Musculoskeletal Disorders in the U.S. Office Workforce

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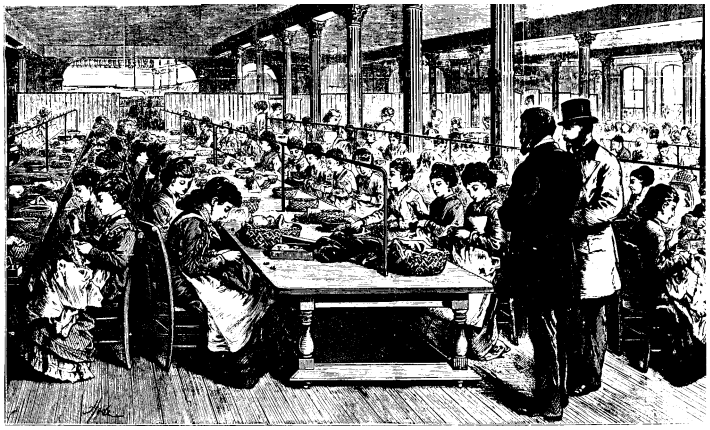


General Introduction to Musculoskeletal Disorders

What are Musculoskeletal Disorders (MSDs)?
The Occupational Safety and Health Administration (OSHA) defines MSDs as "...injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, and spinal discs. They do not include injuries resulting from slips, trips, falls, or similar accidents. Examples of MSDs include carpal tunnel syndrome, tendinitis, sciatica, herniated disc, and low back pain."[2]

The most common use of the term MSD is for disorders of the hands, wrists, elbows, forearms, or shoulders. However, a MSD can affect other parts of the body such as the neck, back, or even the knees.

You may be more familiar with the term Cumulative Trauma Disorder, or CTD. The term MSD, or work-related musculoskeletal disorder (WMSD), is a broader and more widely used term and one that has been adopted by OSHA for use in its proposed ergonomic standard.

How MSDs differ from injuries and fatigue
MSDs are not the same as sprains, strains, and other injuries caused by a sudden trauma or a few days of overuse. They are also not the same as localized fatigue, like the sore shoulders one might get from a week of intense weight training. These injuries, while having symptoms that may resemble MSD symptoms, develop quickly and require only a few days of rest for recovery. MSD symptoms are distinct from these types of injuries in two ways. First, MSDs involve a long latency period—months or years. Second, the symptoms persist even after days of rest. Full recovery in some extreme cases may take years.

Other names for MSDs
We use the term MSD in this paper because it is the term adopted by OSHA and is widely used in the United States. There are many other names for these disorders, however. Here are some you might encounter:

- Cumulative trauma disorders (CTDs)
- Repetitive strain injuries (used by British Commonwealth countries)
- Occupational cervicobrachial disorders (used in Scandinavian countries and Japan)
- Overuse syndromes (used in sports medicine)
- Regional musculoskeletal disorders (used by rheumatologists)
- Work-related disorders (used by the World Health Organization)
- Repeated trauma disorders (used by the Bureau of Labor Statistics)

Because MSDs are not entirely understood, health professionals often disagree on what to call this phenomenon. OSHA chose MSD because CTD is too narrow in its definition.

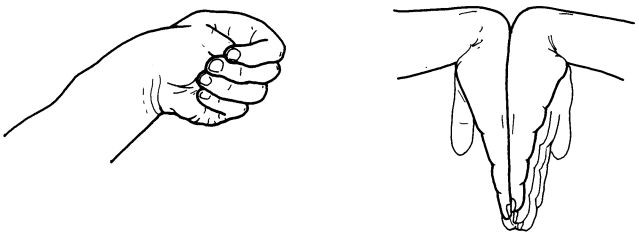
Examples of Common MSDs
MSDs are injuries of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, and spinal discs. Some of the more common MSDs include carpal tunnel syndrome, epicondylitis, tenosynovitis, muscle strains, tendinitis, De Quervain's disease, trigger finger, and low back pain.

Carpal tunnel syndrome (CTS), a nerve condition which causes symptoms of pain, tingling, and numbness in one or both hands, is probably the most well known MSD. According to the Bureau of Labor Statistics, repetitive trauma injuries account for about 60 percent of all occupational illnesses. Even though carpal tunnel syndrome is the best known MSD, it typically makes up less than 10% of the total number of cases.

MSDs include

Muscle problems
- Myalgia (a general term for muscle pain)
- Myofacial pain syndrome (irritation of the membrane around muscles)

Tendon problems
- Tendinitis (irritation of a tendon)
- Tenosynovitis (irritation of the sheath around a tendon)
- DeQuervain's disease (tenosynovitis at the base of the thumb)
- Epicondylitis (irritation of the tendon attachments at the elbow; includes tennis elbow and golfer's elbow)
- Trigger finger (a type of extreme tenosynovitis, leading to locked fingers)



Diagnostic hand positions

Nerve problems

- Carpal tunnel syndrome (damage to a nerve passing through the wrist)
- Guyon's canal syndrome (damage to another of the three nerves passing through the wrist; similar to carpal tunnel syndrome but involving a different nerve)
- Cubital tunnel syndrome (damage to a nerve passing through the elbow)
- Thoracic outlet syndrome (compression of the nerves and vessels between the neck and shoulder)
- Hypothenar hammer syndrome (nerve damage resulting from repeated impacts at the base of the palm)

Are MSDs new?

While they seem to have suddenly appeared in the last decade, MSDs have actually been around for centuries. An Italian physician wrote in 1717 about "the harvest of diseases reaped by certain workers," caused by "certain violent and irregular motions and unnatural postures of the body...[that impair] the natural structure of the vital machine." [3]

In the early 20th century, maladies that we would now group together as MSDs were seen as distinct problems and named after the blue-collar occupations in which they commonly developed. For example, there was "stitcher's wrist," "bricklayer's shoulder," and "cotton-twister's hand." More recently, MSDs developed in white-collar jobs. Telegraphers used to get "telegraphist's cramp," for instance, and clerical workers got "writer's cramp."

The MSDs we're seeing today seem new because they arise with today's new high tech workers such as software engineers, online brokers, customer service representatives and others, as well as increasing numbers of people (including children) who go online to use e-mail and the web. Some believe MSDs have become more exposed in recent years due to the fact that more managers are afflicted with musculoskeletal disorders.

Whatever the case, these injuries are just the latest manifestation of an old category of disorders.

How MSDs are usually diagnosed and treated

Unfortunately, diagnosis and treatment of MSDs are still a difficult business, mostly because so much information is not yet known.

Diagnosis

One problem is the variety of conditions that fall into the MSD category. They have many things in common, but the various kinds of MSDs have different symptoms and methods of diagnosis.

Physicians usually depend on a patient's reports of symptoms, which might include persistent pain, tingling, numbness, aching, stiffness, or a feeling of heat in the affected area both while working and resting. Physicians will obtain a detailed history of the symptoms and of the patient's work and non-work activities.

