

# The influence of psychosocial factors on recovery following acute whiplash trauma

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## THE FOUR ORIGINAL PAPERS ARE

Tina Birgitte Wisbech Carstensen, Lisbeth Frostholt, Eva Ørnbøl, Alice Kongsted, Helge Kasch, Troels Staehelin Jensen, Per Fink. Post-trauma ratings of pre-collision pain and psychological distress predict poor outcome following acute whiplash trauma: A 12-month follow-up study. *Pain* 2008; 139:248-259.

Tina Birgitte Wisbech Carstensen, Lisbeth Frostholt, Eva Ørnbøl, Alice Kongsted, Helge Kasch, Troels Staehelin Jensen, Per Fink. Are there gender differences in coping with neck pain following acute whiplash trauma? A 12-month follow-up study. *Eur J Pain* 2012;16(1):49-60.

Tina Birgitte Wisbech Carstensen, Per Fink, Eva Ørnbøl, Alice Kongsted, Helge Kasch, Troels Staehelin Jensen, Lisbeth Frostholt. Sick leave before acute whiplash trauma predicts course of recovery. Prepared for publication.

Tina B. W. Carstensen. The influence of coping strategies on outcome for whiplash-exposed - focusing on gender differences. Systematic review 2008 (unpublished).

## SETTING AND OUTLINE OF THE STUDY

### Setting

This study recruited participants from emergency departments and general practitioners in four counties in Denmark covering 1,695,808 inhabitants in 2001 (Statistics Denmark 2004). The Danish health care system is tax-financed by the Danish Public

Health Insurance and health care is with a few exceptions free of charge for all citizens. Individuals with acute whiplash trauma were consecutively recruited to this two-centre study conducted by the Danish Pain Research Center and the Back Research Center respectively from April 2001 to June 2003. The patient cohort was established to explore a wide range of research questions. The main reasons for establishing the patient cohort were to conduct a randomized clinical trial (RCT) comparing three different treatments of acute whiplash trauma and to explore potential risk factors for the development of persistent symptoms after acute whiplash trauma. The RCT was carried out in a subgroup, whereas the current study included the entire cohort.

Data in this dissertation comprise self-reported questionnaires completed within the first 10 days after the accident, three months later, and again 12 months after the accident. Furthermore, register data were obtained from a Danish social register of transfer payments administered by the Danish Labour Market Authority on the patient cohort and on a register control cohort matched on gender, age, and municipality. Register data were obtained for a period of 5 years prior to collision and one year after.

### Outline

The thesis includes two areas of research within whiplash trauma. The first part contains the epidemiological part of the study (paper 1 and 2). The second part is concerned with the influence of coping strategies on recovery with a special emphasis on gender differences (paper 3 and 4). Paper 3 is a systematic review and is leading up to the making of paper 4. The review includes an introduction to coping, and therefore this topic is not included in the general introduction.

## INTRODUCTION

### Definitions related to whiplash

Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck and head from rear-end or side-impact motor vehicle collision [1]. Other terms corresponding to this definition are 'whiplash trauma', 'acute whiplash trauma', and 'cervical sprain or strain' [2,3]. The term 'whiplash injury' denotes that symptoms are present, not that an objectively verified injury is

identified. The most frequent symptoms are neck pain, neck stiffness and headache, but other symptoms can be present, e.g. dizziness or cognitive symptoms such as problems with concentration and memory [1]. When experiencing symptoms after a whiplash trauma, the condition is named whiplash-associated disorders (WAD) [1]. Other terms corresponding to this definition are ‘acute whiplash’, ‘acute whiplash injury’, ‘acute symptomatic whiplash injury’, or ‘acute WAD’ [2]. Chronic WAD is by consensus defined as patients remaining symptomatic or showing residual disability after six months [1].

