Evidence-Based Medicine

Comprehensive Review of Epidemiology, Scope, and Impact of Spinal Pain

Laxmaiah Manchikanti, MD[1], Vijay Singh, MD[2], Sukdeb Datta, MD[3], Steven P. Cohen, MD[4], and Joshua A. Hirsch, MD[5]

From: [1]Pain Management Center of Paducah, Paducah, KY; [2]Pain Diagnostics Associates, Niagara, WI; [34]Vanderbilt University Medical Center, Nashville, TN; [4]Johns Hopkins School of Medicine, Baltimore, MD; and [5]Massachusetts General Hospital and Harvard Medical School, Boston, MA.

Dr. Manchikanti is Medical Director of the Pain Management Center of Paducah, Paducah, KY Dr. Singh is Medical Director of Pain Diagnostics Associates, Niagara, WI. Dr. Datta is Director, Vanderbilt University Interventional Pain Program, Associate Professor, Dept. of Anesthesiology, Vanderbilt University Medical Center, Nashville, TN. Dr. Cohen is Associate Professor, Department of Anesthesiology and Critical Care Medicine, Pain Management Division, Johns Hopkins School of Medicine, Baltimore, MD, and Walter Reed Army Medical Center, Washington, DC. Dr. Hirsch is Chief of Minimally Invasive Spine Surgery, Depts. of Radiology and Neurosurgery, Massachusetts General Hospital and Assistant Professor of Radiology, Harvard Medical School, Boston, MA.

Address correspondence:
ASIPP
81 Lakeview Drive
Paducah, KY 42003
E-mail: asipp@asipp.org

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Persistent pain interfering with daily activities is common. Chronic pain has been defined in many ways. Chronic pain syndrome is a separate entity from chronic pain. Chronic pain is defined as, "pain that persists 6 months after an injury and beyond the usual course of an acute disease or a reasonable time for a comparable injury to heal, that is associated with chronic pathologic processes that cause continuous or intermittent pain for months or years, that may continue in the presence or absence of demonstrable pathologies; may not be amenable to routine pain control methods; and healing may never occur." In contrast, chronic pain syndrome has been defined as a complex condition with physical, psychological, emotional, and social components.

The prevalence of chronic pain in the adult population ranges from 2% to 40%, with a median point prevalence of 15%. Among chronic pain disorders, pain arising from various structures of the spine constitutes the majority of the problems. The lifetime prevalence of spinal pain has been reported as 54% to 80%. Studies of the prevalence of low back pain and neck pain and its impact in general have shown 23% of patients reporting Grade II to IV low back pain (high pain intensity with disability) versus 15% with neck pain. Further, age related prevalence of persistent pain appears to be much more common in the elderly associated with functional limitations and difficulty in performing daily life activities. Chronic persistent low back and neck pain is seen in 25% to 60% of patients, one-year or longer after the initial episode.

Spinal pain is associated with significant economic, societal, and health impact. Estimates and patterns of productivity losses and direct health care expenditures among individuals with back and neck pain in the United States continue to escalate. Recent studies have shown significant increases in the prevalence of various pain problems including low back pain.

Frequent use of opioids in managing chronic non-cancer pain has been a major issue for health care in the United States placing a significant strain on the economy with the majority of patients receiving opioids for chronic pain necessitating an increased production of opioids, and escalating costs of opioid use, even with normal intake. The additional costs of misuse, abuse, and addiction are enormous. Comorbidities including psychological and physical conditions and numerous other risk factors are common in spinal pain and add significant complexities to the interventionalist's clinical task.

This section of the American Society of Interventional Pain Physicians (ASIPP)/Evidence-Based Medicine (EBM) guidelines evaluates the epidemiology, scope, and impact of spinal pain and its relevance to health care interventions.

Key words: Chronic pain, chronic spinal pain, chronic low back pain, chronic neck pain, chronic thoracic pain, prevalence, health care utilization, loss of productivity, interventional techniques, surgery, comorbid factors, socioeconomic effects, health care impact

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Persistent pain is one of the most common and compelling reasons for seeking treatment (1-4). When pain persists for weeks or months, its broader effects on well-being can be profound with significant impairment of physical and psychological health, and performance of social responsibilities including work and family (5-35). Despite improvements in the understanding of pain (including diagnosis and treatment), chronic pain continues to be an epidemic and is coupled with claims of inadequate treatment (36-40). While chronic pain is highly prevalent and has effects on all walks of life (5,35,36,41-48), the consequences may be especially grave for the elderly resulting in vocational, social, and family discord, which may make the difference between life and death (14,37,49-56). From an epidemiological perspective, prevalence and care seeking continue to increase (33,34).

Encouragingly, interventional pain management has been advanced based on the discoveries of chemical mediation, and the development and understanding of precision diagnostic and therapeutic interventional techniques, together with reported successes with minimally invasive treatments (17,36,57-119).

1.0 Chronic Pain

1.1 Description

1.1.1 Chronic Pain

Chronic pain is beset with controversy, starting with its definition. For some chronic pain conditions, it is defined as, "pain that exists beyond an expected time frame for healing." For other conditions, it is recognized that, "healing may never occur." Bonica (120) defined chronic pain as, "pain which persists a month beyond the usual course of an acute disease or a reasonable time for any injury to heal that is associated with chronic pathologic processes that causes a continuous pain or pain at intervals for months or years." In many cases, chronic pain is understood as persistent pain that is not amenable to routine pain control methods. Pain is a sensation that results from an extraordinarily complex and interactive series of mechanisms integrated at all levels of neuraxis, from the periphery to higher cerebral structures (121). Pain is usually elicited by the activation of specific receptors, either by 2 types of peripheral nociceptors connected with C- and A-delta fibers in the case of nociceptive pain (122) or from injury to sensory fibers or from damage to the central nervous system in the case of neuropathic pain (123). Thus, Turk (124) described chronic pain as a chronic disease and should be treated as such. The National Academy of Sciences (NAS) (125), following the synthesis of a diverse body of literature, conceptualized the injury process as a physiological pathway that begins with some form of structural low-tolerance relationship, progresses to symptom occurrence or adaptation, and ultimately results in either impairment or disability.

Smith and Gribbin (126) based on the legislative mandate of the Ontario government, described the definition of pain and chronic pain. The panel's full definition of chronic pain is, "pain that persists 6 months after an injury and beyond the usual recovery time of a comparable injury; this pain may continue in the presence or absence of demonstrable pathology." Thus, considering that chronic pain is a complex phenomenon and multifactorial, a combination definition could be used as follows: chronic pain is pain that persists 6 months after an injury and beyond the usual course of an acute disease or a reasonable time for a comparable injury to heal, that is associated with chronic pathologic processes that cause continuous or intermittent pain for months or years, that may continue in the presence or absence of demonstrable pathology; may not be amenable to routine pain control methods; and healing may never occur.

1.1.2 Chronic Pain Syndrome

In addition to chronic pain, there is also terminology describing chronic pain syndrome, which has been defined as a complex pain condition with physical, psychological, emotional, and social components (127,128). Both chronic pain and chronic pain syndrome can be defined in terms of duration and persistence of the sensation of pain and presence or absence of psychological and emotional components. However, chronic pain syndrome as opposed to chronic pain, has the added components of certain recognizable, psychological, and socioeconomic influences with characteristic psychological and sociological behavior patterns inherent in chronic pain syndrome that distinguish the 2 conditions (127).

According to the 5th edition of the *Guides to the Evaluation of Permanent Impairment*, published in 2000 (128), the term chronic pain syndrome, even though not official nomenclature, is frequently used to describe the condition of an individual who is markedly impaired by chronic pain with substantial psychological overlay. These guides also state that chronic

pain syndrome is largely a behavioral syndrome that affects a minority of those with chronic pain. It may best be understood as a form of abnormal illness behavior that consists mainly of excessive adoption of the sick role. The guides also caution that, while the term is useful in certain situations, it is not, however, a substitute for a careful diagnosis of physiologic, psychological, and conditioning components that comprise the syndrome. Thus, chronic pain syndrome is different from chronic pain itself and must be used with caution, as grouping pain problems together under a general disorder may mask and leave untreated important physiologic differences. Consequently, chronic pain usually exists in the absence of chronic pain syndrome, but chronic pain syndrome always presumes the presence of chronic pain. The International Association for the Study of Pain (IASP) has eliminated chronic pain syndrome from its glossary (129). In fact, the IASP Task Force noted that the term chronic pain syndrome is often, unfortunately, used pejoratively. Further, the literature shows that chronic pain syndrome is not a common phenomenon (130).

However, in the 6th edition of the *Guide to the Evaluation of Permanent Impairment* (131), the definition and classification of chronic pain syndrome states that this definition does not include any specific time frame to use in making the diagnosis of chronic pain syndrome. The diagnosis of chronic pain syndrome should then be temporarily connected to the point at which given condition or conditions were expected to have resolved rather than to any arbitrary time period for any injury or event. They described 3 or more characteristics required for the diagnosis of chronic pain syndrome as follows:

- Use of prescription drugs beyond the recommended duration and/or abuse or dependence on prescription drugs or other substances.
- Excessive dependence on health care providers, spouse, or family.
- Secondary physical deconditioning due to disuse and/or fear-avoidance of physical activity due to pain.
- Withdrawal from social milieu, including work, recreation, or other social contacts.
- Failure to restore pre-injury function after a period of disability, such that the physical capacity is insufficient to pursue work, family, or recreational needs.
- Development of psychosocial sequelae after the initial incident, including anxiety, fear-avoidance, depression, or nonorganic illness behaviors.