Symptoms can vary in their severity depending on the amount of exposure. Often, symptoms appear gradually (as muscle fatigue or pain at work) but then disappear during rest. Usually, symptoms become more severe as exposure continues.

If the problem seems to be an MSD, the physician might do tests to determine which kind of MSD is involved. Tests might involve moving the wrist in particular ways or using instruments to determine whether nerve function has been affected.

Treatment

Treatment, of course, depends on the nature and severity of the condition. Mild cases caught early can often be successfully treated with anti-inflammatory drugs, rest or restricted activity, and possibly physical therapy. There is increasing evidence that early treatment is far more effective, per dollar spent, than late treatment. Depending on the type of MSD, severe or long-standing cases may be treated with prolonged rest, anti-inflammatory drugs, immobilizing splints, heat or ice treatments, or physical therapy, or a combination of these.

The treatment for carpal tunnel syndrome may involve surgery, the use of anti-inflammatory drugs, and/or splints for the hands to reduce tendon swelling in the carpal tunnel. However surgery is considered a last resort. The operation involves severing the band of ligaments that forms one wall of the carpal tunnel. When this operation is done properly, many patients experience immediate relief and can return to work after a recovery period. (There is often a slight residual numbness and loss of strength.) However, not everyone is a candidate

for surgery; careful screening is imperative.

These interventions have not always been successful, however, especially when the injured worker returns to the same working conditions that caused the problem in the first place.

NIOSH is conducting ongoing research in the area of musculoskeletal disorders, including CTS. Current NIOSH information about musculoskeletal disorders is available from the Center for Disease Control (CDC) Fax Information Service (1-888-232-3299).[4]

Another somewhat controversial treatment is exercise. So far, there has been little research on its effects on MSDs. Although some studies have suggested that exercise can be beneficial[5], another found no effect on MSD symptoms[6]. Many experts agree exercise can even cause possible harm. One commonly recommended exercise for office worker's wrists, for example, places the hand in exactly the position that has been shown to increase pressure inside the carpal tunnel.

MSDs in the Office: Trends

Number of office workers affected

How many office workers suffer from MSDs is certainly the question everyone wants answered, but it seems no two researchers agree on a number. Estimates for individual companies run from as low as zero percent of all office employees to as high as 40 percent. The true figure for the total office worker population is no doubt somewhere in the middle, probably well below 10 percent.

With almost any kind of illness, there is a "background" rate of occurrence in the general populations. In other words, a certain number of people get MSDs for non-work reasons: because of predispositions, activities such as sports, weekend carpentry, gardening, driving, or perhaps even because of the position of their hands when sleeping. Thus, any company can expect a certain number of MSD cases among their employees even if all MSD risks are eliminated at work. Background rates are important in assessing other health risks as well. In order to determine whether the Love Canal chemical dump caused cancer, for example, the incidence of cancer in Love Canal occupants was compared to the background rate for other parts of the country.

Unfortunately, no one knows exactly what this background rate is for MSDs. If it is ever pinpointed, companies will be able to compare the MSD rates among their employees to the background rate and so determine whether they have an unusual problem. Researchers have so far failed to agree on a background rate, largely because of differences in the way studies are designed, how cases are diagnosed, and the sources of data.

Since neurological disorders are more easily diagnosed than other types of MSDs, it is somewhat easier to study carpal tunnel syndrome background rates. The Mayo Clinic, whose findings are cited often on this question, found a background rate of about one new case of carpal tunnel syndrome per year per 1000 people. This number applies to people of all ages and occupations, but only describes cases severe enough to prompt the sufferer to seek treatment.[7] The state of Washington, using more recent data on employed people, found about two new cases per 1000 people per year.[8]

Although men and women are both susceptible to injury, women develop CTS three times more often than men according to a Mayo Clinic women's publication. No one knows exactly why, but researchers believe hormonal changes may be partly to blame; oral contraceptives or going through menopause may make women more susceptible to injury.[9]

Are MSDs a growing problem?
According to recent Bureau of Labor Statistics, repeated trauma disorders fell by 24 percent in 1998, marking the fourth such decrease since 1994, when the number of injuries peaked. It's important to note that three-fifths of the disorders reported occurred in the manufacturing sector.

Disorders caused by repeated trauma included in the BLS data include conditions such as carpal tunnel syndrome, tendinitis, tenosynovitis, and noise induced hearing loss among others.

The BLS data shows a steady downward trend in the total number of occupational injuries and illnesses. The 1998 rate was the lowest on record since the bureau began reporting this information in the early 1970s.

The total number of repeated trauma disorders in 1998 was 253,300, down 8.4 percent from 276,600 in 1997.

The drop in injuries is certainly good news but the reason is unknown. One possible explanation is that business and industry have proactively instituted voluntary ergonomic programs.

How an outbreak works
In the last few years, the press has reported a number of MSD "office outbreaks" at companies in the U.S., especially in the journalism and telecommunications industries.

Talk to someone from a company that has experienced an outbreak and you will probably hear a pattern similar to the following.

First, one or more severe cases are reported. These initial cases may involve almost total incapacitation in the affected area because the employees involved have waited a long time to report the condition and seek treatment. The victims may not have realized what an MSD was, they may have ignored the symptoms, or they may not have thought their pain was job-related. Some employees also hesitate to report MSDs because they're afraid of getting in trouble.

Probably because the first reported cases raise awareness among fellow workers, other cases—both advanced and mild—soon come to light. The number of cases reported typically continues to increase for about two years before peaking and then tapering off. The entire outbreak can last as many as five or six years, but the duration and intensity of the outbreak varies according to how quickly and seriously employers and employees respond with preventative and treatment measures.[10]

The media's effect on perceptions of the problem
Interestingly, the number of reported MSD cases seems to be strongly associated with the number of articles about MSDs in the press. Some experts believe that if there were no articles about MSDs, the number of reported cases would be showing a much smaller increase than what we now see, but the number of actual cases wouldn't change at all.

One reason MSDs have turned up in the news so frequently may be that journalists are among the groups most affected by the disorders. This is not surprising, since it's not unusual for reporters to spend hours at their computer, taking breaks only when they've met their deadline. Over many months, this pattern might lead to MSDs.

The media's attention to MSDs has made many employers nervous about preventing an outbreak at their organization. Employees have certainly become more aware of MSDs, too. A few skeptics say this "hyper-awareness" has resulted in paranoia or even abuse of the system, with people reporting MSDs at the first sign of simple work-related fatigue. Others applaud the publicity, noting that when employees have good information on the causes and symptoms of MSDs, they could end up saving everyone money and hassle by reporting MSDs in the early stages.

