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EPIDEMIOLOGICAL ASPECTS ON PAIN IN WHIPLASH-ASSOCIATED DISORDERS

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In memory of Meta

*"If you know **exactly** what you are going to do,*

what is the point doing it?"

Pablo Picasso

ABSTRACT

Introduction: Whiplash-associated disorders (WAD) are common after car collisions. Little is known about risk factors for onset of the injury or about factors influencing the recovery.

Objective: The general objective of this thesis was to assess the influence of psychosocial factors on pain and disability in WAD. The aim of papers I and II was to assess the associations between pre-injury factors and neck pain intensity within 30 days of a motor vehicle collision. The aims of paper II were to assess the incidence and course of widespread pain in persons with WAD and to investigate factors associated with the onset of widespread pain. The aim of paper IV was to assess if injured persons´ expectations for recovery are a prognostic factor for recovery from WAD.

Materials and Methods: The thesis is based on two populations of insurance claimants who have reported WAD as a result of being vehicle occupants in traffic collisions. Participants answered questionnaires at baseline and at several follow-up periods. The follow-up times differed depending on the study population. The definition of WAD was based on neck injury specific items in the questionnaires. Papers I and II are based on injury claimants from Saskatchewan, Canada and include persons injured between July 1, 1994 and December 31, 1995. Paper I includes baseline information on 5,970 persons. Pain intensity was measured with a visual analogue scale 0-100 mm (VAS), and was categorized into mild, moderate, and severe pain. Paper II includes 266 persons who reported localized spinal pain at baseline and responded to at least one of the follow-up questionnaires at six weeks, four, eight, and 12 months. The identification of cases with widespread pain was based on pain drawings completed at the follow up. Papers III and IV are based on a Swedish cohort including persons injured between January 15, 2004 and January 12, 2005, who filed a claim to either of two insurance companies. Paper III includes baseline information on 1,187 persons. Pain intensity was measured with the VAS 0-100 mm, and categorized in the same way as in paper I. Paper IV includes 1,032 persons, who did not have a full recovery when they responded to the baseline questionnaire and who were successfully followed. Disability due to pain was measured with the Pain Disability Index at follow up.

Results and Conclusions: Neck pain intensity within the first month after WAD was influenced by several factors, in addition to the physical injury. Female gender, low socio-economic status, and poor prior health were associated with more severe pain intensity. In addition, having the head rotated or not knowing the head position at the time of collision was associated with more severe pain (Papers I and III). Subsequent widespread pain mostly occurred soon after the injury (Paper II). Continuous widespread pain was rare, even though 21% report such condition at some point over a one-year follow-up period. Depressive mood, intense neck pain, having several associated symptoms, and having more than three of five anatomic regions in pain early after the injury were all associated with the onset of widespread pain (Paper II). Those who thought they were less likely to make a full recovery after the injury were at higher risk to have moderate or severe disability at the follow up, compared to those who thought they were very likely to make a full recovery (Paper IV).

In summary, the results indicate that pain and disability in persons with WAD are influenced by psychosocial factors at various time points after the injury. In the early management of persons with WAD it is important to consider psychological status, expectations for recovery, and social circumstances in addition to the biomedical components of the injury.

Key words: neck injury, whiplash-associated disorders, traffic collision, psychosocial.
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LIST OF PUBLICATIONS

The thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I. Holm LW, Carroll LJ, Cassidy JD, Ahlbom A.
Factors influencing neck pain intensity in whiplash-associated disorders.
Spine 2006; 31 (4) E98-104

II. Holm LW, Carroll LJ, Cassidy JD, Skillgate E, Ahlbom A.
Widespread body pain following whiplash-associated disorders; incidence, course, and risk factors. The Journal of Rheumatology; 2007 34(1),193-200

III. Holm LW, Carroll LJ, Cassidy JD, Ahlbom A.
Factors influencing neck pain intensity in whiplash-associated disorders in Sweden.
Submitted 2006

IV. Holm LW, Carroll LJ, Cassidy JD, Skillgate E, Ahlbom A. Do persons´ expectations for recovery matter for the prognosis? A prospective cohort study of whiplash-associated disorders
Manuscript

CONTENTS

LIST OF ABBREVIATIONS

ACR-90	American Colleague of Rheumatologist definition of widespread pain for the definition of fibromyalgia, 1990
AIS	Abbreviated Injury Scale
CES-D	Center for Epidemiological Studies Depression Scale
CI	Confidence interval
CRP	Chronic regional pain
CT	Computerized Tomography
CWP	Chronic widespread pain
CWP-M	Manchester definition of chronic widespread pain
HADS	Hospital Anxiety and Depression Scale
IASP	International Association for the Study of Pain
ICF	International Classification of Functioning, Disability and Health
IES	Impact of Event Scale
NRS	Numerical rating scale
MRI	Magnet Resonance Imaging
OR	Odds ratio
PDI	Pain Disability Index
PMI	Pain Management Inventory
RR	Risk ratio
SF-36	The MOS 36-Item Short Form Health Survey
SGI	Saskatchewan Government Insurance
VAS	Visual Analogue Scale 0-100 mm
WAD	Whiplash-associated disorders
WHO	World Health Organization
QTF	The Quebec Task Force on Whiplash-Associated Disorders

1. AIMS OF THE THESIS

The general aim of this thesis is to add to the knowledge regarding occurrence of pain in whiplash-associated disorders (WAD) after motor vehicle collisions, and in particular to increase the knowledge and understanding of the influence of psycho-social factors on various dimensions of pain that persons experience after such injuries.

1.1 SPECIFIC AIMS

- To assess the associations between pre-injury factors and neck pain intensity within 30 days after a motor vehicle collision in a province of Canada. The factors of interest were prior health, demographic, socioeconomic, and collision related factors. (Paper I)
- To assess the incidence and course of widespread pain in persons with localized spinal pain after a motor vehicle collision and to investigate factors associated with the onset of subsequent widespread pain. Factors of interest include depressive mood, neck pain intensity, number of pain-associated symptoms, and number of painful body areas after the injury. (Paper II)
- To replicate the study in paper I on another population, and to assess the associations between similar pre-injury factors and neck pain intensity within 30 days after a motor vehicle collision in Sweden. The factors of interest were prior health, demographic, socioeconomic, and collision related factors. (Paper III)
- To assess if injured persons´ expectations are a prognostic factor for recovery after WAD. (Paper IV)

2 INTRODUCTION

Epidemiology is the study of the occurrence of disease and illness. It is a scientific discipline with roots in biology, logic, and philosophy of science. (1)

The rational for writing this thesis was anecdotal case reports and experiences from various professionals involved in the management and treatment of whiplash-associated disorders (WAD). These reports formed hypotheses around the potential influence of psychological and social factors for the experiences of acute and persistent pain in WAD, independent of the impact of severity of the physical injuries.

2.1 PAIN

Everyone feels pain at times in their life. Daily life would be difficult without the ability to feel pain when we experience things that are harmful and unhealthy. Being affected by pain is not a pleasant experience, but not having the ability to sense pain is life threatening and fortunately extremely rare. Thus, one could view acute pain as a useful sensation, in contrast with long lasting pain, which is frequently disturbing, distressing, and may impact adversely on ability to function effectively and on quality of life. The experience of pain is also likely to be related to the perception of threat, which may be associated with the circumstances for the onset of pain. For example, pain caused by exposure to a life threatening event may be interpreted differently than pain caused by a trivial event.

Pain due to various diseases or injuries is common in the general population, and accounts for a significant societal burden in terms of work disability and production loss in many countries, (2-4) and also in decreased quality of life in people who are affected by it. (5, 6)

2.1.1 Definition of pain

According to the International Association for the Study of Pain (IASP), the definition of pain incorporates psychological as well as physiological features.

> *"Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage"*

This is probably the most commonly cited definition of pain, although its completeness may be challenged. For instance, transient headache or neck pain, might not be caused by tissue damage.

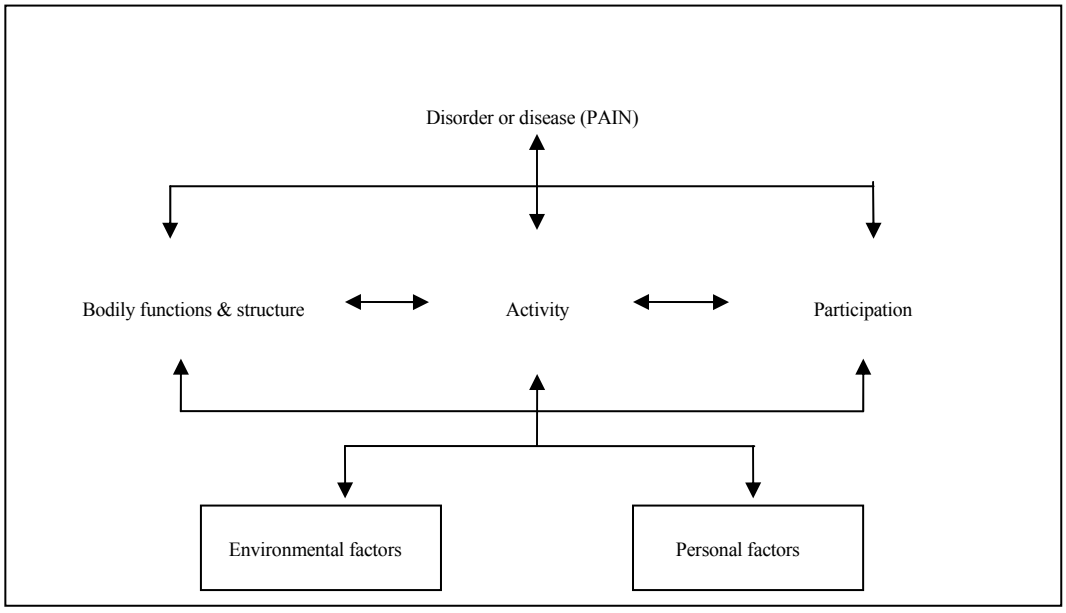
Nevertheless, pain is both a sensory and an emotional experience, and is subjective and individual. It is only the person herself who can determine the severity of pain. Clinical experiments have recognized that stimuli which cause pain are liable to damage tissue, and in most cases, pain has a pathophysiological cause. However, the experience and interpretation of pain also reflects a psychological state.

2.1.2 Dimensions and assessment of pain

Dimensions of pain

Dimensions of pain are often described in terms of how it is experienced and the consequences for the individual: *Duration of pain* refers to lengths of pain episodes. *Intensity of pain;* to how much it hurts. *Affection due to pain*; relates to a persons´ feelings when she is in pain, and *extent or distribution of pain*: refers to the anatomical regions where pain appears. Another important dimension of pain is *perception of pain-related limitations to participate in family or social activities or limitations of work capacity*. The latter one also concerns disability due to pain and the social consequences and restricted activities due to pain. This is included in the World Health Organization's (WHO) conceptual framework, the "ICF Model of Functioning, Disability, and Health" (7) (Figure 1). It is a classification system using body, individual, and societal perspectives and describes the impact of the disorder on body functions and structures, activities, and participation and social functioning. This classification system applies a biopsychosocial approach to the understanding of bodily functioning and social functioning, by including interactions between environmental and personal factors, and also including the consequences of the health condition.

Figure 1. The ICF model, (WHO 2001)



Assessment of pain

The most common way to assess pain and how it affects persons is with use of questionnaires. These may be designed for a specific anatomical region, for example, the neck; or for generic pain in any anatomical region. Development and testing of measurements or questionnaires is a separate scientific discipline, and we will only briefly discuss some key issues. The process of selecting or developing a questionnaire for a study involves testing of its usefulness by assessing reliability and validity. Reliability refers to how reliable the measurement is in producing the same result when it is used in a reproducible manner. Thus, it is a function of the questionnaire

and the user. Validity reflects the extent to which the questionnaire or scale is measuring what was intended to measure. It refers to how accurate the operational definition (as measured by, for instance, a scale) is in relation to either other measures, or to an observational golden standard. Another important consideration is the population in question. Questionnaires developed for use in in-hospital patients to measure severity of pain, may not be appropriate or sensitive for use in general population surveys. Generic questionnaires on the other hand, may not be sensitive enough to use for pain specific conditions. Without reliable (reproducible) and valid (accurate) measurements, any true effect of treatment or true association can be obscured by measurement errors.