1.2 Prevalence

In 1988, von Korff et al (18), recognizing the need for epidemiologic research to establish the dimensions of the morbidity burden of chronic and recurrent pain, conducted a survey concerning common pain conditions and psychological distress in a sample of the adult enrollees of a large health maintenance organization in Seattle, Washington. They described its natural history, identified characteristics of persons at high risk of developing chronic pain behaviors, and evaluated methods for preventing disability. The results showed that the prevalence of pain in the prior 6 months was 41% for back pain, 26% for headache, 17% for abdominal pain, 12% for chest pain, and 12% for facial pin. They also reported, that on average, persons with a pain condition had higher levels of anxiety, depression and non-pain somatic symptoms, poorer self-rating of health status, and more family stress compared to persons without a pain condition.

In 1990, von Korff et al (19) examined the association of social, psychological, and behavioral variables hypothesized to indicate pain dysfunction with a graded classification of pain status. They reported population data in a probability sample of 1,016 health maintenance organization enrollees, with observation of recurrent or persistent pain in 45%; severe and persistent pain in 8%; severe and persistent pain with 7 or more days of pain related activity limitation in 2.7%; and severe persistent pain with activity limitation and 3 or more indicators of pain dysfunction in 1% of the population sample. They also showed that graded chronic pain status was associated with psychological impairment, unfavorable appraisal of health status, and frequency of use of pain medications and health care. The presence of severe and persistent pain increased the likelihood of multiple indications of pain dysfunction, but there was considerable heterogenicity in pain dysfunction among patients with comparable pain experience.

von Korff et al (132) studied as the risk of depression for the first onset of common pain symptoms and concluded that psychological distress increases among pain patients, especially among those who have higher levels of non-pain somatic symptoms. Sternbach (133) in a 1985 Nuprin-survey of 1,254 American adults, 18 years or older, evaluated chronic pain of 101 or more days in the preceding year. The results showed that 10% of the patients had chronic joint pain, 9% chronic back pain, 5% chronic headache, and 5% chronic muscle pain. They also showed that higher prevalence was seen among younger responders.

In a population-based estimate of pain in the United States, the results showed overall population prevalence of musculoskeletal or joint pain lasting greater than one month or longer during the previous year as 14% based on the data collected from 1971 to 1975 (134). However, when the same cohort was re-interviewed 8 to 10 years later, the prevalence of musculoskeletal joint pain was 20% with higher rates in women than men, and in older compared with younger respondents (135). The data from the National Health Interview Service (NHIS) (32) also showed a prevalence of low back pain in 2006 of 27.4%, neck pain of 14.3%, migraine or severe headache in 15.1%, and face or jaw pain in 4.5% of the population.

The American Pain Society's "Chronic Pain in America" survey (136) has estimated that 9% of the adult population suffers from moderate to severe, non-cancer related pain. Two-thirds of these people said that they have been living with pain for over 5 years. The survey also showed that pain was found to have a significant impact on quality of life and emotional well being, with patients experiencing significant improvements in these factors when their pain was well controlled.

In an evaluation performed in an urban and rural setting in southeast Ontario to determine the prevalence and determinants of pain and pain-related disability, 76% reported some pain over the past 6 months (10). Among these, high pain intensity with low pain interference was seen in 26% (Grade II) and high pain intensity with high pain interference was seen in 16% (Grades III and IV), as shown in Fig. 1. This study also showed that in the patients who were reporting pain, 49% reported chronic pain with a minimum duration of 90 days over the past 6 months, which represented 37% of the sample.

1.2.1 Chronic Pain in Children

Epidemiological studies of chronic pain in children and young adults have increased over the last few years (137-146). In children, the prevalence of any pain within the previous 6 months was 70%, while chronic pain was reported by 14%, and 7% of the children suffered from Grade III or Grade IV pain with high intensity associated with moderate to severe disability, as illustrated in Fig. 2 (139). Further, it has been stated that chronic pain is a common problem among the general pediatric population, which negatively affects everyday functioning of children and their families (138,144-146). It was also demonstrated that children who had a chronic pain condition reported a worse quality of life, missed more days of school, and were more likely to use pain medication and seek medical care for pain relief (139). Mikkelsson et al (137) in a prospective 4-year follow-up study in evaluation of onset prognosis and risk factors for widespread pain in schoolchildren, found of the children who had widespread pain at baseline, 31% and 30% reported persistence or recurrence of symptoms at one- and 4-year follow-up, respectively.

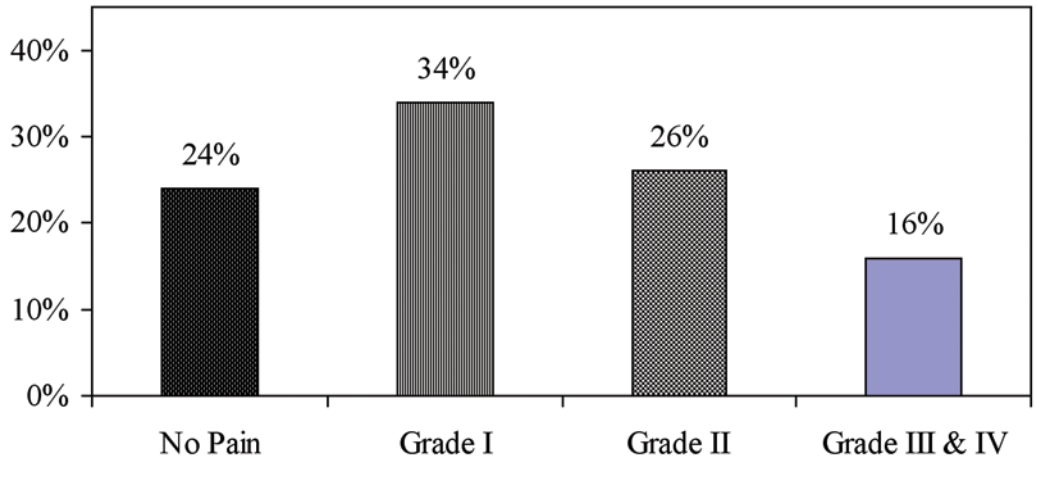

Fig. 1. *Percentage distribution of the graded chronic pain scale scores by age category (years) (n = 1052) (10).*

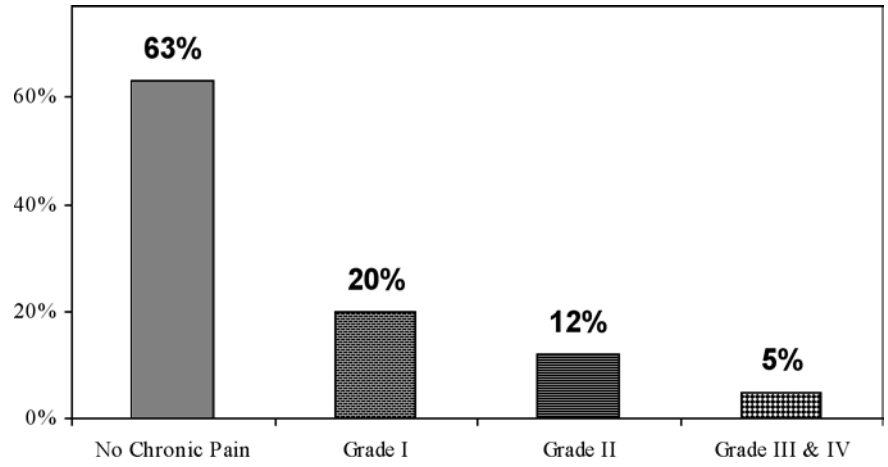

Fig. 2. *Severity of chronic pain in children.*

Adapted from Huguet A, Miró J. The severity of chronic pediatric pain: An epidemiological study. *J Pain* 2008; 9:226-236 (139).

1.2.2 Chronic Pain in the Elderly

Chronic pain is a common symptom and significant problem for older adults (45,47-56,147,148). Epidemiologic data in the elderly suggests that up to 50% of community-dwelling older adults and as many as 80% of residents of long-term care facilities experience persistent pain (56,147-150). In an evaluation of pain characteristics of adults 65 years of age and older referred to a tertiary pain care clinic (47), the older patients (14.7% of the total sample) had relatively more physical problems concordant with their complaints, but fewer psychological factors contributing to disability than the younger pain patients. Further, musculoskeletal and neuropathic disorders affected 40.7% and 35.2% of the older patients, respectively, while several patients had more than one painful disorder. Chronic pain in the elderly is associated with an elevated perception of burden, even exceeding the burden associated with high levels of acute pain (151). Sawyer et al (147) in a report of pain and pain medication use among community-dwelling older adults showed 74% of the subjects reporting pain; among these, 52% had daily pain, with 26% reporting dreadful or agonizing pain. An increase in the prevalence of pain with age has been attributed to arthritis (150-153). Further, underreporting of pain (154-156) has been attributed with expectations that pain is a natural part of growing older (152,157) or an attitude of stoicism (154,158-160) leading to a greater reluctance to report pain. Even though declines of pain and severity of pain have been reported in elderly over the age of 85 (155,156), the clinical significance of this decrease may be minimal (158). This may be due to the fact that community-dwelling older adults may be moved to nursing home settings (155).