Cost of MSDs
According to OSHA, the average cost per incidence for a repetitive strain injury is estimated to be $12,000. This cost includes lost work with full wages, replacement wages, lost productivity, and medical treatment (not including surgery). If surgery is required, the average cost bumps up to $43,000 per incidence according to the American Society of Orthopedic Surgeons.[11]

A similar figure was arrived at in a survey conducted by CTDNews, a monthly publication dedicated to legislative and research activities involving repetitive strain injuries. CTDNews polled corporate officers and health and safety professionals who reported direct costs for a single MSD case to be $3,720 but costs increase to at least $12,000 per case when indirect costs such as overtime, employee retraining, and production losses are included.[12]

According to a 1997 study released by the General Accounting Office (GAO), employers who had implemented ergonomic programs cut MSD costs while increasing employee morale, health, and productivity. The report showed the average cost per MSD both before and after ergonomic program implementation. Four of the five employers in the report decreased costs considerably following implementation of an ergonomic program.[13]

Workplace regulations

Currently, there are three types of regulations and guidelines aimed at reducing MSD problems.

State and local laws

California was the first state to adopt regulations governing ergonomics in the workplace. The highly controversial regulation became effective July 3, 1997, and applies to any employer in California in every industry. It is believed that the California regulation may generate similar or even more rigorous federal or state regulations

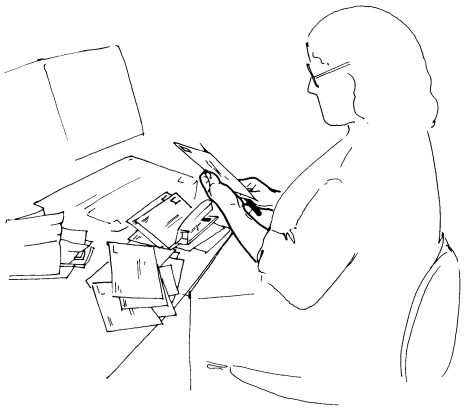
At the time of publication, we are aware of three states in various stages of implementing ergonomic regulations: North Carolina (currently on hold), Washington (passed in 2000), and Maine. Other states may include ergonomic requirements within existing workers compensation laws.

Proposed OSHA ergonomic regulation

For nearly a decade, OSHA has been working to develop a national ergonomic standard that would require employers to establish an ergonomic program to control work-related musculoskeletal disorders (WMSDs). The controversial proposed standard is available on OSHA's web site at www.osha-slc.gov/SLTC/ergonomics/ergoreg.html. The web site also contains an appendix of frequently asked questions about the proposed regulation (see "Resources" in Appendix).

ANSI/HFS

ANSI (American National Standards Institute), a national coordinator of voluntary standards for industry, has already developed, with the help of the Human Factors Society (HFS), an ergonomic standard for VDT users. This standard is called ANSI/HFS VDT-100 1988 and is commonly accepted by employers and legislators. In 1992, a committee was formed to review and update the 1988 standard. As of today, the revision committee is continuing to work toward a revised standard.



Opening envelopes for long periods of time

MSDs in the Office: Possible Risk Factors

Research is still far from complete on exactly what causes MSDs. Organizations with MSD problems are finding that they may occur in one department but not in another, even when both departments have the same furniture, job activities, and electronic equipment. So far, it seems that MSDs are caused by a complex set of conditions having to do with job activities, individual physiology, the work environment, technology, management, and sociology, as well as non-work activities and environments.

As they are currently understood, risk factors for MSDs can be split into three general groups:

Ergonomic stresses
These factors involve the interaction between the body and the physical environment.

Psychosocial stresses
Psychosocial stresses refer to the effects of the organizational or social environment on the worker.

Physiological predisposition
Some MSD risk factors arise from the individual worker's physiology.

Ergonomic stresses
The Center for Ergonomics at the University of Michigan and other institutions use a multi-factor ergonomic model to analyze MSD risk in a work environment. Briefly, the ergonomic stresses include

- Repetitive activity
- Holding a position without movement
- Use of force or strength
- Localized pressure
- Awkward positions
- (Low temperature)
- (Vibration)

The last two usually do not apply to offices but are included here to show the complete model.

Although repetition is only one factor on this list, the risks caused by the other factors become greater if repetition is involved.

Ergonomic stress 1. Repetition without rest breaks
A number of studies have given strong evidence that repetitious work is associated with increased MSDs.[14] The question then is, how much repetition is too much? One research suggests that human tendons cannot tolerate more than 1,500 to 2,000 exertions per hour.[15] This is about the number of keystrokes performed in an hour by each finger when a person types at 60 words per minute.

But infrequent periods of intense repetition may not be a very serious MSD risk. Researchers are convinced that, in order to be high-risk, the repetitive activity must make up a large component of the worker's typical day. Studies have found a relationship between MSDs and very short "work cycles," when those work cycles are performed for more than 50 percent of the worker's on-the-job time.[16, 17] Very short work cycles are activities that take less than 30 seconds to perform once. Some examples are opening letters, stapling, flipping though files, or sorting letters.

In offices, repetition has become more commonplace since the advent of computers. Keyboards are apparently not the issue, since MSDs do not appear to have been as prevalent among typists in the age of typewriters. Typewriters necessitated that the user take brief

Holding one hand still for long periods while the other hand uses cursor keys

Long periods of telephone use without changing positions

breaks in order to change paper, make corrections, and hit the carriage return lever. These built-in breaks may have kept typists from developing MSDs. Such momentary breaks in a repetitive routine are often called "micro-breaks" and they may be more valuable than the standard twice-daily 15-minute breaks many employees are entitled to in the workplace.[18, 19, 20, 21, 22, 23]

Ergonomic stress 2. Holding a position without movement

Holding a position for a long time, generally speaking, reduces blood flow, depletes nutrients, and leads to a buildup of harmful metabolic wastes. This causes fatigue and, if done over a long period, can cause permanent damage.[24] In fact, holding a position for a long time requires a longer recovery time than an equivalent period of repeated movements of the same type.[25,26]

People who work in call centers—whether customer service centers, telemarketing, or emergency service—are particularly vulnerable to this type of ergonomic stress. Many people, even those who work in call centers, believe their primary task is typing. In fact, recent studies revealed that call center workers type about one-tenth as much as a typical word processor. Repetition is not a problem for them. However static exertion (holding one position without movement) and high stress (due to productivity monitoring, dealing with angry callers, noise, and lack of control over their job) are risks for these workers.

Other kinds of sustained hand positions can also cause problems in the office. People using computer mice sometimes keep their mouse-hand in a grasping position for long positions.[27] Holding the telephone to the ear for a long time is another possibly dangerous habit, causing potential problems in the nerves passing through the elbow.

All in all, workers can hold static postures for four primary reasons: habits, the environment, stress, and the nature of the job.