There is an arsenal of questionnaires and scales in pain research. They address one or more of the dimensions of pain: location; intensity, affection, disability, and reflect different time frames. The choice of measurements for a study should be guided by its validity and psychometric property for the study population and by the research question(s).

2.2 NECK PAIN IN THE GENERAL POPULATION

Neck pain is common in general populations around the world, and may or may not have a known etiology. Individuals with neck pain are also part of the population at risk for sustaining a neck injury in the case of being exposed to a car collision. This section will therefore present a brief overview of the current knowledge of prevalence, incidence, and factors associated with neck pain in the general population.

The annual cumulative incidence of onset of any neck pain in adult population is reported to be approximately 18%. (8) The prevalence of any neck pain during the previous six months has been found to be 30-54%. (9, 10) A recent study from Sweden reports the prevalence of any neck pain to be 43%. (11) As expected, long lasting severe and disabling pain is less common, around 5%, during a six month period. (12) Neck pain is also common in adolescents, where 27-79% reported any neck/shoulder pain during the previous 12 months in two studies. (13, 14) One study suggest that neck pain is a recurrent condition, which may resolve, followed by a new onset, again with subsequent improvements, but in many instances people do not reach complete resolution. (15)

The etiology of neck pain has been the topic of numerous studies. A major focus has been on work related factors. However, most of these studies are cross sectional, (16) which limits conclusions about temporality and causality. Some known risk factors from prospective cohort studies or case-control studies are physical and psychological work exposures. (17-20) Demographic factors such as older age and female gender are commonly viewed as risk factors for neck pain although the results for age are not consistent across studies. (8, 15, 21, 22) Recent twin studies indicate a genetic influence on neck pain, adding an interesting component to the etiology. (23, 24)

Factors associated with subsequent persistent pain or recurrences of pain are clinical characteristics (e.g. more intense pain), passive coping strategies, prior episodes of neck pain or other musculoskeletal disorders, and older age. (21, 25, 26) Female

gender is associated with poor recovery in some studies, (15, 27) but when controlling for psychosocial factors in other studies, there is no effect of gender. (25, 26)

Furthermore it is known from cross sectional studies that the prevalence of neck pain is higher in persons who have a lifetime experience of a neck injury in a motor vehicle collision or in other mishaps, compared to persons who do not recall such event. (8, 28, 29)

2.3 WHIPLASH-ASSOCIATED DISORDERS (WAD)

The term whiplash injury has been used since the late 1920's, when H. E. Crow coined the term at a medical meeting in San Francisco. It originally described an injury mechanism to the neck, but was later also used to define the actual symptoms after such event. The first known case report was published in JAMA in 1953, when Gay and Abbot described 50 patients who had been exposed to whiplash mechanism in car collisions. (30) It was reported that the majority had been exposed to rear-end collisions and the majority were examined between one and 24 months after their collision, thus representing a mix of patients with acute or persistent symptoms. Cervical pain with radiation into the occipital region of the skull, shoulder girdle, or upper extremities were common symptoms. The authors also reported irritability, poor concentration, and subjective vertigo.

Persons who are exposed to energy transfer to the neck, in sports, falls, or other mishaps may also experience cervical pain. (31-33) After such events however, it is less common that the injury is labelled "whiplash", but instead other terms such as neck strain, neck sprain or simply neck injury are used.

2.3.1 Conceptual definition and classification of WAD

In 1995, the first task force on this topic; the Quebec Task Force on Whiplash-Associated Disorders (QTF), pointed out the need for a separation of the injury mechanism, the injury itself, and the subsequent symptoms. (34) They therefore adapted the term Whiplash-Associated Disorders (WAD) in order to describe the clinical entities related to the injury, and to distinguish it from the injury mechanism.

The QTF formulated the following conceptual definition;

> *Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck. It may result from rear-end or side-impact motor vehicle collisions, but can also occur during diving or other mishaps. The impact may result in bony or soft-tissue injuries (whiplash injury) which in turn may lead to a variety of clinical manifestations (Whiplash-Associated Disorders)*

The Quebec Task Force also suggested a classification of WAD into five categories based on clinical symptoms and signs (Figure 1). This classification is mostly used to classify WAD in the acute phase.

Figure 1. Quebec Task Force classification of WAD (34)

Grade	Clinical Presentation
0	No complaint about the neck No physical sign(s)
I	Neck complaint No physical sign(s) [a]
II	Neck complaint AND musculoskeletal sign(s) [b]
III	Neck complaint AND neurological sign(s)
IV	Neck complaint AND fracture or dislocation

*WAD classification suggested by a Swedish consensus group (35)

[a] Musculoskeletal signs include decreased range of motion and point tenderness.

[b] Neurologic signs include decreased or absent deep tendon reflexes, weakness, and sensory deficits.

Symptoms and disorders that can be manifested in all grades include deafness, dizziness, tinnitus, headache, memory loss, dysphagia, and temporomandibular joint pain.

A Swedish medical consensus group have suggested a revision* of the QTF classification, by removing Grade 0 and grade IV from WAD, since grade 0 does not satisfy the QTF definition of WAD, and grade IV refers to a different type of injury, with a distinct diagnose and special treatment. (35)

2.3.2 Common operational definitions of WAD

The QTF definition must be developed into an operational definition before being used in studies. In the scientific literature there are many definitions of WAD, and they are largely dependent on the study population and the source of data collection; but they have also been changing over time. There are recent clinical studies where the QTF WAD classification has been used. (36-38) Others use unspecific definitions such as "neck pain following a traffic collision", (39) or "car collision victims with neck symptoms". (40) The Abbreviated Injury Scale (AIS) has been used to define WAD in earlier studies (AIS1 neck injury, which excludes fracture or dislocation to the cervical spine), (41, 42) but some more recent studies based on insurance claims, e.g. self-report of injury, have also used such coding. (43, 44) In other studies, insurance data has been extracted using the International Classification of Diseases – ninth revision, ICD-9 code 847.0 (*sprain, strain to the neck including whiplash injury*). (45) Since the cardinal feature of WAD is reported neck pain, it is acceptable to consider self report of neck pain subsequent to a recent exposure to an injury mechanism to be appropriate for a case definition of WAD. The exact operational definitions may differ somewhat, but, regardless, it is a common way to define WAD. (46, 47)

2.3.3 Operational definition of WAD for this thesis

The operational definitions of WAD in this thesis were based on self report of symptoms in questionnaires that were completed shortly after a motor vehicle collision. WAD is defined in a similar way across two cohorts of injury claimants:

In papers I and II, WAD was operationally defined as having answered "yes" to both of the following questions: "Did the accident cause neck or shoulder pain?" and "Have you felt neck or shoulder pain, or have you felt reduced or painful neck movement since the accident?" Persons with cervical fractures were excluded.

In papers III and IV, WAD was operationally defined as an injury to the neck, determined by a self report check-list of injured body parts. The respondents also had to have answered "yes" to any of the following questions: "Do you have or have you had pain/ache in the neck due to the accident?" or "Do you have or have you had reduced neck movement that you relate to the accident?" Persons with cervical fractures were excluded.

2.3.4 Clinical diagnosis of WAD

The clinical diagnosis of WAD differs from the above conceptual and operational definitions of WAD in that the diagnosis is determined on the basis of clinical examination. Persons with WAD have different signs and symptoms resulting from their injury, and the exact etiology is uncertain. Several experimental studies on animals and human cadavers have sought to identify the physical etiology for the injury. (48-50) Hemorrhage in the cervical adjacent musculature and/or lesions or strain to facet joints, ligaments, or discs are possible explanations for symptoms in the cervical region. However, findings from such studies should be interpreted in a critical light, when it comes to extrapolation to persons with WAD. Prevalence of lesions to various cervical structures is unknown, and the lesions are normally not verifiable with modern diagnostic tools, such as Magnet Resonance Imaging (MRI) or Computerized Tomography (CT).

Instead the diagnosis of WAD is based on clinical signs and symptoms such as cervical pain, stiffness of cervical vertebrae, and musculoskeletal tenderness in the cervical/scapula area, and/or neurological signs. When using the QTF classification in acute WAD, the majority are WAD grade I and II; and the incidence of WAD grade III, that is, clinically verified neurological dysfunction is <5%. (38, 51, 52) The most common acute symptoms, apart from neck/shoulder pain, are reduced range of cervical motion and headache. (47, 53, 54) A recent study also demonstrates that depressive symptomathology is frequent in the early course of WAD. (55)

Interestingly, transient symptoms similar to those seen in WAD have been reported in approximately one fourth of healthy volunteers who have been exposed to sham collisions in experimental environment, rising questions about the extent to which fear, anxiety and expectations contribute to whiplash symptoms after a car collision. (56) Clinical diagnostic criteria are also limited by the high prevalence of neck pain and other WAD-like symptoms in the general population. (10, 29, 57)

Pain intensity and severity of other symptoms are also sometimes considered a proxy for physical injury severity in WAD in the absence of objective findings. (58) However according to studies from other fields of research, pain intensity is also influenced by psychological, social and demographic factors, which may reduce its accuracy for measuring physical injury severity. (59-62) *The influence on pre-injury factors for the rating of pain intensity has not been studied in persons with WAD.*

2.3.5 Incidence and trends

WAD is the most common type of injury resulting from traffic collisions in many industrialized countries. (47, 63, 64) A thesis, based on traffic injuries from the late 1970's was the first to describe the relative frequency of "soft tissue neck injuries" in Sweden. Twenty-two percent of all injury claims among passenger car occupants reported to one traffic insurer were "soft tissue injuries to the neck". (65) In a later thesis, based on a similar population, in the years of 1993-1994, the corresponding frequency for WAD was 67%. (43) We must, however, keep in mind that severe and fatal injuries have decreased since the late 1970's due to improved interior and exterior safety of passenger cars, and increased use of seatbelts, which to some extent may explain a difference in the relative frequency over time. In Saskatchewan, Canada, WAD accounted for 83% of all traffic injury claims during 1994 and 1995. (47)

Annual reports from the Swedish Insurance Federation provide data that can be used to calculate the overall injury claim rate per traffic collision. The frequency increased from nine injury claims per 100 collisions in 1991 to 12 per 100 collisions in the year of 1994. Since then there has been little fluctuation, with the exception of years 2002 and 2003, with 14 and 15 injury claims per 100 collisions during those years.

Studies based on emergency room attendance due to neck pain after traffic collision, indicate a major increase in the cumulative incidence over the past decades. For instance Björnstig et al., estimated the annual cumulative incidence, based on emergency visits in Umeå in 1985-1986, to be 79 per 100,000 inhabitants. (41) Five years later the incidence had increased to 147 per 100,000. (42) The most recent study from that geographic region included visits to general practitioners as well (about 10%) and report an incidence of 320 WAD per 100,000 in the year of 1997. (36) A similar trend has been observed in the Netherlands. The average annual incidence of emergency attendance due to WAD after a motor vehicle collision, in one city in the Netherlands, increased from 3.4 per 100,000 inhabitants during 1970-1974, to 40.2 per 100,000 in 1990-1994. (66) The cause could not be ascertained. However a similar trend, but with a smaller increase in incidence, was observed in neck sprain due to other causes than motor vehicle collisions. Over the same 25-year period there was an almost five fold increase of the incidence of emergency attendance due to neck sprain without relation to collisions. (32) These findings raise the question of whether the increase might partly be explained by changes in health care seeking behavior.

