6 Epidemiology and Risk Factors of Spinal Disorders

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Core Messages

- ✔ In 85 % of patients with a spinal disorder the etiology is unclear
- ✔ In non-specific spinal disorders, axial pain (i.e. cervical, thoracic, lumbar pain without radiation into the extremities) is the main symptom
- ✔ Back pain in non-specific spinal disorders is a symptom, not a disease
- ✔ With a 12-month prevalence of 15 – 45 %, a 12-month incidence of up to 20 %, and a yearly recurrence rate of up to 60 %, low back pain (LBP) is a major health problem.
- ✔ The prevalence and incidence rates for neck pain are only slightly lower
- ✔ For the majority of people with an acute episode of LBP (80 – 90 %), the prognosis is good: within 1 month, marked improvements in pain and disability occur, and work can be resumed
- ✔ Work-related disability from non-specific spinal disorders has become epidemic in industrialized countries
- ✔ Only a minority of patients are chronically disabled, but such cases cause most of the costs
- ✔ Over 50 % of the costs of spinal disorders are related to indirect societal costs
- ✔ The best predictor of future episodes of back pain is previous back pain
- ✔ Models of back pain are multifactorial, and include genetic, biological, physical, psychological, sociological, and health policy factors
- ✔ Occupational psychosocial variables are clearly linked to the transition from acute to chronic neck and back pain, work disability, recovery, and return to work

General Scope

Epidemiology is **research on the frequency and causes of diseases or syndromes** in different populations. The baseline idea of epidemiology is that disease and causal factors are not distributed at random in human populations. Individuals who develop a disease are expected to be exposed to antecedent risk factors to a greater degree or for a longer time than are individuals who stay healthy. It is important to bear in mind that epidemiology estimates the association between risk factors and diseases in statistical terms.

Epidemiology estimates the association between risk factors and diseases in statistical terms

A second significant **goal of epidemiology** therefore is to rule out alternative sources of association, e.g. confounding factors, study bias, and chance. Epidemiological knowledge contributes to the planning and evaluation of primary prevention. Epidemiological data also serve as a guide to the management of patients in whom disease has already developed. The number of individuals that suffer from a disease or a syndrome is expressed in terms of prevalence rates, and the number of new cases is expressed in incidence rates.

Prevalence. Prevalence refers to the percentage of a population that is affected with a particular disease at a given time or for a given period. Frequently used time periods are the whole adult **lifetime** until the establishing diagnosis (life-

time prevalence), or 1, 6, or 12 months before the interview-establishing diagnosis (1-, 6-, or 12-month prevalence rates; also called **current prevalence rates**). **Point prevalence** indicates the percentage of those reporting pain on the day of the interview.

Incidence. Incidence refers to the number or rate of new cases of the disorder per persons at risk (usually 100 or 1 000) during a specified period of time (usually one year). To determine the incidence rate, individuals who were healthy at the beginning of the observation period and who become affected during the observation period are counted. From this definition it follows that incidence rates are hard to estimate when conditions are widespread or often reoccur and therefore lack clear information on first onset. Incidence rates tend to be higher when comparably weak criteria are used to define health at the beginning ("no symptoms during 2 months before"), and are lower when criteria are stricter ("never experienced symptoms before").

Persistence and Recurrence. Because of the high prevalence and incidence rates, the burden of back pain in adult populations is better estimated with measures of the persistence ("**duration of pain episodes**") and recurrence ("**number of recurrent episodes**"). Persistence and recurrence are also captured by measuring the total number of days with pain in the last year. For instance, work disability is longer in recurrent compared with first episodes to low back pain [107].

Severity. The intensity of pain and functional disability represent the main focus in attempts to devise a grading system indicating the severity of disorders [78, 97].

Objectives in Spinal Disorders

The **specific objectives of epidemiology** in the management of spinal disorders are to [77]:

- pinpoint the problem
- estimate the societal and economic burden of spinal disorders
- forecast the problem in future
- describe and differentiate spinal disorders
- classify and grade symptoms within spinal disorders
- describe the natural history (assisting decision making)
- identify preceding risk factors and estimate their impact (alone or combined)
- identify protective resource factors preventing disease or promoting healing
- evaluate primary and secondary prevention efforts
- provide guidance for health care planning

Epidemiology helps to classify spinal disorders, identify risk factors, predict natural history and estimate costs

Epidemiology contributes to the standardization of terminology, a matter that is still unsatisfactory in spinal disorders. For instance it was shown recently that different definitions of back pain are systematically related to differences in prevalence rates [68].

Risk and resource factors comprise demographic, genetic, and other individual factors, and occupational, societal and even non-identified cultural characteristics [52]. Epidemiology is often a source for methodological development that helps to crystallize evidence from a data pool. Finally, epidemiology helps to evaluate primary and secondary prevention efforts and offers important guidance for planning health policy [77].

Classification of Spinal Disorders

Spinal disorders are a wide and heterogeneous variety of diseases affecting the vertebrae, intervertebral discs, facet joints, tendons and ligaments, muscles, spinal cord and nerve roots of the spine (Table 1).

Etiology

Spinal disorders comprise a variety of disorders that all involve the spinal column

We can differentiate spinal disorders according to their etiology. We differentiate on the basis of whether a specific cause can be found which conclusively explains the patient's symptoms:

Specific spinal disorders have an unambiguous etiology and can be diagnosed on the basis of specific structural pathologies that are consistent with the clinical picture.