• Habits

Many sustained static positions observed in office work are unnecessary; they are simply the result of habit. For example, some people use a great deal of effort to hold their elbows out and hunch their shoulder while typing, while other with the same furniture use chair armrests and relax. Some people cock their heads stiffly while typing, while other constantly and subtly change head position. Some people hold one or more fingers straight out while using a mouse (rather like some people hold teacups).

• The environment

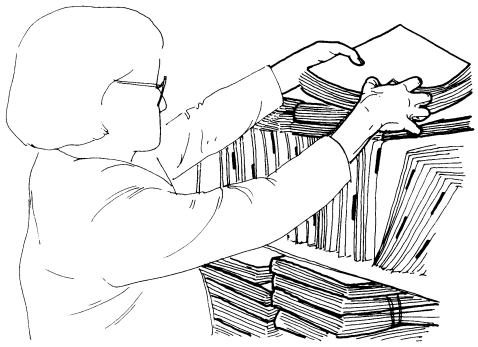
Sometimes, workers don't change posture because their environment makes it difficult. For example, a receptionist may hold his/her hand outstretched to reach a mouse that is located on a work surface beyond the keyboard tray. Glare on the computer screen may force an operator to slouch low in his/her chair and never switch to other postures. A typist may hold his/her hands stiffly over the keyboard when pausing because he/she has no comfortable and convenient place to rest his/her hands.

• Stress

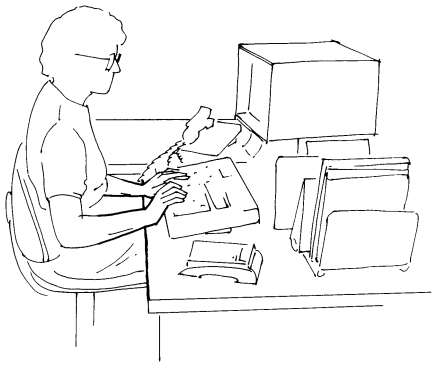
Another possible reason workers maintain static positions is due to tension or stress.[28] Relaxed workers, for instance, typically rest their fingers and hands between keystroke bursts or mouse movements. Tense workers, on the other hand, often extend fingers unconsciously or assume stiff postures. Unfortunately, the twinges of pain experienced in the early stages of MSDs can make a person even more tense.

• Job requirements

The last reason for sustained, static positions is that some jobs just demand it. Prolonged typing leads to prolonged sitting, for example. Mouse work can require long periods of gripping (although it is possible to grip loosely). Some jobs require long periods on the phone.



Repeated grasping and lifting of heavy files



Wrists resting on sharp edge of worksurface

Ergonomic stress 3. Excessive use of force or strength
Not surprisingly, repetitious activities requiring moderate force are harder on the body than similar activities requiring light force. This principle certainly applies to typing. A typist may make up to 10,000 separate impacts per finger per day. Obviously, a few extra grams of force per impact can really add up.

Research suggests that keyboard design affects the amount of impact fingers experience. People unconsciously type more lightly on some keyboards than on others, partly because the keys depress more easily on these keyboards, and perhaps also because the keys give clearer or quicker feedback through a tactile or audible click.[29]

On the other hand, it's possible that some people simply use more force regardless of the equipment. One study showed that people with carpal tunnel syndrome used 18 percent more force to do a given activity than people without carpal tunnel syndrome, even though both groups used the same equipment.[30]

Keying, though, is only one of several kinds of activities in the office that can lead to force-related MSDs. It's possible to use too much force when:

• Stapling, stamping, or performing other impact activities

Stapling is an underestimated problem. The fleshy part of the hand that usually does the stapling covers an important nerve which can be affected by the impact.

• Grasping large file folders or books

Large, heavy, smooth, dry objects such as manila folders require a surprising amount of force to keep the item from slipping out of the fingers. This requires a strong "pinch grip" that can be quite taxing.[31]

• Lifting a file or book

Habitually lifting items incorrectly can be equivalent to using too much force. For instance, picking up even a one-inch-thick file folder can demand considerable force from the tendons and muscles of the hand and forearm, especially if the folder is high on a shelf or far from the body across a table.

• Pushing or pulling a heavy file drawer or scooting around an office on a chair

When people "scoot" their chairs around the offices, they usually perform awkward, difficult exertions of the legs, lower back, and sometimes arms. This is an often overlooked potential area for excessive use of force.

Ergonomic stress 4. Localized pressure
Too much external pressure on muscles, blood vessels, nerves, and tendons can lead to inflammation and reduced blood flow. Over time, constant pressure can cause MSDs.[32, 33, 34, 35]

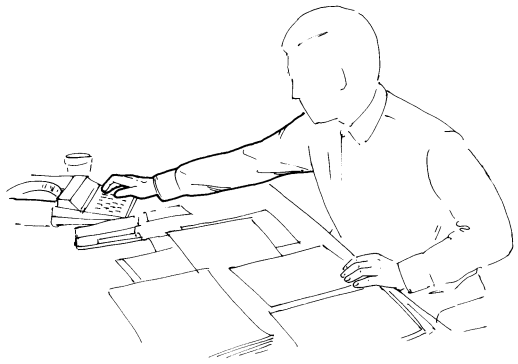
Carpal tunnel syndrome is an example of an MSD caused partly by localized, though usually internal, pressure. Experts believe carpal tunnel syndrome is to a great extent a result of excess pressure on the median nerve inside the wrist. Swollen tendons in the carpal tunnel or external pressures on the base of the palm can squeeze the median nerve, damaging its ability to conduct signals to and from the hand.

In offices, workers put excess pressure on the forearms and hands when they habitually rest them on angular surfaces such as sharp keyboard edges, work surface corners, or hard, angular chair armrests.

Hard, flat surfaces can also cause localized pressure, especially when angular parts of the body such as elbows rest on them. A major nerve that runs round the outside of the elbow can easily be pressed between the bone and a hard surface. You're familiar with the vulnerability of this nerve if you've ever hit your "funny bone."

Ergonomic stress 5. Awkward positions
Habitually placing parts of the body in awkward, overextended, or unbalanced positions can also lead to MSDs, mostly because awkward positions press on nerves, stretch tendons, or otherwise push and pull tissues beyond their normal capacity.

Talking on the phone for long periods, for example, has potential for awkward posture. Some people use their shoulder to prop the telephone against the ear, putting strain on the tissues in the shoulder. Even those who hold the phone with their hand while talking can cause problems in elbows and hands.



Extended reaching while using a calculator

Phones aren't the only culprit, of course. Just about any activity done in an awkward way frequently or for long periods has MSD potential. In every case, repetition or use of excess force aggravates the harmful effects of awkward positions.

Observers often see poor neck postures in offices. People may turn their head to the side to read copy while keying, or bend the head back to see a screen placed too high for their comfort or to see the screen through bifocals.

People doing several simultaneous tasks, such as checking e-mail, answering the phone, and assembling files, often lean far over their work surface to reach staplers, printers, etc.