A Californian study estimated the annual cumulative incidence of hospital visits in the US population in the year of 2000, to 328 per 100,000 inhabitants thus similar to that of northern Sweden. (67) In Canada, the annual cumulative incidence based on insurance claims of WAD varies between provinces and time periods, from 70 per 100,000 inhabitants in Quebec in 1987, (34) to around 600 per 100,000 in Saskatchewan in 1995. (47) Both provinces had similar compensations systems, but the policy regulation for being entitled to compensation differed to some extent between the two provinces.

In summary, WAD affects many people in many countries, and there are strong indications that the reporting of WAD has increased over time. There are different

possible explanations to this. For example, as the number of registered cars increases, presumably more people are at risk for collisions. Public attention to WAD, which may make people more aware of neck pain, and more likely to report it, may also explain an increase in incidence.

2.3.6 Risk for onset of WAD after motor vehicle collision

The knowledge of the etiology of WAD is limited. One reason is the difficulty in obtaining accurate and appropriate denominators to calculate risks. Rather than using persons exposed to collisions as the denominator, researchers have used proxies, such as registered licensed drivers, (45) population censuses, (67, 68) or persons involved in collisions where at least one persons was injured. (43) Some studies have adjusted for some possible confounding factors, others not. Examples of possible confounders are gender, age, pre-morbid health, and severity and direction of crash impact. Risk factors for WAD reported in these studies include presence of neck pain prior to the collision, (69) being the driver or the front seat passenger (compared to rear-seat passenger), and being exposed to a rear-end collision or frontal collision rather than a side collision. (43) Female gender has been suggested to be associated with a slightly higher incidence of WAD, (43, 45, 67) but other studies found no gender differences. (66, 68) All these studies have weaknesses, primarily the lack of "true" denominators, and/or the limited possibility to control for potential confounders.

One possible risk factor for WAD is the severity of the crash impact. The basis for biomechanical research on WAD is formed mainly on experimental studies using cadavers, volunteers and simulation experiments. So far, the injury mechanism has not been established, and as a matter of fact, there may be several injury mechanisms. The car occupant acceleration, velocity and rebound are central factors. (70) A major focus of much of the research is on rear-end mechanisms of injury, despite consistent findings that rear-end collisions are only responsible for 40-55% of all WAD in motor vehicle collisions. (39-43, 53) However, there are some promising results from real life rear-end collisions that redesign of headrests and seats which limit the extension of the head in rear-end crashes, has reduced the incidence of WAD. (71, 72) Before firm conclusions about the magnitude of the effect of such preventive interventions can be drawn, we need larger studies with well defined outcome measures and control for potential confounders.

The course and prognosis in WAD is critical. Will people recover from this common injury, and when? If the injury is transient and self limited, there would be no need to put major efforts on prevention and intervention strategies.

2.3.7 Treatment and prognosis of WAD

The current *state of the art* in the management and treatment of persons with acute or sub-acute WAD is to promote activity. (73, 74) There is evidence from randomized controlled trials that regular movement of the head, neck and shoulder, exercise, and/or different mobilization techniques promotes recovery. (75, 76) There are so far no evidenced based interventions, specially oriented to patients with WAD when symptoms persistent beyond the sub-acute phase. Instead these patients may benefit from effective interventions available for long lasting neck pain of other origin.

The natural course and prognosis of WAD has been a matter for many controversies. Some claim that such injury and its prognosis is solely determined by the physical injury and its severity, and that pre- and post psychosocial factors are not relevant in recovery. (77-79) Others claim that persistent WAD is mainly a "psycho-cultural" illness, and refer to studies from Lithuania and Greece where there is no or little awareness of WAD. (80-82) In these studies, less than 2% of the study participants report long lasting symptoms after car collisions. (69, 83) However, drawing firm causal conclusions based on the findings of these studies is inappropriate, since "psycho-culture" per se was not studied. Nevertheless, when persons without experience of neck pain after car collisions, have been asked to report on which symptoms they would expect after neck injury or minor head injury, persons from Lithuania and Greece do not expect to have as many symptoms or having as long-lasting symptoms as compared to persons in Canada. (84-86) In the majority of other studies, the recovery rate is substantially lower than the ones from Greece and Lithuania. Some report 66-68% recovery rate at 12 months after the injury, (36, 87) whereas others report less than 40% recovery rate at a similar time point. (88, 89) Differences in recovery rates are at least partially due to selection bias. For instance in the study by Miettinen et al., the follow-up rate 12 months post injury was only 58% of the invited study population. (88) Despite various possible explanations for differences in the course of recovery after WAD, the magnitude of the importance of persons´ expectations for ill health and pain, and its potential impact on recovery has not been established.

Some factors known to contribute to poor prognosis in WAD are similar to those for other persistent neck pain. These factors include female gender, lower education, passive coping strategies, poor mental health, high pain intensity. (8, 26, 47, 90, 91) Similar to the literature on neck pain in the general population, gender does not seem to be a clear prognostic factor in WAD, after adjustments have been made for psychosocial factors. (88, 92) This suggests that the observed poor prognosis in females might be explained in terms of the social rather than the biological construction of gender. Furthermore, societal factors such as insurance systems with possibilities to claim for pain and suffering, (47) and extensive health care utilization in the early stage of the injury, (93) have been suggested to be associated with delayed recovery in WAD.

One important aspect on the course of WAD is whether the neck injury is a trigger for subsequent widespread pain. This has been suggested from cross-sectional studies, but temporality is unclear from these designs. (94, 95) A potential etiological explanation is a neurophysiologic disturbance in the peripheral and central nervous system, which, in some instances, leads to an increased sensitivity to pain. (96, 97) Another possible explanation for widespread pain is that new tissue damage may result from an altered pattern of movement due to the neck pain. The exact etiology of widespread pain is likely complex and multifactorial, but there are no indications that it would be specific to WAD. It may also occur after surgical intervention or any tissue damage. (96) In addition, large prospective studies on pain of other etiology have demonstrated that psychosocial factors at work, repetitive strains or other physical strains at work, and awareness of symptoms, and illness behavior may increase the risk for development of widespread pain. (98-100) Thus, it seems that

biological as well as psychological, and social factors contribute to the development of widespread pain. *Prospective studies investigating the incidence, course, and risk factors for widespread pain after WAD are lacking.*

An additional possible prognostic factor that, to date, has not been investigated in subjects with WAD is the influence of recovery expectations. An expectation is a degree of belief that some event will occur. (101) It is influenced by personal and psychological features, such as anxiety, self-efficacy, coping abilities, and fear. Health expectations are primarily learned from the cultural environment, and are based on "prior knowledge". Persons´ beliefs about their emotional and physical reactions may also actually affect the autonomic nervous system, thus involving biochemical processes, which may explain the power of placebo and nocebo effects. (97) It explains why persons who strongly anticipate they will recover, really do recover, and why strong perceptions about bad health are bad for your health.

There is a widely spread perception in Sweden, that being exposed to a car collision (or rear-end impact) is likely to result in years of suffering from disabling neck pain and other symptoms. This perception is supported by the Swedish media where daily newspapers have portrayed such injuries as being a threatening disorder. In the year 2000 local and nationwide newspapers published 280 articles on WAD. Three years later almost 600 article were published. (102) Most of them describe severely disabled persons, fighting for their right to disability pensions, extensive pain rehabilitation, societal handicap benefits, or insurance compensation. Some articles call for putting pressure on the car manufactories to improve car design to reduce WAD. There is a lack of reports on the natural course of WAD. The lay person gets the impression that WAD is an injury they are not likely to recover from. Such "prior knowledge" may be of importance for a person's expectations for the course of recovery, once she has been exposed to a motor vehicle collision and experienced neck pain.

Furthermore, it has been suggested from randomized controlled trials on interventions in patients with acute WAD, that accurate information and advice about WAD, have a positive influence on recovery, (103, 104) although such findings are not consistent. (105) This lack of consistency might be a function of different intervention approaches or different inclusion criteria. From studies on patients with health problems similar to WAD, it has been suggested that persons who report positive expectations, that is, who expect to recover soon, experience better subsequent recovery and faster return to work, even after controlling for symptom severity. (106-109)

2.3.8 A biopsychosocial approach to WAD

When reviewing the literature on prognosis after WAD, it becomes evident that biomedical, psychological and social factors play a role and also interact. There is therefore a need for a combined biopsychosocial approach to WAD both in research and in treatment. Engel proposed the concept of a biopsychosocial model in 1977, in order to introduce an alternative to the biomedical model of illness or disease. (110) As opposed to the biomedical model, the biopsychosocial model emphasizes interactions among the various aspects of pathology; psychology; behavioral adaptations; and attitudes in clinicians, in patients and in the society. The biopsychosocial model also acknowledges the interplay between disease and illness. Some have criticized this model arguing that each discipline should stick to their field of science, and if, for example, epidemiologists are studying psychological or social determinants or outcomes, there should always be a biomedical theory behind the hypotheses. (111) Since the framework was proposed by Engel, numerous narratives have been published, and a biopsychosocial model appears today to be the most appropriate concept for understanding most health related conditions, including the clinical course of pain and risk factors for persistent pain. (112, 113) Gallagher developed a diagnostic matrix for a biopsychosocial model in the treatment of chronic pain, and based it on four corner stones; "Predisposition", "Precipitation", "Illness pattern" and "Perpetuation". (113) This matrix or biopsychosocial net was adapted for this thesis. We think, however, there is an overlap between Illness pattern and Perpetuation, and have therefore focused on three of the corner stones (Figure 2). In this thesis the main objective has been to explore the psychosocial part of the biopsychosocial net.

Figure 2. The Biopsychosocial net and example of factors, possible involved in whiplash-associated disorders after car collisions. Partly adapted from Gallagher R.M. Am J Phys Med Rehabil, Vol 84, no 3 (suppl) ,2005. (113)

	Predisposition	**Precipitation**	**Perpetuation**
PHYSICAL	Age Sex Family or personal history of: - physical vulnerability, e.g. previous pain condition, disc herniation, arthrosis	Tissue damage such as - nerves - muscles - ligaments Impaired blood circulation Inflammatory response	Disturbed immune response Tissue damage Other concurrent injuries Neurophysical disturbance
PSYCHOLOGICAL	Age Gender Education Vulnerable personality including low pain threshold Pre-traumatic stress Pre-traumatic mental disorder	Circumstances of the collision - severity of injury of significant others, or other parties. Post traumatic stress Guilt and anger	Depressive mood Anxiety Cognition Guilt and anger Illness attribution Coping and pain behavior Perceived helplessness Uncertain or decreased recovery expectations Other concurrent injuries
SOCIAL	Abusive or traumatic relationship with health care system or insurance system Illnesses or social dysfunction in other family members Economic stress Media information - “prior knowledge”	Severity and direction of collision impact Interior and exterior car design Comfort and social support - at work - at home Health care management Paramedical management	Social support including - family network - reinforcement of dependency Job related factors - unemployment - high physical and mental strain Deficiency of heath care - poor coordination - introducing iatrogenic effect Traffic insurance system - financial incentives - slow and lengthy process Media information- “prior knowledge”

3 MATERIALS AND METHODS

The thesis is based on two populations that have filed insurance injury claims as a result of being an occupant in passenger car collisions. These persons were identified by the insurers and were approached with questionnaires at baseline and at follow ups. The follow-up waves differ depending on the study population. The four papers included are all based on cohort studies.

3.1 MEASUREMENTS

The measurements for this thesis are validated or commonly used in pain populations. In Figure 3, all measurements are listed and referenced when validated or previously used. The use of a numerical rating scale (NRS) 0-10 to measure recovery expectations, has, to our knowledge, not been used in previous studies.