1.2.3 Cultural Differences

There may be cultural differences in the pain perception or reporting, with ethnic and racial minorities more likely to demonstrate stoicism, having the attitude that pain is to be endured without complaint (50,159-163). However, few studies of race and age evaluated the relationship to chronic pain (164). Green et al (162) concluded that consistent with the Institute of Medicine's (IOM) report on health care disparities, racial and ethnic disparities in pain perception, assessment, and treatment were found in all settings and across all types of pain. Further, they concluded that the sources of pain disparities among racial and ethnic minorities are complex, involving patient, health care provider, and health care system factors. Further, the study of experimental pain sensitivity in 3 ethnic groups (163) showed differences in pain responses with African-American and Hispanic subjects showing lower cold and heat pain tolerances than non-Hispanic white Americans. They provided evidence of ethnic group differences

in responses to experimental pain across multiple noxious stimuli, with both minority groups exhibiting greater sensitivity to laboratory evoked pain compared to non-Hispanic white Americans. Green et al (50) also noted that blacks reported greater severity and disability from chronic pain than non-Hispanic whites. Other studies also have showed greater pain related interference with daily living, even though African-American and Caucasians did not differ significantly with regard to prevalence (32,165,166).

1.2.4 Chronic Pain in Women

Gender prevalence ratios reveal a higher prevalence of pain in females for headache, migraine, temporomandibular pain, burning mouth pain, neck pain, shoulder pain, back pain, knee pain, abdominal pain, and fibromyalgia (16,56,101,102,167-169). Figure 3 illustrates female predominance and age-related increase or prevalence of pain in Canada (169).

1.2.5 Chronic Pain in Multiple Regions

Chronic pain with involvement of multiple regions has been reported in 60% of the patients (25-28,33, 42, 47,93,101,102,114,115,170-183). Chronic widespread pain with involvement of multiple regions is a common symptom, with an estimated prevalence between 4.7% and 13.2% (176,178,179). Strine and Hootman (175) in the estimation of US national prevalence and correlation of low back and neck pain among adults reported an American prevalence of low back and/or neck pain of 31% (low back pain: 34 million, neck pain: 9 million, both back and neck pain: 19 million).

1.3 Increasing Prevalence of Chronic Pain

Similar to the chronicity and duration of chronic pain, increasing prevalence or lack thereof is a major topic of controversy. It is widely believed that prevalence has remained stable over the years. However, the evidence is in contrast to this belief.

Harkness et al (33) in a 2005 publication showed

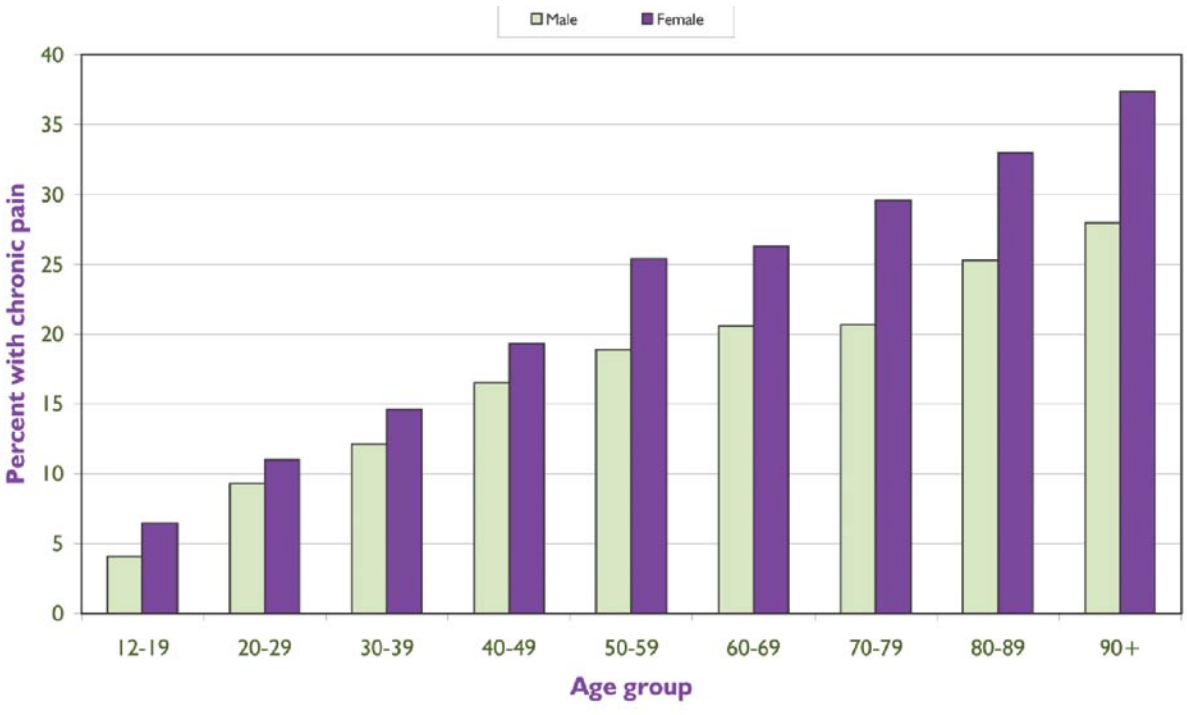

Fig. 3. *The prevalence of chronic pain by age and gender.*

Source: Meana M et al. Chronic pain: The extra burden on Canadian women. *BMC Womens Health* 2004; 4(Supp1):S17 (169).

that there was a large difference in the prevalence of musculoskeletal pain over a 40-year period under investigation. To test the hypothesis that the prevalence of specific musculoskeletal pain symptoms has increased over time in the northwest region of England, the authors examined the difference in the prevalence of low back, shoulder, and widespread pain between the 1950s and the second study conducted in 1994 and 1995 in persons aged 18 to 64. The data was collected by an arthritis research campaign. The results showed that overall low back pain increased from 8.1% in males to 17.8%, whereas in females, it increased from 9.1% to 18.2%. This study also showed an increasing trend of shoulder pain, as well as widespread pain from study I to study II. Further, in both studies, there was a general trend of increasing prevalence by age group for all syndromes.

Table 1 illustrates age related prevalence of low back pain, shoulder pain, and widespread pain. This study shows clear data that there are significant differences in the prevalence of pain increasing from 2- to 4-fold between the 2 surveys.

In 2 population-based estimates of pain in the United States, the results showed overall population prevalence of musculoskeletal pain of 14% based on the data collected from 1992 and 2006 (34), with the

Table 1. *Numbers and percentage of subjects reporting musculoskeletal pain by age group, gender, and study.*

	Study 1		Study 2	
	Males	**Females**	**Males**	**Females**
Gender	**48% (505)**	**52% (547)**	**43% (835)**	**57% (1118)**
Low Back Pain				
18–24	0%	5.6% (2)	7.8% (5)	11.6% (13)
25–34	1.7% (2)	5.7% (6)	15.7% (29)	14.8% (35)
35–44	8.6% (9)	9.8% (12)	14.1% (28)	12.9% (36)
45–54	15.2% (23)	13.2% (20)	22.1% (42)	24.6% (61)
55–64	7.1% (7)	7.5% (10)	22.9% (41)	24.7% (55)
All ages	8.1% (41)	9.1% (50)	17.8% (145)	18.2% (200)
Age standardized rates (95% CI)	**6.3% (4.3%–8.2%)**	**8.6% (5.9%–11.3%)**	**16.3% (13.5%–19.1%)**	**17.3% (14.8%–19.7%)**
Shoulder Pain				
18–24	2.9% (1)	0%	6.3% (4)	7.1% (8)
25–34	7.5% (9)	0%	9.7% (18)	13.5% (32)
35–44	3.8% (4)	4.9% (6)	11.6% (23)	16.5% (46)
45–54	7.3% (11)	6.6% (10)	21.6% (41)	25.0% (62)
55–64	10.1% (10)	11.9% (16)	24.6% (44)	25.6% (57)
All ages	6.9% (35)	5.8% (32)	15.9% (130)	18.7% (205)
Age standardized rates (95% CI)	**6.3% (4.1%–8.5%)**	**4.4% (2.8%–5.9%)**	**14.0% (11.5%–16.5%)**	**17.1% (14.7%–19.6%)**
Widespread Pain				
18–24	2.9% (1)	0%	3.1% (2)	3.6% (4)
25–34	2.5% (3)	0.9% (1)	6.5% (12)	5.5% (13)
35–44	2.9% (3)	3.3% (4)	4.5% (9)	9.0% (25)
45–54	5.3% (8)	3.3% (5)	13.2% (25)	16.1% (40)
55–64	11.1% (11)	8.2% (11)	14.5% (26)	21.1% (47)
All ages	7.4% (26)	5.8% (21)	9.1% (74)	11.7% (129)
Age standardized rates (95% CI)	**4.6% (2.7%–6.4%)**	**2.9% (1.6%–4.2%)**	**7.9% (6.1%–9.8%)**	**10.5% (8.6%–12.3%)**

Modified from Harkness EF et al. Is musculoskeletal pain more common now than 40 years ago?: Two population-based cross-sectional studies. *Rheumatology* (Oxford) 2005; 44:890-895 (33).

prevalence of musculoskeletal joint pain increasing to 20% with higher rates in women than men, and in older compared with younger respondents, when the same cohort was re-interviewed 8 to 10 years later.

