

Repetitive Stress Injuries in Computer Users: Prevention

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Repetitive stress injuries (RSIs) are the most common work-related injury, accounting for more than 50% of all occupational illness. Treatment costs are high, totaling as much as an estimated \$20 billion per year in the United States alone. Even more costly to the individuals involved are the considerable pain and functional impairment that result from an RSI. For these reasons, and because postinjury treatment is often ineffective, prevention is seen as the best approach to RSIs in the workplace.

PREVENTION OF MUSCULOSKELETAL RSIs

Overuse is the most avoidable cause of RSIs. Computer users should take frequent rest breaks—several minutes per hour—or alternate computer use with other tasks that require movements different from those used to type or to operate the mouse.¹ Change position, stretch, or walk around during the day if you begin to feel tired. This will help reduce muscle strain and lower wear and tear on the lumbar disks and spine.

In addition, prevention of RSIs requires identification of sites and tasks that place employees at risk and supportive efforts aimed at decreasing those risks in the work environment.² It is essential to examine the entire work environment to determine all possible causes of discomfort; changing just one element is not likely to eliminate all discomfort or all potential causes of RSI. Intervention may take any of three forms: ergonomic alterations in the work environment, alterations in equipment, and exercise and stretches designed to relieve the stress imposed on certain muscle groups during the work day.

Ergonomic Alterations in the Work Environment

Proper Arrangement of the Work Area

The work surface should be arranged such that items used constantly (67% to 100% of the time) (eg, keyboard, mouse) are within the *primary* work area, measured as the distance from elbow to wrist, or 15 to 23 inches from most users. Items used frequently (34% to 66%) (eg, telephone, pens) should be arranged in the *extended* work area, defined as within arm's length (20 to 28 inches). Items that are rarely or never used (0% to 33% of the time) (eg, stapler, ruler, computer speakers) should be in the *tertiary* work area, which is beyond arm's length, or more than 28 inches from the user.³

Proper Seating and Desk Height

The chair is the key component in the ergonomics of any workstation. It should be made of permeable material; have a five-spoked, star-shaped base for support; and have a backrest with support for the lumbar area of the back; preferably this support should be adjustable to fit for individual spinal curvature. The front edge should have a "waterfall"

contour, falling away from the back of the chair and toward the floor, to decrease pressure on the legs, as this can reduce whole-body circulation. Any tension in the legs, back, or shoulders is a sign that the chair is poorly adjusted and not providing adequate support. If the chair itself is not adjustable, a wide range of lumbar supports and cushions, both fixed and adjustable, are available. Arm rests should have a 2-inch minimum width, be adjustable, should allow the arms to be supported but relaxed, and should fit underneath the desk.

Seat height should be adjusted so the thighs are nearly horizontal and the feet are resting flat on the floor (typically 18 to 22 inches); use a footrest if you cannot rest your feet comfortably on the floor. The resulting angle between the upper and lower legs should be 60 to 100 degrees.

The ideal desk height is 26 inches from the floor, not the 30 inches more typical of mass-manufactured desks. Like the chair, the desk should have a waterfall edge to avoid producing pressure points on the wrists and forearms.

Finally, sitting for long periods, even at an optimally adjusted workstation, can lead to muscle fatigue. Users should move around frequently during the day to help reduce muscle strain and lower wear and tear on the disks and spine.

Those who desire a tutorial in adjusting their workstation may want to purchase Ergo Health, a single-user CD-ROM that provides a multimedia 40- to 50-minute training program instructing office workers in the correct adjustment of their chair, keyboard, monitor, and accessories. It is available for \$35 from Ali-Med (see list of retailers accompanying this article).

Proper Posture

Keep your elbows close to your sides to reduce upper back and shoulder strain. Try to maintain a 90-degree angle (the "neutral" position) between the upper and lower arm, but any position between 70 and 135 degrees is acceptable. The wrist and forearm should be held in a straight line, parallel to the floor. Adjust the keyboard to a slope of 0 to 25 degrees, and use a foam or gel-filled wrist support to help maintain a neutral arm/wrist position. However, the wrists should not rest on the wrist rests during typing; instead, the rests should be used *between* keystrokes.

