The Magnitude, Science Base, and Solutions for One of the Largest Occupational Health Problems in the United States

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MAGNITUDE OF THE PROBLEM

The surveillance data on work-related musculoskeletal problems clearly indicate that they are one of the largest occupational health problems in the United States. Some MSDs have specific diagnostic criteria and clear pathological mechanisms (e.g., carpal tunnel syndrome). Others are defined primarily by the location of pain and have a more variable or less clearly defined pathology (e.g., back disorders). MSDs represent a wide range of disorders, which can differ in severity from mild periodic conditions to those that are severe, chronic, and debilitating. While some of these disorders, such as low back pain, are common in the general population, NIOSH research has consistently found that the rates of these disorders are higher in heavily exposed workers, such as those in meatpacking, grocery-store checking, newspaper editing, and warehousing, compared to those with lower exposure.

One of the sources of national information on the magnitude of work-related MSDs is the Annual Survey of Occupational Injuries and Illnesses conducted by the Department of Labor's Bureau of Labor Statistics (BLS). This information includes the total number of cases categorized on the OSHA 200 logs as either an injury or an illness.

From this part of the survey, BLS reports that in 1998, 253,200 reported illnesses were due to repetitive motion. The number of cases of disorders due to repetitive motion increased dramatically from 23,800 cases in 1982 to 332,000 cases in 1994, a fourteen-fold increase. Since 1994, BLS has reported about a 24% downward trend. This downward trend has been observed in nearly all types of injuries and illnesses collected by BLS, not only those associated with MSDs. There have been several explanations offered for this decline, such as growing emphasis on cost control in response to rising workers' compensation costs, but undoubtedly one reason is the increase in the efforts of employers and employees to address these problems. Despite this recent decrease, the number of cases of disorders due to repetitive motion is still high, accounting for 65% of all reported occupational illnesses in 1998.

More than 603,096 employees lost workdays due to overexertion or repetitive motion in 1997, the last year for which the detailed data are complete:

- There were 297,317 injuries due to overexertion in lifting involving days away from work. The majority (58%) affected the back. Another 75,371 injuries were due to overexertion in pushing or pulling objects. In addition, there were injuries due to overexertion in holding, carrying, or turning objects.
- 75,188 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. Sixty-eight percent of these affected the wrist.

The occupations most affected by MSDs are often lower wage jobs that employ high numbers of minority workers. The BLS data also indicate that manufacturing jobs, manual handling jobs, construction, agriculture, and maritime industries, and many repetitive tasks performed in other industries all have elevated risks for one or more MSDs.

BLS data underestimate the true magnitude of the problem for two reasons: 1) approximately one-third of industries are not included in the BLS annual survey, and 2) under-reporting of the true number of work-related health problems on the OSHA 200 logs occurs [Pollack 1987]. Several NIOSH health hazard evaluations (HHEs) identified under-reporting of work-related MSDs as reported by OSHA 200 logs. These HHEs compared the OSHA 200 logs with work-related MSDs ascertained via the following mechanisms: 1) confidential medical interviews; 2) review of employee medical records of private health care providers; 3) health surveys utilizing standardized MSD symptom questionnaires; 4) health surveys defining cases as those with work-related symptoms and positive physical findings conducted by physicians performing physical examinations targeted to the musculoskeletal systems. In addition to the under-reporting noted above, other surveillance systems have also found occurrences of under-reporting of work-related MSDs. The NIOSH-sponsored state-based surveillance program in California found that two thirds of the cases of work-related carpal tunnel syndrome did not appear in the California mandated state-reporting system (Doctors' First-Reports of Occupational Disease) when records were compared to the states's largest HMO (Kaiser Permanente) [California Department of Health Services 1999]. BLS data and NIOSH's analysis of other surveillance data reach the same conclusion—work-related MSDs are one of the largest occupational health problems in the United States. The

magnitude of the problem is confirmed by workers' compensation data. In Washington State between 1990 and 1997, 27% of all workers' compensation claims and 46% of the cost of all claims resulted from non-traumatic musculoskeletal disorders of the neck, upper extremity or back [Silverstein 1999].

Science Base - Critical Review of the Epidemiologic Literature

In 1997, NIOSH published a review of the epidemiologic evidence of the relationship between selected MSDs of the upper extremity and the low back and exposure to physical factors at work [Bernard 1997]. A team of NIOSH researchers systematically reviewed and analyzed more than 2,000 occupational epidemiology studies, and ended up focusing on the best 600—conducted in a variety of workplaces ranging from meat packing plants to offices, garment factories to aluminum mills.