Non-specific spinal disorders are not diseases per se but more of a syndrome. In the vast majority of patients (85 – 90 %) presenting with a spinal disorder it is not possible to identify a pathomorphological source of the problem despite a thorough diagnostic work-up [66]. There are many potential causative and aggravating factors associated with non-specific spinal disorders but no structural pathology can, with certainty, be held responsible for the symptoms. It is not easy to differentiate between specific and non-specific spinal disorders by early symptoms, because the primary manifestation of most spinal disorders is pain involving the neck and back.

For pain which is not radiating into the extremities the term **axial pain** is often used. We can differentiate between:

- axial neck pain
- axial dorsal pain
- axial back pain

Time Course

Spinal disorders can be further classified according to the **time course** of symptoms:

- acute – duration less than 1 month
- subacute – duration up to 3 months
- chronic – duration more than 3 months

Neck and back pain are the most common symptoms in non-specific spinal disorders

Spinal disorders are labeled as **acute** if persisting for a short time period (less than 1 month) with a sudden onset. Symptoms are classified as **subacute** if they occur after a prolonged period (6 months) without pain and with a retrospective duration of less than 3 months. A **chronic** stage is reached if symptoms occur epi-

Table 1. Classification of spinal disorders

Specific spinal disorders	Non-specific spinal disorders
With clearly identifiable pathomorphological correlate (10 – 15 %) such as: • congenital • developmental • traumatic • infectious • tumorous • metabolic • degenerative (depending on the disorder)	**Without** clearly identifiable pathomorphological correlate (85 – 90 %): • non-specific axial neck pain • non-specific axial dorsal pain • non-specific axial back pain

sodically within a 6-month period or last for more than 3 months [47]. Back and neck pain within non-specific spinal disorders are frequently accompanied by other types of musculoskeletal pain, bodily complaints, psychological distress and, especially in chronic cases, amplified dysfunctional cognition (e.g. catastrophizing) and pain behavior [81]. It is important to keep in mind that LBP of less than 7 days' duration is not a disease. However, a complaint can turn into a complex syndrome.

Low Back Pain

Low back pain is common and appears as pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica) [54].

With respect to the cause of back pain the so-called "**diagnostic triage**" [99, 100] classification has become standard. It divides low back pain into **three categories**:

- specific spinal pathology
- nerve root pain/radicular pain
- non-specific low back pain

Back pain often is divided into three large groups with respect to its location, aggravating factors, and temporal nature: **referred** pain, **axial** pain, and **radicular** pain.

- **axial** or **mechanical pain** (neck, dorsal, back) is restricted to the lower back area and gets worse with certain activities or positions.
- **referred** pain comes and goes and varies in intensity. It starts in the low back area and commonly spreads into the groin, buttocks and upper thighs.
- **radicular** pain is deep and usually constant. It radiates down the leg according to the dermatone and is accompanied by numbness or tingling and muscle weakness. This type of pain is caused by injury to a spinal nerve. Some of the possible causes are a disc herniation or foraminal stenosis.

The lifetime prevalence of LBP ranges between 75% and 85%

About 75–85% of all individuals will experience LBP at some time during their life (**lifetime prevalence**). Most epidemiological studies do not differentiate between types of pain [66]. The lifetime prevalence for associated leg pain seems to be about half that of back pain in general, and the lifetime prevalence of sciatic pain is estimated to be much lower, approximately 3–5% [40].

The yearly prevalence of back pain is estimated to range from 15% to 20% in the US and from 25% to 45% in Europe. The natural history of LBP is usually favorable and most individuals recover within 2–4 weeks; of the remainder, more than 90% resolve within 12 weeks [3]. A complete view of back-related work absence in Jersey/the UK showed that 3% of those starting absence in 1994 and who were out of work for 6 months or more caused 33% of social benefit costs [108]. This population based study also showed that recurrent episodes are associated with longer work absences, and that more specific diagnoses are associated with longer absences than non-specific back pain and back injuries [108]. In a review of 36 studies, Hestbaek and colleagues reported that, after a first episode of low back pain, the proportion of patients who report recurrent episodes after 12 months was on average 62%, and the percentage who had relapses of work absence was 33% [42]. Pengel and colleagues showed that 73% of patients had at least one recurrence within 12 months [71]. Return to work in the first month after an initial episode of LBP is high (82% of those initially off work), and some further improvement appears in the subsequent 3 months. Thereafter levels for

pain, and disability, and return to work remain almost constant [71]. There is increasing evidence that non-specific back pain in adults shows a fluctuating, recurrent and intermittent course that may ultimately lead to a chronic phase [19]. The unstable and episodic nature of LBP and the uncertainty of onset of any episode make estimation of the incidence of LBP difficult. The figures of up to 36 % for the 12-month incidence may overestimate the "true" incidence of real first time episodes of pain [19].

