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**The Science of Occupational
Musculoskeletal Disorders**

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Foreword

NIOSH prepared this written testimony for a May 21, 1997 hearing on the science of ergonomics held by the Subcommittee on Workforce Protections of the Committee on Education and the Workforce in the U.S. House of Representatives. Dr. Rosenstock did not have the opportunity to present this testimony in person but it was submitted for the record. This document contains her verbatim written statement.

The Science of Occupational Musculoskeletal Disorders

Good morning Chairman Ballenger, Ranking Member Owens and members of the Committee. As the Director of the National Institute for Occupational Safety and Health (NIOSH), I am pleased to be here today to discuss the science regarding occupational musculoskeletal disorders.

NIOSH is a research institute within the Centers for Disease Control and Prevention, a part of the Department of Health and Human Services. NIOSH is the only federal agency mandated to conduct research and train professionals to identify and prevent workplace hazards.

I will discuss the magnitude and scope of the problem of work-related musculoskeletal disorders (MSDs) and the two decades of experience and research that NIOSH has amassed that establish a relationship between work factors and these disorders. I will also describe what we are doing and what we have learned about preventing these health conditions. Finally, I will describe the National Occupational Research Agenda—and the importance that the occupational safety and health community has placed on addressing through research musculoskeletal and other work-related problems.

Let me begin by drawing a distinction between ergonomics and musculoskeletal disorders. Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of the working population. Ergonomics is an approach or solution to deal with a number of problems—among them are work-related musculoskeletal disorders.

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Musculoskeletal disorders include a group of conditions that involve the nerves, tendons, muscles, and supporting structures (such as intervertebral discs). They represent a wide range of disorders, which can differ in severity from mild periodic conditions to those which are severe, chronic and debilitating. Some musculoskeletal disorders have specific diagnostic criteria and clear pathological mechanisms (like hand/arm vibration syndrome). Others are defined primarily by the location of pain and have a more variable or less clearly defined pathophysiology (like back disorders). Musculoskeletal disorders of the upper extremities include carpal tunnel syndrome, wrist tendonitis, epicondylitis and rotator cuff tendonitis. Both nonoccupational and occupational factors contribute to the development and exacerbation of these disorders.

Magnitude of the Problem

Musculoskeletal disorders are among the most prevalent medical problems in the U.S., affecting 7% of the population. They account for 14% of physician visits and 19% of hospital stays. 62% of persons with MSDs report some degree of limitation on activity compared with 14% in the population at large.

What do we know about work-related musculoskeletal disorders? The only national routine source of information on occupational injuries and illnesses experienced by U.S. workers is the Annual Survey of Occupational Injuries and Illnesses conducted by the Bureau of Labor Statistics (BLS). The survey is a random sample of about 250,000 private sector establishments, but excludes the self-employed, farms with fewer than 11 employees, private households, and all government agencies. The survey provides estimates of

workplace injuries and illnesses based on information provided by employers to BLS from their OSHA 200 log of recordable injuries and illnesses.

BLS has conducted this annual survey for the past 25 years; so we have some very basic information on annual cases of occupational injury or illness that required more than first-aid, including medical treatment, restricted work activity, or requiring days away from work for each year since 1972. This information includes the total number of cases categorized on the OSHA 200 log as either an injury or an illness. All back disorders are by definition classified as injuries. The illness data are separated into six subcategories—the category that captures most but not all musculoskeletal conditions is disorders associated with repeated trauma.

From this part of the survey, BLS reports that in 1995, 308,000 or 62% of all illness cases were due to disorders associated with repeated trauma (again excluding low back disorders because they are captured as injuries). The numbers of cases of repeated trauma increased dramatically, rising steadily from 23,800 cases in 1972 to 332,000 cases in 1994—a fourteen-fold increase. In 1995 the number of cases decreased by 7% to 308,000 reported cases, but this number still exceeds the number of cases in any year prior to 1994.

