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National efforts to identify research issues related to prevention of work-related musculoskeletal disorders

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Abstract

Musculoskeletal disorders (MSDs), including low back and upper extremity disorders, represent one of the greatest work-related health concerns facing industrialized nations. Recently, two national groups were charged with developing research agendas aimed at increasing our knowledge of the prevention of these disorders. The first agenda, developed by the National Institute for Occupational Safety and Health's (NIOSH) National Occupational Research Agenda (NORA) MSD team, was based on input from several hundred practitioners and safety and health experts representing industry, labor, and academia. The second agenda, developed by the National Research Council (NRC) and the Institute of Medicine's (IOM) National Panel on Musculoskeletal Disorders and the Workplace, was based on input from leading researchers in the fields of medicine, information science, and ergonomics. This paper summarizes the findings of the two groups and compares the two research agendas.
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1. Scope of the problem

The term ''musculoskeletal disorders'' (MSDs) refers to conditions that involve the nerves, tendons, muscles, and supporting structures of the body. These include such ailments as low back pain, shoulder disorders, and distal upper extremity disorders, including tendonitis, epicondolytis, and carpal tunnel syndrome. The category, sprains, strains, and tears is the leading nature of injury among non-fatal occupational injuries and illnesses. Workers develop these injuries when lifting objects that are too heavy, when working in awkward positions for an extended period of time or when twisting, bending, falling and slipping. These injuries tend to be serious [19]. These disorders also account for a major component of the cost of work-related injuries and illness in the United States. The current economic costs of work-related musculoskeletal disorders are not accurately known. It has been estimated, however, that the cost for low back pain alone, one of many types of WMSDs, was more than $49.2 billion dollars in 1992 [9]. Regardless of the actual costs, the problem is large both in health and economic terms. The enormous scope of the problem is confirmed by statistics from the Annual Survey of Occupational Injuries and Illnesses, conducted by the Bureau of Labor Statistics (BLS). For those cases involving days away from work, BLS reports that in 2001 there were 522,528 MSD cases, 75% of those were due to overexertion and another 11.5% were due to repetitive motion disorders [15]. Specifically:

- 219,665 of these injuries involved lifting and another 69,247 were associated with bending, climbing, reaching, and twisting.
- Approximately 67% of overexertion injuries affected the back and 76.5% were due to strains or sprains.
- The median number of days away from work due to a musculoskeletal disorder was 8 days compared to 6 days for all injuries and illness events combined. More than 43% of the cases, however, involved more than 20 days away from work, and almost one-fourth involved more than 31 days away from work.
- 60,099 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.
- Approximately 62% of the workers reporting MSDs were males and 38% were females.

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- 41% of all reported MSDs were accounted for by one occupation—operators, fabricators, and laborers.
- Industries with the largest numbers of MSDs were services, manufacturing, and retail trade, with 25.8, 22.9, and 16.0%, respectively.
- Approximately 82% of the MSD cases resulted from one of two sources—working with containers or worker motion or position.

Based on these statistics, it is clear that work-related injuries and illnesses represent a significant health problem for the industrial labor force in the United States. Trends in the numbers of cases of reported injuries and illnesses have steadily declined in the last 10 years. According to the BLS, the number of injury and illness cases that resulted in lost work days in private sector industries steadily decreased since about 1990, as can be seen in Fig. 1. During that same period of time, however, the number of cases resulting in restricted work activities steadily increased. In the manufacturing sector, the increase in restricted work cases was even more dramatic, as shown in Fig. 2. The reasons for these declines in lost day injuries and illnesses are unclear, but may include: a smaller number of disorders could be occurring because of more intensive efforts to prevent them; more effective prevention and treatment programs could be reducing days away from work; employers or employees may be more reluctant to report or record disorders; or the criteria used by health care providers to diagnose these conditions could be changing [13]. Nevertheless, these trends suggest that the number of total injury and illness cases may not have changed dramatically over the last decade, but that companies were making efforts to keep the workers on the job longer by restricting work activities, rather than sending the worker home to recuperate.

