CHRONIC MUSCULOSKELETAL DISORDERS IN AGRICULTURE FOR PARTNERS IN AGRICULTURAL HEALTH

Submitted by

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Introduction

For more than a decade, farming has been rated one of the most dangerous occupations in the United States (Mazza, 1997). A considerable number of adverse health conditions, including musculoskeletal disorders, are linked to agricultural work. Many risk factors associated with the development of musculoskeletal disorders are commonplace in agricultural tasks. Occupational risk factors include static positioning, forward bending, heavy lifting and carrying, kneeling, and vibration. Unfortunately, there has been limited application of research related to ergonomics and musculoskeletal disorders, although farmers frequently report musculoskeletal signs and symptoms (Myers et al., 1995).

The industrialization of agriculture has introduced new equipment with little attention paid to ergonomic design. Competition and increased work demands have also increased farmer's exposure to risk factors through increased work pace and/or duration. Of the thirteen most common agricultural health related problems reported by rural health care providers, heavy lifting was the most common exposure of patients, while repetitive motions was fourth (Mazza, 1997).

Frequently, health care providers do not focus upon musculoskeletal disorders in the agriculture population. This may occur due to one of two reasons; (1) health care providers may primarily look for signs of pesticide exposure or (2) the assumption that musculoskeletal disorders are an unavoidable result of farm labor (Fenske and Simcox, 2000). In reality, ergonomic stress associated with farm work can be minimized or in some tasks entirely prevented with the appropriate interventions. These may include, but are not limited to, design of equipment, improved work processes and increased awareness of musculoskeletal disorders and associated risk factors. In forestry and construction occupations, which are similar to agriculture due to the heavy nature of work and variability of environment and tasks, such changes have had a favorable affect on ergonomic problems.

Definition of Problem/Issue

The focus of this chapter is on disorders of the musculoskeletal system that are associated with occupational risk factors. The National Research Council and Institute of Medicine (2001) *defines* work related illness or disease as being caused by, aggravated, accelerated or exacerbated by workplace exposures, which result in impaired work capacity. The World Health Organization (1985) describes "work-related" disorders as being multifactorial in origin such that the work environment and performance of work contribute significantly to the cause or aggravation of the disorder, but personal characteristics, environmental and sociocultural factors may also play a role as well. Terminology that has been used to describe musculoskeletal disorders includes: cumulative trauma disorders, overuse syndrome, occupational cervicobrachial disorder and repetitive motion injuries. Frequently, the terminology work related musculoskeletal disorders (WRMSD) is used, but objections have been voiced to the use of the term, WRMSD, because of the etiologic implications. For the purposes of this chapter, the term musculoskeletal disorders (MSD) will be used to describe conditions affecting the musculoskeletal system (including peripheral nerves and vascular system) that can be triggered or aggravated by movements or activities associated with work.

Numerous studies have demonstrated a relationship between certain jobs and certain risk factors which are associated with increased risk of developing a MSD (NIOSH, 1997a; NRC/IOM, 2001). More than 1 million workers annually sustain injuries severe enough to result in lost time from work due to overexertion or repetitive motion (BLS, 1999). There are numerous types of work-related musculoskeletal disorders that are reported. These include disorders of the back and neck, nerve entrapment syndromes, musculoskeletal disorders such as tenosynovitis, tendinitis, peritendinitis, epicondylitis and nonspecific muscle and forearm tenderness (NIOSH, 1997). The majority of the reported musculoskeletal problems is nonspecific and lacks a well-defined clinical diagnosis (NRC/IOM, 2001). The prevalence of specific disorders and syndromes are not precisely known since many of these disorders have been difficult to classify in epidemiologic studies (NIOSH, 1997). This may be due to inconsistent case definitions and that many musculoskeletal disorders are difficult to ascertain using conventional medical diagnostic tools. Although quantitative laboratory tests such as nerve conduction studies are available for nerve entrapment syndromes, it is difficult to objectively measure the presence or severity of disease and functional deficits in muscular or tendon disorders. Additionally, few studies apply modern epidemiologic principles to validate outcome measures (Viikari-Juntura, 1994).

Unfortunately, the majority of studies investigating MSD are completed in settings other than agriculture. Bobick and Myers, 1994 investigated agriculture – related strains and sprains and found that injuries to the back and extremities were quite common. Back pain and pain in the shoulders, arms and hands are the most common symptoms reported by farmers (NIOSH, 2001).

The Annual Survey conducted by the Bureau of Labor Statistics is the recognized national occupational injury surveillance system for agricultural workers (Bobick and Meyers, 1994). According to the BLS (1999), approximately 772,600 persons were employed in production agriculture in 1998. A major limitation with BLS data is that it excludes contract laborers and farm with fewer than 11 employees. In the State of Wisconsin, only 5% of farms reported having greater than eleven employees (Kelsey, 1994). The BLS established a system to supplement the Annual Survey information with data provided by state workers' compensation agencies, but farmers and farm workers are typically not covered by workers' compensation. Furthermore, farmers and their families are less likely to have medical insurance as compared to workers in other industries (Chapman, 1996). Therefore, the total number of injury incidents reported is believed to be an underestimation of the total number.

Additionally, cultural barriers may exist to acknowledging the presence of injury and symptoms among both farmers and farm workers. Farmers may be less likely to report symptoms until they reach a level that interferes with their ability to perform their jobs. Language barriers may also exist between hired farm workers and health care providers, since the majority of hired farm workers are foreign born and Hispanic (Mines 1997 in McCurdy). Martin et al., (1994) estimates that there are two million hired farm workers in the US working in crop production. In Wisconsin, there is an estimated 8000 migrant and seasonal agricultural workers (Migrant Health Program, 1990). Finally, a healthy worker effect may be another factor. Workers who develop problems tend to leave the line of work for a different career and this information is not tracked.

Given the inherent limitations in the current reporting systems, determining the scope of musculoskeletal disorders in agriculture relative to other industries, and within the agricultural industry itself is difficult. Musculoskeletal disorders include those classified in the US as illnesses (i.e. disorders due to repeated trauma, carpal tunnel syndrome, tendonitis) and injuries (i.e. sprains and strains, back pain (US Bureau of Labor Statistics, 1999). The Bureau of Labor Statistics (1999) reported that sprains and strains were the most common cause of loss time cases (43.6%) and most frequently involved back injuries.

Gustafsson et al., (1994) investigated the presence of musculoskeletal symptoms in Swedish dairy farmers during the preceding 12 months. Eighty-two percent of males and eight six percent of females reported musculoskeletal symptoms. Dairy farmers reported frequent symptoms in the shoulders, elbows, lower back, hips and knees. In addition, female dairy farmers reported severe hand and wrist problems. As compared to women, men reported more back and knee problems. Women reported more symptoms in the neck, upper back and upper extremities than men. This is similar to the findings by Hildebrandt et al., 1995a, in which, 75% of farm workers reported experiencing musculoskeletal symptoms during the previous 12 months.

Considerable variation exists among rates of musculoskeletal health problems due to cumulative trauma among farmers and farm workers. For agricultural crop production a rate of 9.9 (per 10,000 workers) was reported, as compared to a rate of 27.6 for agricultural livestock production (BLS, 1999). The rate for strain and sprains was 117.7 and 126.6, respectively, for agricultural crop and livestock production (BLS, 1999).

However, this information must be interpreted cautiously since it reflects only the experience of farms with at least eleven or more employees, which make up less than 5% of all farms. This makes it difficult to determine musculoskeletal health information about farmers and farm workers.

Population-based surveys that focused closely on production agriculture work were completed in the mid-1990s as part of the US National Institute for Occupational Safety and Health (NIOSH) Farm Family Health and Hazard Survey. Researchers in a half-dozen states were funded to collect information from population-based samples of farmers and farm workers. A NIOSH Farm Family Health and Hazard Survey study of individuals working on small family farms in Colorado, where over 90% of the operations had fewer than five employees, detected a one year period prevalence rate for back pain lasting a week or more of 26.2% (Xiang et al., 1999). This rate for Colorado farm employees was about two and one-half times higher than the National Health Industry Survey for all industry average rate of back pain for males (10.7%). When broken down by sector, the back pain rate for production agriculture workers in Colorado was highest for dairy production at 43%. This one year period prevalence rate was nearly four times higher than the NHIS for all industry rate for males.

The Colorado findings are similar to those found in Iowa. A total of 287 male farmers from Iowa completed a mail questionnaire in a study that investigated the frequency of risk factors related to back pain (Park, 2001). Daily back pain with duration of one week of more was reported by 31% of the farmers. Farmers in the age range 45-59 years and those with an additional non-agricultural job had the highest risk for back pain.

Guo et al., 1999, investigated the prevalence of work related back pain for gender in agricultural production crops and reported the prevalence for males was 16.7 and for females, 10.8. For male workers, an average of 14.9 (SE=9.4) workdays were lost per back incident case. Another study investigating prevalence rates among Dutch trades and professions reported a prevalence rate of 25.9 for males (Hildebrandt et al., 1995b). Information for females was not reported due to the small number of female respondents.

A few studies have been published that investigated whether individuals in agricultural occupations were, over the long term, more likely to suffer work-related disability, retire early, or change the type of work they did than individuals in other occupations. Data from an NHIS follow-up study was used to determine which occupations were associated with the greatest amount of musculoskeletal disability from the longest held jobs of individuals in a national probability sample. Farming was the occupation most often associated with disability in females and the second most often in males (Leigh and Fries, 1992). NHIS also found an increased risk of arthritis among farmers when compared to individuals in other occupations (Schenker, 1996). Considerable research still needs to be done to investigate the financial and social impact of disability due to MSD in the agricultural population.

Agricultural tasks range from highly mechanized operations employing state-of-the-art technology to maintenance of subsistence plots (Fenske and Simcox, 1995). Given the vast diversity of agricultural activities, this represents a challenge to health care providers. The identification of occupational health hazards and the development of systems to evaluate, intervene, and decrease musculoskeletal risk factors and resulting disorders can be quite labor intensive and will require extensive occupational health knowledge.

