CTDs that may be due to computer use. This chapter focuses on ergonomic interventions related to computer use.

Method

Candidates for the Intervention

People who have *sustained or chronic pains* due to computer use are candidates for the intervention. Examples of CTDs that have been reported related to computer use include carpal tunnel syndrome, neck strain, DeQuervain's disease, tendonitis, cubital tunnel syndrome, lateral and medial epicondylitis, Guyon's canal syndrome, radial tunnel syndrome, tenosynovitis, trigger finger, thoracic outlet syndrome, eye strain, dry eye syndrome, myofascial pain syndromes, headaches, and other general conditions such as arthralgia, sprains and strains, and back, shoulder, and neck pain (Brewer et al., 2006, Foye et al., 2002; Hamilton et al., 2005; Loy, nd; Trujillo and Zeng, 2006).

Epidemiology

Cumulative trauma disorders have been reported as prevalent in the workplace among individuals who utilize the computer extensively. Some statistics reported in the literature include the following:

- Incidence rates vary from 11 to 67 per 10,000 workers for workers in mathematics and computers, information services, and financial activities.
- Seventy percent of all occupational illnesses are musculoskeletal disorders of the upper extremity.
- The number of computer keyboard workers with CTDs is as much as 12 times that of non-keyboard users.
- The prevalence of musculoskeletal disorders has been reported to be as high as 86% among data processors.
- Over 500,000 injuries that result in days off work have been attributed to CTDs.
- Yearly costs of CTDs have been estimated at over $100 billion, which is close to 50% more than for other work-related injuries or illnesses.
- Injuries to the trunk and back are the most frequently reported, but upper-extremity musculoskeletal injuries are twice as frequent as those in the lower extremity.
- Cumulative trauma disorders are twice as common among women among workers ages 30 to 50 years (Bureau of Labor Statistics, 2007; Foye et al., 2002; Hamilton et al., 2005; Keller et al., 1998; Loy, nd; Pascarelli and Hsu, 2001; Trujillo and Zeng, 2006; Weiss and Chan, 2008; Werner, 2006).

However, some studies suggest the incidence of carpal tunnel syndrome and other CTDs among office workers is not as high as previously reported (Andersen et al., 2003; Atroshi et al., 2007; Stevens et al., 2001).

Settings

Occupational therapists typically see clients with CTDs in the workplace or in outpatient clinics in conjunction with hand or orthopedic surgeons, physical therapists, ergonomists, vocational rehabilitation specialists, case managers, or occupational health physicians or nurses.

The Role of the Occupational Therapist in Applying the Intervention

Occupational therapists are important members of the intervention team addressing CTDs among computer users. They are skilled at activity analysis. Often the problems are due to a specific activity that, if avoided, could result in elimination or reduction of symptoms. One example of this is the computer user who experiences cubital tunnel syndrome due to excessive leaning on his or her elbow on a hard surface while typing. OTs are also skilled in using interviews and observations to solve the root problem of these disorders. Restorative and adaptive approaches are used to modify the environment or to provide interventions such as rest, splinting, alteration of movement, and alteration of work schedule. The interventions

seek to restore tissue integrity, allow for healing, or to prevent further injury. OTs provide education to workers, management, and caregivers regarding preventative, restorative, or adaptive measures. Finally, OTs have expertise in assistive technologies, ergonomic principles, and modifying a task or environment to maximize functional performance of occupations.

Results

Clinical Application

Interventions for Cumulative Trauma Disorders Related to Computer Use in the Workplace

Modification of the workstation can be categorized into (1) modification to eliminate factors related to posture, force, duration, intensity, positioning, or repetitive motion that may contribute to the disorder; (2) modification of schedule or work activities (including rest); (3) use of assistive devices not related to the workstation such as eyeglasses or a splint; (4) physical agent modalities, medications, surgery, or other medical interventions; (5) patient education related to the condition; and (6) behavioral interventions such as relaxation training, exercises, stress management, and interventions to improve psychosocial function in or outside the workplace (American Industrial Hygiene Association, nd; Bernaards et al., 2007; Bohr, 2000; Brewer et al., 2006; Goodman et al., 2005; Nainzadeh et al., 1999 Trujillo and Zeng, 2006).

This chapter focuses on interventions to modify the workstation and the schedule.

