



1991  
Conference  
Summary

**A National  
Strategy For  
Occupational  
Musculoskeletal  
Injuries:  
Implementation  
Issues And  
Research Needs**



## **1991 Conference Summary**

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# **A National Strategy for Occupational Musculoskeletal Injuries – Implementation Issues and Research Needs**

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# PROCEEDINGS OF THE CONFERENCE ON A NATIONAL STRATEGY FOR OCCUPATIONAL MUSCULOSKELETAL INJURIES—IMPLEMENTATION ISSUES AND RESEARCH NEEDS

## 1.0 INTRODUCTION

### 1.1 Scope of the National Problem

Musculoskeletal injuries include both acute and chronic injury to the muscles, tendons, ligaments, peripheral nerves, joint structures, bones and associated vascular system. *These injuries may be reported as sprains, strains, inflammations, irritations, and dislocations.* In the medical literature, this broad class of physical symptoms or complaints is often referred to as wear-and-tear disorders, overuse or overexertion injuries, osteoarthritis, degenerative joint diseases, chronic microtraumas, repetitive strain injuries and cumulative trauma disorders.

In 1983 the National Institute for Occupational Safety and Health (NIOSH) developed and published a "Suggested List of Ten Leading Work-Related Diseases and Injuries." Severe occupational traumatic injuries such as amputations and lacerations, some of which involve acute musculoskeletal injuries, were separated from other musculoskeletal injuries such as low back pain and carpal tunnel syndrome. While severe traumatic injuries kill and maim workers, the non-traumatic musculoskeletal injuries and disorders were themselves increasingly recognized as major occupational health problems in 1983 because of the following statistics:

- Musculoskeletal injuries then were the leading cause of disability during a person's working years, afflicting 19 million persons, with nearly one-half the workforce affected at some time during their working life.
- Musculoskeletal injuries were ranked first among health problems affecting the quality of life.
- The cost of musculoskeletal injuries based on lost earnings and workers' compensation payments exceeded that of any single health disorder.
- Musculoskeletal injuries accounted for one-third of annual workers' compensation claims.
- Musculoskeletal injuries were expected to increase with more older workers performing manual labor in certain industries.

Unfortunately, none of the above statistics have improved since 1985. Each year the Bureau of Labor Statistics (BLS) surveys the records of job-related injuries and illnesses of 250,000 employers. The results of the surveys in the 1980s recorded a sharp rise in the musculoskeletal disorders associated with repeated trauma (e.g., conditions due to repeated motion,

pressure of vibration). These disorders rose from 18% of all occupational illnesses in 1985, to 52% in the 1989 survey which was reported in 1991. Manufacturing had the largest number of reported cases of repeated trauma-related disorders in 1989 with meat packing plants, poultry processing, and motor vehicle manufacturers having the highest reported rates in the manufacturing sector. The data from the BLS, like all surveillance data, has limitations. For example, low back pain is not recorded separately from occupational injuries such as lacerations, and is not included in the repeated trauma category.

Coupled with the large amount of human suffering caused by occupational musculoskeletal injuries is the rapidly escalating cost of diagnosis and treatment, which is born by taxpayers and consumers in terms of higher priced goods and services. Though cost estimates vary greatly, most authorities believe the medical and workers' compensation costs of these disorders are in the range of \$20 to \$40 billion annually in the United States. The total costs are believed to be at least double the direct costs; and these additional costs do not reflect the reduced quality of products and services produced by a worker who is suffering from such disorders, but who elects to stay on the job for economic and other personal reasons.

The Director of NIOSH, Dr. J. Donald Millar, acknowledged in his opening remarks to the Conference Attendees, that by any epidemiological criteria, occupational musculoskeletal injuries represent a *pan-epidemic problem in the U.S.* with gigantic effects on the quality of millions of peoples' lives every year. Because the precise organic cause of the pain and functional limitations now being classified as musculoskeletal disorders are not well established in the medical sciences, diagnosis and treatment is often ineffective and expensive, which further substantiates the need to improve our knowledge and use of proven prevention strategies.