Many factors complicate the development and implementation of a comprehensive program to prevent musculoskeletal disorders. Some factors already mentioned include limitations with existing surveillance programs, injury reporting mechanisms and cultural issues. Additional problems, such as workforce issues, the nature of agricultural work and cost of safety and ergonomic interventions, also increase the complexity of successful development and implementation of programs. Workforce issues consist of seasonal, temporary and migrant workers with language barriers present. Additionally, many of the workers may be hesitant to seek health care due to lack of insurance coverage or barriers to travel. Cost issues may impede introduction of appropriate hazard controls. The majority of farms are small businesses with low profit margins, therefore available funding for activities not associated with operational efficiency may be limited. And finally, the nature of agricultural work is diverse. It is physically demanding, involves external time constraints and experiences rapid changes in environment and tasks.

Pathophysiology

A disorder, in the context of musculoskeletal disorders, has a gradual onset as compared to an acute injury, which is due to a single identifiable event. A disorder is typically mediated by some pathogen or prepathological progression (Kumar, 2001). Mechanical degradation of tissue may occur due to exposure over time from mechanical stresses that are repetitive, prolonged or forceful. The term "load" is frequently used to describe the physical stresses acting on the body and structures within the body. These stresses include kinetic (force), kinematic (motion), oscillatory (vibration), and thermal (temperature) energy sources (Radwin et al., 2001). Loads can originate from the external environment or result from action of the individual.

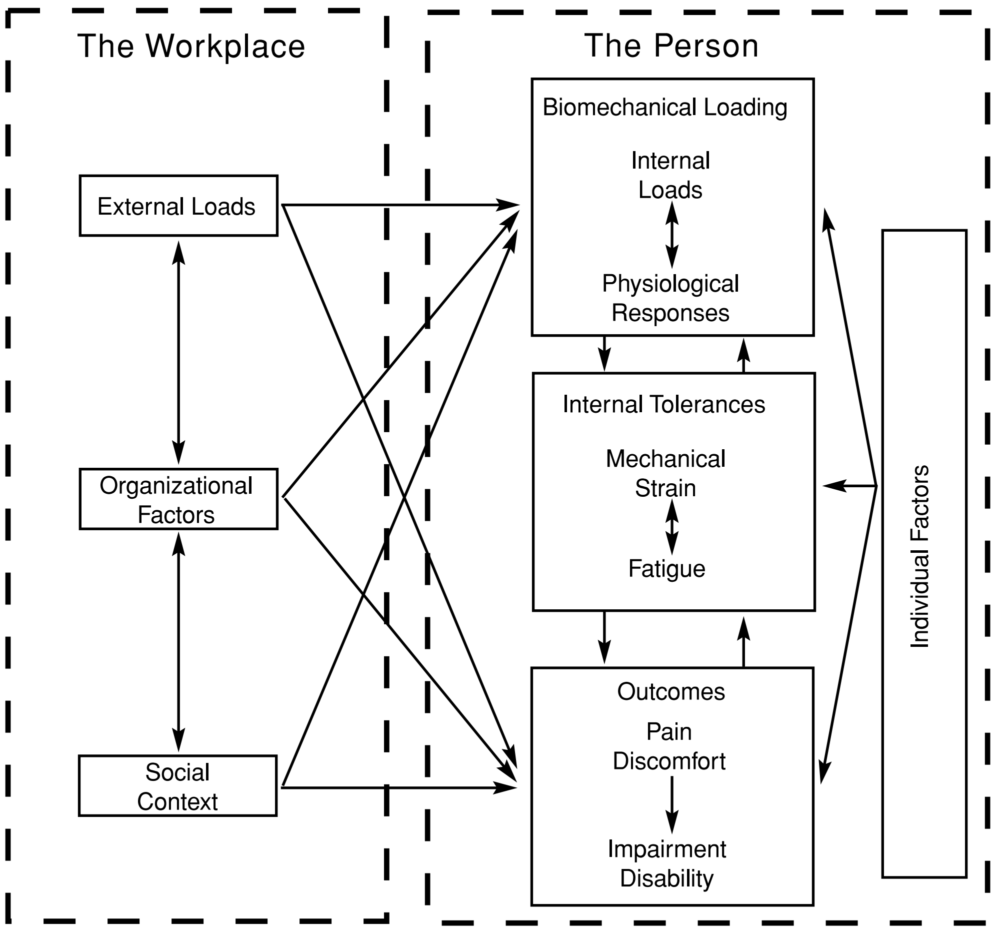
The National Research Council and Institute of Medicine (2001) developed a conceptual model that illustrates the possible roles and influences that various factors may have in the development of musculoskeletal disorders. Two categories are included in the model, workplace factors and characteristics of the individual. The interrelationships that exist and can contribute to the development of MSD are also illustrated. Workplace factors include external loads, and organizational and social context variables. External loads are transmitted through biomechanical forces on the limbs and trunk to create internal loads. Organizational and social factors can influence biomechanical loading and affect tissue tolerance, as well as the risk of developing a disorder. Examples of organizational factors include work pace, work involvement and organization of work tasks. Examples of social factors include support systems and relationships with supervisors and co-workers.

External loads are produced in the physical work environment and are transmitted through the biomechanical forces of the body, specifically the limbs and trunk, to create internal loads on tissues and anatomical structures. Biomechanical variables include body position, exertions, forces and motions, as well as individual factors such as age, strength, agility and dexterity, and other factors that mediate the transmission of external loads to internal loads on anatomical structures. Tissue damage may occur when the imposing load exceeds the internal tolerance of the tissue and results in an outcome of discomfort, pain, impairment or disability.

The cumulative trauma load tolerance model proposes that injury may develop from the accumulated effect of transient external loads that, when in isolation, are insufficient to exceed internal tolerances of tissues (NRC/IOM, 2001; Radwin et al., 2001). This is in contrast to the acute trauma model in which injuries are caused by a single identifiable event. Internal tolerance of tissues may be exceeded when accumulation of loading occurs due to repeated exposures, or exposures of long duration. The cumulative trauma model explains why many MSDs are associated with work, since throughout the workday, workers often repeat the same or similar actions. For additional specifics on the cumulative trauma load tolerance model refer to Radwin et al., 2001 and NRC/IOM,2001.

MSDs arise from a complex interaction of events that may accumulate over time. The internal tolerance of tissues to withstand loading is multidimensional, and a specific threshold may not be identifiable, but rather should be viewed as the capacity of tissues to resist mechanical strain or fatigue. Overall, if loading of the structures exceeds the tolerance, then this situation can result in a disorder.

Figure 1 – A conceptual model of various factors that may contribute in the development of musculoskeletal disorders



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External Physical Stresses

Physical stress can be described in terms of fundamental physical quantities of kinetic, kinematics, oscillatory, and thermal energy. These basic quantities constitute the external and internal loading aspects of work and energy produced by, or acting on, the human in the workplace.

Force is the mechanical effort for accomplishing an action. Voluntary motions and exertions are produced when internal forces are generated from active muscle contraction in combination with passive action of the connective tissues. Internal forces produce torques about the joints and tension, compression, torsion, or shear within the anatomical structures of the body. External forces act against the human body and can be produced by an external object or in reaction to the voluntary exertion of force against an external object. Force is transmitted back to the body and its internal structures when opposing external forces are applied against the surface of the body. Localized pressure against the body can transmit forces through the skin to underlying structures, such as tendons and nerves. Pressure increases directly with contact force over a given area and decreases when the contact area is proportionally increased. Contact stress is produced when forces compress the soft tissues between anatomical structures and external objects.

Motion describes the movement of a specific articulation or the position of adjacent body parts. Motion of one body segment relative to another is most commonly quantified by angular displacement, velocity, or acceleration of the included joint. Motion creates loads on the involved tissues and may result in transmission of loads to underlying musculoskeletal and neurovascular structures. This may create pressure between adjacent structures within or surrounding the joint.

Vibration results when an object undergoes oscillatory or impulsive motion. Vibration can be transmitted to the human body via physical contact, typically through the seat or feet, such as what occurs in whole body vibration. This type of vibration typically occurs when riding in a vehicle, such as a tractor, or when standing on a moving platform. The other method by which vibration is transmitted to the body is through the hand, such as when grasping a vibrating object during power tool use or during grasping of vehicle controls. Physiologic reactions to vibration have been documented in numerous systems, including the neurovascular and musculoskeletal systems (Bovenzi et al., 1994; Nilsson et al., 1989). Vibration transmission is dependent on the vibration magnitude, frequency and direction.

Heat loss occurs when working in cold environments, handling cold materials or during exposure to cold compressed air exhausts. Peripheral cooling in the hand may inhibit function, such as deterioration in dexterity, sensation and strength.

The physical stresses described above can be characterized by the properties of magnitude, duration and frequency. Magnitude quantifies the force, motion, vibration or temperature. Repetition is the frequency or rate and duration corresponds to the time that one is exposed. Relationships exist between the external physical stress factors and internal stress factors. This relationship is summarized in table 1.

Table 1- Relationships Between External and Internal Physical Stress

Physical Stress	Property: Magnitude	Repetition	Duration
Force	• Tissue loads and stress • Muscle tension and contraction • Muscle fiber recruitment • Energy expenditure, fatigue, and metabolite production • Joint loads • Adjacent anatomical structure loads and compartment pressure • Transmission of vibrational energy	• Tissue loading rate and energy storage • Tissue strain recovery • Muscle fiber recruitment and muscle fatigue rate • Energy expenditure, fatigue, and elimination of metabolites • Cartilage or disc rehydration	• Cumulative tissue loads • Muscle fiber recruitment and muscle fatigue rate • Energy expenditure, fatigue, and metabolite production
Motion	• Tissue loads and stress • Adjacent anatomical structure loads and compartment pressure • Transmission of vibrational energy*	• Tissue loading rate and energy storage • Tissue strain recovery	• Cumulative tissue loads
Vibration	• Transmission of vibrational energy to musculoskeletal system • Transmission of energy to somatic and autonomic sensory receptors and nerves • Transmission of energy to muscle spindles*	• Recovery from vibrational energy exposure	• Cumulative vibrational energy exposure
Cold	• Thermal energy loss from the extremities • Cooling of tissues and bodily fluids • Somatic and autonomic receptor stimulus	• Recovery from thermal energy loss	• Cumulative thermal energy loss

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Disorders of the Extremities

Soft tissue injury triggers a complex cascade of events involving an inflammatory response, which marks the first phase of the healing process, followed by a proliferative stage, and finally, a remodeling stage. Progression through these phases without complication typically requires a temporary reduction in loading, followed by a gradual increase in loading to stimulate healing and tissue remodeling.

