ERGONOMIC ASSESSMENT & DESIGN

Key to Reducing Back Injuries

By JEFFREY S. OAKLEY and SUSAN M. SMITH

Back injuries are a leading cause of human suffering as well as a significant cost to employers. The "Healthy People 2000" project, an agenda developed by a consortium of some 350 organizations, has identified 22 priority areas and 319 supporting objectives designed to lead to improved health for all Americans. Cited within these areas/objectives is the need to reduce back injuries and eliminate chronic back conditions (DHHS 73).

This article focuses on ergonomic assessment and design as the key to reducing back injuries. Specific strategies—including training/educational programs, back schools, back belts, and/or wellness/exercise and flexibility programs—designed to reduce both on- and off-the-job injuries—are reviewed. Many of these efforts focus on reducing injury symptoms rather than on efforts to design and implement engineering controls that prevent back injuries. Proper workplace design, which includes ergonomic design of workstations, must be used to reduce opportunities for poor posture and need for frequent lifting.

Nearly 6.5 million people in the U.S. are bedridden because of back injuries, according to some estimates. New cases are occuring at a rate of approximately 1.5 million per month. Each year, these injuries cost employers millions and remove many able-bodied employees from the workforce (Khalil, et al 9).

Approximately 28.5 percent of all workplaces offer some type of back injury prevention or care (Fielding and Piserchia 19). The four primary types of programs are: 1) training and education programs; 2) back belts; 3) wellness programs/exercise/flexibility; and 4) back schools.

According to the literature, these programs have had limited success in preventing back injuries. According to Courtney, et al, ". . . it is very difficult to discern whether the progress in reducing work-related injuries has been limited by the selection of inappropriate interventions or by the inadequate implementations of interventions" (103).

Most current literature focuses on efforts to reduce injury symptoms rather than to correct the root cause. As a result, in many cases, no in-depth evaluation is performed to determine what is causing the injuries. Based on this review, in the author's opinion, programs structured around limited interventions (such as training and back belts), or that use physical fitness and weight management strategies, will not adequately prevent back injuries.