1.4 Course and Prognosis

Several population studies have reported on the course of chronic pain over time and factors associated with both the development and persistence of chronic widespread pain (26,182,183). MacFarlane et al (183) reported persistence of chronic pain at 2 years in 35% of the patients. McBeth et al (182) found that 56% of subjects with chronic widespread pain still reported symptoms after one-year. Papageorgiou et al (26) reported that 77% of the patients reported chronic widespread pain 7 years later after the initial diagnosis.

2.0 Spinal Pain

Pain arising from various structures of the spine constitutes the majority of the problems in chronic pain settings. The lifetime prevalence of spinal pain has been reported as 54% to 80% (1,4,8,16-21,33,35,132-138,184-195).

2.1 Neck Pain

It has been stated that most people can expect to experience some degree of neck pain in their lifetime. Neck pain is also associated with issues related to quality of life, social, and economic consequences.

2.1.1 Prevalence

The annual prevalence estimates of any neck pain among adults ranged from 12.1% to 71.5% and among children, it ranged from 34.5% to 71.5%, with most estimates of annual prevalences between 30% and 50% (173,187,190-192,194-212). Further, the 12 month prevalence of neck pain limiting activities among adults was estimated as 1.7% with limited ability to work due to neck pain (200); 2.4% limited social activities due to neck pain (200); and 11.5% limited activities due to neck pain (209). Bovim et al (198) showed an overall prevalence of neck pain in the past year of 34.4% with a total of 13.8% reporting neck pain that lasted for more than 6 months. Guez et al (205) showed neck pain in 43% of the population with more women than men. They also showed that chronic pain, defined as a continuous pain of more than 6 months duration, was more common in woman (22%) than men (16%). Huisstede et al (199) showed a prevalence of complaints of the arm, neck, and/or shoulder pain in 36.8%, with a point prevalence of 26.4, and chronic neck pain in 19% of the patients.

The data from the NHIS (32) showed a prevalence of neck pain in 14.3% of patients, along with migraine or severe headache in 15.1% of the patients. In the study of neck pain and related disability in Saskatchewan adults, Côté et al (190) illustrated various grades of chronic neck pain with 5% of the patients suffering with grades III and IV neck pain associated with high pain intensity and disability (Fig. 4).

Neck pain prevalence by age group among adults shows increasing prevalence with age (174,205,210). However, some reports (200) showed no significant association between neck pain prevalence and age, although crude prevalence showed highest values engaged. Even then, Côté et al (190) showed high intensity neck pain with disability had a more consistent prevalence across age groups. Among children and adolescents, the prevalence of neck pain increased with age, even though some evidence showed similar prevalences at different ages, whereas yet others showed reduced prevalence with increasing age. The evidence also showed higher prevalence for women than men (174,198-201,205,207,210) with ratios ranging from 1.1 to 3.4 for 12 month prevalence.

2.1.2 Prevalence of Whiplash-Associated Neck Pain

Chronic neck pain resulting from whiplash associated disorders (WAD) has been described (213-215). Whiplash injuries occur primarily after motor vehicle collisions, although they can also occur in other settings, such as work and sports. WAD after traffic collisions affect many people. However, the evidence regarding risk factors for WAD is sparse but seems to include personal, societal, and environmental factors. A comprehensive review (215) showed that younger ages and being a female were both associated with filing claims or seeking care for WAD, although the evidence is not consistent. Preliminary evidence suggested that headrests/car seats aimed at limiting head extension during rear-end collisions had a preventive effect on reporting WAD, especially in females. A review on whiplash injuries (213) described that these injuries are of serious concern with most acute whiplash injury cases responding well to conservative treatments. However, chronic whiplash injuries are often harder to diagnose and treat and often result in poor outcomes. The most com-

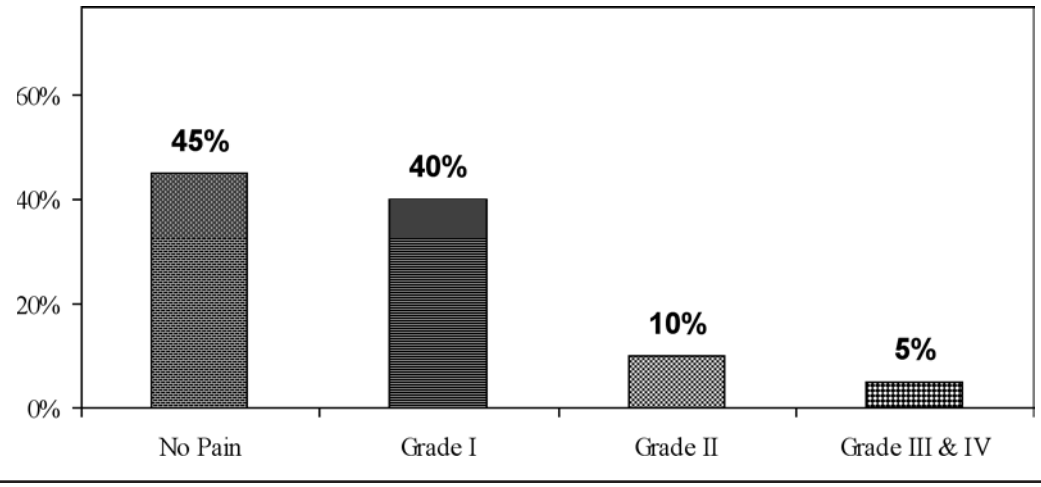

Fig. 4. *Severity of neck pain (age standardized rate).*

Adapted from Côté P et al. The Saskatchewan Health and Back Pain Survey. The prevalence of neck pain and related disability in Saskatchewan adults. *Spine* 1998; 23:1689-1698 (190).

mon acute symptom of whiplash injury is neck pain (62% to 100%), which can be focal or associated with radiating pain (213). Pain continues to be the number one symptom associated with chronic whiplash injury. Other symptoms are cervical spine stiffness, headache, shoulder and back pain, numbness, dizziness, sleeping difficulty, fatigue, and memory and cognitive deficits. In chronic whiplash injury, multiple structures may be involved including intervertebral disc, facet joints, ligaments, and other soft tissues (68,71,75,85,92,95,98-107,113-116,213).

2.1.3 Prevalence of Occupational Neck Pain

The incidence of compensated musculoskeletal disorders such as back and neck pain has been increasing (34,186,188,216-231). It has been found that neck pain is endemic in workers throughout the industrial world (217). The annual prevalence of neck pain varies among occupations and populations. However, among workers in manual occupations, the annual prevalence of neck pain varied from 16.5% in spinning industry production line workers to 74% in crane operators (227,232).

Each year neck pain is responsible for a significant burden of disability in workers. It has been shown that individual and workplace physical and psychosocial factors contribute to the development of neck pain in workers (214-216).

2.1.4 Risk Factors

Multiple factors have been described either to associate with neck pain or increase the risk of neck pain (233-240). Neck pain has been shown to increase in prevalence with increasing age and in females. However, there was evidence showing no association between neck pain and socioeconomic status or its correlation including education, income, home ownership, and social deprivation although some studies reported increased neck pain prevalence with lower education. There was also no evidence showing the relationship between body mass index and the prevalence of neck pain and radiographic evidence of degeneration and neck pain (233-235). However, there was preliminary evidence that gender, occupation, headaches, emotional problems, smoking, poor job satisfaction, awkward work postures, poor physical work environment, and workers' ethnicity may be associated with neck pain (217), but there was no evidence that interventions aimed at modifying work stations and worker posture are effective in reducing the incidence of neck pain in workers.

2.1.5 Course and Prognosis

While it is well known that neck pain is a common human phenomenon, what is not known is whether neck pain is likely to improve, reoccur, persist, or worsen. Thus, it is bothersome for health care providers, policy makers, and researchers. This ap-

plies to not only the neck pain in the general population, but also neck pain associated with WAD and in workers (241-246). Most of the evidence indicates that between 50% to 75% of people who experience neck pain initially report neck pain one to 5 years later (20,174,203,208,247-249). A study from Canadian adults in the general population reports that only 36.6% of those with prevalent pain at baseline experienced resolution (no neck pain) within the following year, with 37.3% reporting no change (or follow-up) in neck pain intensity or disability (208).

Evidence indicates that in adults, recovery of WAD is prolonged, with approximately 50% of those affected reporting neck pain symptoms one year after the injury (245,249-252). One study (253) found that 30 months or longer after the collision, 58% of patients had symptoms which they attributed to the injury event. In another study (254), at 7 years post injury, almost 40% of those making a claim for traffic related WAD reported often or always having neck pain, compared with less than 50% of the matched cohort who had been in a car crash with no WAD. Further, persons with a history of WAD were also more likely to have pain in other parts of their body and to report general ill health, sleep disturbance, and fatigue at 7 years post injury (255). While the recovery of traffic related WAD is prolonged with only half of those affected reporting no neck pain symptoms one year later, recovery is slower in those with greater initial pain, greater initial disability, and those suffering psychological factors such as post injury psychological distress and passive types of coping. There was also preliminary evidence that compensation or legal factors are associated with recovery (256). Overall, there was consistent evidence that on average, frequent, early health care was associated with poorer recovery (245). In a systematic review and meta-analysis of course and prognostic factors of whiplash, Kamper et al (188) showed that people with a whiplash injury often experience ongoing pain and disability for an extended period after their car accident. In addition, it has been shown that self-reported history is unreliable in patients with continued pain related to an MVA, with respect to previous axial pain and drug, alcohol, and psychological problems (257).

In the evaluation of course and prognostic factors for neck pain in workers, between 60% and 80% of workers with neck pain reported neck pain one year later (246). Few workplace or physical job demands were identified as being linked to recovery from neck pain.