Skeletal Muscle

There has been considerable interest in understanding the sequence of events that occur in skeletal muscles following eccentric activity. The initial event in muscle injury is believed to be mechanical in nature (Armstrong, 1990; Warren et al., 1993; Lieber, 1999 and Friden). The mechanical changes occur when the sarcomere is stretched to a length that prevents the thick and thin filaments from overlapping. Passive elements are left to hold together the overstretched sarcomeres and may undergo further elongation. This may result in damage to the sarcolemma. The muscle injury is further aggravated by a secondary event involving metabolic changes (Armstrong, 1990; Clarkson, 1992; Warren et al., 1993; Lieber and Friden, 1999).

Laboratory studies have found that strain, as compared to stress, precipitates muscle injury (Lieber and Friden, 1993; Best, 1995). Mechanical stress is a measure of force per area and strain is a percentage of elongation beyond resting length. Within a muscle fiber, sarcomeres may have different lengths (Lieber and Baskin, 1983). During an eccentric contraction, non-uniform lengthening of the sarcomeres occur which causes some sarcomeres to be overstretched whereas other sarcomeres are not (Wood 1993). Therefore, the amount of muscle elongation or displacement that occurs during lengthening contractions may have considerable impact on structural changes in the muscle.

Injury of human muscle associated with eccentric contractions involves disruptions of the Z-line and myofibrillar apparatus and has been reproduced in animal models (Lieber and Friden, 1999). The greatest decrease in force production was observed following eccentric contractions as compared to isometric contractions or passive stretch (Lieber et al., 1991). Numerous studies have observed ultrastructural abnormalities in the eccentric contraction group but not in the isometric contraction, concentric contraction or passive stretch groups (Lieber et al., 1991; Faulkner et al., 1993; Frieden and Lieber, 1998). The muscle fibers in the eccentric contraction group display various degrees of disorganization in sarcomeric banding pattern. Streaming of the Z-disk material, focal loss of Z-disks, and extension of Z-disks into adjacent A-bands is also reported (Faulkner et al., 1993; Lieber and Friden, 1999).

Muscular symptoms may also be caused by local ischemia, resulting in impaired muscle function and pain. Persistent degenerative changes of type I fibers with moth-eaten and ragged red fibers have been demonstrated after prolonged static, repetitive loading of the trapezius muscles in women with chronic myalgia. Moth eaten and ragged red fibers also have been found in back muscles of patients who have undergone surgery for lumbar disk herniation. As compared to the less painful side, blood flow has been shown to be reduced in the upper part of the trapezius muscle during rest and during isometric contraction in patients with chronic traqezius myalgia (Henriksson, 1988). In these cases, the observed muscle variations may be caused by chronic protective muscle spasm impairing microvascular blood flow.

Tendon

Tendon disorders can be classified based on the anatomy of the tendon and its surrounding tissues; tenosynovitis, stenosing tensoynovitis, peritendinitis and tendinosis (Viikari-Juntura, 1994; Clancy, 1990). The term tendinosis is often used to refer to chronic tendonitis which is associated with repeated loading and is believed to be due to microtears in the tendon. Acute inflammatory changes were not observed in studies of pathologic changes in chronic tendon injuries but instead, degenerative changes such as reduced collagen content, tendon calcification and fibrosis were reported. Animal studies on overuse of tendons have demonstrated an increase in cellularity and collagen disorganization, and an increase in tendon cross-sectional area and a decrease in tissue stiffness (Carpenter, 1998).

Disturbances of circulation and nutrition of the tendon also seem to be important factors for degenerative changes in the tendon. Zones of avascularity have been demonstrated in the supraspinatus tendon and the biceps brachii tendon (Chard, 1994). During aging, degenerative changes and microruptures are found. Humeral compression of the rotator cuff against the coracoacromial arch and constant tension on the supraspinatus tendon from working with elevated arms has an ischemic effect and may be a major cause of supraspinatus tendinosis. Furthermore, the myotendinous junction is not as strong as the associated tendon and strain may cause a structural failure in this region of the muscle-tendon unit (Clancy, 1990).

Peripheral Nerve

The primary mechanism of mechanical injury to the nerve is by localized compression or increased nerve tension which can compromise the microvascular system. The vascular system which is responsible for providing the energy needs for peripheral nerves can be negatively affected when edema forms in the endoneurial space (Lundborg and Dahlin, 1996). Inflammation and fibrin deposits can occur shortly following nerve compression, followed by a proliferation of endoneural fibroblasts and capillary endothelial cells (Dych et al., 1990).

Vibration exposure that occurs when working with handheld vibrating tools can also negatively affect peripheral nerves. Frequently referred to as hand arm vibration syndrome (HAVS) this can result in sensorineural disturbances. Pathological changes of demyelination followed by fibrosis have been observed in the fingertips of individuals working with vibrating handheld tools (Takeuchi et al., 1986).

Low Back

Low back pain is a one of the most common health problems in industrialized societies. Low back pain is a nonspecific condition in or near the lumbosacral spine that can be caused by inflammatory, degenerative, neoplastic, gynecologic, traumatic, metabolic, or other disorders. Non occupational back disorders that are due to an infectious process, systemic inflammatory disease, cancer or rheumatologic disorders are not included in this chapter.

Low back pain may be acute or chronic in nature and most episodes of low back pain cannot be associated with a specific lesion. In the majority of epidemiologic studies, the specific cause of back pain (e.g. sprains and strains, disc herniation, facet abnormalities) is not identified and categories are typically grouped together.

The intervertebral disc demonstrates time-dependent response to spinal loading. Tissue stress induced by spinal loading may affect the disc through both mechanical and biological pathways. A detrimental response may occur when the tissue stress exceeds the tissue strength. Tolerance to mechanical stress has been investigated largely in cadaveric models. These in vitro experiments demonstrate that failure will occur within the tissue that undergoes the greatest stress. The tissue at risk, and therefore the mechanism of injury, partially dependent on the type of loading (compression, flexion, lateral bending, or torsion). For instance, under pure compression, the disc fails by vertebral body fracture, whereas excessive bending injures the ligaments of the neural arch (Brickmann et al., 1989)

Table 2 Summary of Static Strength for Intact Spinal Segments

Loading Mode	Injury Mode	Average Strength	Notes
Compression	Vertebral endplate fracture	5.2 (1.8)kN[a] 6.1 (1.8)kN (male, 20-50 yrs) [a] 10.2 (1.7) kN* (male, 22-46 yrs) [b]	Dependent on verterbral cross-sectional area and bone density
Shear	Neural arch, facet joint fracture	1.0kN[c]	Uncertain
Flexion	Posterior ligaments	73 (18) Nm	Measured with 0.5 - 1.0 kN compressive preload
Extension	Neural arch	26 (9) Nm[d]	Anterior annulus may be damaged
Torsion	Neural arch/facets	25 – 88 Nm[e]	
Compression plus flexion	Posterior annulus, vertebral body	5.4 (2.4) kN[f]	Disc can prolapse under hyperflexion

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Disc tissues can also be injured through fatigue. When subfailure loads are applied repetitively, tissue failure may occur. Cadaveric experiments demonstrate that damage to the vertebra (including facet joints) may occur prior to damage to the annulus via cyclic loading in compression, bending, torsion, shear or in combination (Brickmann et al., 1989). Additional evidence suggests that the annulus may be injured through fatigue and damage accumulation (Gordon et al., 1991; Buckwalter, 1995; Walsh et al., 2000). The clinical significance of these pathological changes remains unclear.

Disc biology can be affected by stress during spinal loading. Cells can be stimulated to produce more bone in areas of high stress or remove bone in areas of low stress. This process, known as remodeling, is a method to optimize the density and shape of bones for a certain physical stress exposures (Cowin et al., 1985). These cells are also responsible for healing fractures, including microdamage resulting from fatigue. Martin et al., 1998 reported that based on bone healing times, minimal repair of bone microfractures would be expected in about two weeks time. This suggests that vertebral fatigue damage may accumulate in vivo, and not be given sufficient time to heal and possibly lead to fractures.

Spinal discs degenerate with age but the independent contribution of physical stress to degeneration is currently unknown. This is due to inherent variability among individuals, and because aging, this typically corresponds to lengthened exposure to cumulative trauma. Pain may be caused indirectly via chemicals secreted by disc cells and inflammatory factors (Kayama et al., 1998). Due to a lack of specificity of disc degeneration for back pain, the pathophysiological mechanisms linking spinal load and pain in humans are still uncertain (NAS/IOM, 2001).

Musculoskeletal disorders are a major cause of worker impairment, disability and compensation in agriculture. The pathogenesis of these disorders is not fully understood, but it appears to involve the exposure to certain external physical stressors. It has been proposed that these external stressors produce a series of internal biomechanical and physiologic disturbances. Physical stressors are related to work requirements, such as production standards and work equipment, and to individual factors, such as body size and capacity.

In summary, a disorder, in the context of musculoskeletal disorders, has a gradual onset and is typically mediated by some pathogen or prepathological progression (Kumar, 2001). Mechanical degradation of tissue may occur due to exposure over time of mechanical stresses that are repetitive, prolonged or forceful. Biological variations in the tissue also appear to play a role. Certain exposures can be considered hazards and are typically referred to as risk factors. Therefore, a discussion of common risk factors for MSDs and the state of the science for these risk factors needs to be investigated.

Risk Factors

Occupational Physical Risk Factors

Numerous studies have reported an association between certain risk factors and MSDs, although the evidence associating a dose – response relationship is limited at best. Occupational risk factors frequently mentioned as potentially causative for upper extremity musculoskeletal disorders include forceful hand and arm exertions, repetitive upper extremity activity, posture extremes, static postures, and vibration. Occupational risk factors associated with low back disorders include lifting, heavy physical work, static postures, such as stooping, whole body vibration and awkward postures, such as twisting.