### The curious thing about whiplash

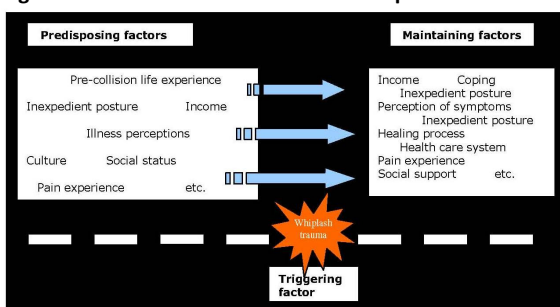
Persistent pain and disability after whiplash trauma has become an increasingly significant problem in many industrialized countries as it has comprehensive individual as well as social costs in terms of sick leave, pensions, lost labour, compensation from insurance companies for disablement, and the patients’ impaired physical, psychological, economical, and domestic conditions [1,4,5]. Actually, these consequences for the individual and society could be consequences of most chronic illnesses. The curious thing about chronic WAD is that the above-mentioned pervasive consequences rise from a relatively minor impact. No dose–response relationship between trauma intensity and subsequent disablement has been shown [6]. Theoretically, cervical sprain (acute whiplash trauma) heals approximately within the same time frame as an ankle sprain, but a substantial part of the whiplash-exposed continue to have symptoms [7].

This gives rise to an interesting question. Most acute whiplash-exposed do recover within the first three months and after this time, the recovery rates level off [8]. A review concludes that up to 50% of whiplash-exposed have not recovered one year after the collision [9]. Why is the impact substantial for some individuals leaving them with persistent symptoms and disability, whereas for others it merely an experience of acute pain after a strain? Despite various studies within research in whiplash trauma during the last sixty years, we still miss substantial pieces of the puzzle, and there are only few conclusive results on which risk factors may lead to negative illness trajectories and disability.

### Multifactorial course of whiplash trauma

The cause of persistent pain after whiplash trauma is probably multifactorial covering a wide range of intertwined bodily, psychological, and social factors including the health care system. Broadly, the involved factors in developing chronic WAD can be classified into predisposing, triggering, or maintaining. In particular, predisposing factors can be very important as to why the same incident or trauma will develop into a chronic illness for some, while for others it will only be a transient health problem (Fig 1).

Figure 1. Multifactorial model of the whiplash trauma



In the following section, a brief review of the current epidemiological knowledge within research in whiplash trauma is presented.

### Incidence

The frequency of the acute whiplash injury in the Western countries varies from 1-3 per 1,000 inhabitants depending on the population studied, type of car accident, and inclusion / exclusion criteria [10]. The National Board of Health in Denmark estimates that annually 5,000-6,000 individuals contact an emergency unit with neck pain after a motor vehicle collision [11]. Some individuals with pain after whiplash trauma do not contact the emergency unit, but consult their GP. Therefore, the incidence is subject to some uncertainty and may be much higher than the above.

### Recovery

One of the most common measures of recovery is neck pain intensity, and up to 50% report symptoms from the neck one year after the accident [9]. This prevalence should be considered in the context of the background prevalence of neck pain; in the general population, 16-45% has experienced any neck pain within the last month [12]. Persistent pain after whiplash trauma is considered to be a social decline as much as an impairment of health-related quality of life; thus affected work capability is also reported. A recent Dutch study reported that 21.7% experienced persistent work disability one year post-collision [13], and a recent Danish study reported 16-21% lower employment propensity in individuals with chronic WAD one year after the accident compared with matched controls in the general population [4]. Consensus on a definition of recovery has not been reached, and the proportion of individuals developing persistent symptoms following whiplash trauma varies considerably depending on study population, assessment of recovery, follow-up time, etc. The wide spectrum of symptoms and disabilities following whiplash trauma may be an explanation for the variety of outcome measures used.

### Persistent symptoms – central sensitisation?

The most frequent symptoms reported after whiplash trauma both in early and later phases are neck pain, neck stiffness, and headache [14]. Persistent pain after whiplash trauma falls under the idiopathic cluster of pain conditions in which the cause of pain is unknown. There is no demonstrable tissue injury or inflammation. These are also called functional pain conditions. A central sensitisation in the nervous system [15] has been proposed to partly explain persistent pain following whiplash trauma, and sensitisation in pain conditions like chronic WAD has been reported [7,16,17].