2.2 Thoracic Pain

The proportion of patients suffering from chronic upper or mid back pain secondary to thoracic disorders is relatively small compared to low back and neck pain.

2.2.1 Prevalence

In interventional pain management settings, thoracic pain has been reported in 3% to 23% of the patients (101,102,171,172,258,259). Leboeuf-Yde et al (192) estimated the prevalence of thoracic pain in 13% of the general population in contrast to 43% in the low back and 44% in the neck during the past year. Limited epidemiologic data in relation to thoracic pain support the view that the thoracic spine is less commonly implicated in chronic pain than the lumbar or cervical spine (192,260,261).

Despite the lower prevalence, the degree of disability resulting from thoracic pain disorders was similar to that of the other regions (260). This supports the view that although mechanical thoracic spinal pain is less common, it can be as disabling as lumbar or cervical pain (261).

2.2.2 Occupational Thoracic Pain

In a survey of factory workers, Occhipinti et al (260) described a prevalence of thoracic pain of 5%, which did not show any association with age in a survey of factory workers. This evaluation also showed the prevalence of cervical and lumbar pain of 24% and 34% respectively with increasing prevalence with age in both cases.

2.2.3 Risk Factors

Occupational and recreational activities may influence the development of thoracic spine pain in an army training program. Milgrom et al (262) observed the incidence of exertional thoracic pain in 8% which was similar to that of the lumbar spine with 10%. In a similar group of recreational sportsmen, the prevalence of thoracic pain or chest discomfort was 15% compared to the prevalence of lumbar spine pain or stiffness of 47% (263). Anderson et al (264) showed that a prevalence of thoracic pain in bus drivers of 28%, in contrast to 10% in non-drivers, which indicates that occupations that require sustained sitting may predispose to thoracic spinal pain. Even then, the prevalence of cervical and lumbar pain was considerably higher in both groups. While it is implied that occupational and recreational activities may predispose

the thoracic spine to postural pain or mechanical dysfunction, this region appears relatively protected in relation to more mobile cervical and lumbar regions.

2.2.4 Course and Prognosis

No separate data is available on thoracic spinal pain in reference to its course and prognosis. However, it is considered to be similar to the course of the cervical and lumbar spine.

2.3 Low Back Pain

Among all chronic pain problems and spinal pain conditions, low back pain is the most common and important clinical, social, economic, and public health problem affecting the population indiscriminately across the world. It is a disorder with many possible etiologies, occurring in many groups of the population, and with many definitions. Consequently, the vast literature available on low back pain is not only heterogeneous, but also contradictory (1,2,4,5,10,12,16-20,175,189,191,265-267).

2.3.1 Prevalence

The annual prevalence of chronic low back pain ranges from 15% to 45%, with a point prevalence of 30% (4,189,191,262-267). The studies evaluating chronic low back pain estimated the average age related prevalence of persistent low back pain in approximately 15% in adults and 27% in the elderly (4,5,141,191). In a World Health Organization (WHO) study in primary care of persistent pain and well being (1), 22% of primary care patients reported persistent pain with 48% reporting back pain. It was also reported that persistent pain was a commonly reported health problem among primary care patients and was consistently associated with psychological illnesses and disability.

In the United States, descriptive epidemiology of low back pain and its related medical care has been reported (265). The data was from the second National Health and Nutrition Examination Survey (NHANES) for the years between 1976 and 1980. The results showed the cumulative lifetime prevalence of low back pain lasting at least 2 weeks of 13.8%. The point prevalence of back pain in this adult population was 6.8%, representing the proportion of the population with low back pain at any given time. Back pain, along with features of sciatica, were reported by 1.6% of respondents, or approximately 12% of persons with low back pain. Only 2.1% of respondents had ever been told they had a ruptured disc in the low back. Utilizing the same methodology, the authors also estimated back pain prevalence and visit rates from U.S. national surveys 2002, published in 2006 (266). In this survey, low back pain lasting at least a whole day in the past 3 months was reported by 26.4% of the respondents, whereas the neck pain was reported by 13.8%. They also showed that back pain was more common among adults over the age of 45 than younger adults. However, the prevalence of back pain fell slightly among the oldest adults. Further, women were somewhat more likely than men to report back pain. Among racial groups, American Indians and Alaska natives had the highest prevalence of back pain, while Asian Americans had the lowest prevalence. They also showed that the prevalence of back pain generally fell with greater levels of education. Respondents with less than a high school diploma had a prevalence of almost 32% versus approximately 22% among those with a bachelor's degree or higher. The prevalence in this evaluation was higher than their previous study (26.4% versus 13.8%) (265,266).

In an epidemiologic comparison of pain complaints (18), the prevalence of pain in the prior 6 months was 41% for back pain. The authors in a separate study (20) showed that the percent of patients reporting Grade III or IV (high disability and pain) was highest for back pain patients. In a 2008 study utilizing NHANES data from 1999 to 2002, back pain prevalence was shown to be 10.1% (8). In a study of U.S. national prevalence and correlates of low back and neck pain among adults, the 3-month prevalence of back and/or neck pain was 31% with low back pain seen in 34 million, neck pain in 9 million, and a combined back and neck pain in 19 million people (20).

Lawrence et al (4) estimated the prevalence of arthritis in selected musculoskeletal disorders in the United States. This work group reviewed data from available surveys, such as the NHANES series. For overall national estimates, they used surveys based on representative samples. Approximately 15% of the adult population reported frequent low back pain or pain lasting longer than 2 weeks during the past year. More persistent pain, lasting beyond 3 to 6 months, occurred in only 5% to 10% of patients with back pain (4). Only 1.6% of adults reported having had back pain with features of sciatica which lasted for at least 2 weeks at some time in their lives (4,265,267,268). Lawrence et al (4) estimated that among the working population (age 20 to 64), more than 26 million Americans have

frequent low back pain, whereas among Americans aged 65 and older, almost 60 million have frequent low back pain.

Cassidy et al (189) evaluated pain associated with disability and graded them into Grade I to Grade IV. Based on this, 11% of the patients had Grade III and Grade IV pain levels with high pain intensity and significant disability (Fig. 5).

2.3.2 Prevalence of Occupational Low Back Pain

In an extensive review of the international literature on the incidence of disabling low back pain, Nachemson (269) reported that the problem of low back pain was even greater in Canada, Great Britain, Netherlands, and Sweden, in comparison to the United States and Germany. This analysis showed that the percentage of the work force affected varied from 2% to 8% with days of absence per patient per year ranging from 9 days in the United States to 10 days in West Germany, to 20 days in Canada, to 25 days in the Netherlands, to 20 days in Great Britain, and 40 days in Sweden. These findings were also echoed by multiple other investigators (176,270-287).

It is estimated that 28% of the U.S. industrial population will experience disabling low back pain at some time and 8% of the entire working population will be disabled in any given year, contributing to 40% of all lost work days (265,270-275). Studies have shown that the one-year prevalence of back pain in the United States to be highly variable, from 10% to 56% (265,271-276).

State-by-state surveys in the United States show that occupational low back pain constitutes 9% to 26% of all industry insurance claims (287). The prevalence and risk of occupational low back pain in the United States with high physical demands is high (288-291). In fact, one study (291) reported that the U.S. estimate of the annual low back pain claims rate decreased 34% between 1987 and 1995. However, in recent years, there have been claims of increasing industrial injuries and compensation costs resulting in numerous guidelines, restrictions, and policies (292). In fact, workers' compensation programs in the 50 states and the District of Columbia and federal programs in the United States combined paid $56 billion in medical and cash benefits in 2004, an increase of 2.3% over 2003 payments (293). However, employers' assessed costs for workers' compensation in 2004 were $87.4 billion, an increase of 7% over 2003 spending. Further, there has been a wide discrepancy in the cost to the employers for workers' compensation programs versus the cost of programs ($87.4 billion vs. $56 billion a year – 37% or $31.4 billion in administrative expenses and profit margin) (130). In addition, occupational diseases represented only 8% of the claims and 29% of the cost (294).

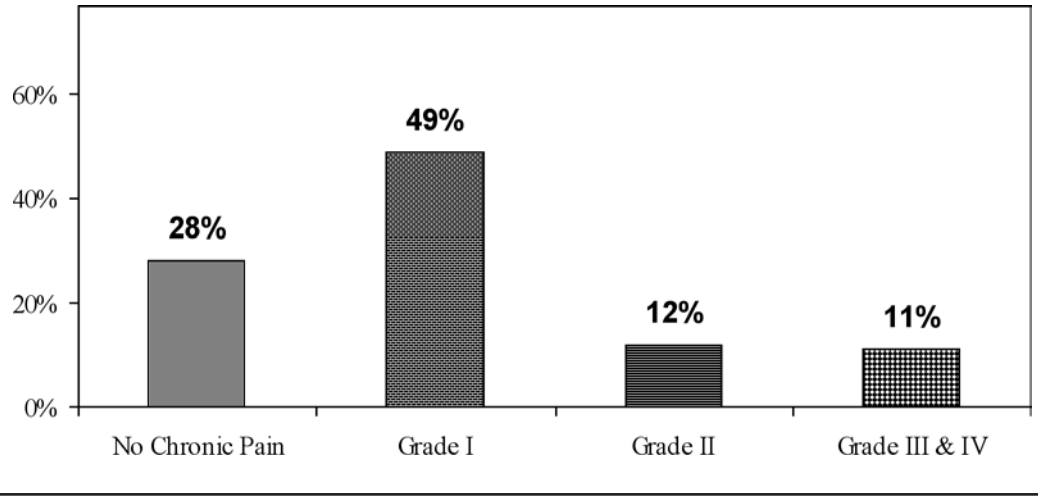

Fig. 5. *Severity of low back pain (age standardized rate).*

Adapted and modified from Cassidy JD et al. The Saskatchewan Health and Back Pain Survey. The prevalence of low back pain and related disability in Saskatchewan adults. *Spine* 1998; 23:1860-1867 (189).