### 1.2 Background—Major Federal Government Initiatives

**1.2.1 1970—Occupational Safety and Health Act Passed.** The Occupational Safety and Health Act was enacted by the Federal Government to provide five major services:

1. Research which would provide the scientific knowledge necessary for effective identification, evaluation and control (or prevention) of all types of injuries and illnesses in the workplace.

2. Education of professionals in those disciplines necessary to both develop the new knowledge needed, and transfer proven prevention methods to the workplace.
3. A policy making and organization structure that would conduct formal reviews of existing occupational health and safety guidelines, research findings, and other consensus standards, from which to promulgate national standards for the control of specific workplace hazards and substances.
4. An organization of trained health and safety inspectors who would visit the nation's workplaces and evaluate conditions and practices to assure compliance with published standards and general occupational health and safety policies. These Compliance Officers could publicly cite and fine employers for violations of occupational safety and health standards and policies.
5. A formalized procedure by which employers can appeal OSHA citations and/or fines to an independent review commission.

The Occupational Safety and Health Act created three distinct organizations to provide these and other services. The roles of research, professional education, and the development of recommended occupational safety and health standards were delegated to the National Institute for Occupational Safety and Health (NIOSH) within the Department of Health and Human Services. The roles of developing health and safety standards and enforcing compliance with these were delegated to the Occupational Safety and Health Administration (OSHA) within the Department of Labor. A separate Occupational Safety and Health Review Commission was established to review OSHA citations and proposed assessments of penalties that are contested by employers.

**1.2.2 1981—NIOSH Releases Report: "Work Practices Guide to Manual Lifting."** During the 1970s NIOSH conducted research and hosted various workshops to determine the extent and cause of occupational musculoskeletal disorders. In 1978 enough information existed to support the writing of a technical report describing the need for and procedures to be used to evaluate and prevent musculoskeletal injuries caused by the act of lifting objects when located directly in front of a worker (i.e., simple symmetric lifting). The resulting report entitled, *A Work Practices Guide to Manual Lifting* was issued in 1981, and was immediately one of the most popular documents distributed by NIOSH. Several other professional health and safety organizations have reprinted the report in various forms. As such, it represents the first federal "Guide" specifically targeting an occupational activity (i.e., lifting loads), which was known to cause excessive musculoskeletal injuries. Several other countries have since adopted national standards incor-

porating all or parts of these NIOSH lifting recommendations.

**1.2.3 1986—NIOSH Releases Report: "A Proposed National Strategy for the Prevention of Musculoskeletal Injuries."** In 1985 NIOSH and the Association of Schools of Public Health (ASPH) convened a Conference involving 50 expert panelists and 450 other occupational safety and health professionals. The resulting document, released in 1986, summarizes 12 broad tactical approaches, and 23 immediate and future actions needed to understand and prevent a variety of occupational musculoskeletal injuries.

**1.2.4 1990—OSHA Releases Report: "Ergonomics Program Management Guidelines for Meatpacking."** As a partial response to a substantial increase in the frequency and severity of cumulative trauma disorders in the meatpacking industry, which were documented by a series of OSHA investigations, OSHA issued a document entitled *Ergonomics Program Management Guidelines for Meatpacking Plants*. The guidelines were intended to provide a starting point for design of occupational health programs to prevent work-related musculoskeletal problems by removing their causes from the workplace. The guidelines emphasized the need for management commitment and employee involvement. In addition, they recommended and endorsed the need for worksite analysis to identify the hazardous jobs and exposures by using both health surveillance, and also ergonomic risk factor assessment. Once problems are identified, prevention of the problems is initiated by use of engineering controls and work practices. The guidelines also addressed the need for a comprehensive program consisting of medical management of affected employees, and the training of managers, supervisors, employees and others in ergonomics.