The National Institute for Occupational Safety and Health prepared an extensive review of the epidemiologic literature that investigates the association between musculoskeletal disorders of the upper extremity, neck and low back with exposure to occupational risk factors. Understanding these relationships is critical to identifying occupational risk factors that can be minimized or eliminated. Occupational risk factors and specific agricultural work tasks associated with upper limb MSDs will be discussed in this section.

Neck and Neck/Shoulder
NIOSH (1997) identified forty-six epidemiologic studies investigating neck MSDs and twenty-three looking at neck/shoulder MSDs. Evidence of association between the individual risk factors of repetition and forcefulness for neck and neck/shoulder disorders was identified. Repetitive work is defined as work activities which involve continuous arm or hand movements which generate loads on the neck and shoulder area. Few studies investigated actual repetitive neck movements. Forceful work is defined as work activities which involved forceful arm or hand movements and generated loads to the neck/shoulder area. Evidence of a strong association exists which shows that working with high levels of static contraction and/or extreme working postures involving the neck/shoulder muscles result in increased risk for neck/shoulder MSDs.

In another study, Scutter et al. (1997) reported that one third of agricultural workers surveyed reported neck pain at least once a week. Tractor driving was reported most frequently as the activity that contributed to neck pain.

Shoulder Disorders
NIOSH (1997) identified over twenty epidemiologic studies investigating shoulder MSDs. Evidence of association between repetition and shoulder disorders was identified. Few studies investigated actual repetitive neck movements. There is also evidence of association between a combination of risk factors; repeated or sustained exertions and elevated shoulder postures (>60 degrees of flexion or abduction) and shoulder disorders. There is insufficient evidence for an association between force and shoulder MSDs. The evidence for specific shoulder postures is strongest where there is combined exposure to several physical factors, such as holding a tool while working overhead.

A study specific to agricultural tasks, Palmer (1996) reported an OR=5.9 for neck and shoulder symptoms when comparing tomato trainers and matched workers. Tomato plants can grow quite tall up vertical wires and are supported by an overhead horizontal system. Tomato trainers reach overhead to adjust the support mechanism for the plants at a frequency of 10,000-16000 times per week (Palmer, 1996). The risk factors accompany this job include repetition, static contractions of the neck and shoulder muscles, and working at or above shoulder level.

Elbow Disorders
NIOSH (1997) identified over twenty epidemiologic studies investigating elbow MSDs, specifically epicondylitis. There is evidence of association between forcefulness and lateral epicondylitis. A strong relationship exists with a combination of risk factors (e.g. force and repetition, force and posture) for lateral epicondylitis. For example, a combination of higher levels of forceful exertions, repetition, and extreme postures of the elbow is associated with epicondylar tenderness. Insufficient evidence exists to support a relationship between postural factors and repetition independently and lateral epicondylitis.

Carpal Tunnel Syndrome
NIOSH (1997) identified over thirty epidemiologic studies investigating physical occupational factors and their relationship to carpal tunnel syndrome (CTS). Evidence of association between repetition alone or in combination with other risk factors and CTS was identified. There is also evidence of association between forceful work and CTS and exposure to vibration and CTS. There is strong evidence of an association between exposure to a combination of risk factors (e.g., force and repetition, force and posture) and CTS. There is insufficient evidence of an association between CTS and extreme postures. NIOSH (1997) concluded that based on the epidemiologic studies reviewed, the evidence is clear that exposure to a combination of the occupational risk factors studied (repetition, force, posture, etc.) increases the risk for CTS.

Hand/Wrist Tendinitis
NIOSH (1997) identified eight epidemiologic studies investigating physical occupational factors and their relationship to hand/wrist tendonitis. Evidence of association between an individual risk factor (e.g. repetition, force and posture) and hand/wrist tendinitis was identified. There is strong evidence of an association between exposure to a combination of risk factors (e.g., repetition and forceful exertions) and increased risk for hand/wrist tendonitis.

In a Swedish study, female milkers had a greater risk of developing hand and wrist MSDs as compared to agricultural workers that were non-milkers (Stal et al., 1996). In this same study, symptoms of numbness and white finger, related to vibration exposure, were also reported.

Hand-Arm Vibration Syndrome
NIOSH (1997) identified nineteen epidemiologic studies investigating vibration exposure and its relationship to hand-arm vibration syndrome. Strong evidence of association between high level exposure to hand-arm vibration (HAV) and vascular symptoms of hand-arm vibration syndrome (HAVS) was reported. Studies reported typical acceleration levels of 5 to 36 m/s2. There is also substantial evidence that as intensity and duration of exposure to vibrating tools increase, the risk of developing HAVS increases. Increasing symptom severity is also associated with increased exposure.

Low Back Disorders
NIOSH (1997) identified over forty recent epidemiologic studies investigating the relationship between low back disorders and occupational risk factors. The five risk factors included for this review are:(1) heavy physical work which is defined as work that has high energy demands or requires some measure of physical strength, (2) lifting and forceful movements, (3) bending and twisting (awkward postures), (4) whole-body vibration (WBV), and (5) static work postures. Many of the studies addressed multiple work-related factors. There is evidence of association between back disorders and independent physical factors of heavy physical work and awkward postures. There is strong evidence that low-back disorders are associated with work-related lifting and forceful movements. Several studies also suggest that a combination of risk factors (e.g. lifting and awkward postures) increases the risk of low-back disorder. There is also strong evidence of an association between whole body vibration exposure and low back disorders. Insufficient evidence exists with regard to static work postures and low-back disorders.

In addition to the studies reviewed by NIOSH, Ahonen et al., (1990) investigated the level of physical strain accompanying dairy farming and found that female farmers frequently worked above 50% of VO_2 max during most of their work tasks. Heavy physical work has been associated with increased risk of low back pain. In this study, the handling of feed and manure was found to be the heaviest work task in dairy farming.

Farmers are exposed to long periods of sitting in a twisted posture while operating farm equipment. In addition to the awkward posture, vibration accompanies operation of farm equipment. The twisted posture, while at the same time undergoing exposure to vibration has been shown to cause increased energy consumption as compared to single exposure only of twisted posture or vibrations (Magnusson M et al.,(in Nordin, Anderson, Pope p. 79)). Whole body vibration appears to hasten muscular fatigue in the lumbar erector spinae muscles (Hansson et al., 1991and Magnusson et al., 1992) in Nordin, Anderson and Pope .79.

Toren et al., (2002) investigated the relationship between tractor driving hours and low back and hip symptoms. This is an important farm activity to elucidate a potential relationship with injury because of the frequency that this activity is performed. The driver of an agricultural tractor is exposed to a combination of risk factors, such as prolonged sitting, whole body vibration and twisted posture. This study showed that production farmers working with meat and crop production drove tractors most frequently. Ploughing was the most time-consuming work operation but it did not appear to influence the risk for low back or hip pain prevalence (61% and 33%, respectively). Silage chopping seemed to contribute to an increased risk of low back symptoms and exposure to tractor driving showed an increased risk for hip symptoms. Increased risk for low back symptoms may be explained by the differences in the type of vibration exposure between silage chopping and ploughing.

Although not discussed previously, there is increasing evidence that farmers are at increased risk for degenerative changes of the hip. Croft et al.,(1992) reported farmers who had farmed for more than 10 years had eight time greater risk of developing hip osteoarthritis as compared to controls. Several risk factors may contribute to the development of hip osteoarthritic, such as heavy lifting, stress on the hip from walking over uneven, rough ground and exposure to whole body vibration, but the exact mechanism remains unclear.

Psychosocial Risk Factors

Psychosocial factors may be important in the development of musculoskeletal disorders and the likelihood that a disability may occur. Seyle presents that "stress is a biological process by which the body attempts to adapt to some challenge by mobilizing its energy, disease-fighting and survival responses." This process has the potential to increase the risk of CTDs through physiological changes, such as increased muscle tension and pain, as well as feelings of muscular fatigue. Job stressors such as workload, lack of job control, and job future ambiguity can produce stress responses that increase the potential for MSDs.

Psychosocial factors are often separated into two main categories. The first category includes factors that are specific to the workplace, such as job satisfaction, social support, work organization, etc.The second category includes factors that are specific to the individual, such as depression. Specific work related psychosocial factors that were identified by the report from the National Research Council, as being associated with low back disorders includes rapid work pace, monotonous work, low job satisfaction, low decision latitude, and job stress. High job demands and high job stress are associated with the occurrence of upper extremity disorders. It is important to remember that this is information is generalized to the agricultural population from other industrial sectors. The reader is encouraged to refer to the National Research Council report for more details concerning work related psychosocial factors. The remaining discussion about ergonomics will focus on the prevention of chronic and overexertion injuries and syndromes that result from the physical stressors in the work environment.

Nonoccupational Risk Factors

As is true for almost all illnesses associated with work, a number of nonoccupational factors also increase risk. Factors include pre-existing rheumatologic disease, history of musculoskeletal disorder, and, at least for carpal tunnel syndrome, body mass index, pregnancy, diabetes, renal dialysis, and, possibly, thyroid disease. In general, rates of musculoskeletal disorders increase with increasing age and female gender. It is possible, however, that these associations are because of increased durations of exposure and preferential placement of women workers into jobs with intense hand use.

A dose response relationship has not been elucidated for these disorders and risk factors. So, quantitative levels of acceptable exposure are not available. As a result, prevention of occupational musculoskeletal disorders cannot be based upon the application of simple exposure limits, as is done for many chemical exposures (Mani and Gerr, 2000). Additionally, since the process is unclear as to the development of chronic disabilities, it is difficult to predict which individuals that will go on to develop chronic disabilities. Instead, a comprehensive ergonomic program that includes the following elements; (1) inspection of facilities for potentially hazardous exposures, (2) surveillance of workers for unusual elevations of disease incidence, (3) control of exposure when experience suggests they are likely to be hazardous or incidence rates indicate a problem, (4) appropriate management of clinical illness when it occurs, and (5) education of employees and managers is the best method of preventing these disorders.