Figure 3. Presentation of the measurements use in the thesis

Abbreviation	Name/Description	Used in	Outcome in
CES-D	Center for Epidemiological Studies Depression Scale (114)	Paper II	
HADS	Hospital Anxiety and Depression Scale (115, 116)	Paper IV	
IES	Impact of Event Scale (117, 118) (post traumatic stress)	Paper IV	
NRS 0-10	Numerical rating scale 0-10 (assessment of expectations for recovery and of pain intensity (119))	Paper IV	
-	Symptom checklist adapted and modified from the Quebec Task Force (34)	Papers II and IV	
-	General health prior to a collision. Modified version of an SF-36 subscale question (120)	Papers I-IV	
-	Frequency of neck pain prior to the collision. adapted from the Quebec Task Force (34)	Papers I-IV	
-	Frequency of headache prior to the collision. Adapted from the Quebec Task Force (34)	Papers I-IV	
-	Frequency of being tired and having lack of energy prior to the collision.	Paper I	
-	Pain drawing (121)	Papers II and IV	Paper II
PDI	Pain Disability Index (122)	Paper IV	Paper IV
PMI	Pain Management Inventory (123) (passive coping scale)	Paper IV	
VAS	Visual analogue scale 0-100 mm (119)	Papers I - III	Papers I and III

3.2 MATERIAL PAPERS I AND II

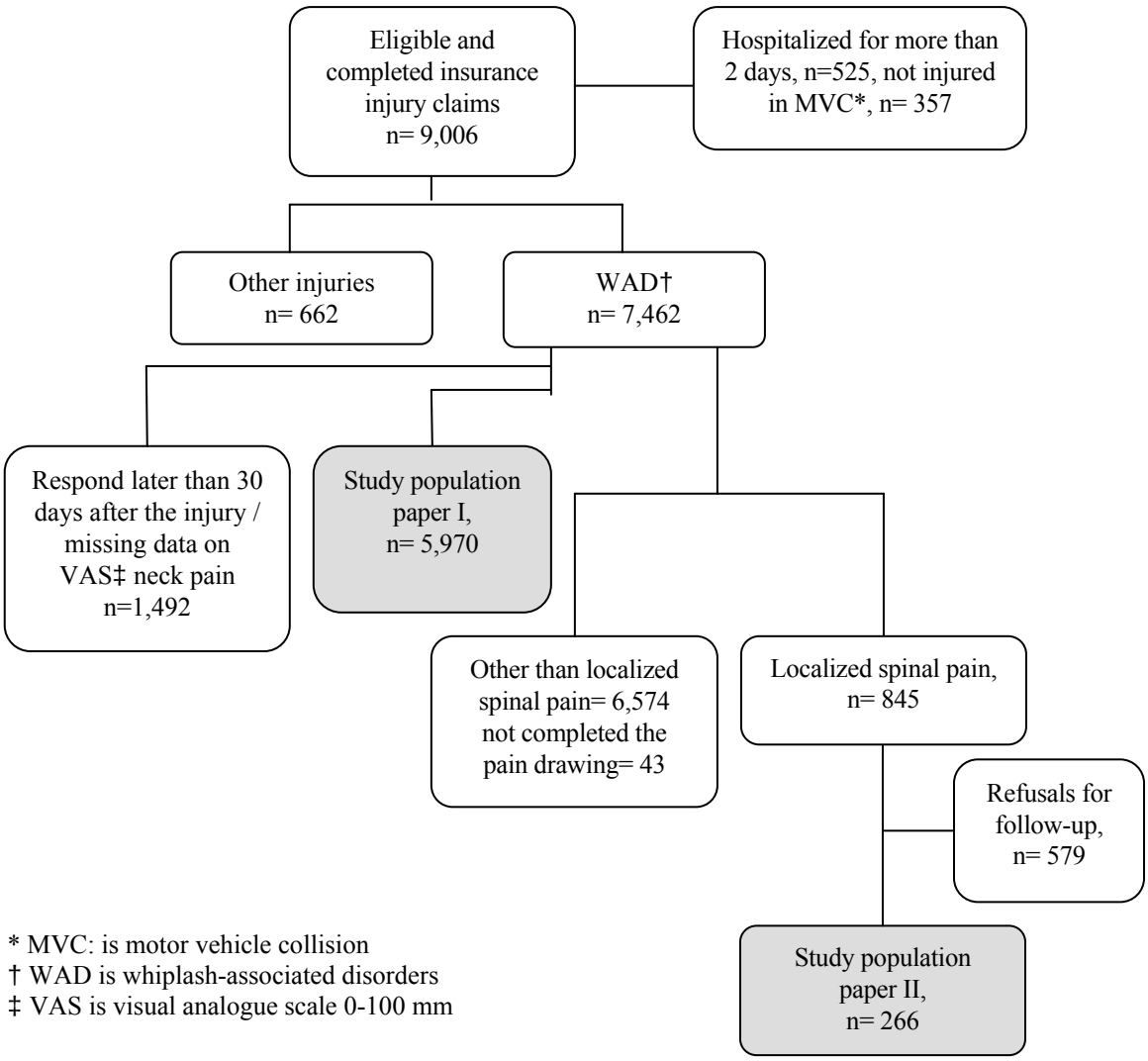
The studies in papers I and II are based on a cohort in Saskatchewan, a province in Canada with a population of approximately one million and with one single motor vehicle insurer. In that province, there were approximately 750,000 registered vehicles during the study period. The cohort includes all adult passenger car occupants (18 years or older) who were injured in motor vehicle collisions between July 1, 1994 and December 31 1995 and who sought health care and/or reported a claim to Saskatchewan Government Insurance (SGI). They also had to be residents of Saskatchewan and understand English sufficiently to complete a questionnaire, have been hospitalized less than three days, indicating a less severe injury, and not have serious injuries or serious disease (*e.g.* coma or Alzheimers disease) that preclude the completion of a question- naire. Those persons whose injury was covered by the workers' compensation system were not included, since the claim process is separate from traffic injury claims. The study persons were consecutively included into the study by completing a questionnaire which was part of the insurance application form. Those who gave their consent to participate in the follow-up part of the study were asked to complete an additional questionnaire as soon as possible after the initial one. These data formed the baseline information. During the year following the injury, question- naires were completed at six weeks, four, eight and 12 months. Data collected at baseline included demographic and socioeconomic factors, pre-injury health status, collision details, post-injury symptoms as outlined by a checklist, pain intensity and pain location, and perceived health including depressive symptoms. Follow-up information included repeated measures of symptoms, pain intensity, pain location, and perceived health, including depressive symptoms.

During the study period the Saskatchewan government changed the automobile insurance legislation from a tort system to a no-fault system. These changes came into effect on January 1st, 1995. Under the tort system compensation was paid for a limited amount of expenses, and injured persons who were not at fault for the collision could also sue or make a claim against the responsible party for pain and suffering and for additional expenses. Under the no-fault system there was virtually no possibility to sue another party for pain and suffering, but benefits for disability and treatment costs, income replacement, and other expenses were expanded, and were available to injured persons regardless of fault for the collision.

The studies were approved by the University of Saskatchewan's Advisory Committee on Ethics on Human Experimentation and by the Regional Committee on Ethics at Karolinska Institutet, Stockholm.

Figure 4 displays the Saskatchewan cohort and details of the study populations for papers I and II.

Figure 4. Description of the Saskatchewan cohort



* MVC: is motor vehicle collision
† WAD is whiplash-associated disorders
‡ VAS is visual analogue scale 0-100 mm

3.3 METHODS PAPER I

Inclusion criteria

In paper I we included 5,970 persons who (a) reported WAD according to our definition (page 18) and (b) completed the initial questionnaire within 30 days after collision.

Outcome

The outcome was pain intensity measured with a 100 mm visual analogue scale (VAS), (119, 124) and trichotomized into mild pain (VAS 0-30), moderate pain (VAS 31-54), and severe pain (VAS 55-100). (125)

Potential risk factors

We considered demographic, socioeconomic, and health related factors together with collision factors to be potentially related to post-injury neck pain intensity. Socioeconomic status was defined both based on educational level and on total family income. Health status before the collision was assessed with a modification of the Medical Outcome Study Short-Form 36 (SF-36) "general health" subscale question. (120) The modification consisted of a change aimed to record the time frame of one month prior to collision, but offering the same response options as in the original SF-36 question. We also adapted the recommended questions from the Quebec Task Force on frequency of neck pain and headache before the collision. (34) An additional health question was frequency of tiredness and lack of energy before the collision including the same response options as those recommended by the Quebec Task Force. Collision factors were: insurance system (tort/no-fault), impact direction of the crash, occupants´ head position and seat position, and collision responsibility. The latter was retrieved from the insurer.

Statistical analysis

The data were analyzed using multivariable polytomous logistic regression to assess the associations between the potential risk factors, and neck pain intensity. Polytomous logistic regression allows a dependent variable with more than two categories. (126) We first tested for presence of colinearity between the independent variables on the ordinal scale with use of Spearman rank correlation coefficient (r_S). Colinearity was present if r_S exceeded 0.80. If the r_S was less, suggesting that colinearity was not present, we entered the factors one by one into a polytomous logistic model. We tested for effect modification by stratifying by gender, insurance system and impact direction of the crash. Gender was found to modify the effect of some of the associated factors and we therefore built separate models for males and females. The results are presented as adjusted odds ratios (OR) with 95 % confidence intervals (CI).

We also did sensitivity analysis in order to test the stability of the model and the arbitrary cut-off points for neck pain intensity, which was used for the main analysis. We did this by using different dichotomous cuff-off points on the VAS and tested these in bivariate models.

3.4 METHODS PAPER II

Inclusion criteria

For paper II there were 7,419 potentially eligible persons who reported WAD according to our definition (page 18) and who completed the baseline pain drawing. Of these 845 reported localized neck/back pain without any other associated body areas in pain at baseline. We included 266 persons who responded to at least one of the four follow ups over a 12-months period. Localized neck/back pain was defined as fulfilling the definition of WAD, and on the initial questionnaire by having shaded the following body regions on a pain drawing, (121, 127) posterior neck pain with or without posterior shoulder pain, head pain, thoracic pain, or low back pain. The pain drawings were made on a manikin, displaying back and front. For the coding we used a transparent template including 45 anatomical regions, as suggested by Margolis et al. (121) We restricted the criteria for included subjects to have a maximum of five of eleven areas, in order to exclude those with widespread pain at entry to the study.

Outcome

The pain drawings, (121, 127) were also used to classify subjects into "caseness" of widespread pain. We arbitrary defined onset of widespread pain as having nine or more body regions in pain including posterior neck, as reported in the pain drawing at any of the four follow-ups.

Potential risk factors

The potential associated factors were baseline depressive mood assessed with Centre for Epidemiological Studies Depression Scale (CES-D).(114, 128-130) We also considered neck pain intensity, measured with a visual analogue scale 0-100 mm (VAS), (119, 124) number of painful body regions, (121) and number of other associated symptoms.

Statistical analysis

The natural course of widespread pain was described by frequencies and proportions. For the main analysis we used multivariable logistic regression. We first assessed the crude associations between each of the four potential risk factors of interest. We assessed potential colinearity between each of theses factors with use of Spearman rank correlation coefficient (r_S). Colinearity was present if the coefficient exceeded 0.80. If r_S was less than 0.80, we entered the factors, one at the time into a multi-variable model. We assessed the possible confounding effect of age, gender and health status prior to the collision. The latter included the SF-36 sub scale "general" health question, (120) which was a modified to capture a one month time frame prior to the collision. We also included frequency of prior neck pain and headache during the month before the collision. If a potential confounding factor changed any of the beta estimates of the four mental/pain related symptoms by 10% or more, that factor was included in the final multivariable logistic model. Results are presented with odds ratios (OR) and 95% confidence intervals (CI).

We also conducted a sensitivity analysis by changing the definition of widespread pain, using both eight and ten painful body areas (instead of nine, which was our main outcome), in order to test the stability and robustness of the model.