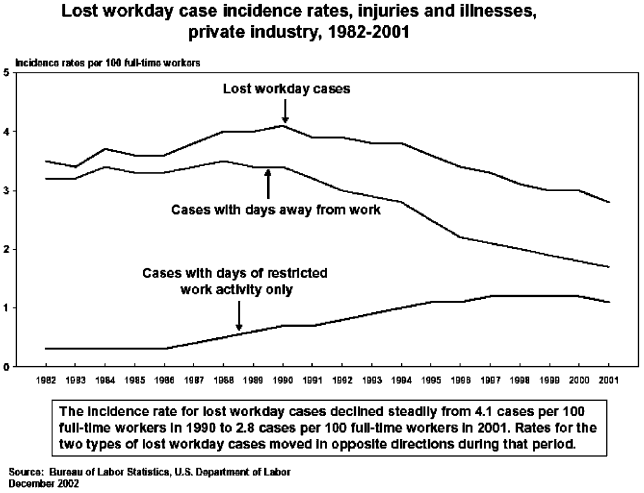

Fig. 1. Injury and illness case incidence rates, 1982–2001.

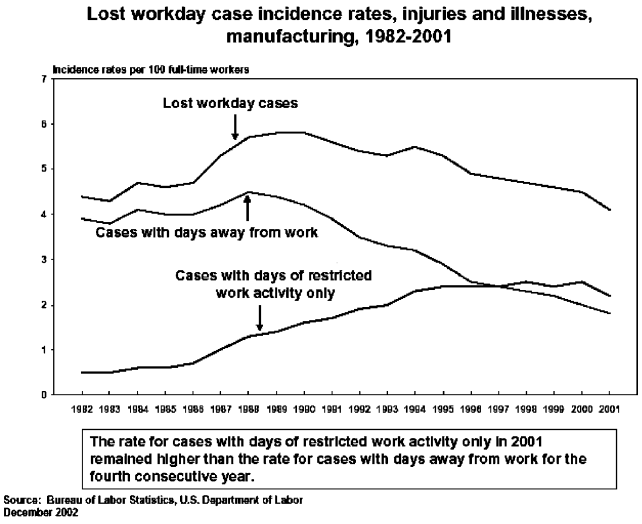

Fig. 2. Injury and illness case incidence rates for manufacturing, 1982–2001.

2. Identifying research priorities

During the past decade, approximately 4000 articles focusing on MSDs have been published [20]. The findings presented in many of these publications have been summarized in various literature reviews [1–8,10,11–13,16–18]. In order to move the science forward, it is critical that research gaps be identified and prioritized in order to maximize the effectiveness of the limited resources available to address this serious health hazard.

As shown in Fig. 3, the number of NIOSH funded intramural and extramural research projects focused on prevention of MSDs has increased steadily over the last 5 years. In addition, NIOSH provides funding for 16 educational resource centers (ERCs) to provide training and educational opportunities aimed at the prevention of MSDs.

In 1996, NIOSH unveiled the national occupational research agenda (NORA), a framework to guide occupational safety and health research into the next decade. The NORA process resulted in identification of 21

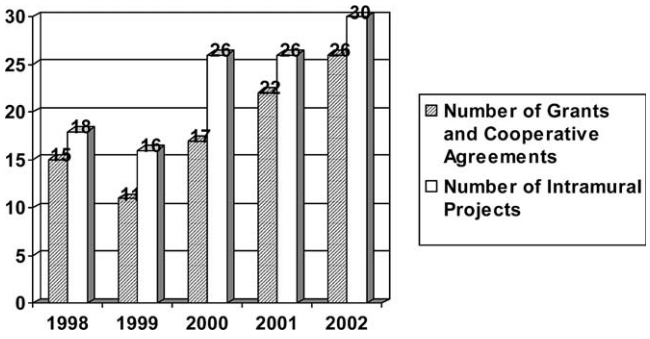

Fig. 3. Number of NIOSH intramural and extramural research projects focusing on prevention of WMSDs, 1998–2002.

high priority areas, two of which included specific work-related musculoskeletal disorders (low back disorders and upper extremity MSDs). In order to address the high priority nature of these two important areas, NIOSH assembled a team of experts representing industry, labor, academia and government to evaluate the status of the scientific research and to identify future research needs in the area of work-related MSDs. In 2001, the NORA MSD team published a national occupational research agenda for musculoskeletal disorders [14]. The team believed that this agenda would serve as a blueprint for building a national research program by identifying high-priority MSD research problems. To obtain maximum input from all stakeholders, NIOSH held a series of regional focus group meetings with practitioners and academicians and asked them to identify high priority research gaps. These meeting have been described elsewhere [14,20].