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Because these summary data did not adequately describe the nature of occupational injuries and illnesses and the related risk factors, the survey was redesigned in 1992 to capture more detailed information on injury and illness cases requiring days away from work. This redesigned survey captures

demographic information about injured workers as well as specific characteristics of the injury or illness, including: (1) the *nature* of the injury or illness condition as described by the employer, such as sprain or carpal tunnel syndrome; (2) the *part of the body affected* by the specified condition, such as back or wrist; (3) the *source of the injury or illness* that directly produced the disabling condition, such as a crate, heavy box, or a nursing home patient; and (4) the *event or exposure* that describes the manner in which the injury or illness was inflicted, such as overexertion while lifting or repetitive motion.

For those cases involving days away from work, BLS reports that in 1994—the last year for which the detailed data are complete—approximately 32%, or **705,800** cases, were the result of overexertion or repetitive motion. Specifically:

- There were **367,424** injuries due to overexertion in lifting. The majority (65%) affected the back. Another **93,325** injuries were due to overexertion in pushing or pulling objects (52% affected the back). In addition, there were **68,992** injuries due to overexertion in holding, carrying, or turning objects (58% affected the back). The median time away from work due to these injuries was six days for lifting, seven days for pushing/pulling, and six days for holding/carrying/turning.

- **92,576** injuries or illnesses occurred as a result of repetitive motion, including typing or key entry, repetitive use of tools, and repetitive placing, grasping, or moving of objects other than tools. Fifty-five per cent of these affected the wrist, followed by 7% affecting the shoulder, and 6% affecting the back. The median time away from work was 18 days as a result of injuries or illnesses due to repetitive motion.

- The remaining **83,483** occurred in other and unspecified overexertion events.

The precise cost of occupational musculoskeletal disorders is not known. Estimates vary depending on the method used. A conservative estimate previously published by NIOSH is \$13 billion annually. Others have estimated the cost at \$20 billion annually. Regardless of the estimate used, the problem is large both in health and economic terms.

An industry survey found that 55% of large companies reported an increase in workers' complaints in just one year (1995-1996) and most were taking preventive actions: 84% said that they were modifying equipment/task/processes; 83% said that they were analyzing work stations/jobs; and 79% were buying new equipment to alleviate these problems.

Review of the Scientific Literature

NIOSH scientists are finalizing the most comprehensive review of the occupational epidemiological literature to date. More than 2,000 scientific studies have been reviewed. Occupational epidemiology is the study of workplace exposures and their association with the frequency and distribution of illnesses and injuries among populations. In addition to workplace factors, some occupational epidemiological studies have designs that allow the researchers to consider lifestyle and behavioral risk factors that may contribute to the development of musculoskeletal conditions. The goal of formal epidemiological studies is to evaluate relationships in populations among risks, exposures and health conditions.

The NIOSH review examines relationships among workplace factors and musculoskeletal disorders of the neck, upper extremities,

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and low back and analyzes the strength of the epidemiologic evidence for causal links between specific workplace factors and musculoskeletal disorders. The review describes the magnitude of the problem and the relationship of musculoskeletal disorders to specific workplace hazards, as well as to psychosocial (work organization) issues in the workplace. The researchers systematically reviewed articles from diverse workplaces—from data entry workers to meat packers, from garment workers to dentists and ultrasonographers.

The review assesses the inclusion by the authors of the studies of well-accepted epidemiologic methods (such as appropriately constructed study designs, and use of reasonable health outcome and exposure criteria). Non-occupational factors were also examined. These studies were used to evaluate the relationships among disorders and risk factors.

The NIOSH review document has undergone a particularly comprehensive review, over and beyond the rigorous review that is normally carried out for all NIOSH documents. Each NIOSH document is scrutinized for scientific accuracy, reliability, and validity through an established review process. We are now finalizing the document based on feedback from this extensive peer review. We expect the document to be available in the next few months. It will provide detailed analyses of studies in the scientific literature.

What Does the Scientific Literature Tell Us?

Low Back Disorders

The epidemiologic literature supports a relationship between the development of low back disorders and each of the following

workplace risk factors: (1) lifting and forceful movements, (2) bending and twisting in awkward postures, and (3) whole-body vibration.