**1.2.5 1990s—NIOSH Research and Training Activities.** NIOSH has supported a number of extramural-funded research projects ranging from field studies of exposure effect relationships between forceful repetitive work and musculoskeletal disorders, to the development of sophisticated biomechanical models of the spine during lifting. Surveillance and intervention activities undertaken by state health departments have been supported along with projects focusing on model programs to prevent the progression and aid in the rehabilitation of work-related musculoskeletal disorders. NIOSH also has an active intramural research program involving work-related musculoskeletal disorders of the back and upper extremity. Intramural research areas include the use of laboratory studies: to understand the biological mechanism of damage; to identify stressors; and to develop recom-

mended guidelines for overhead work, asymmetrical lifting and data entry tasks. NIOSH epidemiological and field studies have been undertaken by several manufacturing, food processing, service and newspaper industries. Intervention and control projects related to back disorders have been initiated in the nursing homes, beverage delivery, and meat packing industries. NIOSH interest in prevention of occupational musculoskeletal injuries has resulted in their support of related graduate training in ergonomics, occupational medicine and industrial hygiene by individual training project grants and the Educational Resource Center program (ERCs). While a large number of specific projects have been undertaken both extramurally and intramurally, most have been funded modestly in this problem area. NIOSH also has developed and pilot tested an ergonomics training program for practicing professionals.

**1.2.6 1991—Year 2000 Objectives.** Healthy People 2000 is a statement of national opportunities for improving the health of the national public. Although the Federal Government sponsored its development, it was the product of 22 expert working groups, a consortium of 300 national organizations including the Institute of Medicine, and the National Academy of Science. The Year 2000 objectives are intended to improve the health of the national public. Two objectives (out of fifteen occupational health objectives) directly address issues of work-related musculoskeletal disorders.

*Year 2000 Objectives Directed at Work-Related Musculoskeletal Disorders.*

**First Objective:** Reduce cumulative trauma disorders by 40% (compared to BLS 1987 incident rates). **Second Objective:** Increase to at least 50% of the proportion of worksites with 50 or more employees that offer back injury prevention and rehabilitation programs (Baseline: 28.6% offered back care activities in 1985). **Third Objective:** Reduce work-related injuries resulting in medical treatment, lost time from work or restricted work activity to no more than 6 cases per 100 full-time workers (compared to BLS 1987 incident rates). This objective includes both traumatic and nontraumatic injuries. While objectives are important in themselves, perhaps more importantly they signify that many in the nation recognize the importance of these work-related musculoskeletal disorders and injuries.

*NIOSH/OSHA Ergonomics Planning.*

NIOSH continues to refine the 1981 *Work Practices Guide for Manual Lifting* to enable its application in

a broader spectrum of lifting situations. OSHA continues to evaluate the format and scope of a general industry ergonomics standard.

### **1.3 Objectives and Process used to Develop this Report**

Over five years ago NIOSH published its first strategic plan regarding the prevention of occupational musculoskeletal injuries. Because there continues to be a growing interest in the topic, it was deemed appropriate to examine progress towards implementation of the recommendations in the 1986 NIOSH plan. To perform this examination, a one and one-half day Conference was held in Ann Arbor, Michigan in April, 1991. The Conference (A National Strategy for Occupational Musculoskeletal Injury Prevention—Implementation Issues and Research Needs) was promoted and organized by the University of Michigan's Center for Occupational Health and Safety Engineering, with partial funding from NIOSH and the National Institute of Arthritis and Musculoskeletal and Skin Diseases. The objectives for the Conference were to:

- Provide a public forum for experts to discuss:
  - a) strategies and resources needed to prevent occupational musculoskeletal disorders.
  - b) knowledge base and research needed to provide a scientific basis for preventing occupational musculoskeletal disorders.
- Provide a means for public comment on present strategies and research activities during several panel discussions.

A distinguished group of experts participated as speakers, panel chairs and session chairs for the Conference (see Conference Participants). Approximately 400 people attended the Conference, and during three panel discussion periods they presented relevant information to the experts.

Immediately following the Conference, the invited experts at the Conference, joined by additional health and safety professionals, attended two Workshops.

The goal of the Workshops was to develop a consensus as to the state of scientific knowledge necessary to effectively prevent occupational musculoskeletal injuries. One Workshop focused on the current state of knowledge and future research needed related to the following general questions:

1. Can we correctly identify hazardous musculoskeletal stressors in the workplace (e.g., static exertion levels, postures, frequency of exertions, vibration, temperature, psychological demands)?