Neck Pain

Neck pain located by a mannequin drawing is most often defined as pain occurring in the area from the occiput to the third thoracic vertebra [21, 22]. Neck pain seems to be less common than low back pain, but there is limited epidemiological data on neck pain compared with low back pain [66]. Many studies examine shoulder pain together with neck pain, reporting prevalence numbers for **neck and shoulder disorders** (NSD) to be high in industrialized countries [66]. Recently Fejer and coworkers showed in their review of 56 epidemiological studies that neck pain is common in many areas of the world and numbers did not differ systematically with most definitions of neck pain (i.e. pain, ache, troublesome, soreness) [35]. However, numbers are higher when definitions like stiffness are used, and numbers are lower when neck pain of longer duration or high severity is assessed. Numbers did not differ systematically depending on whether the shoulder region was included or not, nor was the quality of studies systematically related to prevalence rates. Point prevalence rates ranged between 5.9 % and 22.2 % in adult populations with a mean point prevalence of 7.6 %. Mean week-prevalence was slightly higher (12.5 %), and increased with the period of time captured in prevalence data (23.3 % in 1-month prevalence, 29.8 % in 6-month prevalence, 37.2 % in 1-year prevalence, and 48.5 % in lifetime prevalence) [35].

Neck and shoulder pain are often associated

The so-called **whiplash associated disorder** denominates injury-related neck pain and subsequent associated disorders (see Chapter 30). It was first specifically defined as an **acceleration-deceleration injury** (usually related to accidents in vehicles), but later on the term whiplash syndrome was adopted for all types of neck injuries [66]; nonetheless, the causal link to trauma is not well documented. Although neck pain following trauma is common, few studies to date have included a control group in order to compare neck pain after injury with prevalence and incidence rates to be expected in the absence of a trauma [66]. According to Schrader and coworkers [82], the period prevalence of neck pain after trauma of around 35 % equaled the prevalence in a control group.

Whiplash associated disorders may result from cervical sprain (frequently rear-end collision)

Compared with low back pain, there is less knowledge about the incidence and course of neck pain. In the **Saskatchewan Health and Back Pain Survey**, a population-based cohort study of Saskatchewan adults, the incidences of neck pain and back pain were assessed [18, 19, 22]. The age and gender standardized annual incidence of neck pain was 14.6 % (back pain: 18.6 %). The annual rate of resolution of neck pain was 36.6 % (back pain: 26.8 %). Contrary to the popular belief of many clinicians, most individuals with neck pain do not experience complete resolution of their symptoms and disability.

Incidence and course of neck pain is less well documented compared with LBP

Pain, Impairment and Disability

Impairment defines an abnormality in structure or functioning of the body that may include pain, and **disability** defines the reduction in the performance of activities. Because in non-specific spinal disorders the etiology is uncertain, the establishment of impairment in these disorders is often less clear-cut than that of

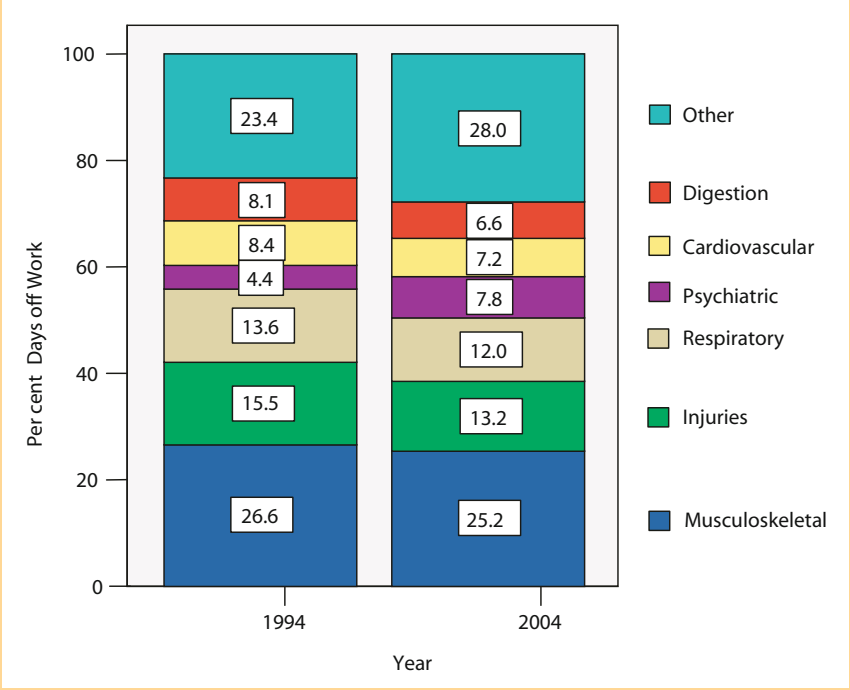

Figure 1

Work disability caused by disorders in Germany in 1994 and in 2004 [94]. Note: Within musculoskeletal disorders in 2004, the most frequent diagnosis was back pain ICD-10 M54 (7.7% days off work).

disability. Disability at work and in one's private life includes restrictions in the individual's major role and limitations in social and recreational activities. Individual functional losses include subcategories of functional capacity, such as mobility (part of the activities of daily living, transportation, leisure activities, sexual activities and other social role handicaps – occupation and household). It is also important to make a distinction between **pain** and **disability**. Pain and disability differ in their risk factors, prevalence and incidence, and they have developed very differently in their prevalence rates over time. An historical review [2] has indicated that people have always suffered from back pain, but back pain disability shows a trend for a steady increase over time. For example, Donald [27] reported a 208.5% increase in back pain disability in the UK between 1978 and 1992 compared with a 54.6% increase in other types of disability. In Germany, in 2003, musculoskeletal complaints (ICD XIII) caused 24.9% of days of work absence [94]. The mean number of absence days per LBP episode was among the highest (18.2 days), with only psychiatric disorders (ICD V) causing longer spells (28.5 days) [94]. In Germany and some other countries, however, the trend for an increase in absence days in recent decades has stopped and numbers seem to have leveled off [94].