2.3.3 Increasing Prevalence of Lower Back Pain

Contrary to the popular belief that low back pain prevalence remains the same, studies have shown increasing prevalence of chronic pain (33), specifically low back pain (34). Freburger et al (34) reported the rising prevalence of chronic low back pain following an evaluation of North Carolina households conducted in 1992 and repeated in 2006. The results showed increasing prevalence of chronic impairing low back pain over the 14-year interval from 3.9% (95% CI, 3.4% – 4.4%) in 1992 to 10.2% (95% CI, 9.3% – 11.0%) in 2006. Increases were seen for all adult age strata, in men and women, and in white and black races. Symptom severity and general health were similar for both years. The proportion of individuals who sought care from a health care provider in the past year increased from 73.1% to 84.0%, while the mean number of visits to all health care providers were similar. Table 2 illustrates the prevalence of chronic low back pain in North Carolina from 1992 to 2006. Overall prevalence of low back pain increased by 162% with increases of 226% in non-Hispanic blacks and 219% in the 45 to 54 year-old age group. While overall prevalence of chronic low back pain increased 162%, among females aged 21 to 34 it increased 320%, among males from age 45 to 54 it increased 293%. The authors concluded in their first population-based study in the United States which has examined trends in the prevalence of chronic low back pain using similar survey methods and identical definitions of chronic low back pain, an alarming increase in the prevalence of chronic low back pain from 1992 to 2006 in North Carolina, which occurred across all demographic groups. Further, the authors also found that episodes of acute low back pain defined as pain that limited usual activities for at least one day, but less than 3 months or less than 25 episodes of low back pain that limited activities in the past year increased from 7.3% to 10.5%. They also postulated that the smaller increase in the prevalence of acute versus chronic low back pain is consistent with a greater percentage of acute cases transitioning to chronic cases. Obesity was considered as a potential reason with increasing prevalence of obesity in North Carolina from 13.4% in 1992 to 26.6% in 2006 (295). However, obesity as a risk factor for low back pain continues to be unclear (296-298). Changes in psychosocial and physical work demands have also been attributed to the increase in prevalence (299). The work force in North Carolina has changed over the past 15 years with decreases in the percentage of manufacturing jobs and increases in the percentage of construction and service industry jobs (300).

Increases in back pain prevalence may also be due to an increase in depression prevalence. The rate of major depression in the United States more than doubled from 3.33% in 1991 to 1992 to 7.06% in 2001 to 2002 (301). Longitudinal studies suggest that major depression increases the risk of developing future chronic pain (302-304). Individuals with major depression were considered almost 3 times more likely to develop incidents of chronic back pain within 2 years relative to nondepressed individuals (304). In addition, depression was seen in 20% to 76% of patients in interventional pain management settings (171,180,305-309).

Other speculated causes of the increases in back pain prevalence may be due to increased symptom awareness and reporting (47,310). Increasing public knowledge of low back pain via medicalization, the media, and the internet have likely made back pain a more prominent part of life over the last 2 decades (34). Consequently, current care for chronic low back pain not only includes multiple health care professionals and numerous modalities of treatments, but focuses on relief at any cost (47,311-317). In fact, an analysis of data from several German health surveys indicate that immediately after reunification, rates of back pain prevalence were roughly 10 percentage points less in East Germany relative to West Germany, but they were essentially similar 10 years later secondary to dissemination of back-related attitudes and beliefs from the more "medicalized" West Germany to East Germany (318). However, similar patterns were not found in North Carolina and when the authors tried to assess whether the respondents were simply labeling ongoing back symptoms as functionally impairing, they found that those with back pain in 2006 were functioning either similarly or worse than in 1992, with decreased employment, greater use of disability insurance, and continued high pain scores.

Similar to the increase in the prevalence of low back pain, national data indicates that the proportion of Social Security Disability Income awardees claiming musculoskeletal disease as their cause of disability has also increased markedly from 15.2% in 1992 to 28.2% in 2006 (319). While the musculoskeletal disease classification includes conditions other than back pain, this national trend is consistent with the data on Medicare recipients with chronic low back pain younger than 62 years (34). Further, in 1983 musculoskeletal disorders

Table 2. *Prevalence of chronic low back pain by age, sex and race (North Carolina, 1992 and 2006).*

Characteristics	Prevalence, % (95%, CI)		Increase, %
	1992 (n=8067)	2006 (n=9924)	
Total	**3.9 (3.4–4.4)**	**10.2 (9.3–11.0)**	**162**
Male	2.9 (2.2–3.6)	8.0 (6.8–9.2)	176
Female	4.8 (4.0–5.6)	12.2 (10.9–13.5)	154
Age (Yrs)			
21 – 34	***1.4 (0.8–2.0)***	***4.3 (3.0–5.6)***	***201***
Male	1.6 (0.8–2.5)	3.5 (1.8–5.2)	115
Female	1.2 (0.5–1.9)	5.1 (3.2–7.0)	320
35 – 44	***4.8 (3.3–6.3)***	***9.2 (7.2–11.2)***	***92***
Male	3.4 (1.2–5.6)	6.5 (3.9–9.2)	92
Female	6.1 (4.0–8.2)	11.9 (8.8–15.0)	96
45 – 54	***4.2 (3.0–5.5)***	***13.5 (11.4–15.7)***	***219***
Male	2.6 (1.2–4.0)	10.3 (7.6–13.1)	293
Female	5.8 (3.7–7.8)	16.5 (13.1–19.9)	187
55 – 64	***6.3 (4.2–8.3)***	***15.4 (12.8–17.9)***	***146***
Male	5.7 (3.1–8.4)	13.7 (9.9–17.5)	139
Female	6.7 (3.9–9.5)	16.9 (13.2–20.5)	152
>= 65	***5.9 (4.5–7.3)***	***12.3 (10.2–14.4)***	***109***
Male	3.7 (1.9–5.5)	9.7 (6.6–12.7)	159
Female	7.3 (5.3–9.4)	14.3 (11.2–17.4)	95
Race/ethnicity			
Non–Hispanic white	***4.1 (3.5–4.7)***	***10.5 (9.4–11.5)***	***155***
Male	3.0 (2.1–3.8)	8.3 (6.9–9.8)	177
Female	5.1 (4.2–6.1)	12.4 (10.8–14.0)	143
Non–Hispanic black	***3.0 (2.0–4.0)***	***9.8 (8.2–11.4)***	***226***
Male	2.5 (1.2–3.8)	7.3 (5.1–9.4)	192
Female	3.5 (2.0–5.0)	11.7 (9.3–14.0)	234
Other	***4.1 (1.4–6.8)***	***9.1 (6.0–12.0)***	***120***
Male	3.3 (0.0–6.9)	7.0 (3.1–10.9)	112
Female	5.0 (0.5–9.5)	11.8 (7.0–16.5)	136
Hispanic	***. . . b***	***6.3 (3.8–8.9)***	
Male	. . .b	2.7 (0.6–4.7)	
Female	. . .b	11.7 (6.2–17.1)	

CI = Confidence Interval
A The PRRs and CIs were estimated via bootstrapping; 97.5% CIs were reported rather than to assume normality.
b Unable to estimate owing to small cell count (n< 5).

Adapted and modified from Freburger JK et al. The rising prevalence of chronic low back pain. *Arch Intern Med* 2009; 169:251-258 (34).

were the fourth leading diagnostic group in disability awards, whereas in 2003, they were the leading diagnostic group (320).

It also has been hypothesized that the increases in the use of health care services for chronic low back pain are due to increased health care seeking for surgical interventions by those with the condition (266,310-317,321-330). However, Freburger et al (34) illustrated that the increased prevalence may be the primary factor contributing to the increased use of health care services. They also showed that there was only a moderate increase in health care seeking from 1992 to 2006, with little change in the total number of visits to physicians, physical therapists, and chiropractors. In addition, the proportion of individuals who had surgery was also similar across both study periods. From 1997 to 2005, surgical procedures per person among the North Carolina population increased 157% (34) paralleling the increase of prevalence. In addition, based on the increase in surgery rates using state and national data (312,322-325), the rates of surgery among Freburger et al's survey respondents – individuals with chronic low back pain – were similar in 1992 and 2006.

Thus, the authors (34) have concluded that these findings suggest that increasing health care services including surgery are secondary to increasing prevalence of chronic low back pain rather than increased use of health care services and surgery by those with chronic low back pain, at least in North Carolina.

Since these results are similar to increases in chronic pain as described by Harkness et al (33) in a 2005 publication, it appears that this may be a phenomenon for all types of pain rather than low back pain alone (Table 1).