2. Do we have the tools needed to measure the type and extent of worker exposures to known or suspected hazardous stressors in the workplace?
3. Are there effective biomarkers indicating the existence of specific neuromuscular-skeletal tissue damage?
4. Do we have the means to identify and protect groups of individuals who may be at special risk of future occupational musculoskeletal injury?
5. Do we understand the biomechanical mechanisms that cause pathological conditions to develop from certain types of stress in the workplace?

The second Workshop group focused on the following types of strategic issues:

6. Are we deploying proven surveillance methods in a way that effectively identifies both hazards to the musculoskeletal system and also the corresponding workplace stressors to prevent injurious exposures?
7. Are we developing effective engineering and administrative methods for controlling and preventing occupational musculoskeletal injuries?
8. Do we know what resources are needed to implement and evaluate the variety of engineering and administrative controls now being proposed?

The process to answer these and other related questions was as follows:

1. A set of issues related to each of the above questions was prepared by the Workshop Chairs and sent to the participants before the Conference.
2. With the assistance of professional Conference Facilitators, the issues sent to the participants were discussed and refined at the beginning of the Workshops.
3. The revised issues were then rated by the participants to indicate the relative need for further laboratory and field research on each.
4. The results of the ratings were verbally summarized by subgroups of the Workshop participants.
5. The important issues were further discussed by the larger group to better define the relative *importance of each*.
6. Summaries of the discussions were used to form a draft of Sections 5 and 6 in this report.
7. The entire report draft was circulated to the Workshop participants for final comment and revision.

## 2.0 What is Occupational Musculoskeletal Injury?

### 2.1 Definition of Acute and Chronic Musculoskeletal Injury

Acute musculoskeletal injury most often develops from a specific mechanical stressor that traumatizes certain musculoskeletal tissues and results in the sudden onset of pain and possibly movement limitation. An example would be when a person slips and falls while walking. The injurious mechanical stress could be of an internal type, when the neuromuscular system quickly contracts muscles to stop the impending fall as the foot slips. This unexpected muscle contraction may tear muscles and tendons in the legs, back and arms, and even dislocate joints. In other cases, the mechanical stress could be external in nature, resulting from the impact of the person with an object or floor during the fall. In this case the impact stress may rupture muscles and ligaments or even fracture bones.

In contrast, the specific site of anatomical damage in most chronic musculoskeletal injuries or disorders is less clear. Chronic work-related musculoskeletal disorders of the upper extremity have been given a number of labels including cumulative trauma disorders, repetitive trauma disorders, repetitive strain injuries, overuse syndromes, and regional musculoskeletal disorders. In cross-sectional examinations of active working groups in jobs with several risk factors for these types of disorders, many workers will report some intermittent hand, arm or shoulder pain during the course of a year. A small minority (3% to 10%) will have symptoms and physical findings consistent with carpal tunnel syndrome, while an approximately equal number will have symptoms and signs consistent with some type of hand or forearm tendinitis. Some workers will have pain and either no definite physical findings or findings not clearly related to specific anatomical sites such as a specific tendon. Many chronic cases of low back pain or neck pain are similar, in that the specific site of the anatomical damage or mechanism is unclear.

Acute and chronic work-related musculoskeletal disorders present a spectrum ranging from conditions such as a prolapsed lumbar disc or carpal tunnel syndrome, where the cause of the pain or loss of function is clear, to other conditions where the specific diagnosis is less clear. These conditions are also quite variable in terms of severity and level of impairment.

The precise number of workers affected each year by work-related musculoskeletal disorders is not known. The magnitude of the problem is very large. For example, in a recent National Health Interview Survey over five million workers reported back pain from repeated activities at work such as lifting; over one million workers reported that they had stopped working, changed jobs, or made a major change in

work activity because of hand discomfort not related to an acute injury. In a similar question related to back pain, over two million workers reported they had stopped working or changed jobs because of back pain. Analysis of virtually all data sources confirms that work-related low back disorders represent a major source of human suffering and economic loss for employers, employees and society.

