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Editorial

Spine biomechanics, government regulation, and prevention of occupational low back pain

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Recently, there has been much controversy about the relationship between work and the risk of experiencing low back pain (LBP). A comment by Rick Deyo in *Scientific American* [1] notes a paradox in that even though industrial automation has improved and clinical assessments have advanced, disability resulting from LBP continues to increase. Some have hypothesized that because almost everyone gets LBP at some time in their life, this is a natural part of the aging process and, therefore, is not related to work exposure. So why has the government attempted to impose ergonomics standards on society in an attempt to control this and other musculoskeletal risks at work? Is there sufficient evidence to warrant such measures? These are important questions, because mandating such measures can incur significant costs for business and society and would be good investments only if there were a relationship between work exposure and LBP. Hence, it is important that we understand the relationship between LBP and work.

The spine research community has been in search of LBP causality for some time. For those who have followed spine research developments over the years, it appears that certain causal link methodologies fall in and out of vogue for periods of time at the expense of a balanced approach to understanding LBP causality. In the 1980s we focused on biomechanical factors, in the 1990s the focus was on psychosocial factors, and today most funding is going toward understanding genetic and biochemical sources of LBP. It has been a common experience at scientific meetings to observe researchers totally discounting one approach to the problem in lieu of another more popular causality pathway. Such thinking has led to the "causality of the decade" approach to understanding LBP and has segregated our understanding of LBP causality into different "camps."

This has resulted in a situation where the literature is replete with apparent contradictions. We can find evidence of relationships between back pain and individual factors (such as age and gender) [2], back pain and psychosocial factors (such as work monotony or poor co-worker relations) [3], as well as back pain and work design [4]. On the surface it appears that we have conflicting evidence and a great deal of confusion associated with causality and LBP. However, if one examines these relationships in a systematic fashion, one can see that factors are simply influencing or biasing the injury pathway in different ways. The National Academy of Sciences (NAS) recently published two research reports on the work relatedness of musculoskeletal disorders [5,6]. In both of these reports they were able to synthesize the diverse body of literature by conceptualizing the injury process as a physiological pathway that begins with some form of structural load–tolerance relationship, progresses to symptom occurrence or adaptation, and ultimately results in either impairment or disability (Fig. 1). This process is influenced at different points along the physiologic pathway by many factors, including individual physical and psychological factors, work biomechanical demands, organizational factors, and social context. Different research methodologies are simply monitoring this process at different points along the pathway. Thus, much of the literature is simply looking at different parts of the same system. The presence of one risk factor along the causal pathway does not negate the possibility that other risk factors also influence the system. One can view this situation as analogous to cardiovascular disease. We know that everyone has some baseline risk of cardiovascular disease. However, if one becomes overweight, smokes, and does not exercise, we also know that this risk increases rapidly. One can think of the contribution of workplace factors to the development of LBP in a similar fashion. Everyone has some level of baseline risk of LBP. The risk can be increased by personal factors or genetics, but it may also be increased by work exposure. So the question is not one of whether work can lead to back pain; rather the question should be how much exposure to work factors might increase the risk of experiencing LBP to an unacceptable level.

This framework affords us an opportunity to view the LBP causality literature in a systematic fashion. However, it

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does not prove that the causal linkages to the risk factors have been established. In other words, it can set the stage for conceptualizing causality relationships between potential factors, but it does not necessarily prove the causality in and of itself. In science, the Bradford Hill criteria have been well accepted as an approach to determine a causal inference across a variety of studies. The criteria consider the strength of association, temporality, consistency, specificity of association, dose–response association, and biological plausibility. Reviews of the literature by the National Institute for Occupational Safety and Health [7] and the NAS [5,6] have clearly established these associations for physical work factors and for many psychosocial factors in the establishment of causality of LBP using the Bradford Hill criteria.

The most recent NAS review [6] has also helped us address the issue of how much of an increase in risk can we expect with workplace risk factors. For this review the NAS applied stringent criteria for study selection and then assessed attributable risk (attributable fraction) for work factors. Attributable risk is a measure that calculates the decrease in outcome (in this case LBP occurrence) that would be present if the offending exposure were removed. This review assessed the LBP risk factors and the range of the associated attributable fractions (AF) observed in the various studies. Using methodologically rigorous criteria for study acceptance, the NAS committee identified the risk factor and associated AFs as lifting and carrying loads, AF 11% to 66%; whole-body vibration, AF 18% to 80%; bending and twisting, AF 19% to 57%; and heavy physical work, AF 31% to 58%. Hence, for every risk factor, significant decreases in LBP would be realized with decreases in exposure to these risk factors. In addition, the risk would be expected to decrease by even more dramatic amounts when exposure to interactions between the risk factors is considered.

Also of interest in the assessment of the risk is our ability to control the risk through identification of risk factor exposure. It is not enough to know that risk factors are present at work. In order to control the risk, one must know how much exposure is too much exposure. Biomechanical field studies have shown that the better specified the biomechanical requirements of the task, the greater our ability to identify risk [8,9]. Intervention studies have shown that it is possible to quantify LBP risk to the point where risk predictions coincide with observed industrial incidence rates [10]. Hence, for controls to be effective, countermeasures must be precise and quantitative in their characterization of risk.