2.3.4 Course and Prognosis

The duration of back pain and its chronicity have been topics of controversy. It is widely believed that most of the episodes will be short-lived with 80% to 90% of attacks resolving in about 6 weeks, irrespective of the administration or type of treatment, with only 5% to 10% of patients developing persistent back pain (331,332). However, this concept has been frequently questioned as the condition tends to relapse and most patients will experience multiple episodes (2,22,30,31,144,333-350). Overall, studies have shown that low back pain is still present after long periods of time (at least after 12 months) in an average of 50% of patients (2). However, Stanton et al (351) reported that the recurrence of low back pain was found to be much less common than previous estimates suggest, ranging from 24% using the 12 months as the definition of recurrence, to 33% using the pain at follow-up as the definition of recurrence. Even then, this is higher than the conventionally believed 10%.

2.3.5 Risk Factors

Low back pain is a multifactorial disorder with many possible etiologies. Consequently, to analyze the various risk factors of low back pain and dissect this twentieth century health care enigma, many epidemiologic studies have focused on risk factors for low back pain, attempting to analyze occupational, non-occupational, and psychosocial factors (1,2,4,10,22,145,190,276-291,352-357). Cohen et al (357) concluded that the risk factors for progression to chronic back pain are predominantly psychosocial and occupational.

The role of psychological distress in the development of low back pain has been highlighted by a number of authors. Factors such as anxiety and depression, catastrophizing, kinesophobia (fear of movement), and somatization (the expression of distress as physical symptoms or their persistence) have been suggested as risk factors for low back pain in prospective studies in adults and children (358-369).

Employment and workplace factors, both physical and psychological, have been associated with low back pain. Heavy lifting, pushing, pulling, and prolonged walking or standing were found to be predictors of future back pain and there are similar associations with heavy lifting, physical work load, job demands and control, stressful and monotonous work, and dissatisfaction with work (370-378). Vehicular driving had been associated with a higher incidence of back symptoms and degenerative changes, which were attributed to the effects of whole-body vibration on the intervertebral disc (379-385). However, in an extensive review from the Swedish National Institute for Work and Life (386), it was cautioned that though most of the studies revealed significantly higher frequencies of back symptoms and degenerative changes in the vertebrae and intervertebral discs of drivers compared with referents, "uncontrolled confounding factors may have affected the results in all studies, and the conclusions about the causal role of whole-body vibration for the observed injuries and/or disorders, therefore, becomes uncertain."

A number of lifestyle and social-demographic factors have been linked with low back pain in a variety of studies (371,372,387). Body mass index has been linked to low back pain with obese people in particular at increased risk (388-396). Leboeuf-Yde et al (298) in a systematic review of epidemiologic literature to establish whether body weight is truly associated with low back pain, and whether the link may be causal, showed that of the 65 studies reviewed, 32% reported a statistically significant positive weak association between body weight and low back pain. However, one study found this to be true only among women (397).

Leboeuf-Yde (398) conducted a systematic review of epidemiologic literature on smoking and low back pain in 47 epidemiologic studies. She reported at least one statistically significant positive association between smoking and low back pain in 51% of the studies. A statistically significant positive association with smoking was reported for 34% of the 97 different low back pain variables in the cross-sectional studies, and for 35% of the 26 low back pain variables in the longitudinal studies. However, 64% of the 11 larger studies with study samples of 3,000 or more had at least one significantly positive association, compared with 47% of the 36 smaller studies with samples of less than 3,000. Consequently, this analysis showed consistent evidence in favor of a causal link between smoking and low back pain. Further, Leboeuf-Yde et al (399) in a cross-sectional postal survey of 29,424 people, aged 12 to 41 years, showed a positive association between smoking and low back pain that increased with duration of low back pain, concluding that there was a definite link between smoking and low back pain that increased with the duration and frequency of the low back pain problem, but the link was unlikely to be causal. In chronic pain settings, current cigarette smokers reported significantly greater pain intensity and pain interference with functioning (400). Further, symptoms were more pronounced in smokers with more severe nicotine dependence. Epidemiologic studies have suggested that cigarette smoking may be associated with painful musculoskeletal disorders (209,401-403). Further, smokers are also more likely to use analgesic medications than people who have never smoked (404). Cigarette smokers enrolled in a national spine network database have shown to have more severe back pain and lower scores on all the sub-scales of the SF-36, a measure of functional status, than non-smokers (405). It has also been shown that patients with fibromyalgia who smoke cigarettes have greater pain intensity and functional impairment than non-smokers with fibromyalgia (406,407). Several mechanisms have been suggested to explain the association between the intensity of pain in chronic pain states and smoking status (400). Smoking has been associated with alterations of the levels of neuropeptides that play a role in chronic pain states. Patients with fibromyalgia that smoke have higher levels of substance P in the cerebral spinal fluid (408). Smokers also have lower plasma beta-endorphin levels than non-smokers (409,410). In contrast, in subjects without chronic pain, in experimental settings, nicotine has antinociceptive effects in response to electrical, cold pressor, thermal, and ischemic pain stimuli (411-417). However, more research is needed on the effects of smoking on nociception in patients with chronic pain.

Associations between low back pain and social class, low levels of educational and low income have been reported (177,265). Social problems such as sexual and physical abuse (418) or deterioration in social life (371) have also been suggested as risk factors for low back pain.

Disc degeneration which was once viewed as a result of aging and "wear and tear" from mechanical trauma and injuries resulting in low back pain is now viewed as being determined in great part by genetic influences (419-424). Battié et al (380) in a review of contributions to a changing view of disc degeneration concluded that disc degeneration is now considered a condition that is genetically determined in large part, with environmental factors, although elusive, also playing an important role. Further, most of the specific environmental factors once thought to be the primary risk factors for disc degeneration appear to have very modest effects, if any (424). In addition, other work on disc degeneration in twins (420,423) established a substantial role of heredity and disc degeneration through the identification of high degrees of familial aggregation, suggesting a substantial genetic influence. However, the investigation of genetic influences on disc degeneration is still in its infancy.

Increasing age has been associated with an increase in musculoskeletal symptoms. A US national survey of physician visits among patients age 75 or older revealed that back pain is the third most frequently reported symptom in general and the most commonly reported in the musculoskeletal system (425). In another study, 17% of total back problem visits occurred in the 65-years-and-older age group (426,427). A Canadian epidemiological report ranked back problems

as the third leading cause of chronic health problems in the 65-years-and-older age category for women and the fourth leading cause of such problems for men in the same age category (428). Estimates of U.S. prevalence of back pain (32) showed higher rates for the elderly over the age of 65 and at least one day of back pain in the past 3 months and a lifetime prevalence of low back pain lasting at least 2 weeks. The prevalence of low back pain was higher in 2005 and 2006 for elderly over the age of 65.

However, it has been stated that low back pain usually begins in early life, with highest frequency of symptoms occurring in the age range of 35 to 55; while sickness, absence, and symptom duration increase with increasing age (351). The major studies and developments in the study of the epidemiology, diagnosis, and management of low back pain have dealt with and continue to deal with the specific problem of occupational low back pain. While the overall statistics of persons suffering from back pain are staggering, it has been shown that persons over 65 years of age experience low back pain with greater frequency and have been under-represented in research, as well as in management (429). A review of studies that evaluated pain in the elderly suggests that complaints of pain are more prevalent, varying from 44% to 84%, in contrast to the general population, in which pain complaints are seen in 14% to 29% of the population (47-54,56,429-436). Similarly, the studies of back pain in childhood also indicate that low back pain has a relatively high prevalence during school years, which varies from country to country; Finland has the lowest incidence at 20%; Switzerland the highest with 51% and the United States in between with an incidence of 36% (437,438).

Bressler et al (429) undertook a systematic review of the literature from 1966 through 1998 to determine the prevalence of low back pain associated with aging. Of the 12 articles identified, 9 studies sampled individuals in the general community (267,439-446), 2 were derived from medical practices (18,33), and one involved a long-term care facility (447). Bressler et al (429) reported a prevalence of back pain among the elderly within the community ranging from 13% to 49%; within the medical practice setting, the range was from 24% to 51%; and in the long-term care setting, the prevalence was 40%, with an overall prevalence of 27%. They concluded that there was an under-representation of the older population in the back pain literature, suggesting that the prevalence of low back pain in this population is not known with certainty and is not comparable with that in the younger population.

Low back pain has been reported consistently in a higher proportion of females than males (274,275,448-455). However, gender differences have been small in some studies and some did not find any differences, yet some studies found that men reported more low back pain at the time of interview than woman (443,456,457). Further, occupational low back pain and other types of disorders are seen in higher proportions in men (449,458,459). Also, back pain appears to be a significant problem during pregnancy which continues after the delivery (460-469).

3.0 Health and Economic Impact

Spinal pain is associated with significant economic, societal, and health impact (15,23,24,35,186, 204,214,267,272,305-308,317,326-330,427,470-515). Estimates and patterns of direct health care expenditures among individuals with back pain in the United States have reached $90.7 billion for the year 1998 (496). On average, individuals with back pain incurred health care expenditures about 60% higher than individuals without back pain ($3,498 versus $2,178) (502). In the United States, it was estimated that the cost of treatment in the first year after failed back surgery for pain was approximately $18,883 in 1997 (505). Further, annual health care costs incurred by chronic pain patients, excluding cost for surgical procedures, may range from $500 to as high as $35,400, with the average ranging from $12,900 to $18,883 annually (502,505). However, the majority of these costs are associated with disability compensation, lost productivity, and lost tax revenue. Disability secondary to spinal pain is enormous (35,203,486-491,496,508,509). In the United Kingdom, low back pain was the largest single cause of absence from work in 1988 and 1989 and accounted for 12.5% of all sick days and over £11 billion in direct and indirect costs in 2000 (507).