• Awkward positions of the wrist

When talking about MSDs, the awkward positions considered to have the greatest MSD potential have to do with the wrist.

Quite a bit of research has associated MSDs with awkward wrist positions. Statistical studies have shown that constantly working with the wrist excessively bent up, down, or to the side is related to MSDs.[36, 37, 38, 39, 40, 41,42,43, 44, 45]

Other studies have supplemented this statistical relationship with more physiological observations. Using catheters inside the wrist, these studies have confirmed that certain awkward wrist postures produce pressures within the carpal tunnel that are high enough to cut off blood flow and potentially cause other damage.[45, 46]

Based on these studies and on the physiology of the wrist, ergonomists believe the most healthy wrist position is straight or bent slightly upward.

Many factors in the office can contribute to awkward wrist positions. Some examples are inappropriate keyboard height or angle, lack of support for resting hands, splayed elbows, or too thick wrist rests. In addition, computer users may bend their wrists incorrectly to the side when they reach for side function keys.

Computer mice are also associated with awkward wrist posture. Many mouse users rest their forearms on their work surface and move the mouse around primarily through wrist movements. The resulting side-to-side bending of the wrist is believed to potentially cause MSDs.

Some research has suggested that conventional flat keyboards inevitably cause an incorrect position of the wrist because they force the forearms to rotate inward and often force the wrists to bend sideways. New research supports keeping the wrist in a neutral position (0-22 degrees of extension), the hand in a gentle, relaxed curve, and the forearm rotated slightly so the thumbs are nearly on top.

This assumption has led to the design of numerous alternative keyboards such as the Microsoft Natural Keyboard, The Comfort Keyboard, Datahand, Kinesis, GoldTouch, and several others. Some of these keyboards split the keys into left-and hand right-hand groups, aiming them inward to reduce bent wrists. Other keyboards abandon all pretense at flatness and crack the keyboard in half, raising the center point to create a tent shape. This eliminates the forearm rotation for standard flat keyboards.

Psychosocial stresses
Lately, researchers have been giving more attention to non-physical factors that seem to contribute to the incidence of MSDs. Numerous studies have suggested that psychosocial factors may be linked to the development of musculoskeletal injuries. Psychosocial factors include fear of job loss, lack of job control (including workload and pace), lack of social support, and even computer breakdowns. Psychosocial factors may help explain why companies have outbreaks at some of their sites but no cases at other sites, despite identical equipment, jobs, and furniture.

Psychosocial factors cause two types of stress: emotional and physical. Emotional factors include depression, frustration, anxiety, lack of fulfillment, and insecurity. Physical factors may include fatigue, increased heart rates, sweating, and sleeplessness.

Psychosocial stress is a two-way street: the employer has a responsibility to recognize when a problem exists and the employee has the responsibility to communicate his/her needs and help solve the problem.

Psychosocial stress 1. Job-related stress
Two recent studies conducted at the Los Angeles Times and US West have indicated a link between job-related stress and MSDs. Factors considered in the studies were: lack of control over their job, isolation, limited task diversity, and increased work load. Other possible stressors include boredom, unclear rules, job dissatisfaction, job insecurity, lack of social support, management-labor conflicts, and major workplace changes.

Some people have objected to the findings of research studies because they rely not on objective, observable evidence, but on worker's own reports concerning stress and symptoms. The question here is whether stress causes MSDs, or whether having MSDs causes increased perception of stress, or both.

Psychosocial stress 2. Apprehension and ignorance about MSDs
People involved in the Australian MSD epidemic of the mid-1980s recall lurid media stories in that country implying that a twinge of tendinitis is always the first step in an inevitable downward spiral toward permanent crippling. The resulting panic, some observers believe, contributed as much to the four-year-long epidemic as any ergonomic factors.[49]

In light of such observations, some North American employers hesitate to inform their workers about MSDs because they're afraid of starting a panic. Some companies have found a consistent jump in reported cases after every educational presentation on MSDs. However, these same companies have concluded, and studies have proven, that MSDs caught and treated early involve a quicker and less expensive recovery than MSDs left untreated until the crisis stage.

The way in which a company's management responds to MSD cases seems to contribute to the pattern of an outbreak. If management denies the problem altogether or punishes sufferers somehow, any or all of these three patterns may occur:

1) increased job stress and anger, leading to more MSD cases as well as other organizational problems
2) suppression of reporting symptoms, leading to more advanced cases when symptoms can no longer be ignored, or
3) desertion by employees with symptoms, who decide to change to less risky careers or find more understanding employers.

Individual predispositions
The causes of MSDs are extremely complex and not completely predictable. Many people with ergonomic risk factors do not develop MSDs; others get MSDs for no obvious external reason.

There is some evidence that workers new to a job are more prone to developing MSDs. One possible reason for this is that new workers are not physically conditioned for the particular activities the job requires. Based on this assumption, some companies have instituted exercise programs aimed at strengthening muscles and improving flexibility.

Some research has also found an apparent correlation between certain physical conditions and MSDs. Some of these conditions are:

- vitamin B-6 deficiency
- diabetes
- obesity
- rheumatoid arthritis
- taking oral contraceptives
- gynecological surgery
- small or square wrists

Gender, too, may be a factor in the development of MSDs. A number of recent studies involving VDT workers have found women are at increased risk of upper extremity disorders compared to their male counterparts. The reasons are unclear, but researchers at the Sweden's National Institute for Working Life speculate the causes may be rooted in:

- Differences in the type of work men and women perform
- Higher physical stress on women from non-work activities (housework and childcare)
- Physiological differences (body size or mass, hormonal differences)
- Differences in the willingness to report or seek medical care (women may be more willing to seek medical care when they experience symptoms)

There is some good news for women, however. The Mayo Clinic recently reported that pregnancy is not a major factor in the development of carpal tunnel syndrome.

Reducing the Risk Factors for MSDs

Of course, the best way to deal with MSDs is to prevent them.

OSHA believes work-related musculoskeletal disorders are the most widespread occupational health hazard facing the U.S. today and estimates their proposed standard would prevent about 3 million work-related MSDs over the next decade, saving an estimated $9 billion annually.

Under OSHA's proposed ergonomic standard, employers would be required to establish an ergonomic training program for jobs where a work-related musculoskeletal disorder has been identified. The rule outlines six basic elements that are required to be in place by the employer:

- Management leadership and employee participation
- Hazard identification and information
- Job hazard analysis and control
- Training
- MSD management
- Program evaluation

A more complete description of OSHA's proposed standard can be found on their web site at www.osha-slc.gov/SLTC/ergonomics/ergoreg.html.

Opponents of the standard believe the rule is too broad, lacks scientific evidence, and that OSHA has underestimated the cost to businesses. Some also believe it places an unnecessary burden on industries that do not have significant issues. Proponents, on the other hand, argue workers need a rule that would protect them in the workplace and that there is strong evidence to suggest work-related musculoskeletal disorders can be controlled with effective ergonomic programs.