For work-related musculoskeletal disorders of the upper extremity, there has been a marked increase in the number of cases reported by the Bureau of Labor Statistics and a much greater recognition of these disorders by many in our society: government, medicine, media, unions, and employers. There is an active debate over whether this elevation reflects solely an increase in reporting, or changes in work in the 1980s due to an increase in economic competition or technological changes such as the introduction of computers and VDTs into the office. Most likely, the truth lies somewhere between these two explanations. Whatever the cause of this increase, it may well continue into the 1990s, because the factors that may be contributing to the increase do not seem to be diminishing (e.g., an increasingly older work force, increasing international competition for our manufacturing industries). The recognition and prevention has been characterized by Assistant Secretary of Labor for Occupational Safety and Health, Gerard Scannell.

## 2.2 Anatomical Structures of Concern

The musculoskeletal system provides four basic functions: 1) support of vital organs against gravity, 2) protection against external mechanical stressors (e.g., impact forces), 3) mobility to move about and reach objects within the physical environment, and 4) control of the manual forces necessary to alter performance and the environment. These four functions are made possible by the unique structure and physiological performance capability of the human musculoskeletal system.

The components of the system are arranged such that relatively small movements of muscles allow the extremities to demonstrate large motions. This is accomplished by rotating bones about several joints in a coordinated fashion. Hence, a person is capable of curling up into a small form or extending the arms and torso to reach objects several feet in front, to the side, or over the body. Unfortunately, the same structural form that provides this wonderful mobility also produces very large muscle, tendon, ligament and joint internal forces when reacting to the weight of the body and any other external forces acting on the body (e.g., hand loads). In fact, if one pushes a button with 10 pounds of force on the end of a finger, the finger flexor tendons and more proximal joints, such as the wrist, may be subjected to 50 pounds of force. Likewise,

when picking up a 50-pound box from the floor, the low back muscles and spinal discs can be subjected to over 1000 pounds of force, depending on specific postures and precise motions involved.

When the internal forces become very large, as they do in many manual tasks, precise control of several different muscles also is necessary. Otherwise a single muscle, tendon or ligament becomes overstressed, and acute injury results. Further, even at levels of exertion that are well below the short-term mechanical capacity of individual tissues, injuries can occur. This is because these tissues cannot tolerate sustained or highly repeated stresses. In fact, skeletal muscles lose their capacity to contract and precisely shorten when statically contracted for several hours at only 5% of their short-term strength. This muscle fatigue results in acute pain and diminished coordination. Repeated episodes of muscle fatigue may result in chronic changes in either the structure or metabolism of muscle fibers. The precise mechanisms of these hypothesized changes have not been clearly delineated, but may be associated with chronic pain. Chronic localized neck pain, which is most likely due to muscle damage, is common in workers who persistently work for prolonged periods with their heads in a forward flexed posture.

Likewise, with tendons that are repeatedly stressed during low force, tendon fiber tears and inflammation can occur. If a tendon that is subjected to such repeated stresses also passes around or through other supporting tissues at a joint (e.g., synovium or bursa), then these may also become irritated and inflamed (i.e., tendinitis, synovitis and bursitis develops), all of which can produce chronic limitations for the individual. Typically, the resulting pain and motion limitation is progressive with each episode when associated with bouts of repetitive or strenuous exertions. The course and severity of these tendon-related disorders is quite varied. Some are mild and intermittent; others are severe and persist for long periods even after the initial cause has been eliminated. The most common name for these tendon-related disorders is "cumulative trauma disorders" based on the scientific belief that these disorders are due to repeated stresses on the tendons not the result of a single stress. The level of force and repetition that causes the chronic inflammation may not be hazardous if adequate periods of rest or recovery from mild symptoms are used.

If inflammation involves those tendons that pass through the palmar side of the hand (i.e., the finger flexor tendons) the resulting swelling in this region can entrap the median nerve in the wrist. Such entrapment produces chronic pain in the hand with loss of sensation and coordination (i.e., carpal tunnel syndrome develops). These conditions can probably be more accurately identified as work-related musculoskeletal disorders because, in some cases of chronic pain and impairment, the specific mechanism of injury

is not known and cause of pain cannot be prescribed to a specific anatomical structure such as a tendon.