Pain and disability must be differentiated

Disability causes great loss of productivity at home and at work, and the economic burden of chronic disability has become enormous in both the developing and industrialized countries [26].

Risk factors and obstacles to recovery potentially can differ for pain and disability

The Glasgow Illness Model is an operational clinical model of low back disability [99, 104] that includes physical, psychological, and social elements (Fig. 2). It assumes that most back and neck pain starts with a physical problem, which causes nociception, at least initially. Psychological distress may significantly amplify the subjective pain experience and lead to abnormal illness behavior.

Figure 2

Glasgow Illness Model of Disability [99]. This operational model of low back disability describes the development from a physical problem causing nociception to illness behavior and an alteration of the social role.

High levels of pain and illness behavior alter social function, and the individual may adopt a "sick role". A small minority of patients persist in the sick role, experiencing high levels of pain, even though the initial cause of nociception should have ceased and healing should have occurred.

Burden of Spinal Disorders

Back pain related heath care utilization is common [55]. Musculoskeletal complaints account for about 10 – 20 % of primary care visits and are the second most common reason for consulting a doctor [76].

Papageorgiou and Rigby [70] characterized the back pain related contact with medical services by applying a **one-in-five rule of thumb**: One in five of the population experience back pain at any one period of time; of these, one in five consult their GP; and one in five of those consulting are referred to a specialist. One in five of those attending outpatients are admitted to hospital, and one in five of those admitted undergo surgery for back pain.

Low back pain has a severe impact on the individual, families, and society

Musculoskeletal complaints are second only to respiratory disorders as a cause of short-term sick leave [87], and are the leading cause of long-term absence from work (> 2 weeks) in many countries [11]. Furthermore, musculoskeletal complaints are among the leading causes of long-term disability [94, 102]. Individual disability includes subcategories of functional capacity, such as mobility (part of the activities of daily living, transportation, leisure activities, sexual activities and other social role handicaps – occupation and household). As such, non-specific back pain is often accompanied by psychological distress (depression or anxiety), impaired cognition and dysfunctional pain behavior.

Economic Costs

The estimation of costs depends largely on the perspective that is chosen, such as the societal perspective, the patient's perspective, the health insurance perspective, the health care provider perspective or the perspective of companies. Whether results are comparable depends largely on the chosen perspective. Economic evaluations usually refer to a societal perspective. In that case, all relevant outcomes and costs are measured, regardless of who is responsible for the costs and who benefits from the effects. Since spinal disorders result in high costs to society, there have been an increasing number of economic evaluations. Van

Table 2. Direct costs of musculoskeletal disorders

ICD 10	Diagnosis	1994 direct costs for treatment (%)	1997 direct costs for treatment (billions DM)
XIII	Musculoskeletal disorders	12.6	48.8
X	Respiratory disorders	5.2	20.1
XIX	Injuries, poisonings	7.8	30.2
V	Psychiatric disorders	10.9	42.2
	Others	63.5	245.7
	Total	100	387

Cost estimates according to Thiehoff [89]

Table 3. Lost work days and lost productivity due to musculoskeletal disorders in 2003

ICD 10	Diagnosis	Lost work days (millions)	%	Lost productivity (billions EUR)	In % GNP
XIII	Musculoskeletal disorders	116.50	24.9	10.60	0.50
X	Respiratory disorders	66.05	14.1	6.01	0.28
XIX	Injuries, poisonings	61.04	13.0	5.55	0.26
V	Psychiatric disorders	45.54	9.7	4.14	0.20

According to Deutsches Bundesministerium für Wirtschaft und Arbeit (2003) Bericht der Bundesregierung: Sicherheit und Gesundheit bei der Arbeit. http://de.osha.eu.int/statistics

Roer, Boos and van Tulder recently gave an introduction to cost analysis [91]. The economic burden of spinal disorders includes:

- direct,
- indirect, and
- intangible costs

Direct costs concern medical expenditure, such as the cost of prevention, detection, treatment, rehabilitation, and long-term care. Direct costs of spinal disorders are estimated to be high. For instance back pain was estimated to cost the National Health Service in Britain £480 million in 1994 and accounted for £1.4 billion in social security costs [20].

The total costs of low back pain are enormous, and are predominantly caused by disability

Indirect costs consist of lost work output attributable to a reduced capacity for activity, and result from lost productivity, lost earnings, lost opportunities for family members, lost earnings of family members, and lost tax revenue. In Germany, musculoskeletal disorders are the most expensive form of work disability for companies and cause almost 27% of all production downtime due to sick leave from work. Estimates of direct and indirect annual costs of musculoskeletal disorders add up to approximately 24.5 billion euros for the labor force and approximately 38 billion euros for the total population [89]. However, working with spinal disorders produces additional loss as recently shown by Hagberg, Tornqvist, and Toomingas [37] in employees working at video display units. Participants in this study rated their loss in productivity due to musculoskeletal problems in the last month compared with the previous month. Among those with no sick leave in the last month, 6.1% of women and 8.3% of men reported a loss of productivity as a result of musculoskeletal disorders.

Finally, intangible costs are the most difficult to estimate. Intangible costs include psychosocial burdens resulting in reduced quality of life, such as job stress, economic stress, family stress, and suffering.

Reports dealing with direct and indirect costs from different countries have recently been reviewed and discussed [36, 56, 59].