While much is not known about the causes of MSDs, the information on the following pages is meant to help reduce the risk of injury.

Identifying present and potential problems
A sound ergonomic program requires a commitment by management and staff. It requires involvement by both employers and employees to identify and remove hazards that pose health and safety problems.

Management must provide a method for employees to report MSD symptoms and encourage them to do so. Employees should be involved in developing, implementing, and evaluating an ergonomic program. Workers should be assured that they can report symptoms honestly without fear of retribution of any kind from management.

Once problem areas are identified, the jobs and work areas involved should be analyzed for MSD risks, preferably by an expert. The ergonomic risk factors described previously, along with the interventions described on the following pages, can help guide this analysis.

Ergonomic interventions
The five ergonomic stresses described in Section III generally have clear implications for ways to reduce risks. Not all of the appropriate measures are easy to implement, however. Most of them involve a combination of engineering or design interventions along with work practice or administrative changes.

Interventions of either the ergonomic or psychosocial kind should be implemented with employee input both before and after in order to evaluate overall effectiveness. There are a variety of evaluation approaches, ranging from health records to discomfort surveys.[50,51]

Some companies install mockup workstations which can be systematically evaluated by a succession of workers. This helps choose the most effective interventions without paying much for those that are not found to help. In addition, worker participation in such decisions often has a positive effect on all workers' cooperation with the interventions.

Ergonomic intervention 1. Avoid repetition without breaks
• Building in breaks

One way to avoid long periods of repetitive motion is to try to get employees to break up their work sessions with breaks. Another benefit is that, despite time off from the job, rest breaks may actually improve productivity as employees can work more comfortably without accumulated aches and pains.

Typically, workers in the United States are entitled to two 15-minute rest breaks a day in addition to a lunch break of 30 minutes or an hour. Many workers, however, find it too disruptive to take advantage of these breaks.

NIOSH has looked into integrating complex computer tasks with frequent "micro breaks" ranging from 15 seconds to three minutes in length. Results indicate that breaks helped workers to be more relaxed and calm on the job, with fewer musculoskeletal complaints, and with little or no loss in productivity, in spite of the break time. In fact, rest breaks appear to enhance productivity and leave workers more physically and mentally refreshed.[52]

Studies show that regular rest breaks, including stretching, are beneficial in reducing stress, shoulder and neck pain, low back discomfort, and eyestrain. Frequent breaks of 30 seconds to three minutes can be very effective. These breaks should not replace the morning and afternoon breaks. It's important to take the break before fatigue sets in as fatigue is the body's way of sending out distress signals.

Should break length and frequency be left entirely up to workers? Maybe not. Studies suggest that when this is done, workers tend to wait until they have begun to feel fatigued before taking breaks or resume work before "recovery" is complete.[53, 54] The best approach might be clearly defined expectations about break times and lengths.

• Reducing keyboard work

To cut down on keyboard use, one organization stopped using electronic mail, causing people to return to using the telephone or foot transportation around the office. Walking down the hall to talk to the person is an easy way to cut down on keyboard use.

Another company eliminated keyboard work for employees recuperating from MSDs by investing in voice-recognition software capable of taking dictation. A word of caution, however, as chronic voice problems can be just as debilitating as MSDs. Consider using a voice coach prior to using this type of software.

• Redesigning jobs

It's often possible to expand job descriptions so that each worker performs a more varied group of tasks throughout the day. For example, clerical work can be redistributed so workers perform more

Mico-break

general departmental support rather than single activities. Word processors can take on file management, telephone, calendar maintenance, or mail processing work, while mail processors or receptionists can do more word processing. This can be an informal process, or a more formally planned process of job rotation.

Many workers have sufficient task variety but perform their tasks in excessively repetitious ways. Such workers can rearrange their tasks to avoid repetition. For example, mail processing clerks tend to open all the mail at once, then spend hours processing it on a computer. They could be encouraged instead to alternate between opening and recording small batches.

• Limiting work hours

As suggested in Section III, people doing repetitious or forceful work should avoid doing so for long periods. Eliminating overtime is one way of preventing extreme overuse, and some companies with many clerical workers have done so.

Ergonomic intervention 2. Avoid maintaining positions for long periods

The four reasons for holding static positions—habit, the environment, stress, and job requirements—each require slightly different interventions.

• Changing habits

Unconscious work habits can be as tough to break as unconscious personal or speech habits. Some companies are trying to help their employees do so and have instituted programs that involve raising awareness of the value of good work habits, doing individual evaluations, and providing diligent follow-up. They often find that making the employee aware of his own habits is one of the most difficult steps. Playing videotapes back to the employee has proven helpful for this. Another useful tool is a small feedback instrument, worn while working, that beeps when the arms aren't relaxed.[55] One company involved in this process has learned that permanent habit change takes a minimum of two weeks of nearly daily reminders and check-ups. After an initial evaluation and "prescription," they assign trainers to observe and counsel individual workers for as long as it takes.

• Reducing stress

General stress reduction programs are more common than habit-changing programs, since stress is thought to contribute to many work-related problems besides MSDs. Corporate stress reduction programs are typically comprehensive programs with a long time frame. They might include education about stress recognition, coping behaviors, relaxation methods, health behavior, and personality typing. Of course, these programs are most effective when they not only train people to cope with stress but also work to eliminate underlying stressful conditions, particularly when those conditions have to do with the company's policies or culture.

• Adjusting the environment

One good way to avoid static postures is to avoid static furniture. Some examples:

Adjustable-height tables are valuable for overall posture change. Some desks and tables adjust from sitting to standing height, a great feature for refreshing circulation. Keep in mind that workstations designed for one task should address several components including worker

Sustained awkward posture caused by inappropriate workstation arrangement

comfort, adjustability, safety, and efficiency. Sit/stand workstations are often recommended for workers with chronic back pain.

Since there is no one ideal posture, it is essential that the work chair permits posture changes. Some experts believe that freedom to move around is the single most important consideration in chairs designed for use in computer-intensive environments.[56]

Tilting, swiveling monitors and glare screens enable users to move anywhere without glare constraints.

Articulating arms let users bring light, phones, and other equipment with them as they move around in the workstation.

Headsets free up the arms and shoulders for frequent phone users.

Mobile document holders allow workers to change the angle and position of a document so they can move their head and neck occasionally and still see their work.

Some companies see adjustable furniture as a key factor in reducing MSD risks. Some even stock "libraries" of specialized ergonomic support accessories. Employees can borrow items to see if they're helpful, then order one for themselves if they wish. A few companies even stock a variety of the larger adjustable items for employees to try, like ergonomic chairs and adjustable tables. Others use outside resources. Many stores now offer a service in which they will help employees choose the most appropriate chair for their special preferences, work style, and task requirements.