We assessed the impact of attrition through loss to follow-up by using a multivariable logistic regression model to assess person characteristics at baseline in relation to being a study participant or not. We included the characteristics we had information on for all 845 persons who were considered for the study. This included gender, age, educational level, combined family income, neck pain intensity at baseline, number of painful body regions at baseline, and number of other associated symptoms at baseline

3.5 MATERIAL PAPERS III AND IV

The studies in papers III and IV are based on a cohort of adult car occupants who were injured in a motor vehicle collision in a passenger car insured by Trygg-Hansa or Aktsam, Sweden, between January 15, 2004 and January 12, 2005. In Sweden traffic insurance is a private insurance business and Trygg-Hansa and Aktsam had a total share of approximately 20% of the market for motor vehicle insurance at the time of the data collection. Sweden had an average of 4,113,000 registered passenger cars in the year of 2004.

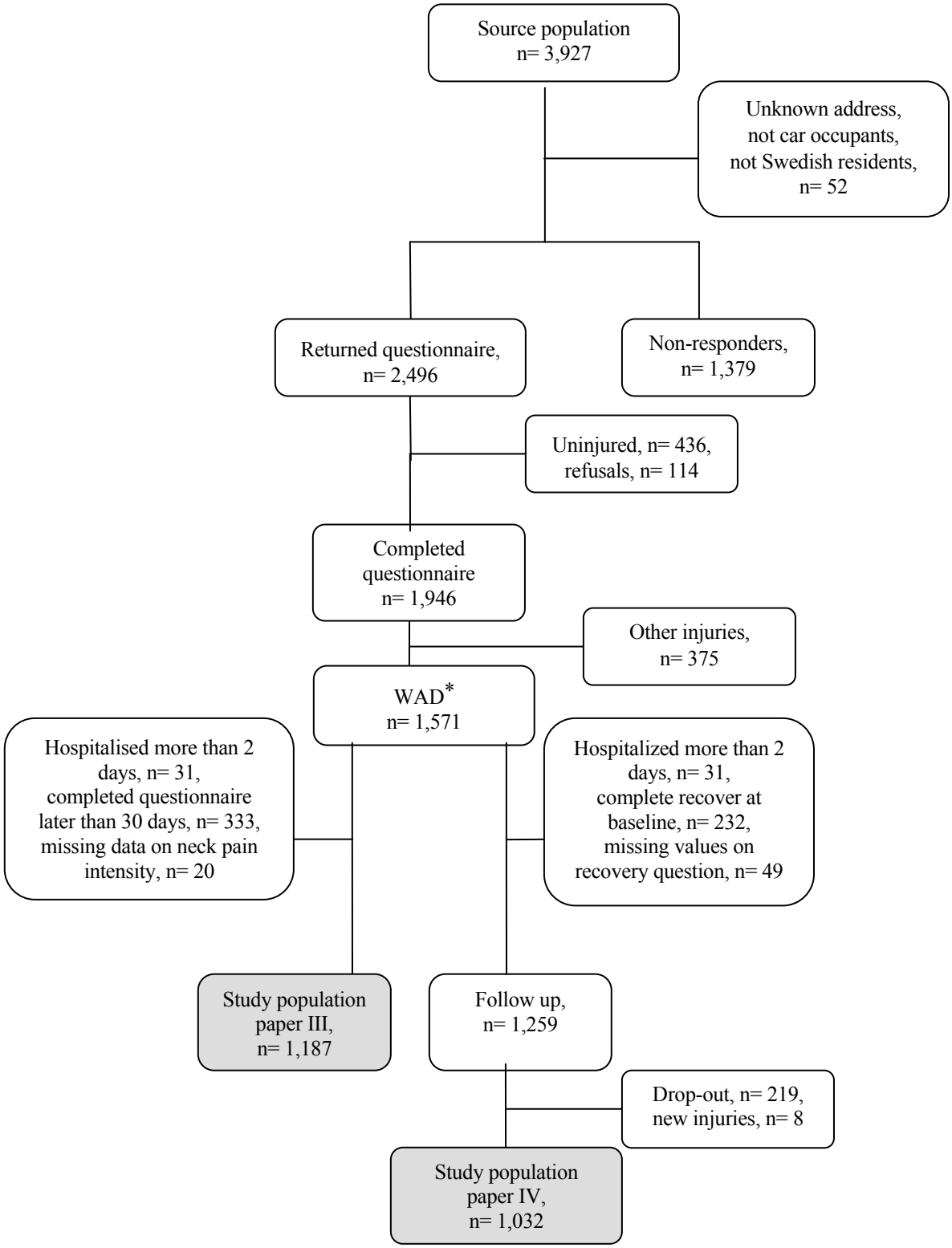
The design of the questionnaire and the algorithm for the data collection was developed and tested in a pilot study conducted in fall of year 2003. The study persons were consecutively included into the study. A weekly computer based search of new injury claims was performed at Trygg-Hansa and Aktsam based on the following criteria: age 18-74 years; injured as a car occupant in a motor vehicle collision; filed an injury claim within 30 days of the collision; and no fatal injury to another passenger in the car. Information about the name and personal security number of injured persons was transferred to the research group at Karolinska Institutet on a weekly basis. The day following this notification, an initial questionnaire was sent from Karolinska Institutet to persons who were residents of Sweden. Those who completed the initial questionnaire were followed up at six months after the baseline questionnaire was distributed, again with postal questionnaires. For both occasions, two reminders were sent to those who did not respond to the first request. At six months after the last inception into the study we retrieved information from the insurers on all claimants about: fault for collision, whether the claim had been completed, and whether the claim was opened or closed.

Data collection at baseline included socioeconomic factors, collision details, pre-injury health status, type of injury and symptoms using two checklists, measurements of pain (intensity and location), psychological measures, and passive coping strategies. The baseline questionnaire also included measurements of expectations for recovery. Follow-up information included repeated measures of symptoms as assessed by a checklist, pain intensity and pain location as well as the psychological measurements. We also included a pain disability questionnaire and questions about sick absenteeism, measured in days since collision.

The studies were approved by the Regional Committee on Ethics at Karolinska Institutet, Stockholm.

Figure 5 shows the Swedish cohort and details for the study populations for papers III and IV.

Figure 5. Description of the Swedish cohort.



* WAD is whiplash-associated disorders

3.6 METHODS PAPER III

Inclusion criteria

In paper III, we included 1,187 persons who (a) reported WAD according to our definition (page 18), (b) responded to our study questionnaire within 30 days of the collision, (c) were not hospitalised for more than two days, which would indicate a less severe injury, and (d) had only one injury claim reported to the insurers during the study period.

Outcome

The outcome was pain intensity measured with a 100 mm visual analogue scale (VAS) (119, 124) and trichotomized into mild pain (VAS 0-30), moderate pain (VAS 31-54) and severe pain (VAS 55-100). (125)

Potential risk factors

We considered demographic, socioeconomic, and health related factors together with collision related factors to be potentially associated with post-injury neck pain intensity. Socioeconomic status was determined by educational level, and we also considered family status, (living as sole adult, with or without children, versus other adults). Health status before the collision was assessed with a modification of the Medical Outcome Study Short-Form 36 (SF-36) "general health" subscale question. (120) The modification consisted of a change aimed to record the time frame of one month prior to collision, but offering the same response options as in the original SF-36 question. We also adapted the questions about frequency of neck pain and headache before the collision, recommended by the Quebec Task Force. (34) We modified the question slightly in that we defined a time period of one month prior to the collision. Collision factors were: impact direction of the crash, occupants´ head position, seat position, and collision responsibility. The latter was retrieved from the insurers.

Statistical analysis

The data were analyzed using multivariable polytomous logistic regression to assess the associations between the potential risk factors and neck pain intensity. Polytomous logistic regression allows a dependent variable with more than two categories. (126) We first tested for presence of colinearity between the independent variables on the ordinal scale with use of Spearman rank correlation coefficient (r_S). Colinearity was present if r_S exceeded 0.80. If r_S was less we entered the factors one by one into a polytomous logistic model. We tested for effect modification by stratifying by gender and impact direction of the crash. The results are presented as adjusted odds ratios (OR) with 95% confidence intervals (CI).

In order to assess potential selective participation we built a multivariable logistic regression model with participation status as the dependent variable. In the model we entered the factors we had information on for all persons eligible for the study: gender, age, and whether they had completed their claim or not.

3.7 METHODS PAPER IV

In paper IV we included the 1,032 persons who were successfully followed at six months after the injury, and who (a) met the definition of WAD (page 18), (b) were not hospitalized for more than two days, indicating a less severe injury, (c) had only one injury claim reported to the insurers during the inception period, (d) had not had a full recovery by the time the baseline questionnaire was completed, (e) did not have missing data on expectations for recovery, and (f) had no new injury during the time of the follow up.

Outcome

Disability due to pain was assessed with the 7-item Pain Disability Index (PDI) questionnaire, in which scores can range from 0-70, with 0 indicating no disability due to pain. (122) The PDI was arbitrary trichotomised with cut-off scores at the median, and at the 75th percentile. The data was skewed: the median PDI score was 4 and the 75th percentile was 21.

Exposure

Expectations for recovery were measured with a numerical rating scale (NRS), ranging from 0-10. The respondents were asked about how likely it was, in their own judgment that they would make a full recovery. The scale was labeled "not at all likely that I will recover" at the 0-anchor and "very likely that I will recover" at the 10-anchor. For the final analysis the scale was categorized into three groups; NRS 0-5 "less likely to make a full recovery", NRS 6-9, "intermediate group", and NRS 10, "very likely to make a full recovery".

Statistical analysis

The data were analyzed using multivariable polytomous logistic regression to assess the associations between recovery expectation and pain disability. (126) We first assessed the crude associations between the exposure and pain disability. The exposure was treated both as a continuous and a categorical variable. We then determined the role of 27 possible confounders by including them one at them time in the model. If they changed any of the crude estimates by more than 10%, they were included in the final model. We also tested for the presence of interactions of gender and neck pain intensity. Since the odds ratios for recovery expectations were different in different neck pain strata, we built a model to test for biological interaction, based on recovery expectations and neck pain intensity. Results are presented as crude and adjusted odds ratios (OR) with 95% confidence intervals (CI).

Sensitivity analyses were performed by building crude models using different cut-off points for the outcome PDI. We considered the following alternative cut-off scores; (0, 1 14 and 15+) and (0, 1-28, and 29+).

Non-participants were descriptively compared with participants, in order to determine potential bias due to selective participation. We also compared those who responded to the baseline questionnaire with those who were successfully followed for six months.

4 RESULTS

4.1 PAPER I

The average number of days from the collision to completion of the baseline questionnaire was 10 days (median 8 days; 25th and 75th percentiles 4 and 14 days). The overall mean neck pain intensity on VAS was 58, with a median of 61 (25th and 75th percentiles 41 and 76).

The results of the multivariable polytomous regression revealed a number of pre-collision factors that were associated with level of initial neck pain intensity. Overall female gender was associated with high pain intensity (OR 1.5, 95% CI;1.3-1.7). Gender was also an effect modifier, thus the analyses were stratified by gender. In females the factors associated with severe pain were perceptions of fair or poor general health status (OR 4.0, 95% CI;1.8-8.9), low educational level (OR 2.6, 95% CI;1.8-3.8), and frequent neck pain prior to the collision (OR 2.3, 95% CI;1.3-4.2)

In males, low family income (<$20,000/year) was associated with severe pain intensity (OR 2.3 95% CI;1.5-3.4) and frequent headache prior to the collision (OR 2.1, 95% CI;0.8-5.0).

Factors that were almost similar across gender were not being at fault for collision, claiming under tort system, and not being aware of the head position at the collision or having a rotated head position.

We found a relation between some of the associated factors and moderate pain intensity as well, but the risk elevations were smaller than for severe pain, which indicates dose response relations.