Ergonomics

Ergonomics, the study of humans at work, seeks to understand the complex relationships among people, machines, technology, tools, job demands, tasks and work methods. All work, regardless of its type or nature, places both physical and mental stresses on the worker. As long as these stresses are kept within reasonable limits, work performance will be satisfactory and worker's health and well being will be maintained. If stresses are excessive, however, undesirable outcomes may occur in the form of errors, accidents, injuries or illness. The application of ergonomic principles facilitates fitting of workplace conditions and job demands to the capabilities of the working population. Effective and successful "fits" assure high productivity, avoidance of illness and injury risks, and increased satisfaction among the workforce.

A goal of ergonomics is to design facilities, furniture, equipment, tools, work processes, and job demands to be compatible with human capabilities and limitations. A successful ergonomics program should not only reduce the risk injury and illness associated with ergonomic related risk factors but also improve productivity. In agriculture this is an extremely important concept. If ergonomic interventions increase the time or costs necessary to complete a task, they will ultimately fail.

Agricultural work is diverse, therefore agricultural ergonomics must bridge many specific problems with an adaptable, generic approach. While agricultural work, in general, is precarious for musculoskeletal disorders, the industry is diverse and the risks vary depending on the type of work done. Agriculture is composed of five major groups: crop production (SIC 01), livestock production (SIC 02), agricultural services (SIC 07), forestry (SIC 08), and commercial fishing, hunting, and trapping (SIC 09). Although similar hazards may exist for different agricultural groups, such as exposure to material handling activities, the materials handled may vary from large vegetable containers to farm animals.

The rigorous nature of farm work exposes workers to a number of risk factors that have been associated with musculoskeletal disorders. Heavy lifting, working in awkward positions for a prolonged period of time, and poorly designed tools and implements take a toll on both farmers and farm workers and make musculoskeletal conditions the most commonly reported health problem (NIOSH, Priority). Harvesting tasks are stressful to the upper extremities due to the rapid, repetitive motions and awkward postures. Material handling activities that are frequently performed include: loading hay, carrying feed, shoveling manure or carrying vegetable or fruit containers.

In addition to a reduction of injuries, the goals of an ergonomics program may include improvement in production efficiency and work process, reduced injury absences and turnover and lower labor costs with reduced expenditures for medical care and worker compensation. A barrier to a successful injury or illness prevention program in agriculture is the lack of available information to identify hazards and risk factors. Much of the information to date is borrowed from other industrial sectors and generalized to agriculture (Meyers et al., 1995). This may present problems since agricultural work is unique among U.S industries because people of all ages are at risk of being injured while in a work setting (Purschwitz and Field, 1990 in Bobick and Myers, 1994). This occurs because farms are both work sites and homes, with farm employment being equivalent to employment of the whole family. Additionally, agricultural work has long cycles, as compared to manufacturing or assembly work, which has short job cycles. Agricultural work is diverse with tasks varying from day to day and occurring in various environmental conditions, as well as utilizing tools and tasks that are crop specific. Given these differences, it is important to remain cognizant of the applicability and generalizability of ergonomic information to the agricultural sector.

NIOSH Elements of An Ergonomics Program

NIOSH (1997b) has developed a seven-step "pathway" for evaluating and addressing musculoskeletal concerns in an individual workplace. The seven steps are as follows:

1: Identify signs of a potential musculoskeletal problem in the workplace, such as frequent worker reports of aches and pains, or job tasks that require repetitive, forceful exertions.
2: Demonstrate management commitment in addressing possible problems and encouraging worker involvement.
3: Provide training to assist and improve management and worker ability to evaluate potential musculoskeletal problems.
4: Gather data to identify jobs or work conditions that are most problematic, using sources such as injury and illness logs, medical records, and job analyses.
5: Identify effective controls for activities that pose a risk of musculoskeletal disorders and evaluate these approaches following implementation to see if they have reduced or eliminated the problem.
6: Establish health care management to emphasize the importance of early detection and treatment of musculoskeletal disorders for preventing impairment and disability.
7: Minimize risk factors for musculoskeletal disorders when planning new work processes and operations.

<u>Looking for signs of work related musculoskeletal problems</u>
The following resources are helpful for identifying signs of work related musculoskeletal problems: (1) OSHA Form 200 logs or workers compensation claims, (2) evaluating certain jobs or tasks that cause workers complaints of strain, localized fatigue, discomfort, (3) workers seeing health care providers for physical aches and pains related to certain types of work assignments and (4) job tasks that involve risk factors such as: repetitive and forceful exertions; frequent, heavy, or overhead lifts; awkward work positions; or use of vibrating equipment. More than likely, items (2), (3) and (4) are going to provide the most information to health care providers since the majority of farm workers do not complete OSHA 200 logs or have workers' compensation insurance.

<u>Management commitment and worker involvement</u>
On larger farms, it is important that the farm manager give ergonomic efforts priority. Farm workers must realize that safety and ergonomics are as important as productivity issues. This is also an important philosophy to be communicated to smaller and/or family farms, although this is often done informally.

Worker involvement in safety and health issues means obtaining worker input on several levels. Real or suspected job hazards need to be identified with farm workers providing valuable information. Another method for employee involvement is to encourage suggestions on ways to control suspected hazards. A third method of employee involvement involves working with management in deciding how best to put controls into place. No single form or level of worker involvement fits all situations or meets all needs. Much depends on the nature of the problems to be addressed and the skills and abilities of those involved.

Training - Building in House Expertise
Training is recognized as an essential element for any effective safety and health program (NIOSH, 1998). For ergonomics, the overall goal of training is to enable farmers and farm workers to identify aspects of job tasks that may increase risk of developing musculoskeletal disorders, recognize the signs and symptoms of the disorders, and participate in the development of strategies to control or prevent them. Training employees ensures that they are well informed about the hazards so they can actively participate in identifying and controlling exposures.

Gathering & Examining Evidence of MSDs
Farmers and farm workers should be encouraged to report, as early as possible, signs and symptoms related to MSDs. Early reporting allows corrective measures to be implemented before the results of a job problem worsen. Exploring individual worker complaints that certain jobs cause undue physical fatigue, stress, or discomfort may be signs of ergonomic problems. Following up on these reports is essential. Such reports indicate a need to evaluate the jobs to identify any ergonomic risk factors that may contribute to the cause of the symptoms or disorders. Additional methods for gathering evidence of MSDs are: OSHA logs or other injury records, conducting symptom surveys, using periodic medical examinations, screening jobs for risk factors and, if needed, completing a job analysis.

Developing Controls
A three-tier hierarchy of controls is widely accepted as an intervention strategy for controlling workplace hazards, including ergonomic hazards. They are as follows:
Reducing or eliminating potentially hazardous conditions using engineering controls. The preferred approach to prevent and control WMSDs is to design the job to take into account of the capabilities and limitations of the workforce. A good match (meaning that the job demands pose no undue stress and strain to the working population as a whole) helps ensure a safe work situation. Some examples of engineering controls are:

Changing the way materials, parts, and products can be transported, for example, using material handling devices to relieve heavy load lifting and carrying tasks, or using handles or slotted hand holes in packages requiring manual handling

Changing workstation layout, which might include using height-adjustable workbenches or locating tools and materials within short reaching distances

Changing how parts, tools, and materials are to be manipulated; examples include using clamps to reduce the strain of static grasping on the hands and arms.

Changing tool designs—for example, longer handles on tools to minimize stooping or reaching

Implement changes in work practices and management policies, sometimes called administrative controls. Administrative controls are management-dictated work practices and policies to reduce or prevent exposures to ergonomic risk factors. Administrative control strategies include (1) changes in job procedures such as scheduling more rest breaks, (2) rotating workers through tasds, and (3) training workers to recognize ergonomic risk factors and to learn techniques for reducing the stress while performing work tasks. Some examples of administrative controls are:

Reduce shift length or curtailing the amount of overtime.

Rotate workers through several jobs with different physical demands to reduce the stress on limbs and body regions.

Schedule more breaks to allow for rest and recovery.

Broaden or vary the job content to offset certain risk factors (e.g., repetitive motions, static and awkward postures).

Adjust the work pace to relieve repetitive motion risks and give the worker more control of the work process.

Train in the recognition of risk factors for WMSDs and instruction in work practices that can ease the task demands or burden.

Use of personal protective equipment. One of the most controversial issues in the prevention of MSDs is whether the use of personal equipment worn or used by the employee (such as wrist supports, back belts, or vibration attenuation gloves) is effective. Some consider these devices to be personal protective equipment (PPE). In the field of occupational safety and health, PPE generally provides a barrier between the worker and the hazard source. Respirators, ear plugs, safety goggles, safety shoes, and "hard hats" are all examples of PPE. Whether braces, wrist splints, back belts, and similar devices can be regarded as offering personal protection against ergonomic hazards remains controversial. Although these devices may, in some situations, reduce the duration, frequency, or intensity of exposure, evidence of their effectiveness in injury reduction is inconclusive. In some instances they may decrease one type of exposure but increase or introduce another type because the worker has to "fight" the device to perform his or her work. An example of this is the use of wrist splints while engaged in work that requires wrist bending. The benefits versus the drawbacks of using bracing need to be evaluated carefully by the health care provider.

Finally it is important to evaluate the effectiveness of the control measures in reducing MSDs, risk factors and/or signs and symptoms. It is important to stress that any control or action that is perceived to reduce production or quality will unlikely be adopted by farmers and will ultimately fail.

<u>Health Care Management</u>

Effective health care management requires the cooperation of the farmer, farm worker and health care provider. Early reporting of signs and symptoms of MSDs should be encouraged and be followed by an evaluation by a health care provider.

The health care provider should:

Acquire experience and training in the evaluation and treatment of MSDs.
Seek information and review materials regarding job activities.
Ensure employee privacy and confidentiality to the fullest extent permitted by law.

Evaluate symptomatic employees including:

Medical histories with a complete description of symptoms,
description of work activities as reported by the employees,
physical examinations appropriate to the presenting symptoms and histories,
initial assessments or diagnoses,
opinions as to whether occupational risk factors caused, contributed to, or exacerbated the conditions, and
examinations to follow up symptomatic employees and document symptom improvements or resolutions.