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The recent NAS study [6] has shown that there is indeed an abundance of evidence that indicates a causality link between work and the risk of LBP. Work factors can affect risk above and beyond the risk associated with inherent factors and leisure time activities. In addition, risk can be controlled, but the risk must be quantified so we know how much is too much exposure. Practically, this means that any tools used to assess risk in the workplace must be rooted in the science base. Validation for the risk instrument must be present before society can be asked to adopt the instrument for control purposes.

How does this situation influence the recent developments in Congress? Recently, the congressional review act was employed for the first time in history to recall ergonomic regulations issued by OSHA that became effective in January 2001. Arguments to repeal the law centered on the cost of making workplace changes and the causality issues just discussed. The recent NAS report [6] should have laid to rest any issues of causality. This was the third comprehensive review of the literature that has established the causality link between the workplace and musculoskeletal disorders. No comprehensive review has ever presented any evidence to the contrary. The economics of workplace musculoskeletal risk has also been addressed. The General Accounting Office issued a report [11] reviewing ergonomics programs to control musculoskeletal disorders in the workplace. They reviewed both large and small industry efforts and found that companies that adopted these programs saved 35% to 91% on workers compensation costs. When one considers the escalating cost of health care, it is apparent that control of workplace risk can be a “win” for everyone but only if done properly using our scientific knowledge. This has been reinforced through personal experience many times. The big three automobile manufacturers all have effective corporation-wide ergonomics programs in place. They have found that health-care costs are contained and car quality is improved with such programs, and this makes them more competitive with foreign competition. One large manufacturing company in the Midwest recently suggested that ergonomics was their “best kept secret” and their competitive edge. A high-level executive in charge of several distribution centers revealed that he had reluctantly incorporated several lift tables in one of his centers in order to help control LBP at the “urging” of OSHA. To his delight, not only were the back injuries substantially reduced but the productivity of the workers assigned to the improved jobs increased by 33%.

Hence, it appears that we have in place the causality link between work design and LBP as well as an economic

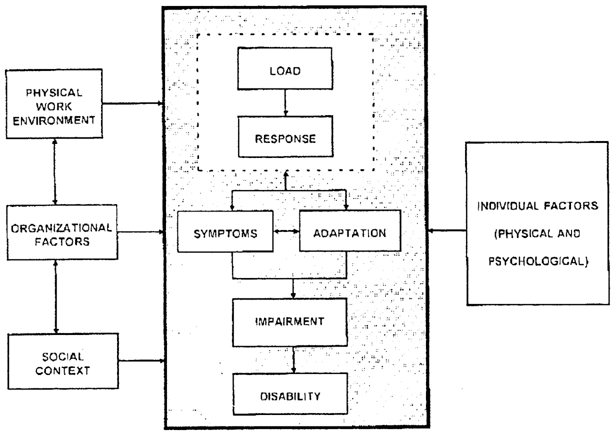

Fig. 1. Conceptual model of the physiologic pathways associated with musculoskeletal disorders and the influence of various risk factors in the process [5].

driver. So why are some people still fighting government regulation of ergonomics in the workplace? One can understand by talking to those who have had negative experiences with ergonomics. How can this be, given our previous discussions about causality and control? The key to this answer is related to the proper application of our science base to the workplace. Two issues have made this problematic. First, the ranks of self-proclaimed ergonomists have swelled since it was apparent that ergonomics was going to be mandated in industry. Many of these people are individuals who have had no formal training in the science of ergonomics and are attempting to provide ergonomics services based on intuition. Unfortunately, much of the time ill-considered solutions to ergonomics issues are suggested. Few consumers are aware of the fact that there is a national certification board (Board of Certified Professional Ergonomists located in Bellingham, Washington) that can ensure that the ergonomist has at least a basic level of competency in the field. Second, it is clear that we have been able to take advantage of our scientific knowledge base and develop effective applications for the control of the workplace. However, the majority of assessment tools used for workplace evaluations are products of commercial endeavors or individual contributors who have designed the tools for ease of use but have not considered the relationship between the tool output and LBP causality at work. Nor have the necessary validation tests been performed for these tools to assess their predictive value. Unfortunately, these "easy to use" yet unvalidated instruments are the tools that have been promoted and are often employed in the workplace. Some laboratory research tools will never be practical for field workplace assessments. However, as researchers, we must find ways to work with practitioners to transition the rich science base to the development of quantitative tools that can be properly used in the workplace and can answer the question "how much exposure is too much exposure"? With such effective tools in hand, industry would be foolish not to scientifically engineer the workplace to minimize risk of LBP, for those who did not would soon be out of business.

Such is the state of the science of biomechanics and ergonomics, government, and industry in the control of occupationally related LBP. There are many voids in our knowledge base that still need to be filled. But it is also clear from the existing science and industrial experience that we currently know enough to control, to a large degree, LBP risk resulting from occupational tasks. The key to making ergonomic solutions financially feasible in industry lies in the ability to transition the rich science base to application by qualified individuals. This would clearly be a "win-win" for all, regardless of governmental regulations.

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