Age had only a minor influence on the pain rating and the youngest age group with severe pain had slight elevated odds compared to the oldest age group. Marital status, being tired and having lack of energy before the collision were not associated with pain intensity.

The sensitivity analyses revealed similar crude odds ratios regardless of which cut-off we used on a dichotomous scale. We therefore are confident that that the cut offs we used for trichotomised scale we used yielded robust findings.

4.2 PAPER II

Of 7,419 eligible persons with WAD who reported pain, only 845 (11%) fulfilled the definition of localized pain at baseline according to our definition. The others had either different pain patterns or already had more widespread pain when making the claim, and so were not at risk for onset of widespread pain. Of the 266 persons who responded to one or more of the four follow ups over the 12 months, 56 (21%) reported widespread pain at least at one of these follow-up points. The pain spread occurred within the first six weeks in the majority of cases, and was usually followed by improvement. However, 20 cases did not improve, or got worse.

Baseline factors associated with onset of widespread pain were: depressive symptomathology (OR 3.2, 95% CI;1.6-6.3), moderate neck pain intensity (OR 2.4, 95% CI;0.9-6.5), severe neck pain intensity (OR 3.2, 95% CI;1.3-8.0), having more than two pain associated symptoms (OR 1.9, 95% CI;0.9-3.8), and reporting more than three of five painful body areas (OR 2.6, 95% CI;1.3-5.4).

4.3 PAPER III

The average number of days from the collision to completion of the baseline was 18.5 days (median 18, 25th and 75th percentiles 13 and 24 respectively). The overall mean neck pain intensity on VAS was 32, with a median of 27 (25th and 75th percentiles 10 and 52).

Many findings from the Canadian study in Paper I were similar in this Swedish cohort. Low educational level (OR 2.8; 95% CI;1.8-4.5), prior neck pain (OR 2.9; 95% CI;1.4-6.2), prior headache (OR 2.2; 95% CI;0.7-6.9), and prior poor general health (OR 2.6; 95% CI;1.4-4.8) were all associated with severe initial neck pain intensity. In addition, being sole adult in the family (OR 1.6; 95% CI;1.1-2.2) and being exposed to roll-over collision (OR 1.9; 95% CI;1.0-3.8) were also risk factors for severe pain intensity in this study. Female gender was only associated with neck pain intensity in the crude analysis, whereas the adjusted model yield a slight elevated and not statistical significant OR of 1.2 (0.9-1.6) for severe pain intensity. Furthermore we cannot draw any conclusions about effect modification by gender in this study. Although there was a trend for gender differences in the association between frequency of prior neck pain and present neck pain intensity, the estimates were imprecise and the other results were similar across gender.

As in paper I, there were associations between some of the associated factors and moderate pain as well, but with smaller risk elevations.

Additional analysis

Education is a proxy for socioeconomic status. One possible explanation for the findings of higher pain intensity in persons with less education is that those with fewer economic resources might be more likely to travel in smaller or older cars. Such cars are considered to be less safe, and therefore the occupants might in general be exposed to more severe impact of crash, as opposed to occupants in larger and newer cars. It has also been reported that females travel in smaller cars more commonly than men. In order to test if such hypotheses could explain why persons with low education or females were more likely to have severe pain, we stratified car year model and car weight by gender and education. The results are presented in Table 1 a-b. We found that the occupants' level of education was equally distributed across car year model and car size. Proportionally more females were occupants in cars of <1.600 kg max weight, but we found no differences in the gender distribution across car year model. Car weight did not correlate with neck pain intensity in females (data not shown).

Table 1a. Passenger car year model stratified by gender and education.

		Car Year Model			
Variables		1962-1989 n (%)	1990-1998 n (%)	1999-2005 n (%)	Total
Gender					
	Males	77 (15.5)	223 (45.0)	196 (39.5)	496
	Females	100 (14.5)	358 (51.9)	232 (33.6)	690
TOTAL*		177 (14.9)	581 (49.0)	428 (36.1)	1,186
Education					
	University	48 (11.9)	192 (47.5)	164 (40.6)	404
	High school	99 (16.3)	301 (49.5)	208 (34.2)	608
	Less than high school	30 (17.5)	86 (50.2)	55 (32.2)	171
TOTAL*		177 (15.0)	579 (48.9)	427 (36.1)	1,183

* Sum of the numbers in the cells differs due to missing values

Table 1b. Passenger car weight stratified by gender and education

		Car Max Weight			
Variables		≤1,600 n (%)	1,601-1,900 n (%)	1,901-3,500 n (%)	Total
Gender					
	Males	86 (19.9)	199 (46.0)	148 (34.2)	433
	Females	200 (33.4)	268 (44.7)	131 (21.9)	599
TOTAL*		286 (27.7)	467 (45.3)	279 (27.0)	1,032
Education					
	University	133 (33.7)	136 (34.4)	126 (31.9)	395
	High school	177 (30.3)	224 (38.3)	184 (31.5)	585
	Less than high school	41 (25.0)	72 (43.9)	51 (31.1)	164
TOTAL*		351 (30.7)	432 (37.8)	361 (31.6)	1,144

* Sum of the numbers in the cells differs due to missing values

4.4 PAPER IV

After adjustment for initial pain severity, other associated symptoms, and mental health, persons who thought they were less likely to make a full recovery were more likely to report high disability six months after their injury, compared to those who thought they were very likely to make a full recovery (OR 4.2, 95% CI;2.1-8.5). We found a dose response relation, in that having expectations falling into the intermediate group (NRS 6-9) was also associated with severity of disability at follow-up, but the estimate was smaller (OR 2.1, 95% CI;1.2-3.2). When we stratified the data by mild (NRS 0-4) versus moderate/severe (NRS 5-10) baseline neck pain, we found a stronger effect in the mild neck pain strata. However, there were only 22 persons in the joint category of "moderate/high neck pain intensity" and stating that they were "very likely to make a full recovery", which precluded a formal interaction analysis. Associations between expectations and disability were also found among persons with moderate disability; (OR 2.0, 95%CI;1.0-3.8 for those stating that they were less likely to make a full recovery, and OR 1.5 95%CI;1.0-2.3 for the intermediate group).

5 DISCUSSION

5.1 RESULTS

One of the main findings from this thesis is that persons' physical, psychological and/or social predisposed factors, as well as circumstances around the collision, are associated with initial neck pain intensity in WAD.

In the natural course of WAD, initial neck pain intensity is also a risk factor for subsequent widespread pain, as are other associated symptoms and depressive mood in the early course of WAD. Although 21% report widespread pain at some point during the year following the collision, continuous widespread pain is rare.

An additional finding is that injured person's expectations for recovery is an important prognostic factor independent of the physical and psychological health state after WAD.

In conclusion, it is of utmost importance that the management of persons with WAD should be guided not only by the physical components of the injury, but also by the early psychological status of the injured person, her expectations for recovery, as well as by social components.

5.1.1 Papers I and III

Results from paper I and III indicate that neck pain after a physical trauma is influenced by personal characteristics, such as education, socioeconomic status, and gender. The results were consistent across the two studies. Females had slightly higher odds to report moderate or severe pain compared to males. This finding is supported by those from studies outside the literature on WAD. For instance Unruh et al., summarize in a review, that females report more severe levels of pain than do males. (60) They also discuss potential explanations for this, including gender differences in the underlying biological mechanism, but also discuss the contribution of psychological and social factors in the meaning of pain, and how these may differ across gender. Other recent studies also discuss how psychosocial factors such as gender socialization and social learning influence the experience and reporting of pain. (131, 132) In contrast, other researchers emphasize first-order biological mechanisms, and suggest that sex hormones influence pain intensity, pointing to findings of gender differences in brain response to painful experimental stimulation. (133) The interaction between psychological/social factors and biological factors has to our knowledge not been assessed.

We did not find any studies to support or refute our findings that lower socio-economic status, as measured by educational level or family income, is associated with higher pain intensity. On the other hand lower educational level is found to be associated with poor coping strategies. (134) This might imply that educational level is a marker for coping strategies in our studies, provided that such coping strategies are developed within a couple of weeks after the injury.

Collision characteristics also seem to influence neck pain intensity. In the Canadian study, those who were claiming under tort system, were not responsible for the collision, had their head turned or did not recall their head position, and who were driving the vehicle at the time of the crash were more likely to report severe pain. These findings could only partly be confirmed in the Swedish cohort, where only those exposed to a rollover collision, had their head turned or did not recall their head position at the time of collision reported greater post-injury pain intensity. The influence of insurance system could not be assessed in Sweden, since all persons were claiming under the same system. Our studies are the first to assess associations between collision factors and pain intensity, thus the results should be interpreted with caution. There is a possible biomechanical rationale for a more severe injury if the head is rotated, since this may cause more pressure on the joints and ligaments. However, we have not found supportive explanation for more severe pain in persons who did not remember their head position, other than a possibility that post traumatic stress or shock, may influence the recall of collision details as well as pain.

Surprisingly, the study participants in the Canadian cohort rated their neck pain intensity substantially higher than the Swedish participants did. However, they also completed the questionnaires on average 8.5 days earlier than the Swedish participants did. The differences in pain intensity might therefore reflect the recovery process. To assess this possible explanation, we restricted the two cohorts to the 1,426 persons in the Canadian cohort and 808 persons in the Swedish cohort who completed the questionnaire between 14 and 30 days after the collision. The distributions of days were similar across the two subgroups. Nevertheless, the difference in neck pain intensity remains; with the median pain among the Canadian participants being twice that of the Swedish study participant (Table 2). Differences in the pain rating, therefore, do not explain this discrepancy.

Table 2. Comparison of baseline neck pain within 14-30 days following the collision.

VAS *	Canadian participants n = 1,426	Swedish participants n = 808
Mean	54.2	31.4
Median	53	26.5
25th percentile	35	9
75th percentile	73	51

* VAS: Visual analogue scale

Another possible explanation for this large difference is that the Swedish claimants might have been more eager to report minor and transient injuries compared to the Saskatchewan claimants. However, the injury/collision rate was approximately 17 in 100 collisions in 1994 and decreased to just below 12 per 100 in 1995, after the change in insurance legislation in Saskatchewan.* The corresponding rate for all Swedish traffic insurers was 11.6 per 100 collisions in year of 2004.

* Personal communication, Saskatchewan Government Insurance, 2007

We therefore do not believe that differences in claim reporting behavior can explain the country differences in pain intensity. The majority of the injuries (78%) occurred in urban streets in Saskatchewan. We do not have corresponding information in the Swedish cohort, but the distribution of collision impact was similar between the cohorts.

It may be that the difference in neck pain intensity can be explained by the differences in the data collections across cohorts. The Canadian data was collected as part of an insurance application. This may have influenced the way claimants reported their symptoms after the collision, presumably expecting it to have an impact on the insurance compensation. In the Swedish cohort, the study participants were contacted by a research group outside the insurance companies, and were informed that their participation and their answers would be kept anonymous.

One general problem with postal questionnaires is the researcher's lack of control of the response situation. If differences in the response environment also are related to the exposure and disease under study, such external factor might affect the validity of the study. From a methodological view it is important to consider the environment where the data collection takes place, the purpose of the data collection, and how external or internal factors may influence responses from the study participants.

5.1.2 Paper II

One of the main findings from paper II is that the incidence of widespread pain subsequent to head/neck/back pain was 21%, when using a relatively liberal definition of widespread pain and without inclusion of pain duration, (Table 3). Our definition diverges from one of the most used definitions, proposed by the American Colleague of Rheumatology (ACR-90). (135) Their criteria include pain persistent for at least three months (chronic pain) involving the axial skeleton, and at least two contralateral body quadrants (i.e. below and above the waist, and including at least two contralateral limbs) (Table 3). A more stringent criteria for chronic widespread pain (CWP) was subsequently proposed by a group in Manchester, (136) and has been used in epidemiological studies (CWP-M). (99, 137, 138) Their definition restricts the ACR-90 criteria further: The pain has to last for longer than 24 hours during the preceding month, and in addition to the ACR-90 criteria, must include at least two separate sections of a body quadrant (Table 3). Our definition does not include location of pain other than in the posterior neck. The vast majority also had pain in the thoracic and lumbar spine, and additional other body regions. Furthermore, our definition reflects current pain and we do not claim it to be chronic. The data we had available to us did not allow the use of previously published definitions.