The spinal column and associated intervertebral discs appear to be particularly vulnerable to acute and chronic injury, perhaps because we don't readily sense the extremely high mechanical stresses on the column until the discs have already failed (i.e., after the disc outer fibers have torn and inflammation develops). In such cases, the individual may not just develop low back pain, but if the inflammation and bulging of the damaged disc tissues irritate major spinal nerve roots, then lower extremity pain develops along with diminished sensation and motor coordination (i.e., a condition known as sciatica).

Most people suffering from both acute and chronic musculoskeletal injuries will recover from their symptoms within two weeks following the cessation of the offending stresses. Unfortunately for some, particularly if significant structural damage or neural trauma has occurred, the symptoms will persist, possibly for the rest of their lives. In the case of low back pain, approximately 70% of the population report that they have suffered at least one episode of low back pain during their working lives (18-65 years old), and about 20% of the population report that they are currently suffering from low back pain. It is well accepted that once a person has suffered an episode of low back pain, he or she is at elevated risk for a reoccurrence in the next year independent of other risk factors. In other words, the tissues have been injured and recovery may not be complete although the patient is temporarily free of pain.

Many studies have indicated that individuals with the more chronic and persistent injuries tend to have feelings of depression, anger, and loss of self-esteem. They may lose their hope that they will ever be able to work again, and may in a sense give up, becoming totally disabled by their musculoskeletal symptoms. Other individuals with the same apparent level of discomfort or severity of condition will continue to work despite their symptoms. When musculoskeletal complaints persist, health care providers, family, friends and employers often become frustrated and even skeptical about the physical nature and extent of the injury.

It is likely that an individual's reaction to an injury or disorder depends on many things such as his or her ability to adjust to the working environment and to the impairments. In all of these conditions, the longer a person is on sick or disability leave, the smaller the likelihood that the individual will return to work. Partially as a result of this observation, more attention has been placed on earlier comprehensive rehabilitation programs that address all of the potential barriers to returning to work, such as the need for physical reconditioning, psychological counseling, and redesign of the work environment. In addition, these programs attempt to reduce the need for surgery. Very few prospective studies have been undertaken which

allow us to understand the complex interaction between the individual psychological reaction to an injury, the severity of the injury, and the nature of the work environment from both a social and physical perspective. One of the most controversial issues is the extent to which psychological causes explain impairment from the musculoskeletal injuries and disorders. Regardless of the precise interactions, in a very real sense, it is accepted that the afflicted individual can become both physiologically and psychologically disabled. This is one reason why musculoskeletal injuries are reported to cause so much loss in the "quality of life."

### 3.0 What are the Suspected Occupational Risk Factors?

#### 3.1 Multi-Factored Risk Models

Several occupational risk factors have been linked to the incidence of musculoskeletal injuries. The most frequently cited occupational risk factors for disorders such as low back pain and upper extremity cumulative trauma disorders include: repetitive exertions, forceful exertions, awkward postures, mechanical stress, vibration, and cold temperatures. Often, workers are exposed to more than one risk factor. Currently, there are no extensively validated models to precisely determine a worker's risk level without some degree of uncertainty for a specific musculoskeletal disorder, based on his/her exposure to one or more of these occupational risk factors.

*Repetitive exertions* have been identified as one of the leading workplace risk factors for upper extremity cumulative trauma disorders. The repetitiveness of a lifting task also is associated with an increased incidence of low back pain. The repetitiveness of an operation can be described in several ways including: (1) the number of cycles per hour, (2) the number of lifts per hour, (3) the number of steps (exertions) included in each work cycle, or (4) the total number of exertions per hour.

*Forceful exertions* performed by the upper extremities in a hand-intensive task or by the whole body in a lifting situation are associated with the development of musculoskeletal injuries. The force requirements of a job are related to the weight of the object lifted or carried, the slipperiness of objects being gripped, and other manual reaction forces such as torque. Work pace, the use of gloves, and hand posture have been shown to increase the force requirements to perform a task.

*Awkward postures* of the upper extremities and torso have been identified by researchers and linked to the incidence of musculoskeletal disorders. Standing erect with the arms hanging at the side is considered to be a non-stressful posture. Working with