Proactive Ergonomics
Proactive ergonomics attempt to prevent MSDs from developing in the first place. Proactive ergonomics emphasize efforts at the design stage of work processes to recognize needs for avoiding risk factors that can lead to musculoskeletal problems (in effect, to design operations that ensure proper selection and use of tools, job methods, workstation layouts, and materials that impose no undue stress and strain on the worker).

Types of Interventions in Agriculture

The National Institute for Occupational Safety and Health published a resource for farmers, Simple Solutions: Ergonomics for Farm Workers, February 2001. This resource contains "tip sheets" that show how to make or order inexpensive tools or modify existing ones to reduce the risk factors for musculoskeletal disorders. A few of the examples from NIOSH are contained here.

Weeding Stand for Plant Nurseries
Problem: Plants may be kept on the ground and workers must bend to weed them resulting in sustained flexion and repetitive bending. Worker fatigue and pain can lead to lower work quality as well as low back pain.

Solution: The worker can use a movable table to elevate trays while weeding that may eliminate or minimize sustained stooping. The worker must still stoop to pick up and replace trays, but static stooping is reduced. The tray is also positioned close to the worker and may minimize strain due to reaching activities. Additionally, the use of the table may actually improve productivity. Use of the table may result in a slightly slower pace at the beginning of the work day, but by midday, when discomfort and fatigue may develop and typically decrease worker's pace, the workers using the table will be less tired and potentially may experience fewer symptoms, and therefore likely to move faster than those not using the tray. Instructions are included on how to make a low cost tray.

Mesh Bags: Easy Batch Processing
Problem: Workers must frequently wash leafy greens by hand, which requires static stooping over a washbasin. Static loading on arms occurs while holding produce to drain. Although not an ergonomic risk factor, rough handling of greens lower crop quality.

Solution: The use of mesh bags expedites the washing process by minimizing the duration a worker spends in a static flexed posture. Mesh bags can improve productivity by increasing the amount of greens washed per trip and decreasing the chance of leaf damage from crushing. Information on obtaining mesh bags can be found in Simple Solutions, NIOSH (2001).

Narrow Pallet System
Problem: Workers are exposed to heavy material handling when carrying boxes by hand. Many of the boxes have poor handles making them difficult to handle.

Solution: A hand pallet truck can be used to transport the boxes. A hand pallet truck is similar to a hand truck (dolly) but have pivoting forks instead of a flat plate. This minimizes material handling requirements, while at the same time increases the number of boxes that can be transported per trip. The smaller hand pallet truck should fit through the majority of doorways and tight spaces, as compared to a regular pallet. Resources for obtaining a hand pallet truck are list in Simple Solutions (NIOSH, 2001).

Harvest Cart for Greens
Problem: Harvesting greens can require high energy expenditure along with awkward, static postures.

Solution: A harvest cart minimizes fatigue and discomfort as well as increasing harvest speed. Use of the harvest cart increases green harvesting by 40%. Directions on building a harvest cart can be found in Simple Solutions (NIOSH, 2001) for a cost of about $150.

Management Issues

Prevention

MSDs are a major concern for farm workers, farmers and health care professionals due to the negative impact on the health and productivity of workers. This impact is measurable in terms of health and safety costs, injury and illness rates, lost work time, treatment duration, and workers' compensation costs. Hopefully, by reducing the incidence of MSDs, a reduction in total costs, an increase in productivity, and improvement in employees' quality of life will be realized.

There is a tremendous need for early identification and prevention of MSDs. More than a decade ago, NIOSH stated the need for a national prevention strategy. Early, effective screening and prevention and intervention efforts aimed at higher-risk employees may be able to prevent or reduce disability. The World Health Organization (WHO) outlines three levels of prevention; (1) primary prevention, which prevents the clinical manifestation of a disease before it occurs, (2) secondary prevention, which arrests the development of a disease while it is still in the early asymptomatic stage, and (3) tertiary prevention, which minimizes the consequences of the disease. Strategies for both prevention and intervention measures must consider work place factors such as buildings, tools, equipment, production processes, environment and organizational structure. Personal and life style characteristics to be considered are age, gender, anthropometic characteristics and hobbies.

Primary prevention frequently focuses on engineering controls to reduce the level of exposure. In the primary prevention of MSDs, engineering controls would be used to eliminate or minimize the physical stress experienced by individual. The use of material handling aids would be an example of an engineering control. Primary prevention of musculoskeletal disorders can be achieved through the reduction or elimination of exposures to physical and psychosocial hazards. Therefore, it is important for health care providers to recognize and identify physical stresses to meaningfully participate in counseling and preventive efforts.

The occupational history is the foundation of preventive efforts and needs to be obtained from each patient. Agricultural tasks and hazards may differ between the type of work and between individuals performing the tasks, therefore it is extremely important to gather an occupational history from each patient.

Secondary prevention is difficult because in most instances, the ability to identify asymptomatic conditions that contribute to development of MSDs is limited. So typically, secondary and tertiary prevention programs overlap, particularly those addressing the prevention of MSDs. The use of surveillance, case management and work activity restrictions can all be key components in effective secondary and tertiary prevention programs. Frequently, the health care provider may need to recommend alternate work duties, limit daily exposure, or request complete medical removal. It is extremely important to explain in detail the importance of adherence to work restrictions. Without the worker thoroughly understanding the need and importance of the health care provider's recommendations there is little hope that they will be adhered to due to the demands of agricultural work.

Musculoskeletal disorders are often unrecognized as occupational or environmental in origin. Occupational exposures provide unique opportunities for effective disease prevention because elimination of the exposure may prevent the disease. Health care providers play a unique role in that they can offer important counseling to their patients regarding early recognition of signs and symptoms of MSDs, and their associated risk factors. Knowledge of a patient's work activities may be important in treating non-work related conditions. Examples include deciding when a patient may safety return to work following a hospitalization, and adjusting medication dosing for patients who work night shifts or operating heavy equipment.

The initial step for achieving better recognition of occupational and environmental exposures is for all clinicians to take a basic occupational history from their patients. This history should include:

the patient's past and current job titles and industries,
a description of past and current work duties,
any known exposures to chemical, physical, or biological hazards,
the presence of any symptoms in relation to work.

This initial screening history will suffice for most patients. A detailed history is warranted in patients who report potential occupational hazards in their initial occupational screening. A number of self-administered questionnaires exist to aid the clinician in obtaining a more detailed occupational history (US Preventative Services, 1996).

Because workplace exposures can have a cumulative effect and interact with other exposures, health care providers also need to take into account patient activities outside of work. For example, as women assume more responsibility for farm operations, they may be at greater risk for injury (Carruth, 2001).

Women in farm families often try to balance home, employment off the farm and farm work, potentially increasing the amount of exposure to risk factors while decreasing their rest or recovery time. Counseling patients about work-rest ratios and the cumulative effects of exposure to risk factors represents an additional step that health care providers can take to reduce the overall burden of occupational disease among their patients.

An effective MSD intervention program would be expected to increase awareness and result in earlier reporting of MSD signs and symptoms. This may result in an initial increase in incidence rates, but there should be an observed decrease in the total number of lost workdays, lost time case incidence rate, lost time day severity rate, and workers' compensation costs. Of course, a successful MSD intervention program should at a minimum not adversely affect production but hopefully will contribute to an increase in productivity. Although designing and implementing effective intervention programs to reduce risks is difficult, the potential benefits of even a partially successful program would be expected to result in substantially improved workplace health and safety, reduced injury incidence rates, decreased lost work time, decreased treatment duration, and decreased workers' compensation costs.

Surveillance is a useful tool to help determine the need for safety and health actions. In examining the various musculoskeletal disorders that affect farmers and farm workers, surveillance needs to accomplish three tasks. First, surveillance programs must determine the prevalence of MSD signs and symptoms among agricultural employees. Second, it should assess the effectiveness of ergonomic intervention programs including awareness of musculoskeletal disorders training, better tool design, and organizational factors such as reorganization of work tasks to decrease repetitiveness and awkward postures. Finally, it is essential that surveillance assess chronic conditions and long-term health outcomes. This can be achieved by investigating the prevalence of musculoskeletal disorders among disabled and retired farm workers.

The prevention of musculoskeletal disorders and identification of risk factors is an important task for the health care provider. Control of exposure and risk can include administrative, organizational and engineering changes. Often, a workplace evaluation is helpful to identify risk factors and, if appropriate, implementation of ergonomic interventions. Simple Solutions (NIOSH 2001) may also be helpful in assisting farmers in assessing and developing ergonomic interventions

Diagnosis and Treatment

The following information is designed to complement the quality of care of health care providers and illustrate the role that occupational factors may have in the development and during rehabilitation of MSDs. This information should be used as a guide and does not substitute for individualized assessment and good medical judgment. The reader may want to refer to several recent articles that focus on the treatment of work related MSDs (Piligian et al., 2000; Yassi, 2000; Mani and Gerr, 2000; Borenstein, 2000;Johanning, 2000; Herbert et al., 2000).

History of Current Illness

Typically, pain and inability to perform certain elements of work tasks are the complaints commonly associated with a work related musculoskeletal disorder. Other symptoms might include loss of strength, numbness, paresthesia or muscle fatigue. The health care provider should attempt to quantify the intensity, frequency and duration of the symptoms. Additional pain characteristics such as acuity of onset, quality, location, radiation, daily patterns, and aggravating and alleviating factors should also be ascertained.