At about the same time that the NORA MSD team was developing their research agenda, the National Research Council and Institute of Medicine (NRC/IOM), two groups within the National Academy of Science, were asked by the National Institute for Occupational Safety and Health and the National Institutes of Health to organize a team of experts to review the body of scientific literature on the relationship of work and the workplace to musculoskeletal disorders of the low back and upper extremities. The impetus for the study was a set of questions posed by the United States Congress. Based on their review, the panel published a document that provided conclusions regarding musculoskeletal disorders and the workplace that also con-

Table 1
NORA musculoskeletal research agenda

Surveillance

Surveillance is the ongoing systematic collection, analysis, interpretation, and dissemination of MSD health and hazard information to identify trends, develop prevention strategies, and evaluate the effectiveness of those strategies.

The following are the most significant priorities for surveillance research activities identified by the NORA team:

- Develop user-friendly, standardized workplace surveillance tools for use by both the non-expert and the expert;
- Increase collaboration with federal, state, and non-governmental organizations (insurers, employers, unions, and academics) to encourage comparability of data collection methods;
- Conduct an ongoing national hazard survey targeting physical workplace factors.

Etiologic and medical research agenda

Many risk factors associated with development of musculoskeletal disorders have been identified or suggested. Biomechanical risk factors include exposures to excessive force, awkward posture, movement, and vibration. These can be characterized in terms of their magnitude and temporal factors, such as frequency, repetition, duty cycle, and duration of exposure. Psychological and social factors include work organization arrangements (extended work hours, shift work, piecework, machine pacing), lack of training, inadequate conditioning, and cognitive or emotional stress. Personal factors include variables associated with size, strength, age, gender, cultural factors, and history of injury. Research is needed to better describe the relationship between exposures to these risk factors, both singly and in combination, and the development of disease and disability.

The most significant priorities for etiologic and medical research activities identified by the NORA team are:

- Refine instruments to detect and quantify the contribution of these factors to the disease process;
- More clearly define stages of the MSD process, develop precise diagnostic tools, and provide guidelines for effective treatment and return to work; and
- Clarify the interplay of the factors of different stages of causation, development, and treatment of musculoskeletal disorders and measurement of risk factors.

Intervention research

Research is needed to develop and evaluate new and existing intervention strategies for preventing or reducing the incidence, severity, and disability associated with work-related musculoskeletal disorders. A large amount of research has been conducted over the past few decades, but because of the wide variability between individuals and the complexity of causal and contextual factors and their interactions, there is a need for more research on which interventions are the most effective. Moreover, intervention research is difficult to conduct because adequate comparison controls are often not available and because very large sample sizes are needed to show that an intervention is effective in reducing health outcomes. In many cases, it is not possible to conduct studies aimed at reducing health effects, so studies must rely on demonstrating reduced exposure. Interventions can be tested in the laboratory where confounding factors can be controlled, or tested in the field. Effective control technology should work well in both environments.

The most significant priorities for intervention research activities identified by the NORA team are to evaluate the effects of the following on development and prevention of MSD:

- Alternative (product and/or tool) design criteria (force, spatial requirements of work);
- Optimization of mechanical (force, movement, and posture) work demands and temporal patterns of exposure;
- Manual handling alternatives in posture, movement, force, productivity, and quality;
- Ergonomic training and education;
- Costs and benefits of ergonomics intervention; and
- Job assignment, selection, and choice.

tained a research agenda identifying high priority research gaps [12]. Tables 1 and 2 provide a summary list of the NORA MSD and NRC/IOM research issues.

Although the two research agendas are organized differently, their contents are quite similar. The NORA agenda reflects a practitioner-oriented viewpoint, whereas the NRC/IOM agenda is more reflective of the viewpoint of the research community. This is to be expected, since the NRC panel was comprised of leading researchers in the fields of medicine, information science, and ergonomics and the majority of participants for the NORA meetings included practitioners and safety and health experts from industry and labor. The NORA research agenda also focuses more heavily on surveillance and intervention issues, compared with the NRC/IOM agenda, which emphasizes a need for more basic etiological research. These approaches, though somewhat different, are both needed for greater understanding of causation and control of MSDs.

Both research agendas recommended further research on a number of common issues, including: (1) development of standardized case definitions for health outcomes; (2) development and validation of practical and consistent methods for quantifying physical and psychosocial exposures; and (3) additional human studies to further quantify the relationship between exposures and outcomes. The NRC/IOM research agenda also differs from the NORA research agenda in that it is more detailed in its recommendations regarding the need for studies focusing on tissue mechanobiology and biomechanics, including evaluation of tolerance limits for joints and soft tissue, the relationship between the loading of a joint and pain, and the influence of psychosocial stress on MSD response. In comparison, the NORA research agenda suggests the need for more detailed laboratory research models, which would link exposure, tissue change, physiologic response, adaptation and the disease process. Both agendas specifically recommend that epidemiologic studies be conducted to evaluate the combined or interactive effects of various risk factors, such as physical and psychosocial stressors, individual and genetic factors, and other factors that may affect reporting of MSDs.