• Redesigning jobs

Job enlargement, task rearrangement, and self-pacing can help reduce the demands for long-term sustained positions such as sitting or using a mouse. The issue of job redesign is difficult to tackle, and it benefits from employee as well as management involvement.

Some companies that have undertaken job redesign programs have enjoyed increased productivity and motivation as side benefits. These successful programs have typically used a great deal of employee input and careful, ongoing feedback.

Ergonomic intervention 3. Avoid excessive use of force or strength

The use of force can often be reduced with technological solutions.

• Using less force on keyboards

Many people type with more force than is necessary. It may be possible to learn to type more softly, but it's difficult and requires discipline and follow-up. Companies that have tried to reduce their employees' keying force believe that it takes weeks of monitoring and feedback to get a permanent change. Instruments are available that give continuous feedback to workers about the amount of force they use when typing.

It's also possible that certain kinds of keyboards can encourage people to type more lightly. Some keyboards are advertised as "light-touch," and claim to require less force to operate. Research suggests that these claims may be at least partly true.[57] On the other hand, it's possible for keyboards to be too sensitive, and users may have to suspend their fingers over the keys during pauses rather than resting them lightly on the keys.

• Using less force on other kinds of equipment

Staplers, punches, and stamps can also be risks. These items can be evaluated for ease of operation, and electric models that require no force can be substituted.

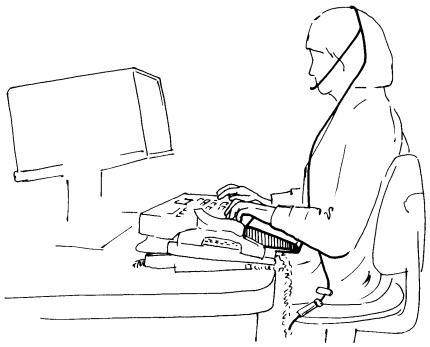
• Lifting carefully

Workers can learn to lift objects from a low position close to the body, especially if shelving can be strategically rearranged. Mechanical devices such as carts or wheeled tables might be used to reduce the number of times a given object has to be lifted. In some cases, it may be possible to divide up heavy files, thereby reducing the weight of individual pieces.

• Scooting safely

An easy, partial solution is to provide a hard chair mat that makes scooting easier. Better workstation design might be even more effective: placing work surfaces in a U shape around the occupant allows him or her to visit several work positions by swiveling rather than traveling.

Arms resting on round worksurface edge



Telephone headset and wrist rest

Ergonomic intervention 4. Reduce localized pressure
One approach to reducing this risk factor is to provide work surfaces with rounded or soft corners in the places where people frequently rest their hands or arms. Waterfall, bullnose, or flexible edge work surfaces are designed exactly for this. Wrist rests can also help people avoid resting wrists on work surface edges.

Soft, rounded chair armrests are important as well. Armrests on many current office chairs are either soft plastic or upholstered foam.

Flat surfaces can contribute to a problem when workers rest angular body parts, such as elbows, on them. People do this frequently when they talk on the telephone, holding the handset to the ear and propping their arms on their work surface or chair armrest. Headsets or even shoulder rests are good solutions.

Ergonomic intervention 5. Avoid awkward positions
Many awkward postures can be reduced simply by rearranging the work area.

- **Wrist posture: up-down**

People who type a lot have a tendency to bend their wrists up or down too much.

To achieve a straight wrist posture is usually a matter of bringing the keyboard, work surface, chair, and floor into alignment with each other. It's a good idea to adjust furniture "from the ground up." The chair's height should be adjusted first, to allow the feet to rest comfortably on the floor or, as a last resort, on a footrest. The keys should then be set at approximately elbow height, and the work surface or monitor support should have the top of the monitor screen at or below eye level. In general, the posture should be comfortable and the wrists as straight as possible.

Even with the keyboard and chair properly adjusted, some people still have a tendency to drop their wrists while typing. In these cases, placing a wrist rest under the wrists will help keep them in alignment.

- **Wrist posture: side-to-side**

Some computer designs can encourage users to bend their wrists in a side-to-side motion. This behavior can be corrected by relearning good habits or sometimes by purchasing alternative equipment.

Older PC keyboards and many industry-specific keyboards have function keys as part of the keyboard. Often people will bend their wrists sideways in order to reach these keys. Those who do so should learn to move their entire hand over to reach the side keys, keeping the wrists straight throughout the motion. Newer keyboards often contain separate function keys that if not used can be disconnected and removed from the work area.

Wrist rests, unfortunately, are sometimes suspected of helping one wrist problem while contributing to another. When users become too dependent on them, they don't bother to lift their hands and arms when reaching for side keys. Users should always be aware of this possibility.

The problem also exists with mouse use. Rather than moving the entire forearm with the mouse, workers rest their forearm on the

Rotated torso and neck

work surface edge and move the mouse around with wrist motions. People can learn to move the mouse correctly or they could change to a different mouse design. Newer mouse designs are sensitive to speed; the cursor moves farther across the screen when the mouse is moved quickly. The result is that these mice theoretically only need about a two-by-two inch square to operate, thus reducing the hand movement necessary to operate them. Trackballs are another option, but because they involve intense use of the thumb, they may have their own set of risks.

• Craned necks and twisted torsos

Using a copy stand and moving the copy to a position very close to the screen—or perhaps below the screen and above the keyboard—is an easy and often inexpensive-solution. Mid-focal length "computer glasses" help bifocal users as does lowering the monitor.

• Leaning

Analyzing the person's activities and rearranging the work area can eliminate long reaches and improve efficiency.

• Raised shoulders

This can happen when work surfaces or keyboards are too high or when chairs are too low. Constantly raised shoulders have been linked with upper back stress.57 This behavior can be improved simply by bringing the different components into better alignment.

Psychosocial Interventions

Psychosocial intervention 1. Stress management programs

The subject of an employee stress management program is beyond the scope of this paper. Such programs, however, can be powerfully effective when used in conjunction with an MSD management program. The resulting "holistic" approach to MSDs has produced excellent results at companies that have tried it.

Several key elements seem to appear consistently in successful stress-reduction programs.

Control. Successful programs often have large steering committees that ensure input from workers as well as managers.

Self-reliance. The various components of the program often stress workers' active involvement rather than passive education by outsiders. Input from workers is especially important if jobs need to be modified.

Dealing with underlying issues. Successful programs should address larger corporate policy and culture issues that contribute to stress, as well as treating the surface symptoms of stress.

Employee goals. Factors outside work often play a big role in producing job stress; these factors can be influenced by a company-sponsored program.

Psychosocial intervention 2. Training and education

We are in an era of greatly increased ergonomic awareness. It seems clear that educating all employees about MSDs and the proper use of equipment is essential to creating injury-free environments. Educating management also seems to be crucial, since uninformed management can block effective prevention or treatment measures.