The goal of epidemiologic studies is to identify factors that are associated (positively or negatively) with the development or recurrence of adverse medical conditions. The NIOSH evaluation and summary of the epidemiologic evidence focused chiefly on disorders that affect the neck and the upper extremities, including tension-neck syndrome, shoulder tendinitis, epicondylitis, carpal tunnel syndrome, hand-wrist tendinitis, and hand-arm vibration syndrome.

No single epidemiologic study will fulfill all criteria to answer the question of causality. However, results from epidemiologic studies can contribute to the evidence of causality in the relationship between workplace risk factors and MSDs. The framework for evaluating evidence for causality in the NIOSH review included strength of association, consistency, temporality, exposure-response relationship, and coherence of evidence.

Based on the review, NIOSH concluded that a substantial body of credible epidemiologic research provides strong evidence of an association between MSDs and certain work-related physical factors when there are high levels of exposure, particularly with exposure to more than one physical factor (e.g., repetition and forceful exertion). The strength of the associations reported in the various studies for specific risk factors, after adjustments for other factors, varied from insufficient to strong. The consistently positive findings from a large number of cross-sectional studies, strengthened by the available prospective studies, provides strong evidence for an increased risk of work-related MSDs for all but one type of MSD studied. This evidence can be seen from the strength of the associations, lack of ambiguity in temporal relationships from the prospective studies, the consistency of the results in these studies, and adequate control or adjustment for likely confounders. For all of the MSDs studied, there is sufficient epidemiologic evidence for a causal relationship with a combination of job risk factors, and in some cases with individual job risk factors. In addition to the epidemiological literature, there is the clinical, laboratory, and psychophysical data that provide significant and independent contributions to assessing the causal relationship between work and MSDs. For example, the epidemiological data for shoulder disorders is notable, but does not reach the level of strong evidence in the NIOSH epidemiological review. However, the laboratory studies of shoulder posture show that increased activities, subjective fatigue, and electromyographic changes all contribute to the causal association between prolonged overhead work and shoulder disorders [Keyserling 2000].

Psychophysical studies conducted by NIOSH investigators [Putz-Anderson 1993; Rosa 1998] provide strong support for the interactive role of force and repetition as significant causal factors associated with shoulder pain severe enough to interfere with work. DeLacerda [1982], Matsen and Kirby [1982], and Neviaser [1983] also found an association between chronic muscle fatigue from repetitive movement and the onset of MSDs. Similarly, quantitative modeling of the acromicon supraspinatus interaction helps explain the epidemiological link between shoulder posture and disorders [Kai-Nan An 1995].

For low back disorders, NIOSH found strong evidence of an association with lifting and forceful movements. Those studies using objective measures to examine specific lifting activities generally found dose/response relationships between exposures and low back pain. These relationships are consistent with biomechanical and other laboratory evidence regarding the effects of lifting and dynamic motion on back tissues. NIOSH also found that bending and twisting in awkward postures and whole body vibration were contributing factors to low back pain. The literature showed that working groups are at increased risk for neck/shoulder disorders when they have jobs with extreme working postures (such as working with the hands above the head or arms above shoulder level), or prolonged static loads (such as working overhead holding tools). Combinations of highly repetitive and forceful work involving the arm and hand also affect the shoulder and neck regions. These studies provided sufficient evidence for work-relatedness as well. Combined work factors of forceful and repetitive use of the hand, wrist, and elbow are associated with carpal tunnel syndrome, tendinitis, and epicondylitis. There is substantial evidence that as the intensity and duration of exposure to vibrating tools increase, the risk of developing hand-arm vibration syndrome increases. There is also evidence that an increase in symptom severity is associated with increased exposure.

The National Academy of Sciences (NAS) assembled a panel of epidemiologists and medical researchers to examine the scientific literature relevant to work-related MSDs . In their report, published in 1999, the NAS concluded that the "associations identified by NIOSH as having strong evidence

were well supported by competent research on heavily exposed populations." Certain limitations in the data in the NIOSH review, due to the large number of cross-sectional studies, the use of self-reported data, and healthy worker bias, were noted in the NAS document and judged to not detract from the overall conclusions of the NIOSH reviews. Finally, the NAS concluded that there is a strong biological plausibility to the relationship between the incidence of MSDs and the causative exposure factors in high-exposure occupational settings. All of these bodies of scientific information are in fundamental agreement with each other.