The direct and indirect costs are considerable and their management utilizes a significant part of the gross national product of many countries. However, as

with prevalence rates, estimates of costs differ considerably due to the use of varying definitions and cost methodologies [59].

Risk Factors

LBP is multifactorial in origin

In non-specific low back and neck pain there is no clear etiology; in these disorders, pain is a **symptom** rather than an illness. There are individual characteristics as well as conditions of work and lifestyle factors that relate to the reporting of symptoms. Four important points should be made here:

- Non-specific low back and neck pain cannot be understood when looking at single factors alone. **Multiple factors** are involved.
- Risk factors contribute differently with respect to predicting **development**, **persistence**, and **recurrence** of symptoms.
- Risk factors differ for **pain reporting**, **disability**, and **pain behavior**. In addition, risk factors differ for morphological alterations such as disc herniation and disc degeneration.
- The association of risk factors with non-specific low back and neck pain is **probabilistic** not deterministic, i.e. an individual showing a risk factor has an increased likelihood of developing symptoms in the future, but it is not inevitable, and the individual may instead remain symptom free.

Risk factors can be categorized into **several domains**:

- individual factors
- morphological factors
- general psychosocial factors
- occupational physical factors
- occupational psychological factors

Individual Risk Factors

By far the most strongly predictive risk factor for neck pain and low back pain is **previous neck pain and low back pain** [41, 81]. Recent studies have indicated that some of the strongest predictors of disc degeneration and LBP are genetic factors [6, 69]. Research in adult monozygotic twins who differ in their history of work-related and other risk factors showed that a considerable amount of disc degeneration is due to heredity [6]. The **genetic influence** in disc degeneration was considerably higher than the influence of work-related factors, which were previously thought to be most strongly related to disc degeneration. The genetic influence on neck and back pain is less clear [34, 39] and seems to depend on age [39]. Genetic influences on back and neck pain might therefore be indirect via morphological factors, or via factors that influence the reporting of neck and back pain, i.e. there might be a genetically determined tendency for psychological distress, as was recently found in a study on adult female monozygotic and dizygotic twins [60]. Besides the influence of genetic factors on spine morphology, there are also various factors such as birth weight and smoking during pregnancy that can affect the development of the vertebral canal [49]. Other individual characteristics affecting **susceptibility to spinal disorders** include:

Age, gender, and body weight are established risk factors

- age > 50 years [100], most likely linked to pain via degenerative diseases
- gender, with females being more likely to report neck and back pain, and men being more likely to have a higher number of days absent from work [67, 94], and diagnosed hernia [67]
- obesity

- general health status and comorbidity
- smoking
- sedentary lifestyle [44]

Recent reviews show that the evidence for body weight, smoking and physical inactivity as risk factors is comparably small [81]. Among various individual characteristics of children (including gender, body height, body weight, trunk asymmetry, thoracic kyphosis and lumbar lordosis), it was shown that being female and having a short stature at 11 years of age predicted the incidence of neck pain [74].

Evidence is increasing that genetic factors are related to disorders that involve discs

With respect to physical activity during leisure time, there is not much evidence for a general association of sports and musculoskeletal symptoms, but a sedentary lifestyle is associated with a higher prevalence of LBP and sick leave [44]. There appears to be a weak positive association between increased body height and disc herniation. Obesity, regardless of height, is associated with disc degeneration and LBP [38, 45]. Low income and lower social class are risk factors, but analyses including multiple risk factors show more specific factors to be behind these categories [81].

Morphological Risk Factors

Morphological factors are poorly correlated with pain

Disc herniation and **disc degeneration** are often present in asymptomatic individuals, a finding that confirms that low back pain symptoms, pathology and radiological findings are not strongly interrelated [8, 16, 30, 50]. Vertebral fractures are not necessarily related to pain [51]. In a recent review, van Tulder and coworkers reported that degeneration, defined by the presence of disc space narrowing, osteophytes, and sclerosis, *was* associated with non-specific low back pain, although the associations were only moderate [92]. **Spina bifida**, **transitional vertebrae**, **spondylosis** and **Scheuermann's disease** did not appear to be associated with low back pain [92]. Patients reporting back pain in spondylolysis and spondylolisthesis are often classified as having non-specific low back pain because a considerable proportion of patients with such anatomical abnormalities are asymptomatic [85, 92]. The anatomical incidence is about 5 % [111].

Among patients reporting back pain, MRI findings of mild to moderate compression of spinal nerves, disc degeneration or bulging, and central stenosis were not found to correlate closely with the severity of symptoms [8, 48].

In one large epidemiological study, the one-year incidence of cervical radiculopathy was 83/100 000 [75]; the incidence of lumbar radiculopathy is probably much higher.

Psychosocial Factors

In accordance with the Glasgow Illness Model, epidemiological research indicates that psychosocial factors are an integral part of the pain disability process. Evidence is increasing that psychosocial factors have more impact on low-back pain disability than do biomechanical factors [66].

There is strong evidence that psychosocial variables are associated with the reporting of back and neck pain [105]. Inappropriate attitudes and beliefs about back pain (for example, the belief that back pain is harmful or potentially severely disabling, or high expectations of passive treatments rather than a belief that active participation will help), inappropriate pain behavior (for example, fear-avoidance behavior and reduced activity levels), low work satisfaction, and emotional problems (such as depression, anxiety, stress, tendency to low mood and withdrawal from social interaction) are strongly linked to the transition from acute to chronic pain and disability [66, 93].