We did, however, define our criteria prior to the analysis, and with the advice of clinicians and experts in the field. The incidence rate from our study is likely to be overestimated in comparison to any of the other more restricted definitions. Whether the case definition is of importance for the assessment of the risk factors is unclear. However, our findings are consistent with studies of chronic widespread pain in the general population, which also report that somatic symptoms and mental dysfunction are risk factors for onset. (99, 139) Others have compared three different " chronic

pain groups" using the ACR-90 definition, the CWP-M definition, and a "chronic regional pain" (CRP) definition, that is. pain that does not fulfill the criteria for any of the other definitions. (138) Most of the point estimates for psychosocial and lifestyle factors were similar across the two CWP definitions with slightly elevated odds ratios for some factors when using the CWP-M definition, whereas the associations were attenuated in the CRP group. This would suggest that our estimates might have been higher if we could have used ACR-90 or CWP-M definitions.

Table 3 Definitions of widespread pain

Widespread pain in this thesis	ACR-90* definition of chronic widespread pain (135)	Manchester definition of chronic widespread pain (CWP-M) (136)
In pain drawings (121) having shaded or marked posterior neck and eight or more anatomic regions (out of 45 possible) at any of the four follow-ups, (six weeks, four, eight, and 12 months).	Pain persistent for at least three months, and involving the axial skeleton, and at least two contralateral body quadrants (i.e below and above the waist, and including at least two contralateral limbs)	Pain during the past month that had lasted for longer than 24 hours, and such pain present in the axial skeleton or lower back sections, and in at least two separate sections of the body quadrant and in two contralateral limbs.

* American Colleague of Rheumatology, 1990

5.1.3 Paper IV

The significance of the findings from paper IV is that persons´ recovery expectations are important for the prognosis of WAD, independent of the emotional and sensory consequences of pain, and independent of post traumatic stress symptoms and other mental health symptoms. Persons who thought they were less likely to have a full recovery were more likely to report moderate or high disability six months later, compared to those who thought they were very likely to make a full recovery. The direction of the findings was not surprising, since there is a body of the psychological literature on how expectancies shape experiences. Our results are also supported by previous studies on conditions similar to WAD, where they found that persons´ expectations are of importance for recovery as well as return to work. (106, 107, 140) Modification of expectations may explain why intervention studies including patients with acute WAD, and where information sessions rather than treatment have been evaluated, have shown positive effect on recovery. (103, 104)

Our findings are especially important because our results suggest that only 27% of the study participants believed that they were very likely to make a full recovery. Successfully interventions aiming to change expectations and beliefs may therefore benefit a large proportion of persons with WAD.

5.2 METHODOLOGICAL CONSIDERATIONS

5.2.1 How should we interpret the findings?

We have used logistic regression analyses, where we calculated the odds ratios (ORs), i.e. odds for an event to occur among the exposed, over odds for the event among the unexposed. These ORs can be interpreted as risk ratios (RR) if the event in question is relatively rare. If the OR >1 it systematically overestimates RR, and if the OR <1 it systematically underestimates RR. The relation between OR and RR depends on the prevalence of the disease and the prevalence of the exposure.

In our studies we have a common outcome, (i.e. moderate or severe neck pain intensity (papers I and III), occurrence of widespread pain (paper II), and the two categories of disability (paper IV)). The prevalence of exposure varies within and across the studies, but is often relatively high. Thus, we cannot accurately interpret the odds ratios as risk ratios. We therefore transformed the OR to RR in paper IV, by using the conversion formula:

$$RR = \frac{OR}{(1 - P) + (P * OR)}$$

where P is the cumulative incidence of the outcome in the non-exposed group. In paper IV the OR for having high disability if the injured persons anticipated they were less likely to recover was 4.2 and the incidence of the outcome among the non-exposed was 8%.

From this follows

$RR = 4.2 / ((1 - 0.08) + (0.08 * 4.2)) = 3.3$

The OR for having moderate disability when the injured persons anticipated they were less likely to recover was 2.0 and the prevalence of the outcome among the non-exposed was 19%

$RR = 2.0 / ((1 - 0.19) + (0.19 * 2.0)) = 1.7$

This demonstrates that the OR overestimates the RR in paper IV, but the increased risk as measured by RR is still substantial, and not likely to be explained by residual confounding.

5.2.2 Precision

The precision of the effect estimates refers to the variability in the data. It is related to the sample size, but also to the distribution across sub categories. The studies in this thesis have relatively large sample sizes, except for the study on widespread pain in paper II. However, some results from the other papers are based on small number of exposed cases in certain categories, and the confidence intervals around the ORs are sometimes wide, illustrating that the precision of some of the results is moderated. In the interpretation of risk estimates, the confidence intervals always have to be considered. This implies that we cannot make conclusions about the precise ORs, but rather that the true estimate is likely to be within the range of the confidence interval.

5.2.3 Internal validity

Internal validity of a study refers to the extent to which results actually measure what the study is aimed to measure. Internal validity is affected by selection bias, information bias, and confounding.

Selection bias

Selection bias refers to the selection of study subjects, and to participation in studies. The selection bias in paper I was close to zero, since essentially all who reported a personal injury claim for WAD, or were treated for WAD were included in the study. However, the willingness to participate in the follow-up part of the Canadian cohort was low, and possible errors due to selection bias in the study reported in paper II have to be acknowledged. The resulting bias is more likely to affect the incidence rates and other descriptive outcomes than associations between the risk factors and the outcome. The attrition analysis included a variety of factors, since we had baseline characteristics of non-participants as well. The results suggest that there was no difference in severity of pain between those who participated in the study and those who did not. Nevertheless, the possibility that selection bias lead us to over, or underestimate the magnitude of the associations cannot be excluded.

The overall response rate in the Swedish cohort was 64%, thus some selection bias might be present in that study as well. The attrition analysis revealed that those who did not complete their claim at the insurances companies, that is, those with no injury or an insignificant, transient injury, were less likely to participate. Since these persons would not have been included in the study, their non-participation would not affect the internal validity of the study. Males and younger ages were also less likely to participate, which to some extend may have affected any age or gender related descriptive outcome of the study.

In both papers II and IV, the drop-out during follow up was less than 16-18%, which is acceptable, providing proper attrition analysis ascertains potential differences between the drop-outs and those remaining in the study. Nevertheless it is clear that losses to follow up are not at random, and that too large drop-out rate may violate the internal validity of a study.

In summary, some degree of selection bias is likely to be present in three of the four studies. It may to some extent have effected the validity of the studies, mainly the descriptive results such as the cumulative incidence, rather than explaining the observed associations of the risk factors for the different pain conditions.

Information bias

Information bias refers to errors in the information collected from or about the study participants. In our studies the major source of information was the study participants. The measurements used in the questionnaire are frequently used and have been tested on pain populations.

Misclassification of outcome as well as of exposure is possible, but is likely to be non-differential, thus increasing the variability of the data, and attenuating the estimates. We have categorized outcomes designed as continuous scales, and may

therefore have introduced some misclassification. Sensitivity analyses suggest that such misclassification was not likely to have introduced major biases.

There was likely underreporting of pre-injury health concerns, such as prior neck pain, prior headache and poor general health prior to the collision. For example, only 4-6% of respondents reported having weekly neck pain prior to the collision, which is lower than one would expect to see in the general population. Such misclassification may have biased the results if underreporting of ill health was also associated with the outcome. Therefore, there might be differential misclassification, especially in papers I and III.

Recall bias is of no, or minor, importance in the current studies. The prospective design of the studies, where exposure data are collected at baseline, is not prone to such bias. Even though data were collected on pre-injury health factors in a retrospective manner, the questions were intended to reflect the health state during a short time period before the collision.

Confounding

Confounding occurs when an unadjusted factor is related both to the exposure and the outcome in question and leads to a systematic error in the exposure – outcome relation. Efforts were made to control for confounding by using multivariable models and by considering as many potential confounders as possible. As in observational studies in general, there are always a possibility of residual confounding, due to unmeasured confounding or due to systematic misclassification in measured confounders.

5.2.4 External validity

External validity is the extent to which a finding is generalizable to other populations and time periods.

The use of insurance injury claims is an efficient way to collect data from traffic injuries. It provides the possibility to find a cohort where an otherwise rare condition, such as WAD, is common. It also provides the possibility to get a study population, representative of a wide spectrum of cases.

In Saskatchewan, Canada, SGI is the only traffic insurer. Thus, the population of Saskatchewan constituted the source population for our Canadian cohort. In the Swedish cohort, persons who traveled in cars insured at either of two insurance companies, with altogether 20% of the market shares, constituted the source population. A general rule is to be cautious when extrapolating results from single studies to other populations. On the other hand, there is no obvious reason to believe that occupants who reported WAD to these insurers are different from those who report WAD to the other Swedish insurers, in terms of relations between the factors we have investigated and the outcomes in papers III and IV.

By replicating the study presented in paper I in a Swedish population (paper III), and getting essentially similar results, the possibility to generalize the results to other populations increases. Still, studies conducted on populations with other cultures, and other sets of competing risk factors, may yield different results.

Caution must also be taken before generalizing the findings from papers II and IV, and the reproducibility of the results should be tested on other populations. An interesting population to study would be persons who not are entitled to insurance compensation or who decide against claiming compensation, since they are not influenced by financial incentives.

5.3 GENERAL DISCUSSION

This work has added to the knowledge of how psychological and social factors influence pain in whiplash-associated disorders. The relative role of psychosocial factors in relation to biomedical factors has not been addressed. The biomedical part of the biopsychosocial model could not be explored due to lack of relevant data.

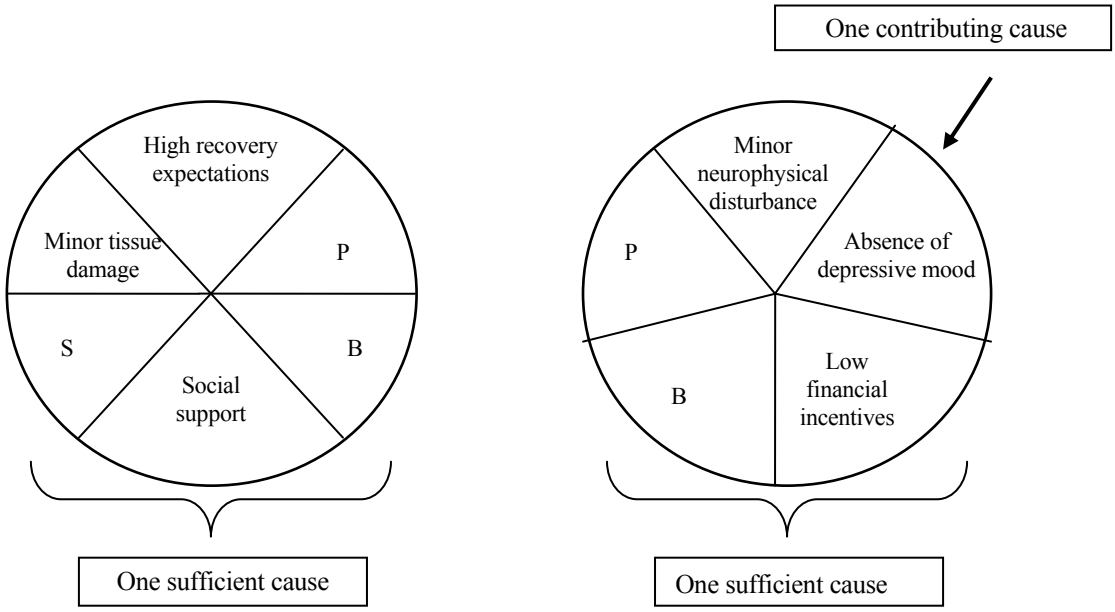
5.3.1 What does recovery from WAD mean?