Occupational History

The purpose of the occupational history is to obtain information about the patient's exposure to risk factors and the specific types of risk factors. To be able to determine an occupational basis for musculoskeletal disorders, it is imperative that the patient's work tasks be discussed. Inquiry should be made about the following occupational risk factors:

awkward postures that involve extremes of range of motion (e.g., work with hands above shoulder height or sitting in a twisted posture);
forceful exertions (e.g., squeezing tool handles or material handling activities);
lifting factors such as weight and dimensions of object, location of load relative to body, transport distance, coupling;
performance of a particular repetitive activity for more than 1 to 2 hours (e.g., use of pruning tools);
exposure to environmental factors such as vibration (e.g., operating farm machinery, power tool use) and temperature;
pacing by external sources (e.g., seasonal and climate demands)

Many employers now keep descriptions of the physical demands of many jobs, but this is uncommon, and often impractical on smaller farms. Frequently, a written job description is not available, but asking the patient to list the tasks of their job and associated physical stress can be helpful for assessing ergonomic risks. The history should also include recreational exposures, such as hobbies and other tasks undertaken outside of work. Finally, information should be collected about the organizational and social context of work. This may include items such as the individual's control over the work pace, deadline pressures, financial issues and job security.

Physical Examination

Physical examination should include inspection; palpation; testing of passive and active range of motion; quality of motion, provocation maneuvers, strength testing, evaluation of nervous system function, and assessment of pulses. Assessment for red flags such as acute changes in neurological status, sacral deficits, bladder symptoms or a clinical picture that is consistent with fracture, infection, cancer or systemic disease process must be completed.

Laboratory Evaluation

The main use of laboratory tests is to rule out systemic illness as a cause or contributor to musculoskeletal symptoms. Systemic disorders include infection, arthritis, gout, calcium pyrophosphate deposition, diabetes, hypothyroidism, and rheumatic disease. Selection of further studies such as radiologic imaging or nerve conduction testing depends on the differential diagnosis formulated following examination.

Treatment

Treatment of most occupational musculoskeletal disorders should begin with conservative measures, including activity modification, anti-inflammatory medication, cold and heat applications and occupational or physical therapy. Control of exposures that were contributory to the development of the disorder is necessary. Treatment without control of the work conditions that led to the disorder is likely to fail (Mani and Gerr, 2000).

Exposure control is especially difficult to successfully accomplish in agriculture industry. Typical controls in other industries include transfer of the worker to another position, reduction of time the worker can be exposed to his usual work activities (restricted duty), redesign of the workplace and work tasks, change in work policies such as worker rotation and increased rest breaks, and use of personal protective devices. Depending upon the farm size and number of workers employed, there may not be anyone else to transfer the work to and due to the time and seasonal restraints, farmers may not be able to postpone the activity.

Musculoskeletal Disorders

Neck and Shoulder

Trapezius Myalgia

Trapezius myalgia, or tension neck syndrome, is discomfort of the trapezius muscles. It is one of the most common of the occupational shoulder and neck disorders. A worker may describe job tasks requiring static positioning of the neck, shoulders, and back, such as data entry on a computer terminal. Occupational risk factors include unvarying stationary positioning of the neck, shoulder, or back or prolonged static loading of shoulder muscles.

Clinical Presentation

Patients report pain, stiffness, or burning of the upper back, shoulder and lateral neck area. They may also complain of “knots” in the trapezius area. During the physical examination, muscle tightness or trigger points” of increased muscle tone and tenderness may be noted. Mild decreases in range of motion can be observed. Differential diagnoses include shoulder pathology and cervical spine disorders.

Treatment
Ice and heat applications may help to reduce or relieve symptoms. Low doses of tricyclic antidepressants may be valuable for control of pain and improvement of sleep for patients with particularly disabling symptoms (Mani and Gerr, 2000). Altering postures at work such as avoiding working with elevated shoulders and minimizing static positioning may help to improve symptoms. Frequent rest breaks should be encouraged.

Rotator Cuff Tendonitis

Rotator cuff tendonitis, (also referred to as supraspinatus tendonitis) is a muscle-tendon disorder that is associated with impingement of structures in the suprahumeral space. This space includes the subdeltoid bursa, the supraspinatus tendon and the long head of the biceps all of which may become impinged if this space is narrowed. Overhead work places the worker at risk for developing shoulder tendinitis. Forceful or repetitive work associated with all movements of the shoulder but especially abduction, flexion and rotation can be problematic. Activities requiring heavy lifting and static postures of the upper extremity can also increase risk for shoulder tendonitis. Impingement of the rotator cuff is also associated with tears, typically the supraspinatus, although the infraspinatus muscle and tendon may also be involved.

Clinical Presentation
The patient with rotator cuff tendonitis may present with weakness, pain, tenderness, and may have limited range of motion, most notably with shoulder abduction and external rotation. Clinically, pain localizes to the superior or lateral shoulder, although it may radiate down the arm. A painful arc of abduction may be present. The impingement test, Hawkin's impingement sign, can reproduce pain by positioning the arm in 90 degrees of forward flexion of the shoulder to 90° with forceful passive internal rotation of the humerus. The supraspinatus tendon may be tender to palpation. Differential diagnoses include other shoulder pathology such as subdeltoid bursitis, biceps tendonitis, arthritis, and pain from cervical radiculopathy.

Treatment
Initial treatment includes restriction of overhead activities and control of inflammation. Physical therapy should begin after the resolution of acute symptoms and progress through range of motion and strengthening activities. Workplace modifications may be needed to prevent reoccurrence or continuation of symptoms. Minimizing overhead tasks and high shoulder loads have shown to be helpful. A surgical consult may be necessary when conservative measures do not lead to improvement.

Bicipital Tendonitis

Bicipital tendonitis is inflammation of the long head of the biceps tendon and tendon sheath as it passes through the bicipital groove. Occupational risk factors include highly repetitive work requiring movement of the shoulder, especially in flexion, and sustained shoulder postures.

Clinical Presentation
The patient with bicipital tendonitismay present with pain in the anterior shoulder area. Tenderness with palpation of the biceps tendon is often reported. Resisted shoulder flexion with the elbow fully extended and forearm in supination (Speed's test) is often painful. Range of shoulder motion is typically unaffected although in chronic conditions it may be decreased. Differential diagnoses include bicipital tendon tear and rotator cuff disorders.

Treatment
Initial treatment includes restriction of provocative activities and control of inflammation. With resolution of acute symptoms, physical therapy may help with gradual strengthening and conditioning of the biceps and other shoulder musculature. Workplace modifications may be needed to prevent reoccurrence or continuation of symptoms.

Elbow Disorders

Lateral Epicondylitis

Lateral epicondylitis, or tennis elbow, is associated with microtrauma of the extensor carpi radialis brevis (ECRB) and common extensor tendon. Pain is typically noted near the origin of the wrist extensor muscles on or near the lateral epicondyle. Occupational risk factors include forceful use of the hands accompanied by repetitive use of the hands and arms. Repetitive rotation of the forearm has been associated with lateral epicondylitis. Forceful gripping with wrist extension, as well as improper tool handle circumference, is also associated with this disorder.

Clinical Features
The patient usually presents with pain and discomfort experienced during repetitive and forceful gripping activities in the area of the lateral elbow. On physical examination, point tenderness at or slightly distal to the lateral epicondyle or tenderness of the proximal extensor muscle mass is present. Pain with resisted wrist extension and stretching of the wrist extensors is suggestive of the diagnosis. Differential diagnoses includes impingement of the radial nerve.

Treatment
Lateral epicondylitis may be slow to improve. Initial treatment includes restriction of provocative activities and control of inflammation. A forearm strap placed over the origin of the ECRB is often utilized. With resolution of acute symptoms, progressive stretching and strengthening exercises are recommended. Workplace modifications may be needed to prevent reoccurrence or continuation of symptoms. Typical focus is on activities that require forceful gripping and use of hand tools.

Medial Epicondylitis

Medial epicondylitis, or golfer's elbow, is associated with overuse of the wrist flexors at or near the medial epicondyle origin. Medial epicondylitis occurs with less frequency than lateral epicondylitis. When it does occur, it is often due to an acute injury. Medial epicondylitis is not well established as an occupational disorder. The literature suggests that the disorder is seen with repetitive wrist flexion.

Clinical features
Pain is often reproduced with resisted wrist flexion and resisted finger flexion. Tenderness to palpation of the medial epicondlye is often reported. The differential diagnoses include arthritis and nerve compression disorders.

Treatment
Treatment is similar to that for lateral epicondylitis. Forearm bracing is typically not used but elbow pads are recommended to cushion the injured epicondyle when resting the elbow on hard surfaces. Control of exposure may aid recovery.

Hand/Wrist Disorders

DeQuervain's Disease

DeQuervain's disease refers to tenosynovitis of the sheaths of the abductor pollicis longus and extensor pollicis brevis tendons in the first dorsal compartment of the extensor retinaculum. The condition manifests as pain over the dorsum of the thumb and radial styloid process area with impaired thumb function. DeQuervain's disease has been associated with jobs requiring repetitive hand motion with frequent extension of the thumb, radial and ulnar wrist deviations, and rotational movements of the forearm.

Clinical features
Symptoms include pain, tenderness, and/or swelling in the area of the anatomic snuff box. Physical examination may reveal tenderness to palpation, swelling or thickening of the first extensor compartment and crepitus. The pain is worsened by abduction and extension of the thumb. A positive Finkelstein's test is the classic diagnostic test. Differential diagnoses include osteoarthritis of the wrist or first carpometacarpal joint, Wartenberg's syndrome (ulnar nerve compression at the wrist), and intersection syndrome (tendonitis of the dorsal wrist extensors).

Treatment
Treatment consists of conservative management, which includes restriction of activities that aggravate the condition, nonsteroidal anti-inflammatory medication and use of heat or ice. Splinting with a thumb spica-splint, and physical or occupational therapy may be beneficial. Changes in work routine and workplace design may be necessary to allow recovery and prevention of further injury. Injection of cortisone is an option following a trial of conservative treatment. Progressive exercise to improve mobility and strength is beneficial once the acute phase is resolved.

Tendonitis of Forearm and Wrist Extensors

The tendons in the 2^{nd}-6^{th} compartments of the wrist and forearm will be considered as a group. Tendonitis of forearm and wrist extensors is characterized by discomfort in the area of the forearm extensor tendons. Wrist tendonitis has been associated with repetitive and forceful hand activity, as well as use of the hands in extreme joint range of motions.

Clinical Features
Clinical presentation includes pain in the region of the tendon and/or localized pain with palpation of the tendon. Physical examination may elicit pain with resisted movements of wrist of digit extension. Pain is often reported with palpation of the tendon. The differential diagnoses include arthritis, acute strain, or direct trauma.