Modification to the Workstation

The workstation can be modified using a universal ergonomic approach, or specific CTDs can be addressed. For example, emphasis on wrist and forearm positions may be more critical in carpal tunnel syndrome. Here these options have to be prioritized due to time or cost considerations. Many resources offer guidelines for equipment and positioning using ergonomic principles. Issues on which there is a consensus include the following:

- *Proper positioning* recommendations include approximately 90 degrees of hip flexion, knee flexion, and ankle dorsiflexion with the head and neck in line with the torso and upright, and the head in slight downward tilt. There should be adequate support of the lumbar spine to facilitate normal curvature of the spine. The arms should be in line with the torso with approximately 90 degrees of elbow flexion. Feet should be resting flat on the floor or supported by a footrest. Wrists should be in neutral in all planes of motion.
- *Armrests and ergonomic chairs* should be used that allow for or encourage the above positioning guidelines and with elbow height below the "J" key, and the

horizontal location of the "J" key more than 12 cm from the edge of the desk. Chairs should adjust for seat height, seat depth, angle of seat, angle of back, height of back, amount of lumbar curve, armrest height. Chairs should be properly rated to support the weight of the worker with appropriate padding for seat and back cushions.

- *Armrest*s should be properly padded and large enough to support the forearm.
- *Align the mouse* with the keyboard on a level surface and in close proximity to the keyboard (e.g., keyboard and mouse trays should accommodate left- or right-handed users).
- The *monitor* is positioned to allow 0 to 20 degrees of downward gaze at a distance that maximizes visibility for the individual user (10 to 30 inches or 25 to 75 cm from the eyes to the monitor).
- The size of the *monitor* should accommodate the visual field and take into account acuity issues.
- A padded wrist rest may be needed.
- *Glare reduction* is accomplished through lighting, glare filters, angle of the monitor, and proper shading.
- If laptops are used, detachable standard or ergonomic keyboards are recommended. Split keyboards with adjustable angles and negative slopes that reduce arm pronation and ulnar deviation are preferred for all computer use.
- *Keyboard* trays should be *adjustable* for tilt, distance from desk, and height. They should tilt in a negative direction.
- All ergonomic devices should be evaluated for adjustability to accommodate changes between persons if there are several users, or to change positions for comfort when an individual requires this.
- *Accessories* and other tasks should be ergonomically considered. Examples of this include the position and type of telephone, document holders, scanners, and printers.
- *Desk height* should be adjustable if possible. If not, clearance for knees and legs should be considered before ordering an appropriate size desk.
- *Pointing devices* should be chosen based on types and location of pain, required tasks, and physical limitations. The pointing device should match the contour of the hand, be thinner to reduce the distance between buttons, have low placement on the keyboard, and reduce the amount of shoulder abduction. Adjustments in sensitivity of the pointing device should be considered.
- Association of symptoms and duration of keyboard/mouse use differ between men (6 hours/day) and women (4 hours/day).
- *Lighting* should be adjustable for intensity, direction, and distance from work.
- *Additional environmental factors* such as temperature, ventilation, and dust should be evaluated and modified if problematic (Blatter and Bongers, 2007; Brigham Young University, 2005; Clemson University, nd; Cook et al., 2000, 2004; Cook and Polgar, 2008; Fagarasanu and Kumar, 2003; Foye et al., 2002; Goodman et al., 2005; Harvard University, nd; Keller et al., 1998; Lee and Jacobs, 2001; Loy, nd; New Jersey Department of Health and Senior Services, nd; Noack, 2005; Marcus et al., 2002; Tittiranonda et al., 1999; University of Connecticut Occupational and