Depression and anxiety are the best explored risk factors

Occupational Physical Risk Factors

Heavy physical work is associated with LBP

There is evidence that there is a moderate association between the incidence (onset) of back pain and heavy physical work [100]. With regard to disc herniation in males, higher incidence rates are found in the wholesale trade industry (10.7/10 000), manufacturing (8.9/10 000), and construction (8.4/10 000) than in the service sector (2.8/10 000) and finance and insurance (2.2/10 000) [67]. When national health statistics include the nature of injury or illness by major events or exposure, nearly 95 % of exposures labeled as "**overexertion**" and "**repetitive motion**" include musculoskeletal complaints [67]. Within private industry in the US, more than half of the cases of illness and injury that mention "overexertion" refer to frequent lifting. Cases filed in connection with overexertion and repetitive motion mostly refer to the region of the back (52 %) and upper extremities (26 %), but rarely to the neck [67]. Interestingly, although the proportion of people involved in heavy work has decreased in industrialized countries, there has been a concomitant increase in the number of people with work disability [99]. Furthermore, the rate of musculoskeletal disorders of the back is higher in many non-manufacturing industries than in manufacturing industries [67]. These discordant trends for heavy physical work and LBP disability suggest that while heavy work may be a contributory factor in the onset of non-specific back pain it is not a cause in many cases of work disability. There is some evidence, however, that the physical demands of work may influence the ease of return after an episode of pain [29].

Physical risk factors for the development of occupational back pain include:

- heavy physical work related to overexertion [39]
- manual materials handling including repetitive motion [39, 100, 101]
- twisting and bending [100, 101]
- frequent lifting [100, 101]
- awkward postures [100, 101]
- whole body vibration [57]

For the **cervical spine** the most consistently identified physical risk factors include [66]:

- exposure to repetitive movement of arms or neck and arm
- static load on the neck region
- segmental vibration exposure through hand-held tools
- rapid acceleration deceleration movements (whiplash)

Occupational Psychological Risk Factors

Psychosocial work factors are associated with disability and return to work

There is increasing evidence that the work factors leading to chronic disability are more psychosocial than biomechanical [9]. Musculoskeletal disorders are closely connected with occupational health psychology not only via biomechanical and environmental strains, but also through occupational variables such as task related and social stressors, control at work, job satisfaction, and support from supervisors and coworkers. The evidence for psychosocial risk factors in back pain [46] and neck pain [4] has been the subject of recent reviews.

Work-related psychosocial factors associated with spinal disorders are [29]:

- a rapid work rate
- monotonous work
- low job satisfaction
- low social support
- low decision latitude
- job stress

The way an individual copes with work factors, and how people attribute symptoms as being related to work factors, also influences the course of the disorder, especially in relation to return to work after treatment [86].

Absence of Evidence for Certain Risk Factors

Remember: Absence of evidence is not evidence of absence

Epidemiology contributes to the search for evidence for various risk factors in the development of LBP. However, also of importance is the **absence of evidence** for other factors. Non-evidence has now accumulated for various factors of importance to our understanding of the development, diagnosis and treatment of LBP:

- limited diagnostic and prognostic value of medical imaging in non-specific back pain [8, 10]
- no positive effect but negative effect of bed rest [25, 98, 103]
- no negative but positive effects of early return to work [17]
- LBP in children and adolescents more common than previously thought [88]
- no seasonal impact [43]

The contribution of medical imaging in predicting the development of future LBP in non-symptomatic individuals is limited [10]. Prolonged bed rest for sciatica is not beneficial [25, 98]. Bed rest may be instead a risk factor for poor recovery in acute LBP [103]. Early return to work after an episode of pain, and even return to work with a moderate level of prevailing pain, is not a risk factor for recurrent pain episodes but may in contrast be beneficial in preventing recurrent episodes [17]. For many years, LBP in children and adolescents was considered to be rare and an indication of serious disease [1]. More recent epidemiological studies have shown that the prevalence of non-specific LBP in children is high, reaching that of adults by the end of the growth period, and psychological factors such as beliefs about general health also seem to predict the first reports of pain episodes [88]. Contrary to widespread belief in practitioners and patients, the empirical evidence for seasonal variation in the prevalence of neck and back pain is minimal [43].

Geographical Variation

The reporting of back and neck pain exhibits substantial geographical variations

Epidemiological knowledge about prevalence of neck and back pain in developing countries is relatively small. Recently Fejer, Kyvik, and Hartvigsen included 56 studies on prevalence rates in their study on neck pain in the world population [35]. Almost half the studies (46%) were from Scandinavia, 23% from the rest of Europe, 16% from Asia, and 11% from North America. Two papers were from Australia and one was from Israel. The mean one-year prevalence rates were higher in Scandinavian countries (36%) compared with the rest of Europe (26%) and Asia (13%), but the differences were not statistically significant. Two studies from the Tokelau Islands (small islands in the South Pacific Ocean) reported lifetime prevalence rates for neck pain that were very low [109] or close to zero [110]. Violinn [95] also reported lower prevalence rates for low back pain in farmers living in Nigeria, southern China, Indonesia, and the Philippines. Of note was the finding that low back pain was more common among inhabitants of these countries who lived in cities. A recent comparison of chronic pain among 15 countries of the EU and Israel showed that self-reports of herniated or degenerated intervertebral discs were more common in Belgium, Austria, and Switzerland compared with Norway, Sweden, Finland and Denmark [13]. Prevalence rates also differ within countries, e.g. in the UK [106] and Germany [81]. Not surprisingly, the use of surgery for low back pain varies widely across regions and between counties [64]. In the United States there are reports of large regional differences in the like-

lihood of being offered spine surgery for a given disorder [7]. The interpretation of geographical data regarding prevalence rates always remains tentative because so many other differences between countries are left unconsidered. Therefore, Deyo characterized geographical comparison as a more "hypothesis generating" approach than "hypothesis testing" [24].