Today's typical ergonomic training programs usually cover the nature, causes, treatment, and possible ways to avoid MSDs. The proposed OSHA standard is even more comprehensive and requires employers to provide training to employees about MSD hazards, how to recognize and report MSD signs and symptoms; the ergonomics program itself; and measures for reducing and eliminating hazards. Those managing the program must know how to set up and operate an ergonomics program; how to identify, analyze, and reduce or eliminate an MSD hazard; and how to evaluate the effectiveness of the program.

Psychosocial intervention 3. MSD management
Conventional medical management programs for MSDs often resemble private medical practice but with more paperwork. Workers seeking help are diagnosed, treated until they are well, and then sent back to work.

The goal of OSHA's MSD management is to reduce the severity of impairment. This requires MSD management promptly whenever an MSD occurs. Caught early, MSDs are more likely to be reversible and not result in permanent damage.

The outlook for prevention
New outbreaks of MSDs are already beginning to subside. Remember how common neckbraces were back in the 1970s? Since then, improved designs of seatbelts and headrests in cars have vastly reduced whiplash injuries. In the same way, occupational health specialists will become more skilled and experienced at catching MSDs early, managers and workers will redesign jobs to avoid MSD danger, prevention programs will settle into place, and research will help improve prevention and treatment. We are already seeing these measures having an effect with fewer injuries being reported.

Even as new cases of MSDs decline from current levels, all evidence points to continuing emphasis on ergonomics, both of the physical and psychosocial kind. Since the first ergonomic office chair was introduced in 1976, interest in ergonomics has increased steadily on the part of employers, facility managers, and workers. Now, because of increased educational efforts, the new millennium may bring awareness of good ergonomics to every aspect of office life.

Glossary: selected ergonomic terms

Ergonomics is the science of fitting jobs to people. Ergonomics encompasses the body of knowledge about physical abilities and limitations as well as other human characteristics that are relevant to job design.

Flexion/Extension: movement that decreases/increases the angle between two adjacent bones.

Incidence: the number of new cases of a disorder that appear during a specified time.

Lateral/Medial describes structures away/close to the body midline.

MSD management is a process for assuring that employees with musculoskeletal disorders are provided with methods for reporting symptoms and getting treatment.

Musculoskeletal disorders (MSDs) are injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs. Examples of MSDs include carpal tunnel syndrome, epicondylitis, tenosynovitis, muscle strains, Raynaud's phenomenon, tendinitis, trigger finger and low back pain.

Prevalence: the proportion of a population that has a disorder at a given point in time.

Pronation/Supination: rotations of the forearm that brings the palm of the hand down/up.

Psychosocial stress: organizational or social impact on the worker.

Radial/Ulnar deviation: bending the hand at the wrist in the direction of the thumb/away from the thumb.

Risk factors: conditions that contribute to the risk of developing a disorder.

Severity: the seriousness of a disorder in terms of its cost to an employer or third party payer; for example, the number of lost workdays per million hours of work.

Symptoms are physical indications that an MSD may be developing. Symptoms can vary in their severity depending on the amount of exposure. Often symptoms appear gradually but become more severe as exposure continues. Symptoms of an MSD may include numbness, burning, pain, tingling, aching, and stiffness.

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Human Factors and Ergonomics Society
PO Box 1369
Santa Monica, CA 90406-1369
Ph: (310) 394-1811
Fax: (310) 394-2410
www.hfes.org/

Bureau of Labor Statistics (BLS)
U.S. Department of Labor
Office of Safety, Health and Working Conditions
Branch of Annual Survey
2 Massachusetts Avenue, NE
Washington, DC 20212
Ph: (202) 606 6179
www.stats.bls.gov

FED-OSHA information:
Office of Ergonomic Safety Standards
Directorate of Safety Standards Programs
U.S. Department of Labor-OSHA
200 Constitution Avenue, NW, Rm. N3609
Washington, DC 20210
Ph: (202) 693-2222
www.osha.gov

National Institute of Occupational Safety and Health (NIOSH)
Clearing House for Occupational Safety and Health Information
4676 Columbia Parkway
Cincinnati, OH 45226
Ph: (800) 356 4674
www.cdc.gov/niosh/homepage.html

CTD News ($173/yr.)
LRP Publications
747 Dresher Road
P.O. Box 980
Horsham, PA 19044-0980
Ph: (800) 341-7874
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www.ctdnews.com/

Other Sources of Information

BLS Home Page
Injury statistics
stats.bls.gov/

ErgoWeb
Ergonomic products and information
www.ergoweb.com

OSHA Ergonomic Standard (OSHA)
www.osha-slc.gov/SLTC/ergonomics/ergoreg.html

Typing Injury FAQ
Help for injured workers
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MSD ergonomic risk factor checklist

We strongly recommend that MSD risk factors of a job or environment be analyzed from the point of view of a thorough understanding of the job and the risk factors themselves, rather than a quick checklist that can easily miss important actions, interactions, or subtleties. In addition, we endorse OSHA's recommendation that job analysis be undertaken by a professional who can interpret job conditions. Nevertheless, we offer the following checklist to help get the reader thinking about possible work-related MSD risks in a given situation, and as a summary of some of the material in this document. As you go through the list, please remember that it deals with MSDs (rather than overall ergonomics) in a work setting.

- What are the job's components?
- What sequence of activities are involved in each task?
- What activities are repetitious?
- What is the rate of repetition?
- How long is each episode of repetitious activities?
- How much time separates episodes? What happens during the interruptions?
- Do the repetitious activities involve excessive force?
- Do the repetitious activities involve awkward postures?
- Does any part of the body stay still for long periods? For how long at a time?
- Is muscle effort used to hold the body part still during those times, or is the body relaxed?
- How much muscle effort is used?
- Does the worker pound the keys?
- Are there other impact activities?
- Does the worker grasp anything large or heavy?
- Does the worker push or pull on anything?
- Does the worker rest or lean arms, hands, or wrists on any sharp edges?
- Does the worker rest or lean arms, hands, or wrists on any hard edges, regardless of sharpness?
- Does the worker rest or lean on any hard, flat surfaces?
- Does the worker grasp anything that has sharp edges?
- While keying or during pauses, does the worker bend his/her wrist up or down excessively, even if supported and relaxed? How often, and for how long?
- Does the worker frequently reach more than 15 inches, or to shoulder height or above?
- Does the worker bend his/her wrist to the side, either occasionally or for long periods?
- During any other activity, does the worker hold his/her hand in anything other than a straight or almost-straight wrist position, for long periods?
- Is the worker able to work in a wide variety of trunk, leg, hand, arm, and head positions throughout the day or throughout a task?
- Does the worker crane his/her neck?
- Does the worker lean to one side for long periods?
- Does the worker work with raised shoulders?
- For all of the above: how often? for how long? with how much force?