When using the keyboard, avoid bending the wrist in an ulnar ("pinky finger") direction. Use a light touch on the keyboard to reduce hand stress. For the adventurous keyboard user, foot controls are available to perform frequent keyboard functions (eg, "shift" or "keypad on"). In most cases these controls are compatible with any keyboard and can be programmed to perform key functions or macros.

To avoid shoulder strain, mouse users should have no more than 30 degrees of shoulder abduction, and the mouse pad should be placed at the edge of the desk to avoid pressure areas. Avoid isolated wrist movements; instead, use the entire arm to move the mouse. Workers who frequently use the numeric keypad may find it helpful to place the mouse on the left side of the desk, as this provides a stretch and change of position for the overused right hand/wrist.³

The American Optometric Association recommends a monitor distance of 20 to 28 inches from the eyes, and the eyes should be in a downward gaze of about 15 degrees when viewing the screen.⁴ The top of the screen should be below the horizontal eye level of the operator and tilted back slightly⁴; users who wear bifocals should lower the monitor by 6 inches.³ Reading material should be positioned at a 20-degree incline, 20 inches away from the eyes (the "20/20 rule").

Alterations in Equipment

Alternative Keyboards

Several alternative keyboards are available that attempt to change the user's posture to a more ergonomic, natural one. Types of alternate keyboards include split keyboards, tented keyboards, keyboards with a negative slope, and keyboards with altered key positions.¹

Split keyboards attempt to straighten the wrist by increasing the distance between the right and left sides of the keyboard or by rotating each half of the keyboard so that each half is aligned with the forearm; some keyboards combine these two methods. Among the most well known split keyboards are the Microsoft Elite and Microsoft Natural keyboards, which are widely available and relatively inexpensive (<\$100). True split keyboards include such models as the Flat Comfort keyboard (\$165), Pace Adjustable keyboard (\$279), and Goldtouch Adjustable keyboard (\$160). Some users desiring a split keyboard may find a cordless model helpful, as it allows greater freedom in keyboard positioning. The Logitech Cordless Freedom Pro (\$95) is a split keyboard with a 6-foot range; its digital radio technology eliminates the need for a clear line of sight between the keyboard and the receiver.

On tented keyboards, the two halves of the keyboard are tilted upward like a tent to reduce rotation in the forearm. The disadvantage of these keyboards is that the keyboard must be placed on a surface lower than that required for a conventional keyboard for the user to achieve proper working posture. An example is the Kinesis Maxim keyboard (\$150). One interesting twist on the idea is the ErgoLogic keyboard, which can be adjusted by the user to the position that feels most natural. The conventional keyboard splits and rises when a knob is turned, and built-in hand rests slide under the palms to complete the change from an ordinary keyboard. (However, questions remain about the usefulness of wrist or palm rests. It is unclear whether such rests increase pressure on the wrists, relieve loads on the shoulder and upper back muscles, or interfere with typing.)

Keyboards with a negative slope allow the user to raise the front edge of the keyboard or slope the keyboard backward, thereby straightening the wrist; negative-slope keyboard platforms can also be used for the same effect.

Other keyboards have attempted to fit the keyboard to the differing lengths of the fingers by curving the rows of keys or placing the keys in concave wells, allowing the fingers to work in a more relaxed position. Examples of these include the Kinesis Ergonomic Keyboard (\$200–\$300) and the Maltron Dual Keyboard (\$395).

Despite proof that alternative keyboards do improve posture, there has been little conclusive evidence that such keyboards reduce the risk of discomfort or injury.

However, a 6-month randomized, placebo-controlled trial evaluated the effect of four computer keyboards on clinical findings, pain severity, functional hand status, and comfort in 80 computer users with musculoskeletal disorders.⁵ The keyboards tested included a standard computer keyboard (the placebo) and three "alternative geometry" keyboards: the Apple Adjustable keyboard, the Comfort Keyboard System, and the Microsoft Natural Keyboard. Compared with placebo, the Microsoft keyboard and, to a lesser extent, the Apple keyboard resulted in improved pain severity and hand function after 6 months of use; there was no corresponding improvement in clinical findings.