Unfortunately, important epidemiological data are not available for large areas of the world, and as such the natural course of non-specific spinal disorders and factors influencing their development and cost cannot be fully determined for these regions.

Some **important future research considerations** include the collection of:

- epidemiological data from different countries in a more uniform manner to facilitate comparative research and to render results comparable [96]
- more data sets in eastern Europe and the developing countries [95]

Flag System for the Risk Factors

The Flag System is very useful for the assessment of risk factors

Consultation with a surgeon is recommended for conditions with "**red flags**". Red flags are symptoms and findings that may indicate tumor, fracture, infection, or cauda equinal compression. **Obstacles to recovery** and **return to work** (the so-called **yellow and blue flags**) are likely to involve more complex clinical and psychosocial issues, requiring more detailed, individual assessment [14, 15, 63]. Finally, black flags indicate factors that are the same for many individuals and relate to the social security and health care system of a country.

A distinction should be made, however, between individual perceived obstacles to return-to-work (**blue flags**) and organizational policies regarding sickness, over which the individual has no control [14, 61]. Dealing with obstacles should include work-focused interventions and individually adapted interventions to meet the needs of individual clients. Altogether, yellow, blue and black flags should contribute to:

- better screening of individuals at risk of developing a chronic problem
- better interventions to increase return to work
- prevention of recurrent episodes of disability

Flags are therefore included in occupational policy guidelines for the management of non-specific spinal disorders, particularly occupational LBP.

Red Flags

Red flags are indicators of **serious spinal pathology** (e.g. cauda equina syndrome, which requires urgent surgical decompression). They represent potentially significant physiological risk factors for developing chronic LBP if not appropriately assessed. Red flags indicating neoplasm, infection, and cauda equina syndromes are extremely rare [16].

Red flags comprise:

- thoracic pain
- fever and unexplained weight loss
- bladder and bowel dysfunction
- history of carcinoma
- ill health or presence of other medical illness
- progressive neurological deficit
- disturbed gait, saddle anesthesia

Yellow Flags

Yellow, blue, and black "flags" address factors that should be taken into account to prevent long-term disability

Yellow flags are individual cognitive, emotional, and behavioral risk factors for developing chronic LBP, including individual attitudes and beliefs towards one's own LBP and its management [53, 58]. Yellow flags **indicate psychosocial obstacles to recovery**, and have been integrated into a systems approach for the management of acute and subacute LBP [53] that recognizes the importance of both clinical and occupational perspectives in the management of LBP at work. **Yellow flags** comprise:

- distress/depression (depression, anxiety, distress, and related emotions are related to pain and disability) [101]
- preexisting chronic pain, either in the back or elsewhere [84]
- fear-avoidance (attitudes, cognitive style, and fear-avoidance beliefs are related to the development of pain and disability) [63, 86]
- coping (passive coping is related to neck and back pain and disability) [65]
- pain cognitions (e.g. catastrophizing, which is related to pain and disability) [72]
- poor self-rated health (self-perceived poor health is related to chronic pain and disability and development of new chronic back pain [84])
- kinesiophobia [72]
- expectation of passive treatments(s) rather than a belief that active participation will help [100]

Blue Flags

Research into occupational health has identified certain work characteristics, such as time pressure and low job satisfaction, that represent risk factors for the development of complaints [83] including LBP [31]. Blue flags are individually perceived occupational factors that impede recovery from prevailing non-specific musculoskeletal pain and disability and increase the risk of prolonged symptoms or recurrence of episodes [23, 29, 73, 101]. **Work-related psychosocial risk factors** include:

- high job demands (time pressure, uncertainty, frequent interruptions, etc.) [83]
- low job control (influence on methods and time, e.g. the ability to independently plan and organize one's own work, and influence on work pace and schedule, autonomy, decision latitude, participation in planning) [31]
- low or inadequate social support from supervisors and colleagues [33]
- low appreciation of efforts (income, social recognition, non-monetary rewards, career progression) [29]
- unfavorable team climate [29]
- low job satisfaction [29]
- attributing the cause of pain to work [86]
- being sceptical about the further management of work tasks and about return to work at all [29]

Black Flags

Black flags relate to **occupational and societal factors** that are the same for many workers. These may initially lead to the onset of LBP ("occupational injury risk"), and may promote disability once the acute episode has occurred ("vocational education system", "sickness policy", "social benefit system", "compensation claims", "micro- and macroeconomic situation", "security obligations"). For instance, the influence of societal factors on work disability due to spinal disorders is shown in

comparing the prevalence of work disability in the former East and West Germany [81]. After unification, the western health and social benefit system was adopted in East Germany. In the first few years after unification, work disability was lower in East than in West Germany. However, the difference in prevalence rates between the two regions decreased continuously in subsequent years, and the figures for East Germany now approach those of West Germany [81].