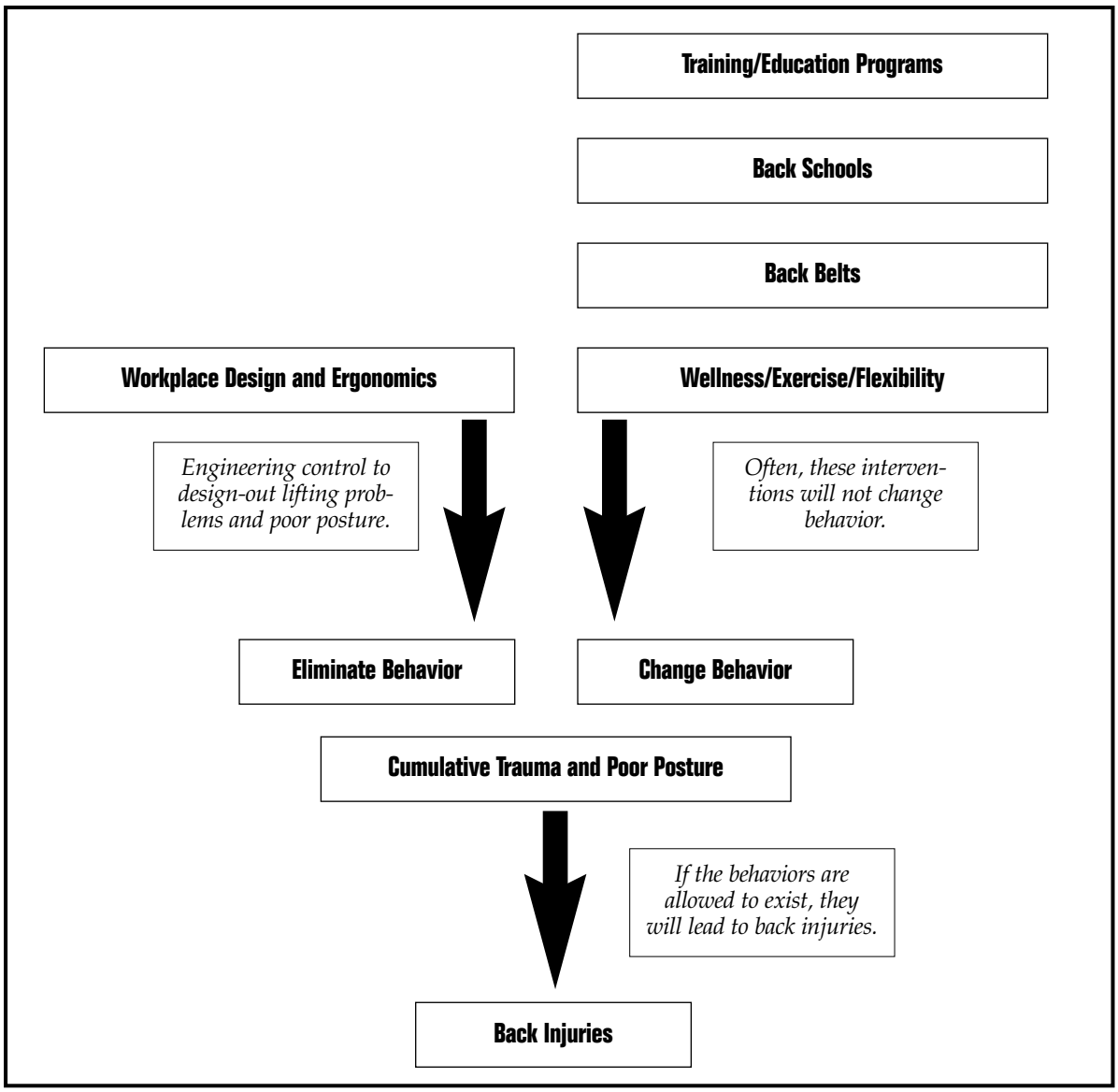
To reduce injuries and eliminate the root cause, management must—for each employee—evaluate design and engineering issues on biomechanic lifting techniques, amount of lifting and lifting requirements (capacity). A functional capacity evaluation is a key component of this assessment; it determines whether the worker is capable of lifting the weight and the repetition of weight. This evaluation, combined with an ergonomically based job analysis, is crucial in preventing back injuries (Isernhagen 137).

BACKGROUND IN WORKPLACE BACK INJURIES

Low-back pain is the most common, complex ailment in the workplace; it affects both males and females of all ages, races, professions, education levels and social status. It has been estimated that eight of 10 people will experience some kind of back pain in their lifetime (Khalil, et al 9). In heavy industry, one of five people are reportedly affected by back injuries on a regular basis. Back injuries are so prevalent that the National Institute for Occupational Safety and Health (NIOSH) developed guidelines for designing manual lifting tasks. These guidelines have since been revised and are an excellent tool if used properly (Waters, et al 749+).

Approximately 60 percent of back injuries require nearly $1,000 of medical treatment and are resolved within a week. However, 10 percent require 30 or more visits to a medical provider (California Workers' Compensation Institute 3). Injuries involving the spine (vertebrae) or back (muscles and tendons) are

FIGURE 1



The most-effective way to prevent back injuries is to eliminate their root cause. In most cases, the work environment promotes behaviors that cause cumulative trauma and poor posture, especially when lifting.

the most costly to employers as compared to other types of injuries (Kelsey 7). Therefore, employers must strive to address root causes and consider ergonomic design to prevent—rather than merely rehabilitate—back injuries.

Back injuries are influenced by: 1) job/task factors, such as load weight, environment, frequency of lifts, task or job design; and 2) personal factors, such as age, gender, and strength (capacity). These factors will determine the levels of fatigue, trauma, emotional stress, congenital defects, genetic factors and physical fitness. Such factors not only determine job risk, but also the level of risk of back injuries (Isernhagen 42).