As mentioned earlier in this thesis, the prevalence of neck pain in the general population is high. Pre-injury neck pain is also associated with poor prognosis in WAD. Therefore it is legitimate to ask: "What does prognosis or recovery after WAD mean?" and "How should recovery from WAD be defined?" In our opinion, the answer must be; a recovery to the habitual state, i.e. having the same frequency and intensity of episodes of neck pain and other symptoms as prior to the injury event. This is an outcome which is difficult to measure with any degree of confidence, for several reasons. Recall bias and unwillingness to report details on previous pain or other associated morbidities seem to be difficult to avoid. (141, 142) A challenge for future research is to increase the understanding of how to measure pre-injury conditions in a reliable and valid manner. Furthermore, the meaning and implications of recovery among lay persons vary. In a qualitative study of injured workers with back pain, Beaton et al. found that "being better" was interpreted in a number of different ways within this group of workers. (143) Apart from the actual resolution of the injury, readjustment of one's life to accommodate the disorders, and adaptation to living with the disorders are also interpreted by some as "being better". Despite no resolution of the pain, these concepts were incorporated into the person's judgment when reporting on recovery. How and when perceptions of readjustments or adaptation are developed in the course of a disease/injury is not known.

5.3.2 WAD in the ´pie´ model

We have used a biopsychosocial model to conceptualize the onset, course and prognosis of WAD. This is an example of a multifactorial causal model and can effectively be discussed using the ´pie´ model, or the component cause model, introduced to epidemiologists by Rothman. (1) In Figure 7 we have inserted some factors from the biopsychosocial net on page 24 that may be involved in recovery from WAD.

Figure 7. The pie model. (1)
Examples of factors related to recovery from WAD.



B = Bio, P = Psychological, S = Social

According to the ´pie´ model, all *contributing causes* in one of the *sufficient causes* are needed, in order to recover from WAD. Each *sufficient cause,* or ´pie´, represents one of presumably several alternative routes leading to recovery. The interactions between *contributing causes* are illustrated in the graph, as separate ´pie slices´ included in the same ´pie´. Slices in one ´pie´ are said to interact, because it is their joint action that lead to recovery.

In the literature, we have not recognized any single *contributing cause* which is *necessary* for recovery from WAD. Neither have we identified any *sufficient cause*. Instead, we have found several *contributing causes* i.e. factors that affect the causes for recovery. When linking this ´pie´ model to the biopsychosocial net, the numerous sets of possible "individual pies" become obvious. In summary, there exist several different *sufficient causes* for recovery from WAD, or in other words, alternative routes that lead to recovery.

In research, we usually investigate the effect of individual *contributing causes,* or risk factors, for the condition in question. Complete *sufficient causes* do usually not lend themselves to studies. Still, it is important to keep the ´pie´ model in mind, when we are interpreting and discussing empirical results on risk and prognosis. A single contributing cause may otherwise be confused for a *sufficient cause.* The whole picture of specific sets of *sufficient causes* is seldom discussed in the research of WAD, or in other contexts either.

The causal process is more complicated than explained by the ´pie´ model, since effects are likely to be time-dependent, or sometimes bi-directional. For instance, some persons in pain may call for support from family members or workmates, which in turn may change the person's future pain perception and behavior. In other

instances, pain intensity may cause depressive mood, in other cases depressive mood may cause more pain. Nevertheless this component cause model is a fruitful way to conceptualize WAD as it visualizes the multifactorial nature of WAD and how biomedical, psychological and social factors interact.

5.4 FUTURE RESEARCH; PRIORITY AND CHALLENGES

The etiology of widespread pain subsequent to WAD needs to be further explored. We are calling for studies using the ACR-90 or the Manchester definition of widespread pain to assess the incidence, course and potential recurrences. Our hypothesis is that the incidence of widespread pain will be substantially lower than in our study, if the ACR-90 or the Manchester definitions are used, since these may have a higher specificity. Whether these case definitions would change the associations between initial physiological and psychological symptoms and the outcome remains to be assessed.

Injured persons´ expectations for recovery after minor traffic related injuries is an important research area that needs to be further explored. Modifiable prognostic factors should be considered in hypotheses for intervention studies, and there is a need for controlled studies on interventions aiming to change recovery expectations. Such studies could be conducted on the population level, for instance as media campaigns. Interventions targeting persons in the acute phase of an injury also need further evaluation.

One challenge in future research of WAD and injuries in general, lies in developing methods to understand and measure pre-injury factors, such as prior physical and mental health, with the use of reliable and valid measurements.

Another step to take from here is to seek to integrate the full biopsychosocial model into WAD research. For instance there is evidence from twin studies of genetic and environmental influence on lifetime prevalence of neck pain. (23, 24) and on chronic widespread pain. (144) One interesting question is if genetic factors are associated with persistent pain in WAD.

Using a biopsychosocial model in research is a challenge. It highlights the need to disentangle interactions between biomedical, psychological and social determinants for disease and illness. The temporal pathways between these determinants are not always clear and have to be explored. WAD is no exception.

6 CONCLUSIONS

- Neck pain intensity within the first month after WAD is influenced by several factors in addition to characteristics of the collision, and the physical injury. These factors are mainly gender and socioeconomic status, but also prior health has an influence on how persons are rating their pain after an injury.

- Subsequent widespread pain after localized spinal pain occurs mostly early after the injury. Continuous widespread pain is rare, even though one fifth report such condition at some point over a one year period. Depressive mood, high intensity of neck pain, and increased number of anatomic regions in pain and symptoms early after the injury, are all associated with the onset of widespread pain.

- It is important to consider the injured persons´ early expectations for recovery after WAD, since these have impact on subsequent disability, independent of severity of mental and physical symptoms.

6.1 GENERAL CONCLUSIONS

In the management of persons with WAD it is of utmost importance to focus, not only on the biomedical components of the injury, but also on the early psychological status of the injured person, her expectations for recovery, and social components. Modifying the population's expectations of duration of symptoms after WAD, may reduce the burden of illness on the society, and should be further tested in intervention studies.

7 SAMMANFATTNING (IN SWEDISH)

Whiplash-associerade besvär (WAD) är en nackskada som är vanlig efter bilkollisioner. Trots att forskning har pågått i flera decennier är kunskapen om detta tillstånd fortfarande begränsad, både vad gäller riskfaktorer för symptom och för faktorer som påverkar tillfrisknandet. Syftet med denna avhandling var att undersöka inverkan av psykosociala faktorer på smärta och funktion vid WAD efter bilkollisioner.

Studierna är baserade på två försäkringskohorter, en från provinsen Saskatchewan i Kanada och en från Sverige. Personer, som ingår i studierna, har till sina respektive försäkringsbolag anmält en personskada efter en bilkollision. Vi har med hjälp av enkäter undersökt hur demografiska, psykologiska och sociala faktorer inverkar på akut eller subakut smärta, på efterföljande smärtutbredning samt på nedsatt funktion vid kvarstående smärta. Frekvent använda frågekonstruktioner och frågeformulär, som visat goda psykometriska kvaliteter, ingick i enkäterna. WAD definierades baserat på frågor om nacksmärta och nackskada i enkäterna.

De två första delarbetena baseras på den kanadensiska kohorten. Här samlades baslinjedata in under tiden 1 juli 1994 - 31 december 1995. Personerna följdes därefter upp efter sex veckor, fyra, åtta och 12 månader. Syftet med delarbete I var att fastställa hur sociodemografiska faktorer, kollisionsfaktorer och hälsotillstånd före kollisionen påverkade personers skattning av akut eller subakut smärtintensitet. Arbetet omfattar 5 970 personer och information från enkäter, som besvarades inom 30 dagar efter kollisionen. Intensitet av nacksmärta mättes med en visuell analog skala (VAS 0-100 mm) och kategoriserades i mild smärta (0-30 mm), moderat smärta (31-54 mm) och svår smärta (54-100 mm). I delarbete II fastställdes förekomsten av utbredd smärta och tidiga självrapporterade fysiska och psykologiska riskfaktorer för att utveckla utbredd smärta. Arbetet omfattar 266 personer, som rapporterade att de hade lokal spinal smärta, inklusive nacksmärta vid studiestarten. Dessutom svarade studiepersonerna på minst en av de fyra uppföljande enkäterna. Utbredd smärta definierades med hjälp av smärtritningar från enkäterna.

Delarbetena III och IV baseras på den svenska kohorten. Baslinjedata samlades in under tiden 15 januari 2004 - 12 januari 2005. Personerna följdes upp sex månader efter skadetillfället. I delarbete III var syftet att på en annan studiepopulation än den kanadensiska replikera studien från delarbete I, för att undersöka om resultaten helt eller delvis kunde upprepas. Vi inkluderade 1 187 personer som besvarade enkäten inom 30 dagar från kollisionen. Intensitet av nacksmärta mättes med VAS 0-100 mm och kategoriserades efter samma principer som i delarbete I. Syftet med delarbete IV var att fastställa hur personers förväntningar på tillfrisknande, skattade vid studiestarten, påverkar smärtrelaterad funktionsnedsättning sex månader senare. Vi inkluderade 1 032 personer som inte var återställda vid studiestarten och som besvarade uppföljningsenkäten. Funktionsnedsättning skattades med hjälp av Pain Disability Index.

Resultat, som var överensstämmande i både delarbete I och III var, att kvinnor hade något högre risk för svår smärta jämfört med män. Personer med låg socioekonomisk

status (utbildning eller låg familjeinkomst) hade högre risk för såväl moderat som svår smärta, jämfört med personer med högre socioekonomisk status. Vidare hade personer, som ofta hade ont i nacken eller huvudvärk före kollisionen och personer med sämre allmänt hälsotillstånd, högre risk för moderat och svår smärta jämfört med personer, som inte hade värk eller andra hälsoproblem. Kollisionsrelaterade faktorer som hade samband med svår smärta i båda studierna var att ha huvudet vridet vid kollisionen och att inte minnas huvudställning vid kollisionen. Resultat specifika för Kanada var, att inte vara skuld till olyckan, att skadan inträffade under en tid med gynnsammare försäkringskompensation och att ha blivit påkörd bakifrån hade samband med högre smärtskattning. (Delarbete I). Resultat specifika för Sverige var att vara ensam vuxen i hushåll med eller utan barn samt att vara exponerad för voltningsolycka hade samband med högre smärtskattning (Delarbete III). Resultat från delarbete II visar att 21% rapporterade smärtutbredning vid någon av de fyra uppföljningarna. Personer som vid studiestarten hade depressiva symtom, hög intensitet av nacksmärta, som rapporterade mer än två symptom utöver smärta, samt hade smärta i mer än tre av fem kroppsregioner, hade högre sannolikhet att rapportera efterföljande smärtutbredning. Långvarig smärtutbredning var ovanlig. Resultaten från delarbete IV visar att personer, som i ett tidigt skede efter skadan hade låga eller osäkra förväntningar på att bli helt återställda, hade högre risk att rapportera funktionsnedsättning sex månader senare, även efter det att hänsyn tagits till fysiska och mentala symptom vid tillfället då skattning av förväntningar gjordes.

Sammanfattningsvis indikerar resultaten att smärta och funktionsnedsättning hos personer med WAD påverkas av flera psykosociala faktorer vid olika tidpunkter under skadans efterförlopp. Det är av stor vikt, att man i det tidiga omhändertagandet av personer med WAD inte enbart fokuserar på skadans biomedicinska komponenter, utan även tar hänsyn till psykiskt status, förväntningar på tillfrisknande och sociala omständigheter.

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