Deyo et al (317) found that the prevalence of back pain and its impact have spawned a rapidly expanding range of tests and treatments. They stated that some of these have become widely used for indications that are not well validated, leading to uncertainty about efficacy and safety, increasing complication rates, and marketing abuses. They concluded that the limited studies available suggest that these increases have not been accompanied by population-level improvements in patient outcomes or disability rates.

Asche et al (473) reviewed low back pain studies with economic implications and found that cost estimates for the management of low back pain were high, consistent with the results of reviews of low back pain economic studies published prior to 2001. A U.S. study by Lind et al (503) performed in 2002 showed that back pain constituted 15% of all outpatient visits. The evaluated company spent more than $52 million with an average of approximately $500 per adult. Katz (504) in an analysis of studies examining the socioeconomic factors of health in the United States, showed that office visits for low back pain in the United States totaled 19 million per year with a median unit cost of $150 per office visit amounting to a total cost of $3 billion. This study also estimated that there were a total of 224,000 medical admissions for low back pain per year at a median unit cost of $9,000 per admission for a total cost of $2 billion, and there were 286,000 laminectomy and discectomy surgical procedures per year at a mean cost of $14,000 per surgery for a total cost of $4 billion. For those undergoing a lumbar spinal fusion procedure there was 298,000 per year at a median cost of $37,000 per procedure to a total cost of $11 billion.

Deyo et al (317) showed that despite no specific concurrent reports of clarified indications or improved efficacy, there was a 220% increase in the rate of lumbar spinal fusion surgeries from 1990 to 2001 in the United States (322). The rise accelerated after 1996 when the fusion cage, a new type of surgical implant, was approved. Their promotion may have contributed to both the rise in fusion rates and increased use of implants. In addition, in the last 5 years of the 1990s, Medicare claims demonstrated a 40% increase in spine surgery rates, a 70% increase in fusion surgery rates, and a 100% increase in use of implants (516). Multiple randomized trials suggest that adding surgical implants to bone grafting slightly improves rates of solid bone fusion, but may not improve pain or function (326-328). However, implants increase the risk of nerve injury, blood loss, overall complications, operative time, and repeat surgery (326-330). Ritzwoller et al (483) in a U.S. study of 16,567 patients who presented with low back pain, showed that on average the annual direct medical costs was $4,284 per person.

Among the various factors contributing to costs in the United States, worker's functional impairment, activity limitations, reduced quality of life (487,517), disability (272,488), underemployment (489), reduced work productivity (35), and direct medical costs (427,490) have all been described. It was estimated that back pain related lost productive time (LPT) in workers 18 to 65 years of age costs employers $19.8 billion per year (35). Moreover, 50% of the annual cost of the back pain-related LPT in these workers was associated with pain exacerbation (491). However, these estimates do not capture other costs associated with the work force "ripple effect," such as the potential hiring and training of replacement workers, impact of coworkers' productivity, and forfeiture of leisure time (492). In an evaluation of back pain exacerbations and LPT costs in United States workers (486), it was shown that the 2-week period prevalence of back pain was 15.1%; 42% of workers with back pain experienced pain exacerbations. Back pain prevalence was associated with demographic factors, but back pain exacerbations were not. Back pain was reported by 42.6% of all workers over a 2-week period. Workers with exacerbations were significantly more likely than those without such exacerbations to report activity limitation and back pain related LPT. Employers' cost was estimated for workers between 40 and 65 years of age at $7.4 billion per year, with workers with back pain exacerbations accounting for 71.6% of the cost.

Stewart et al (35) in an evaluation of low productive time and costs due to common pain conditions in the U.S. workforce concluded that pain is an inordinately common and disabling condition in the U.S. workforce, with most of the pain-related LPT occurring while employees are at work resulting in reduced performance. The authors calculated LPT due to common pain conditions which included arthritis, back pain, headache, and other musculoskeletal conditions expressed in hours per worker, per week, and calculated in U.S. dollars. Thirteen percent of the total workforce experienced a loss in productive time during a 2-week period due to a common pain condition. Headache was the most common (5.4%) pain condition resulting in LPT, followed by back pain (3.2%), arthritis pain (2%), and other musculoskeletal conditions (2%). They estimated that LPT from common pain conditions among active workers cost an estimated $61.2 billion per year. In another review of expenditures and health status among adults with back and neck problems in the United States (186), spine related expenditures for health services were evaluated. They concluded that self reported back and neck problems accounted for a large proportion of health care expenditures, with spine-related expenditures increasing substantially from 1997 to 2005, without evi-

dence of corresponding improvements in self-assessed health status. In 1997, the mean age- and sex-adjusted medical cost for respondents with spine problems was $4,695 (95% CI, $4,181 to $5,209), compared with $2,731 (95% CI, $2,557 to $2,904) among those without spine problems (inflation adjusted to 2005 dollars). In 2005, the mean age- and sex-adjusted medical expenditures among respondents with spine problems was $6,096 (95% CI, $5,670 to $6,522), compared with $3,516 (95%CI, $3,266 to $3,765) among those without spine problems. Overall, total estimated expenditures among respondents with spine problems increased 65%, adjusted for inflation from 1997 to 2005, more rapidly than overall health expenditures. Further, the estimated proportion of persons with back or neck problems who self reported physical functioning limitations increased from 20.7% to 24.7% from 1997 to 2005.

Socioeconomic consequences of health disorders include direct and indirect costs (518). Direct costs are the resources expended on the management of the disorder, including hospitalization, outpatient visits, medications, assistive devices, diagnostic tests, alternative therapies, and other comparable expenses. In contrast, indirect costs are the resource expended to address the disability attendant to the disorder including cost of lost wages due to work missed, reduced productivity among persons who are working with a disability, and costs of additional caregiving, transportation, and other expenditures necessitated by the disability (504). Katz (504) assessed socioeconomic factors and consequences in lumbar disc disorders and low back pain, and discussed socioeconomic factors and disc disorders and consequences of low back pain and disability. He showed that as a society, we spend $33,000 to $85,000 per quality of life per year (QALY) on such interventions as discectomy as compared to conservative therapy (519), non-instrumented fusion for degenerative spondylolisthesis with stenosis versus fusion without instrumentation (520), and instrumentation in patients undergoing anterior cervical disc fusion versus fusion without instrumentation (521, 522). This amount is considered well within the range of QALY that is spent on other treatments, such as medications for hypertension, dialysis for end-stage renal disease, and coronary artery bypass grafting. However, the $3 million per QALY investment in instrumented fusion for degenerative lumbar spondylolisthesis with stenosis is extremely high and should prompt thoughtful consideration of the value of instrumentation in this setting, along with critical review of the assumption of the analysis (504). Similarly, cost effectiveness studies (523-528) have shown quality of life improvement per year with facet joint nerve blocks of $3,461 (523), with caudal epidural steroid injections of $3,635 (524), with interlaminar epidural steroid injections of $6,024 (524), with transforaminal epidural injections of $2,927 (524), with percutaneous non-endoscopic adhesiolysis of $2,080 to $5,564 (525,526), and with percutaneous endoscopic adhesiolysis of $7,020 (525).

There is also data available for implantable devices (502,505,527). Kumar et al (529) showed that the mean cost for SCS therapy over 5 years (inflation-adjusted CAN$30,852) in 2007 equivalent to US$24,799 and patient cost of CAN$41,964 or US$33,722 for 2007 for conventional pain therapy. During the first 2.5 years, the cost for SCS was higher than conventional pain therapy owing to the initial high cost of implantable devices. After this period, however, the cost for SCS remained significantly lower than that for conventional pain therapy, whereas quality of life results showed a 27% improvement for the SCS group compared with a 12% improvement for the conventional pain therapy group.

Frequent use of opioids in managing chronic noncancer pain has been a major strain on U.S. health care (23,24,483-486,493,512,530-550). With the majority of patients receiving opioids for chronic pain combined with increased production of opioids, the costs of opioid use have been much higher even when patients were not abusing. Evaluation of direct costs of opioid use in the insured population in the United States showed prescription drug claims for opioids total at approximately 20% of all prescriptions, whereas opioid abusers had drug claims of almost 60% (530,542). Mean annual direct health care costs of the total prescription bill for opioid abusers were more than 8 times higher than for non-abusers with $15,884 for abusers versus $1,830 for non-abusers (316). Opioid abusers, compared with non-abusers, had significantly higher prevalence rates for a number of specific comorbidities including non-opioid poisoning, hepatitis, psychiatric illness, and pancreatitis, which were approximately 78, 36, 9, and 21 times higher, respectively, than that of non-abusers (550).

Psychological and physical comorbidities and risk factors are common in spinal pain. There is extensive evidence associating chronic pain and psychopathology (180,306-308,511,539,541,551-557). A multitude of physical elements also lead to increased morbidity and mortality along with increased costs in spinal pain

patients. These include lack of fitness, poor health, obesity, smoking, drug dependence, and other comorbidities such as heart disease, diabetes, thyroid disease, etc. (15,23,483,508-513). Diabetes, rheumatoid arthritis, anxiety, psychotic illness, depression, and use of opiates and nonsteroidal anti-inflammatory agents have been associated with significant incremental increases in costs. In a study of cardiovascular risk factors for physician-diagnosed lumbar disc herniation (509), cardiovascular risk factors significantly and independently were associated with symptomatic lumbar disc herniation. Thus, physical and psychological comorbidities and measures of analgesic use are associated with chronicity, increased health care utilization, and costs.

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