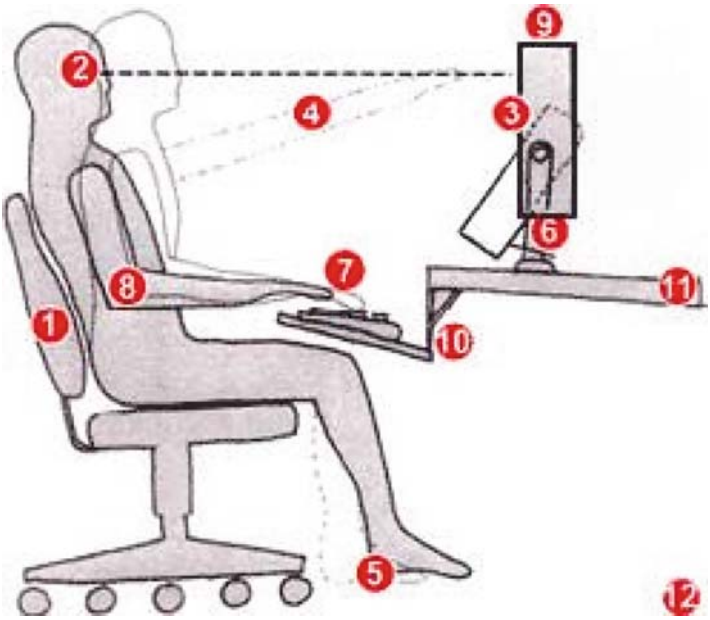

Fig. 6.1 Ergonomic guidelines for computer workstations. 1. Use a good chair with a dynamic chair back that is angled slightly to the rear. 2. The top of the monitor screen should be 2 to 3 inches above eye level. 3. There should be no glare on the screen. Use an optical glass antiglare filter where needed. 4. Sit at arms' length from the monitor, or further if the distance is comfortable and screen is readable. 5. Rest feet on the floor or on a stable footrest (move feet frequently for circulation). 6. Use a document holder, preferably in line with the computer screen. 7. Wrists should be flat and straight in relation to the forearms to use keyboard/mouse/input device. 8. Keep arms and elbows relaxed close to body. 9. Center the monitor and keyboard in front of you. 10. Use a negative tilt keyboard tray with an upper mouse platform or downward tiltable platform adjacent to keyboard. 11. Use a stable work surface and stable (no bounce) keyboard tray. 12. Take frequent short breaks (microbreaks) and stretch. (From Ergo on Demand Web site, http://www.ergoindemand.com/ergonomic-computer-workstation-guidelines.htm, with permission.).

Environmental Health Center, nd; University of Medicine and Dentistry of New Jersey, nd; U.S. Department of Labor, nd; Weiss and Chan, 2008).

Figure 6.1 above demonstrates the application of the above principles.

Modification of Work Activities and Scheduling

Interventions designed to modify work activities and scheduling include the following:

- *Frequent rest breaks*, at least once an hour for continuous users and once every 2 hours for noncontinuous typing, and cessation or reduction of typing for a specified time to allow healing.
- *Exercises* to stretch musculoskeletal tissues and to reduce eye strain.

- *Repositioning* of keyboard, monitor, and mouse at midday if symptoms occur in spite of desired or recommended positions (e.g., change frequently used keys and reduce key-switch force).
- *Vary activities* to intersperse typing with other tasks throughout the day.
- Analysis of all *daily activities* (including computer use activities) that require excessive force, positioning, speed, duration, or movements.
- Consider programs (wellness, smoking cessation, weight reduction, cardiovascular and endurance) that address other contributing factors.
- Consider an *alternative method* of input such as voice recognition, learning keyboard shortcuts as an alternative to mouse control, using the mouse in the nondominant extremity, or a combination of methods.
- *Modification of job* including trading activities with another worker, modification of work schedule, and changing jobs temporarily or permanently.
- Provision of *patient education* on anatomy and disease process (Brigham Young University, nd; Cook and Polgar, 2008; Delisle et al., 2004; Fagarasanu and Kumar, 2003; Goodman et al., 2005; Keller et al., 1998; Lawler et al., 1997; Lee and Jacobs, 2001; Loy, nd; New Jersey Department of Health and Senior Services, nd; U.S. Department of Labor, nd; Weiss and Chan, 2008).

A list of resources and specific ergonomic equipment is given in Table 6.1 to assist therapists with specific recommendations based on the general principles reviewed above.

Evidence to Support Various Interventions for Computer Access in the Workplace

One systematic review of the literature addresses the evidence for preventing musculoskeletal and visual symptoms among computer users (Brewer et al., 2006). The search identified over 7300 articles on this topic. Only 31 of these studies met the rigorous criteria set by these reviewers to be considered in their findings. The following evidence was reported:

- Moderate evidence that alternative pointing devices have an effect on musculoskeletal outcomes.
- Mixed evidence to support the effect of ergonomics training, alternative keyboards, rest breaks, and screen filters.
- Moderate evidence that there is no effect of rest on visual outcomes.
- Moderate evidence that rest breaks and stretching have no effect on musculoskeletal outcomes.
- Moderate levels of evidence reported no effects of workstation modifications on musculoskeletal or visual problems.
- Insufficient evidence to support the effect of stress management training, exercise training, lighting, workstation adjustment, video display terminal (VDT) glasses, or arm supports.