A NIOSH study in a grocery warehouse in Ohio illustrates the problem of low back disorders. Warehouse workers, performing long hours of repetitive, heavy manual lifting, had a rate of workers' compensation claims for back injuries of 16 per 100 workers, compared to the national average rate of workers' compensation claims for back injuries of between one and two cases per 100 full-time workers. In this warehouse, workers sometimes lifted a total of more than 3000 pounds in less than one hour. Clearly, this is a high risk workplace. As a matter of fact, workers' compensation data from the National American Wholesale Grocers' Association and the International Foodservice Distributors Association for the years 1990 to 1992, found that back strains/sprains accounted for 30% of all injuries for warehouse workers. Data from the same report indicated that more than a third of all workers experience an annual injury in warehouse operations, accounting for a cost of \$0.61 per worker-hour. Many other workplaces like this one experience high rates of work-related musculoskeletal disorders.

Disorders of the Neck and Shoulders

For disorders of the neck and neck/shoulder region, the literature identifies two important workplace factors of (1) sustained postures causing static contractions of the neck and shoulder muscles (for example, working overhead in automobile assembly or in construction), and (2) combinations of highly repetitive and forceful work involving the arm and hand, which also affect the musculature of the shoulder and neck region.

Analysis of job components can show how workers develop musculoskeletal disorders. One study describes the job of a carbon setter, an important job in the processing of aluminum, which provides us with an example of repetitive and forceful work. Aluminum ore is melted at very high temperatures in large electric pots, about the size of a conference table. These pots develop a hard crust that must be broken in order to add materials to the melting aluminum. To break the crust, carbon setters frequently throw a large bar weighing twenty-five pounds into the pot. This report documented increased shoulder disorders among the carbon setters in the study.

The basic shoulder motion when throwing down the bar into the pot is the same motion involved in baseball pitching, (and we've all heard about million dollar rotator cuff injuries in the major leagues). In a typical game, a major league baseball pitcher throws between 90 and 120 pitches. A carbon setter throws the equivalent of between one and two double-headers every shift. The bar does not travel 90 m.p.h. like a baseball, but a baseball doesn't weigh 25 pounds.

Disorders of the Hand, Wrist and Elbow

There are several conditions to consider within the hand and wrist region. Combined work factors of forceful and repetitive use of the hands and wrists are associated with carpal tunnel syndrome. Vibration from hand tools like chainsaws (those that do not have vibration controlling mechanisms) also contributes to carpal tunnel syndrome.

Vibrating tool use has also been strongly linked to hand and arm vibration syndrome, a

separate condition of the hand and wrist that affects the nerve and blood vessels.

Workers in industries such as meatpacking, garment work, fish and poultry processing spend their workdays performing forceful exertions and repetitive movements of the hand and wrist. The combination of these has been found to have a strong association with tendonitis of the wrist and have also been associated with disorders of the elbow, such as epicondylitis.

Length and Intensity of Exposure

The epidemiological literature indicates that the greater the level of exposure to a single risk factor or combination of factors, the greater the risk of having a work-related musculoskeletal disorder. The literature also indicates that an important factor is the time between each episode of exposure. With adequate time to recover or adapt, and particularly when lower forces are involved, there may be less harm to the body from repeated exposures. You will recall the carbon setter/major league baseball pitcher analogy; it is important to remember that a major league pitcher plays only every third or fourth game, while the carbon setter throws the equivalent of one or two double-headers five days a week, 50 weeks a year. The intensity as well as the extended length of the exposure to forceful, repetitive work plays a substantial role in the risk of work-related musculoskeletal disorders in many traditional occupational settings.

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Psychological Factors

In workplaces with high rates of work-related musculoskeletal disorders there is little

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scientific evidence that the principal reason for the excess number of injuries or illnesses is the workers' psychological reaction to their workplace. However, there is evidence, particularly in office settings, suggesting that both physical and psychosocial [work organization] factors may be important contributors to musculoskeletal disorders. Work organization refers to the way work processes are structured and managed, and it deals with subjects such as scheduling of work, job design, interpersonal aspects of work, career concerns, management style, and organizational characteristics. We know more about how physical factors contribute to musculoskeletal disorders than we do about work organization factors. NIOSH is supporting research projects in both areas.