The two primary types of back injuries are: 1) injuries to the spinal vertebrae; and 2) injuries to back muscles and tendons (Kelsey 7). Most are caused by overstretching or overexerting some part of the muscle—normally the back muscles (Kelsey 192). The back is rarely injured by lifting a single load, but rather by cumulative trauma. Although a single event may produce the injury, the cumulative effect of bending, twisting, excessive sitting or excessive standing (poor posture) increases the likelihood of the injury (MacLeod 104).

In many cases, these cumulative effects can be prevented by redesigning the work environment, and implementing appropriate rest periods, stretching and flexibility exercises during a shift, and rotation of motions during a work period.

A back injury is caused by either acute or cumulative trauma. Acute trauma is associated with the application of force that exceeds the body's tolerance during an infrequent act. This trauma is normally combined with large amounts of force, such as lifting an extremely heavy object. Cumulative trauma is associated with repeated application of force to the body, which lowers its tolerance to sustain the same amount over time; eventually, the body fails. Lifting objects over time causes cumulative trauma, "wear and tear," and muscle fatigue (Salvendy 235).

TABLE 1

CHARACTERISTICS OF PROGRAM COMPONENTS		
Program Intervention Type	**Strengths**	**Weaknesses**
Training/Educational Programs	1. Comprehensive instruction covers the anatomy of the back and back injuries. 2. Can be taught in any classroom. 3. Covers wide variety of subjects (nutrition, weight management, posture, etc.).	1. No practical application. 2. Employee must change behavior (sometimes difficult).
Back Schools	1. Multi-disciplinary. 2. Combines exercise, posture, and lifting techniques. 3. Hands-on and job-specific.	1. Employee must change behavior.
Back Belts	1. Reduce spinal compression forces during lifting. 2. High employee acceptance. 3. Serves as a reminder to use good lifting techniques.	1. Must be worn correctly to work. 2. "Superman syndrome." 3. Only addresses symptoms.
Wellness Programs/ Exercise/Flexibility Activities	1. Strengthens back. 2. Improves fitness level. 3. Better flexibility.	1. Does not prevent hazardous activity.

TABLE 2

CHARACTERISTICS OF ELIMINATION OF ROOT CAUSE BY ERGONOMICS		
Program Intervention Type	**Strengths**	**Weaknesses**
Ergonomic Assessment and Design	1. Eliminates the behavior and hazardous situation (poor posture). 2. Corrects the root cause, instead of addressing only the symptoms. 3. Job- and task-specific. 4. Uses scientific, engineering and ergonomic principles to reduce the effects of biomechanical stress. 5. Basis for improved quality of work life and comfort on the job (higher productivity). 6. Makes safe work practices a natural result instead of depending on worker capabilities.	1. Assessment and design can be expensive. 2. Ergonomic assessment must be performed by a trained, knowledgeable individual.

Most back injuries are caused by repeated lifting of heavy loads, particularly when weight is lifted farther away from the body. Lifting performed in awkward positions (due to poorly designed equipment/tools, poor workplace design or lack of training) and farther from the body places undue strain and cumulative trauma on the spine (Andersson and Chaffin 228).

REVIEW OF CURRENT PREVENTION PROGRAMS

As noted, the primary types of back injury prevention programs are training/education programs, back schools, back belts and wellness programs/exercise/flexibility.

Training/Education Programs

Typically, these involve classroom lectures designed to inform employees about back injuries and preventive measures. Typical topics include anatomy of the back, proper body mechanics and posture; correct lifting, sitting and standing procedures; proper nutrition and weight management (Gates 61); physical fitness and stretching; and psychological factors (e.g., motivation, stress, anxiety) that provoke back injuries (Delguercio 36).

These programs are designed to create awareness of the potential for injury and offer instruction to protect the back (Gates 59). Most fail, however, because participants have no opportunity to apply the learned skill. To be effective, such programs must include practical application with job-specific lifting examples (Phillips, et al 44).

According to most research, although some short-term behavior change may occur, back injuries are not reduced as a result of training programs (Feldstein, et al 19). This is likely because the work environment—the root cause of the injury—has not been redesigned. Instead, the intervention focuses on individual employee behavior, which must be continually reinforced through training and rewards. As a result, symptom reduction is emphasized over root-cause correction.