Treatment
Treatment consists of conservative management which includes restriction of activities that aggravate the condition, nonsteroidal anti-inflammatory medication and use of heat or ice. Physical and occupational therapy may also be beneficial. Work site modification to minimize aggravating factors is also necessary.

Tendonitis of Forearm and Wrist Flexors

As with extensor tendon disorders, tendonitis of the forearm and wrist flexors is characterized by pain in the affected tendon or tendons. Pain may be elicited with resisted wrist or digital flexion. As with extensor tendonitis, repetitive and forceful hand activity as well as use of the hands in extreme joint range of motions, has been associated with wrist flexor tendonitis.

Clinical Features
The clinical presentation of flexor tendon disorders is characterized by pain in the region of the tendon. Tenderness to palpation, crepitus, or swelling may be found on physical examination. Physical examination may elicit pain with resisted movements of wrist of digit extension. Median or ulnar neuropathies should be considered as alternate causes of pain. As with extensor tendonitis, the differential diagnoses includes arthritis, acute strain, or direct trauma.

Treatment
The treatment of wrist flexor tendonitis is the same as for wrist extensor tendonitis.

Trigger Finger

Trigger finger is caused by narrowing of the tendon pulley or swelling of the finger flexor tendon, preventing smooth tendon movement. Occupational risk factors includes pressure to the area from hard objects, such as tool handles, and repeated hand activities .

Clinical Features
Trigger finger presents with pain or crepitus in the flexor tendon sheath at the A1 pulley and impaired finger flexion with triggering or locking. The affected digit may present with decreased range of motion because of locking in flexion or extension. Pain on palpation directly over the MCP joint is frequently noted.

Treatment
Typical treatments include nonsteroidal anti-inflammatory medication, steroid injections, and splinting. In advanced cases, surgical release has been reported to be effective.

Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is caused by compression of the median nerve as it passes through the carpal tunnel of the wrist. It is much less common than are the tendon disorders. Risk factors for CTS include forceful and repetitive use of the hands, and exposure to hand-arm vibration. Nonoccupational risk factors described include, age, female gender, pregnancy, diabetes, hypothroidism, and renal dialysis.

Clinical Features

Symptoms of pain, numbness, tingling, or burning are present in the distribution of the median nerve. The patient may also report a decrease in dexterity and grip strength. Diminished sensory function may be observed in the median distribution. In advanced cases, weakness of thumb abduction may be present and hypothenar atrophy. Provocative tests such as Phalen's and Tinel's are frequently done, but sensitivity and specificity are reported as variable. The diagnosis of carpal tunnel syndrome is confirmed with electrophysiologic measurement of nerve conduction velocity and needle electromyography. The differential diagnosis includes peripheral neuropathy.

Treatment

Initial treatment is conservative, including splinting and nonsteroidal anti-inflammatory medication. Nighttime splinting can be especially helpful. Physical or occupational therapy can also be beneficial. Worksite modifications need to be explored and surgical consult may be necessary if symptoms do not improve.

Hand Arm Vibration Syndrome

Hand-arm vibration syndrome (HAVS), also known as white finger and vibration-induced white finger, is associated with exposure to vibrating tools. Use of hand-held, vibrating tools such as chainsaws, rock drills, grinders, riveters, pneumatic hammers, and jackhammers is associated with development of HAVS. Exposure to vibration varies according to the characteristics of the vibration and the duration and intermittent nature of the exposure. Low temperature might enhance the effect of exposure.

Clinical Features

The diagnosis of HAVS is based on a reported history of vibration exposure along with sensorineural or vascular symptoms. Musculoskeletal symptoms are frequently present. Symptoms include numbness, tingling, blanching white fingers, burning sensation, diffuse muscle and joint pain, and loss of grip strength and dexterity. It is helpful to inquire about cold intolerance, which is an early symptom. Symptoms are typically episodic, but usually increase in frequency, duration, and severity with increasing intensity and duration of exposure.

A thorough job history is needed to determine vibration exposure, with an attempt to characterize vibration dose by identifying type of tool(s) used and hours of daily use. The frequency of symptomatic attacks should be recorded, noting seasonal or daily patterns. Sensorineural symptoms, which typically occur earlier, and vascular symptoms can occur independently of each other and have separate staging systems (Table 3)

Physical examination should include sensorineural tests such as Semmes-Weinstein, vibration perception threshold and two-point discrimination. Laboratory testing includes nerved conduction testing, which is helpful for identifying concomitant median or ulnar neuropathy. Hand-arm vibration syndrome should be differentiated from, nerve compression, occlusive vascular disease, peripheral neuropathy of other causes, and primary connective tissue diseases such as rheumatoid arthritis and systemic lupus erythematosus.

Table 3-Stockholm Revised Vibration Syndrome Classification System

Stage	Grade	Description
Vascular Component		
1	Mild	Occasional blanching attacks affecting tips of one or more fingers
2	Moderate	Occasional attacks to distal and middle phalanges of one or more fingers
3	Severe	Frequent attacks affecting all phalanges of most fingers
4	Very Severe	As in 3, with trophic skin changes (tips)
Sensorineural Component		
0SN		Vibration exposed, no symptoms
1SN		Intermittent or persistent numbness, with or without tingling
2SN		As in 1SN with reduced sensory perception
3SN		As in 2SN with reduced tactile discrimination and manipulative dexterity

Treatment

Avoiding exposure to cold and vibrating tools is necessary. Splinting at night can be helpful depending on the associated neuropathies. Consistent reversal of vascular or neurologic impairment from HAVS has not been demonstrated, but by eliminating exposure to vibration and cold the disease progression can be halted. Smoking cessation also needs to be strongly encouraged. Medications, including calcium-channel antagonists and antiplatelet agents have been used to control vascular symptoms (Mani and Gerr, 2000).

Low Back Pain

Low back pain is a leading cause of occupational injury and disability in industrialized countries (Johanning, 2000). Risk factors for LBP include heavy lifting and forceful movements, whole body vibration, awkward body postures including static work, bending and twisting, low job control and satisfaction, and monotonous workloads. The disorder has been described in numerous occupations, including vehicle operators, construction laborers and material handlers, agriculture, forestry, lumber and nursing occupations. A number of nonoccupational contributors have also been described, including age, gender, genetics/family history, body weight/height, fitness level and smoking.

Clinical Features
Patients report pain and stiffness in the back and may have referral into the buttock and lower extremity. A detailed history needs to be obtained that includes onset, location, radiation and quality of symptoms. Inquiry about a mechanism of injury and previous back disorders should also be done. Red flags such as cauda equina syndrome with sacral defects and bladder symptoms, an acute change in neurologic function and a clinical picture consistent with fracture, infection or cancer needs to be ascertained.

Treatment
The treatment and management of occupational low back disorders can in most cases follow standard ambulatory care principles, the health care provider needs to be aware of "red flag" symptoms or conditions that require specialty consideration and possibly surgical interventions (Johanning, 2000). Guidelines and algorithms contained in the Acute Low Back Problems in Adults published by the Agency for Health Care Policy and the Royal College of General Practitioners (RCGP) are helpful for acute and simple low back problems. Clinical management of acute of chronic occupational related low back disorders may include any or a combination of the following modalities depending on the patient's history and clinical findings (Johanning, 2000):

Health Education
Analgesics
*Muscle relaxation medications (**caution during use of heavy machinery)*
Epidural steroid injections
Short periods of rest
Early and minimal regular physical activity
Physical Therapy
Spinal manipulation (not for nerve root pain)
Conditioning exercises
Activity Modification
Work place modification and restrictions

Regulation

Due to changing environments and tasks that affect occupational hazards, agriculture work presents unique problems for injury and illness control and regulation. The United State has a history of regulatory exemption for agriculture. Not only was the agricultural workplace exempt from the jurisdiction of OSHA, but also its research counterpart, the National Institute for Occupational Safety and Health. This translated into a lack of federal funding for agricultural safety and health research. For example, in 1985 federal funding for occupational safety in mining was $181 per mineworker as compared to $0.30 per agricultural worker (Schender, 1996). Increased federal funding during the last two decades has helped with NIOSH setting priority areas for research in agriculture.

At the time this chapter was written, there are currently no federal occupational stanards that specifically cover ergonomics. The Occupational Safety and Health Administration is in the process of releasing industry specific guidelines, with the first to address nursing homes. Since the majority of farms employ less than eleven people, they are exempt from OSHA regulations.

Summary

Health care providers in rural settings often care for farmers, farm workers and family members who may be exposed to agricultural occupational hazards. Many challenges exist for health care in providing preventative, diagnostic and counseling services in rural settings. As the needs of the patient and awareness increases related to musculoskeletal disorders, greater demands will be placed on rural health care providers. Therefore, it is essential that lessons learned from other industries in the area of occupational medicine be applied to agricultural issues (Mazza, 1997). Rural health care providers have a pivotal role in providing preventative counseling on musculoskeletal disorders at an individual and community level.

Progress has been and is continuing to be made in developing technology and tools that makes farm work safer. Safety equipment features for tractors, such as roll-over protective structures, contributes to injury prevention and fatality reduction (Hansson, 1991). Sunscreen, hearing protection and respirators are examples of personal protective equipment that reduce serious health problems caused by hazardous environmental conditions. Continued advancements in these areas are important, as well as combining ergonomic interventions to help improve health and safety of farmers, farm workers and families. Increased awareness and dissemination of safety and health information is imperative.

Despite ongoing debate about the occupational factors contributing to development of MSDs, the literature has demonstrated sufficient consistency to conclude that the adverse physical stressors of force, repetition, vibration, and work in awkward postures are risk factors for upper extremity and back disorders. The presence of occupational risk factors does not eliminate contributions by nonoccupational risk factors. Obtaining a detailed occupational history and identification of workplace risk factors is imperative for ensuring an accurate medical assessment. Treatment is usually straightforward but will likely fail unless exposures to risk factors are controlled. Considerable morbidity can be reduced by encouraging farmers in early and timely reporting of symptoms and medical evaluation of symptomatic individuals.

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