Finally, workplace interventions are discussed in both agendas, but the NORA agenda seems to put greater emphasis on intervention research. This emphasis probably reflects the interests of practitioners. The NORA agenda proposes research on engineering controls, work organization, protective equipment, and other intervention issues (e.g. training, regulations, compensation, cost/benefit analysis). The NRC/IOM agenda recommends that intervention studies be conducted to explore multifactorial interventions, economics, working in the community, and dissemination issues.

3. Improving the research process

Those who provided input into the NORA MSD research agenda indicated that the research process could be improved by strengthening communication between those who conduct research and those who

Table 2
NRC/IOM research agenda

Methodological research

1. Develop improved tools for exposure (dose) assessment: Includes developing methods for objectively measuring physical stress in the workplace and developing valid measures of psychosocial exposures.
2. Develop improved measures of outcomes and case definitions for use in epidemiologic and intervention studies: Includes developing tools to identify clinical cases, developing tools and measures to quantify an MSD, further refine standardized survey instruments for epidimiological use, refine physical examination criteria to identify MSDs, refine epidimiologic case definitions, develop classification for nonspecific pain syndromes, refine physiological measures for epidimiological studies, and evaluate definitions of MSDs.
3. In studies of human, further quantify the relationships between exposures and outcomes: Includes dose–response relationships of exposures; evaluating host factors; and interaction of physical and psychosocial factors.

Topic area research

1. Conduct tissue mechanobiology studies: Including animal tissue studies of structural and cellular responses to physical loading; determining whether response to repeated loading is determined by rate, peak, or duration; and identifying sources of pain as related to injury and physical loading.
2. Biomechanics studies: Investigating the role of repetition, workshift and rotation on loading patterns and pain; quantifying the relationship between loading and pain; and exploring psychological stress on musculoskeletal response.
3. Psyschosocial studies: Investigating psychosocial stressors impact on MSDs.
4. Epidemiologic studies: Undertake longitudinal studies of MSDs related to: how MSDs form; physical and psychosocial influences, return to work; rest, recovery, and repair; interventions; and individual factors.
5. Workplace interventions studies: Conduct workplace interventions using: randomized control models; multifactorial interventions; cost-effectiveness; working with industry; and disseminating to targeted industries.

apply research. Researchers expressed frustration at the difficulties associated with gaining access to industrial sites to conduct research, and management and labor felt the need for more input into the research process. Some participants suggested that research might be more applicable to industry if management and labor reviewed research proposals and had a say in funding and prioritization.

The participants generally agreed that improvements in dissemination of research results were needed and that many of the dissemination problems could be avoided if there was better communication between the parties involved in the research process. They also believed that more effective methods of dissemination were needed to improve the application of research findings in the workplace.

The NORA Musculoskeletal Team considers coordination of research activities and information dissemination to be of prime importance in this area. As suggested by several of the focus group participants, coordination of studies through partnerships involving government agencies, university researchers, private industry, and labor unions could be extremely beneficial in bridging communication gaps, developing efficient research strategies, and improving the dissemination of information. Moreover, in addition to development of a research agenda, the NORA MSD team is exploring ways to increase funding for research studies directed at implementing the NORA research agenda. For example, NIOSH, in partnership with the National Institute of Arthritis and Musculoskeletal and Skin Disorders (NIAMS), recently published a request for extramural grant applications specifically directed at areas contained in the NORA research agenda. The NORA MSD team is also attempting to identify additional funding agencies with the goal of bringing funding agencies and researchers together to address the most critical research gaps.

4. Conclusions

Musculoskeletal disorders account for a significant number of the injuries and illness sustained by the US workforce each year. A large volume of research on the causation and control of MSDs has been conducted over the last 15 years and quite a bit is known about these disorders. Studies examining the epidemiology of the MSDs, the effects of biomechanical loading, and other risk factors have been conducted. More research is needed, however, to fully determine how the interactions between these factors may influence the risk to workers who are exposed across a wide range of work environments. By increasing communication among researchers and practitioners and coordinating plans for dissemination of research results, the limited resources that are available can be targeted to have the greatest impact. Working together for these common research goals, there can be significant gains in reducing the number of workers affected with musculoskeletal disorders.

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