Black flags are:

- adverse sickness policy [66]
- ongoing disability claim (results in little involvement in rehabilitation efforts) [5]
- disability compensation at the time of vocational rehabilitation (corresponds to less participation and poorer outcome) [28]
- unemployment (causes physical, psychological, and social effects that interact to aggravate pain and disability) [20, 90, 106]
- legal aspects and the insurance system (e.g. whiplash syndrome is not common in Lithuania, where insurance does not cover compensation for neck pain after traffic accidents) [82]

Direction for Future Epidemiological Research

Improved classifications of spinal disorders are required that are standardized, reliable and valid

Studies should use more standardized classification procedures, which necessitates greater agreement on definitions, classification and staging [112]. In addition to a population based registry approach [79, 80], a greater standardization of the assessment of risk, treatment and outcomes [62, 94] and a more standardized costing methodology are also urgently needed, to help estimate the long-term economic consequences of treatment [59]. There is also a need to distinguish prognostic risk factor analyses with reference to "new", "persistent", and "recovered" courses of symptoms over time, as preliminary evidence shows differences between persistent and "new" chronic back pain in their predictors and associations [84]. Analysis of time-bound cumulative exposure to risk factors might allow new insights into the reversibility of developments [32]. Transition phases into and out of a "chronic pain status" should also be the focus of future research endeavors. Specific types of psychosocial risk variables may relate to distinct developmental time frames, implying that assessment and intervention need to reflect these variables [58]. In addressing such issues, epidemiology may help to screen those workers who are at risk of developing chronic, non-specific spinal disorders [102].

Recapitulation

General scope. Epidemiology helps clinical decision-making by providing evidence-based information with respect to the classification of disorders, the **natural course of disease**, the **frequency** and **development** of the disease in a population, and the burden of costs.

Classification. Most spinal disorders are **non-specific** and within non-specific spinal disorders neck pain and low back pain are the most common symptoms. Non-specific neck pain and non-specific low back pain show high 1-year **prevalence rates**, and their **lifetime incidences** indicate that nearly everyone will experience neck and back pain at some time in their life. There are also **high recurrence rates**. It is the persistence of symptoms in some individuals that causes the **enormous costs** to society.

Risk factors. The etiology of non-specific spinal disorders is unclear. **Genetic factors** associated with the vulnerability of the intervertebral disc to de-

generative change seem to be involved. By far the best predictor of future back/neck pain episodes is previous back/neck pain. According to the **Glasgow Illness Model**, biological, psychological and sociological factors contribute to the persistence and recurrence of disability. Epidemiological evidence shows that psychological, sociological, and health policy factors are more strongly related to chronic pain and disability than are morphological factors and biomechanical load.

Flag system for risk factors. Epidemiological knowledge of risk factors provides the foundation for the flag categorization approach, and this should contribute to better screening of those at risk of long-term disability. Among other yellow flags, **inappropriate beliefs** – such as the belief that back pain is due to (progressive) pathology, that back pain is harmful or disabling, that activity avoidance will aid recovery, and that passive treatments rather than active self-management will help – play a major role in the **persistence of disability**.

Key Articles

Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D (2006) Survey of chronic pain in Europe: Prevalence, impact of daily life, and treatment. Eur J Pain 10:287 – 333
This article provides recent (2003) estimates of the prevalence of pain in 15 European countries and Israel.

Brauer C, Thomsen JF, Loft IP, Mikkelsen S (2003) Can we rely on retrospective pain assessments? Am J Epidemiol 2003 157:552 – 557
Recall bias in the assessment of pain can have a critical influence on estimates of the prevalence and incidence of spinal disorders. This paper describes an empirical approach to the problem in which 12 consecutive weekly pain recordings were compared with the final retrospective judgment of the 3-month period. The results showed that workers were able to accurately recall and rate the severity of pain or discomfort for a period of 3 months.

Carragee EJ (2005) Clinical practice. Persistent low back pain. N Engl J Med 352(18): 1891 – 1898
This excellent overview article begins with a case vignette highlighting a common clinical problem and presents current knowledge on persistent low back pain from a clinical point of view.

Nachemson AL, Waddell G, Norlund AI (2000) Epidemiology of neck and low back pain. In: Nachemson AL, Jonsson E (2000) Neck and back pain. Philadelphia: Williams & Wilkins, pp 165 – 188
This chapter summarizes current evidence from the view of some of the most revered researchers in the field.

Raspe H (2002) How epidemiology contributes to the management of spinal disorders. Best Practice Res Clin Rheumatol 18:9 – 21
A carefully written overview with special reference to a research agenda of topics that are most important to address in further research.

WHO Scientific Group (2003) The Burden of Musculoskeletal Conditions at the Start of the New Millennium. WHO Technical Report Series, 919. http://www.emro.who.int/ncd/publications/musculoskeletalconditions.pdf
Over the last couple of years, a WHO scientific group of experts has been working in collaboration with the Bone and Joint Decade 2000 – 2010 to map out the burden of the most prominent musculoskeletal conditions. The long-term aim of the work is to help prepare nations for the impending increase in disability brought about by such conditions. The group has gathered data on the incidence and prevalence of spinal disorders and considered the severity and course of spinal disorders, along with their economic impact. The group has also made suggestions for a more standardized approach in the measurement of pain, disability, etc.

Waddell G, Burton AK (2001) Occupational health guidelines for the management of low back pain at work: evidence review. Occup Med 51:124 – 35
The article is probably the best evidence-based review of occupational LBP and continuous updates are planned.

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