Table 6.1 Resources for ergonomic interventions for computer users with cumulative trauma disorders

Interventions	Company	Address	Web site	Other contact information
Guidelines for health computing; excellent checklist for ergonomics of computer workstation	OSHA; guidelines for computer workstations	U.S. Department of Labor Occupational Safety and Health Administration, 200 Constitution Avenue, Washington, DC 20210	http://www.osha.gov/SLTC/etools/computerworkstations/	1-800-321-6742
Guidelines for health computing; resources for office furniture	University of Minnesota Department of Environmental Health and Safety	University of Minnesota, W-140 Boynton Health Services, 410 Church Street SE, Minneapolis, MN 5455	http://www.dehs.umn.edu/ergo_office.htm	612-625-5422
Guidelines for health computing	HealthyComputing.com	12323 Caminito Mirada, San Diego, CA 92131	http://www.healthycomputing.com/	619-987-0246
Ergonomic keyboard, mouse, and other devices	EnableMart	EnableMart Sales Office, 4210 E. 4th Plain Blvd., Vancouver, WA 98661, USA	www.enablemart.com	888–640–1999 (Toll Free) 360–695–4133
Ergonomic keyboard, mouse, and other devices	Ergo in Demand	Ergo in Demand Inc., 4900 Industry Drive Central Point, OR 97502	http://www.ergoindemand.com/	1-800-888-6024
Ergonomic keyboard, mouse, and other devices	Ergo-Items.com	4454 N Morris blvd, Shorewood, WI 53211	http://www.ergo-items.com/	414-921-4262 fax
Ergonomic chairs, desks, and peripherals	ErgoStore Online	17319 Meadow Bottom Road, Charlotte, NC 28277	http://www.ergostoreonline.com/	1-877-971-0151

Two other review articles (Lincoln et al., 2000; Williams & Westmoreland, 1994) reported insufficient evidence to identify effective workplace rehabilitation interventions for a variety of CTDs. However, systematic evidence should be carefully interpreted.

In contrast, findings reported by OTs and that are limited to interventions for CTDs related to computer use suggest evidence supporting effectiveness of or need for these interventions:

- Eighty-two percent of musculoskeletal or visual problems were reported solved to the computer user's satisfaction 1 year following a multifaceted ergonomics program provided by occupational and physical therapists (Goodman et al., 2005).
- A holistic intervention approach, utilized by 50 workers in a computer firm, achieved a positive outcome in cost-effectiveness, decrease in lost workdays, and worker satisfaction (Lee and Jacobs, 2001).
- Seventy percent of computer users (n = 55) surveyed experienced symptoms related to computer use. Only 60% had been given ergonomics information regarding the computer workstation. Only 10% of respondents with access to this information reported implementing this knowledge in daily tasks (Berner and Jacobs, 2002).
- A cost-benefit analysis showed projected savings of more than $300,000 from an intervention program to reduce CTDs among computer users (Noack, 2005).
- A meta-analysis found that alternative keyboard designs decrease potentially harmful awkward postures typically assumed on a standard flat keyboard (Baker and Cidboy, 2006).
- Sixty-five of 72 female college students using laptops showed musculoskeletal complaints (Hamilton et al., 2005).
- A retrospective study of 312 workers'-compensation patients found positive correlations between a patient's eventual return to work and the OT's initial rating of the patient's rehabilitation potential as well as the patient's own initial rating of desire to return to work (Waylett-Rendall and Niemeyer, 2004).
- A mixed methodology study of 43 hand patients found the strongest correlations to reported pain intensity were the patients' physical functioning, role limitations due to emotional issues, and social functioning (Chan and Spencer, 2005).
- A qualitative case study with three participants identified psychosocial themes of depression, frustration, loss, dependence, role changes, fear and hopelessness as potential impairments to rehabilitation (Schier and Chan, 2007).

Conclusion

The literature suggests there is a high cost for and incidence of CTDs among computer users, but the relative contribution of the computer to these problems is under debate. Available lists of ergonomic principles and recommendations are remarkably consistent in addressing this problem. Many articles look at the effectiveness of interventions for computer users with CTDs, but none written by occupational

therapists was considered acceptable in comprehensive and rigorous systematic review papers. A few studies written by occupational therapists were found, which specifically addressed the effectiveness of computer workstation issues.

If occupational therapists want to increase their contribution to ergonomic interventions for computer users, more research is needed to address the benefits of OT interventions that perhaps will stand the scrutiny of peer evaluation from other disciplines. Current evidence is encouraging, and suggests that these interventions are effective or at least needed.

This chapter has described best practice based on current evidence. The resources and references cited should help therapists who want to develop new programs or study the effectiveness of existing interventions. There is much more to know in this interesting and important area of practice.

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