Such a strategy also ignores the rapid turnover in many employment sections, which requires constant training and retraining. Some studies reported no differences in lost workdays between groups that received back training and those that did not (Sirles, et al 7). If long-term behavior change could be achieved, then a decrease in back injuries could be sustained (Feldstein, et al 119).

Back Schools

Many facilities employ a "back school" concept—and attach a catchy title such as "Back Care," "Back Power" or "Back Attack." These programs utilize the same concepts as training interventions; the primary difference is the increased focus on exercise, stretching, body mechanics and job-specific lifting techniques. Back school classes often feature job-specific and real-world examples rather than classroom lecture (Conrad and Karas 193).

Back schools can be effective, provided the training is specific to a participant's job (job analysis focused on ergonomics) and that workers are empowered to solve problems by suggesting safer ways to perform tasks. If discussions of the back's anatomy and functions are combined with ergonomic principles, proper posture and good lifting techniques, then back schools can help reduce the number of back injuries (Phillips, et al 44).

Back Belts

Back belts are designed to reduce spinal compression forces during lifting. They tighten abdominal muscles to shift part of the load from the back. Numerous studies have been conducted to analyze their effectiveness, but the outcomes have been inconsistent.

Positive reported benefits include high employee acceptance and the fact that belts remind employees to use proper body mechanics while lifting (MacLeod 254). Some researchers have concluded that acute back injuries are decreased if mandatory back belts are used (Blair 39). In these studies, long-term back injuries were not evaluated; however, previous studies have yielded mixed results (Allen and Wilder 62).

Other studies report negative apsects. Key among them is the fact that belts create the "superman syndrome"—an employee feels indestructible because of the back belt and believes s/he can lift more. Other reported negative side effects include weakening of the stomach and back muscles; improper wear—which negates any potential protection (Schwartz and Walsh 556); and the worker who wears the back belt for a period of

time, then discontinues its use. Research reports a higher injury rate than normal for this group (MacLeod 255).

Wellness Programs/Exercise/Flexibility

Interventions such as wellness programs and physical fitness activities are intended to increase the back's resistance to injury. Japanese industry has reported success with the use of strengthening and calisthenic programs to warm-up before work and mini-breaks to stretch and relax during work (Taylor 52).

Although exercise and flexibility activities may complement a firm's educational programs, they are not reported to be sufficient to prevent back injuries or change behavior. When incorporated into other programs, these measures can help reduce back injuries (Leonard 318). Table 1 summarizes the strengths and weaknesses of the various prevention methods.

PREVENTION VIA ERGONOMICS

The most-effective way to prevent back injuries is to eliminate their root cause. In most cases, the work environment promotes behaviors that cause cumulative trauma and poor posture, especially when lifting. Ergonomics principles can be used to eliminate this behavior (Figure 1).

The first step is to assess the workplace to identify what areas are causing—or have the potential to cause—back injuries (Fragala 99). The workplace can then be redesigned to eliminate repetitive lifting and poor posture. Changes may include use of mechanical aides (e.g., hoists, lifts) or installation of adjustable workstations.

After the ergonomic evaluation is performed and major problem areas are addressed, each workstation should be assessed to: 1) reduce static muscle load; 2) reduce awkward postures; 3) improve task design (physical and mental capacities); 4) improve workplace/equipment design; and 5) improve work organization (take rest breaks, reduce shifts). Table 2 summarizes strengths and weaknesses of this approach.

CONCLUSION

Many occupations in the U.S. are labor-intensive and involve significant lifting, stooping, vibration, standing and physical exertion—all of which can cause back injuries. Programs that focus on reducing an individual worker's "risky" behavior are inadequate. The best specific intervention can only be evaluated after the root cause of such behavior is identified.

Therefore, employers must strive to understand the root cause and take action to improve ergonomic design of tasks and the work environment. The key to success is to start with an assessment of ergonomic design and add complementary training or health promotion components. ■

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