Users considering an alternative keyboard should:

- Assess how the keyboard will fit with their workstation. Some keyboards are extra wide, long, or high and may not fit standard keyboard trays, or may prevent the tray from retracting under the work surface.
- Evaluate how the keyboard will affect performance. Some keyboard designs make it difficult for the user to see the keys, which may be important for "hunt-and-peck" typists.
- Evaluate whether the job requires use of the numeric keypad or specialized keys. Some alternative keyboards eliminate or reconfigure these keys.

Users should expect some frustration as they become accustomed to their new keyboard. If the keyboard is adjustable, gradual adjustments from a conventional (flat) configuration to a more natural position may be helpful.

Mouse Variants

Several alternative mouse variations exist. 3M's Renaissance™ mouse uses an upright design to eliminate pressure on the median nerve. The Logitech cordless mouse, widely available from many retailers, is for users who prefer a conventional mouse but want greater flexibility in positioning. The No-Hands mouse allows total control of the cursor with the feet.

Trackballs and touchpads induce less strain than a mouse because less wrist motion is involved in their use. Numerous trackball models are available, including a cordless trackball made by Logitech. However, trackballs are generally considered less controllable than a mouse.

No finger pressure is required to manipulate the touchpad; the cursor moves as the finger glides over the surface. Light taps on the surface duplicate mouse clicks, or the two mechanical buttons at the bottom of the touchpad can be used in the same way as mouse buttons.

Touchpads vary widely in their sensitivity and features. The most sensitive and advanced touchpads use GlidePoint Control technology, developed by Cirque, the pioneer of touchpad technology. Various models have programmable features and "hot buttons" to customize the touchpad; prices range from \$40 to \$70. Some individuals, particularly those who use graphics software, complain that touchpads, like trackballs, are less controllable than the mouse. However, for applications such as word processing and

spreadsheet programs, control is similar once users have adjusted to the different movements required.

Keyboards that incorporate a touchpad or trackball eliminate the need for a mouse and can greatly reduce forearm tightness and the neck, shoulder, and upper back strain caused by leaning to manipulate the mouse. Once more, the touchpads used in these keyboards vary widely. Keyboard models that incorporate Cirque touchpad technology include the Fellowes split-contour keyboard with built-in gel-filled wrist rest and the Cirque Wave and Smoothcat keyboards.

Articulating Keyboard/Mouse Shelves

Several manufacturers make articulating keyboard shelves or drawers; most include an area for a mouse. One such shelf is the Soft Touch Articulating Keyboard Shelf, which is retractable and has a 360-degree swivel and a 15-degree tilt. Other brands include the WorkRite articulating keyboard platforms (several models available) and the Banana Board. Most fall in the \$70 to \$200 range.

Some manufacturers also make articulating mouse platforms. These may attach to the desk or to an articulating keyboard platform and serve to bring the mouse closer to the keyboard, thereby preventing shoulder and forearm strain. Examples include the Mouse Palette and ErgoFlex; cost is less than \$100.

Exercises to Relieve Muscle Stress

Exercises build strength and increase mobility and range of motion. Proper form and moderation are important to avoid exacerbating problems. Exercises that flex and extend the wrist and the fingers of the hand are particularly important for those who use a keyboard often. Hand exercisers and squeeze balls designed to improve grip strength are widely available. In addition, the following exercises should be done several times a day. Unless noted otherwise, work up to 10 repetitions at a time.

- Hold the hand and forearm straight. Bend wrist downward, holding for a few seconds. Return to neutral position.
- Lay hand on a flat surface. Extend hand upward, holding for a few seconds. Return.
- Extend fingers to fully open, and then to fully closed.
- With arms at your sides, rotate or roll your shoulders, starting with a forward motion, for four revolutions. Then do four revolutions starting with a backward motion first.
- Drop the head to the right, trying to touch the top of the shoulder. Keep torso straight and shoulders relaxed. Bring head to center and then drop to the left.
- Drop the head to one side and roll *slowly* in a circle, extending as close as you can to the upper torso. Perform four revolutions. Then perform four revolutions in the opposite direction.