ERGONOMIC PROGRAM EFFECTIVENESS

NIOSH has concluded that there is substantial evidence that ergonomic programs are effective in preventing substantial impairment and disability from work related MSDs. There are numerous companies who have reported success in using ergonomic programs as a cost-effective way to prevent or reduce work-related MSDs, and reduce lost time by workers with MSDs. Some of these companies also report increases in productivity and workplace morale. The technical and scientific literature, some which was reviewed by the NAS panel—illustrates that interventions, including redesign of tools, machines, and work stations, can reduce workplace hazards and the resulting MSDs. Examples of effective ergonomic interventions studies are found in Grant and Habes [1995] and the NIOSH publication *Elements of Ergonomics Programs* [Cohen et al. 1997]. An article by Kilbom [1988], which reviewed 16 intervention programs for work-related neck and upper limb disorders, found that the most effective approaches included worker training and education and the active contribution from management and employers. Knibbe and Friele [1999] recently published the results of a study in which they implemented patient hoists, reduced manual handling in nurses, and significantly reduced back pain over a 12-month period.

NIOSH has conducted or sponsored several studies which add further support for ergonomic programmatic approaches. Examples of these include:

- Fifty workers involved in hand-sanding typewriter housings experienced 185 lost work days and seven carpal tunnel surgeries over a two-year period. Engineering controls, a $14,000 expenditure, and installing a rotating fixture to hold the housings, reduced exposure to repetitive motions and awkward postures. New carpal tunnel syndrome cases decreased from seven to zero over a two-year period. Worker turnover, which had been 100% about every three weeks prior to the ergonomic intervention, was also reduced [Habes 1996].

- Engineering controls made in the beverage delivery industry, which included external handles on containers, multilevel shelving units on trucks, and counterbalanced delivery hand trucks, reduced worker reports of fatigue, multiple handling of beverage cases, and awkward postures during handling of beverages. The approaches used in this study have served as a model for introducing ergonomic interventions in the beverage delivery industry [NIOSH (McGlothlin) 1996].

- At eight nursing home facilities, "zero-lift programs" were implemented using employee-management advisory teams, replacing manual lifting and transferring of patients with usable hoists and patient transfer assistive devices. Injury statistics were compared pre- and post-intervention for a period ranging from three to five years: the number of injuries from patient transfers decreased by 62%, lost workdays by 86%, restricted workdays by 64%, and workers' compensation costs by 84%. This program also produced many intangible benefits including improvements in patient comfort and safety during transfers and patient care [Garg 1999].

The effectiveness of ergonomics programs was a resounding message echoed by labor, industry, business, universities, health care, and professional societies at two conferences co-organized by NIOSH and OSHA to stimulate an exchange of information about preventing work-related MSDs (January 1997 in Chicago and March 1999 in Houston, co-sponsored with the Institute of Industrial Engineers [Alexander 1999]. In general the successful ergonomics programs have reduced lost work time and cut costs due to injuries and illnesses in a variety of industries and workplaces. Examples of practical and cost-effective solutions from the Ergonomics Effective Workplace Practices and Programs Conference in Chicago, 1997, are presented below. The full text of the Chicago Conference can be found on the NIOSH website http//www.cdc.gov/niosh/ec3mfg2.html.

- Ford Motor Company reported major productivity and quality improvements along with reductions in injuries as a result of their joint ergonomics programs with the United Auto Workers.

- ConAgra not only instituted a participatory program, but also designed a red meat cutting machine which automated part of the cutting job. The new machine reduced exposure, increased quality of the product, and was actually paid for by not having to recut the meat to specifications as was previously required.

- Lunt Silversmiths experienced a drop in total lost workdays from more than 300 to less than 50 after implementation of an effective ergonomics program. Workers' compensation costs were reduced from $192,500 to $27,100. The money saved was greater than the cost of the ergonomic improvements.

- PPG Industries, a coatings and resins manufacturer, instituted an ergonomics program which included job analysis, hazard prevention and control, medical management, and training and education. Prior to the institution of their program, they experienced 2,500 workers' compensation claims a year. Following the institution of the ergonomics program, the number of claims was reduced to 1,000.

NIOSH's experience in evaluating the risks of MSDs in a variety of workplaces and our review of information from a variety of sizes of industries has generally shown that using ergonomic programs is an effective way to prevent or reduce work-related MSDs.

CONCLUSION

Work-related MSDs remain one of the most serious problems facing the American workforce. A large body of widely accepted, consistent scientific studies from a variety of disciplines has shown that there is a clear relationship betweer work factors and MSDs. This base of scientific information is much more extensive than that typically available for policy initiatives, particularly with regard to the epidemiologic and human data that has been published. Solutions are feasible and already working in many large and small companies in diverse industries around the country. These programs have reduced pain, disability, and workers' compensation costs, while improving productivity in workplaces of all sizes across a broad range of industries. We know enough now to prevent or reduce the severity of many of these disorders. NIOSH experience leads us to believe, however, that current level of preventive programs are not enough—the number of workplace MSDs is not declining fast enough. We believe that policy initiatives such as the OSHA proposed ergonomics program rule will be an effective and scientifically valid way to reduce the large numbers of these disorders occurring in the U.S. workforce.

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