What Solutions are in Place?

We aren't working just on the scientific review of the literature of MSDs. Using a public health approach, NIOSH is working to understand and prevent work-related musculoskeletal disorders through research, technical assistance, publications and spreading the word.

In January 1997, NIOSH and OSHA organized a conference, *Ergonomics: Effective Workplace Practices and Programs*. The conference provided a forum to share information about programs that effectively prevent musculoskeletal disorders in the workplace. More than 1,000 persons attended the conference, primarily representing employers. Fifty presenters from the private sector and ten from labor described their ergonomic programs and how they worked. The participants—from labor, industry, business, universities, health care, and professional societies—echoed the same messages: Musculoskeletal disorders are a

major work-related problem, and ergonomic programs can dramatically reduce lost work time due to injuries and illnesses.

NIOSH provides technical assistance to employers and employees. In 1996, NIOSH received 15 requests to evaluate musculoskeletal hazards. In addition NIOSH received almost 4,000 calls requesting information about these problems and their solutions from individuals and employers. NIOSH technical assistance in the workplace helps to develop solutions and illustrates a process that employers and employees can use to prevent work-related musculoskeletal disorders.

For example, in 1990, NIOSH received a joint labor-management request from a motorcycle manufacturer to evaluate musculoskeletal disorders of the upper limbs and back. The labor-management team was concerned with an increase in workers' compensation costs due to an increasing number of injuries. Based on the initial evaluation, NIOSH provided recommendations to reduce ergonomic risk factors. The company responded by forming an ergonomics committee consisting of management and labor representatives to redesign or eliminate jobs where musculoskeletal hazards were identified. NIOSH returned to evaluate the effectiveness of these interventions in response to a second joint labor-management request. After five years, cases of musculoskeletal disorders were reduced by more than half and lost or restricted workdays had dropped from 610 to 190 per 100 workers.

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Disorders. The primer provides basic information for employers, workers, and others in designing effective programs to prevent work-related musculoskeletal disorders. The primer summarizes practical experience NIOSH has acquired, frequently in small and medium-sized businesses. It contains steps that can be used by employers and employees to evaluate and minimize the risks of musculoskeletal disorders.

What Lies Ahead?

While NIOSH recognizes that ergonomic programs can make a difference today, we also recognize that more research is needed. The National Occupational Research Agenda (NORA) was developed last year in partnership with over 500 stakeholders in the public and private sectors. The Agenda provides a framework to guide occupational safety and health research not just at NIOSH but for the nation. The Agenda's 21 priorities focus on critical occupational research that is most likely to improve safety and health of our nation's workforce.

Through effective programs the pain and disability of musculoskeletal disorders can be reduced, workers' compensation costs can be cut, and productivity and employee satisfaction can be improved.

NORA includes two priority areas directly related to musculoskeletal disorders. There was strong consensus among the diverse stakeholders in the selection of these priorities. Five out of five expert working groups rated upper extremity disorders as a top priority. International occupational safety and health directors and our corporate liaison committee survey also agreed. There was the same consensus about low back disorders. A number of other NORA priority areas are relevant to musculoskeletal disorders such as assessing the effectiveness of interventions.

Summary

The scientific literature shows that certain work factors cause musculoskeletal disorders and that musculoskeletal disorders are a major problem leading to adverse health and economic consequences. Through effective programs the pain and disability of musculoskeletal disorders can be reduced, workers' compensation costs can be cut, and productivity and employee satisfaction can be improved. We can take these steps now—as we have done with other occupational health problems—at the same time we continue to do research and become smarter about the causes and solutions of these problems. We know quite a bit—we have more to learn. In science as in life, knowledge may be imperfect, but to deny what we do know about these complex problems is to deny the American worker the benefits of that knowledge.

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