For those who find it difficult to remember to stretch frequently, Jazzercise, Inc., has developed CyberStretch, a software program that offers stretch breaks in an easy-to-use screensaver format. Twenty-six body part-specific stretches are demonstrated, and

users simply mirror the motions of the stretch illustrated on the computer screen. Although many of the stretches can be performed standing, all have been designed to be performed while sitting down. Both PC and Macintosh operating systems are supported, and cost is minimal: Current Jazzercise students and teachers can download the program at no cost; others can download the program for \$5 or obtain a CD-ROM for \$10. Those who are uncertain whether to purchase the software can download a free 7-day trial. Additional information can be obtained at <http://www.cyberstretch.com>.

Stretch Break Pro is another software program that, once installed on a user's hard drive, provides reminders to stretch and take breaks. Users are invited to follow several low-impact stretches demonstrated on the screen. When finished, Stretch Break returns the user to the previous Windows application. Stretch Break is available for \$44.95 from <http://www.safecomputing.com/exercise.html>.

Conclusions

Undue reliance on ergonomics to treat musculoskeletal disorders, to the exclusion of proper diagnosis and attention to medical and health risk factors, can have adverse consequences for the patient.⁶ Although ergonomic interventions can increase comfort in the work environment, and proponents assert that the elimination of certain risk factors related to force, repetition, and posture can prevent or even cure work-related musculoskeletal disorders of the upper extremity,⁶ such interventions should not take the place of proper diagnosis of an RSI, identification of medical risk factors, and treatment.

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Retailers Offering Ergonomic Devices and Other Aids to Help Prevent RSIs

A.D.A. WorkLink, 2566-A Telegraph Avenue at Blake Street, Berkeley, CA 94704-2900; phone: (510) 848-8363; fax: (510) 848-7322; toll-free: (800) 732-0522; <http://www.worklink.net>.

Air Technologies, Inc., 27130 Paseo Espada, Suite 1405-A, San Juan Capistrano, CA 92675; phone: (949) 661-5060; fax: (949) 661-2454; toll-free: (800) 759-5060; <http://www.airtech.net>.

Ali-Med. 297 High Street, Dedham, MA 02026; phone: (781) 329-2900; fax: (800) 437-2966; toll-free: (800) 225-2610; <http://www.alimed.com>.

Back Be Nimble, 2405 Rice Blvd., Houston, TX 77005; phone: (713) 521-0003; fax: (713) 521-2220; toll-free: (800) 639-3746 (U.S. only); <http://www.backbenimble.com>.

Ergobuyer.com, a division of ErgoWeb, Inc., P.O. Box 1089, 93 West Main, Midway, UT 84049; phone: (435) 654-4284; fax: (435) 654-5433; toll-free: (888) 374-6932; <http://www.ergoweb.com/ergobuyer>.

Ergokomfort, a division of Andover Business Associates Inc., P.O. Box 3181, Andover, MA 01810; phone/fax: (978) 686-6262; toll free: (866) 686-6262; <http://www.ergokomfort.com>.

Goldtouch Technologies, 17300 Red Hill Avenue, Suite 100, Irvine, CA 92614; phone: (949) 798-0300; fax: (949) 798-0305; <http://www.goldtouch.com>.

Osmond Ergonomic Office Solutions, 21 Johnson Road, Fernside Business Park, Ferndown Industrial Estate, Wimborne BH21 7SE United Kingdom; Phone: +44 (0)1202-850-550; fax: +44 (0)1202-850-560; <http://www.ergonomics.co.uk>.

Safe Computing, 1361 S. Winchester blvd., Suite 107, San Jose, CA 95128; phone: (408) 364-1962; fax: (408) 866-8396; <http://www.safecomputing.com/index.htm>.