### The biomedical model

In the first decades of research in whiplash trauma, most studies concentrated on the influence of physical factors on the development of symptoms after whiplash trauma, whereas psychosocial factors received less attention. A dualistic view of mind and body prevailed within the health care system, i.e. the biomedical model implicating mind and body working independently [18]. Medical science and the biomedical model were developed in an era where acute infectious diseases were the most prominent causes of death, and the model was very effective in the treatment of these diseases. The model focuses on identifying causes of disease and correlating them with anatomic and/or pathophysiological changes; it does not consider intra- or interpersonal factors, or the impact of society in the development of an illness.

### **The biopsychosocial model**

In the late 1970ies, the biopsychosocial model was introduced [19]. This model was based on the biomedical model, but integrated psychological and social factors implying that illness is multidimensional. The model integrated the biological (e.g. virus, bacteria, injuries), the psychological (e.g. behaviour, beliefs, coping, stress, pain) and the social (e.g. class, employment, ethnicity).

In 1990ies, the biopsychosocial model was introduced in whiplash research [20]. Traditionally, from the biomedical point of view, consequences of the whiplash trauma on the neck (muscles, skeleton, ligaments, etc.) have been seen as the only cause of persistent symptoms. The biopsychosocial approach presents several physical factors (acute neck sprain, inexpedient posture as a reaction to pain, neck- or back pain in the general population) as the base for development of symptoms after whiplash trauma. These symptoms are all common in the general population. For instance, prevalence rates of neck pain of 28% [21], 35% [22], and 43% [23] have been found in three Scandinavian countries. Ferrari et al. stress that physical factors may be viewed as the base on which the psychological factors operate, and physical factors may elicit the psychological factors, e.g. perception of symptoms and reactions to pain (coping strategies), and these reactions can be maladaptive or adaptive [24]. However, this view may seem rather simplified. The biopsychosocial interrelationships are probably much more complicated. The individual enters the motor vehicle collision with a certain lifestyle, previous life experiences, previous experience with illness behaviour etc., which may act as potential vulnerability factors triggered by the provoking factor (whiplash trauma) and interact together with social, psychological, and physical maintaining factors after the accident in the course of developing persistent pain after whiplash trauma. 'Bio' in the word 'biopsychosocial' may refer to the words somatic/physical/biological/bodily. However, when experiencing a so-called 'physical symptom' following an injury, we know that there is already substantial psychology involved in that experience. The definition of pain according to The international Association for the Study of Pain (IASP) implies: An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage [25]. Preferably, the words physical and psychological factors should not be used as these words imply an implicit dualism. However, this is the prevalent terminology as no other fulfilling alternative has yet been proposed. Today the biomedical way of thinking remains in research within several specialities in medicine including whiplash research. However, over the recent years there has been a change towards multifactorial explanations to illness.

### **Risk factors**

#### **Crash-related risk factors**

Crash-related characteristics have been examined thoroughly from the beginning of research in whiplash trauma. However, several reviews have found that there is no substantial evidence for delayed recovery being associated with crash-related factors such as no head rest in use, being unprepared for collision, vehicle stationary when hit [8,9,26].

#### **Post-collision risk factors**

In accordance with the biomedical model, the first decades of research in whiplash trauma focused on examining post-collision physical risk factors. To date, post-collision high initial pain intensity is the most consistent predictor of poor recover, which has been demonstrated in all systematic reviews examining risk fac-

tors [8,9,26,27]. In reviews, conflicting findings have been found for neck range of movement as predictive factor [26], and there is moderate evidence for the presence of cold hyperalgesia predicting poor outcome [27,28]. Later researchers also went into examining post-collision psychological predictive factors. Recent reviews report that post-traumatic stress symptoms [29], depressive mood [9], and pain catastrophizing [26] show some evidence of a predictive capacity for developing persistent pain following whiplash trauma.

### **Socio-demographic risk factors**

Some reviews found that female gender and low education were associated with negative outcome [26]. Other reviews found strong evidence that gender has no prognostic value for delayed recovery [8], while other reviews had inconsistent results or found modest evidence [9,10]. With respect to education, another review presents diverging results on associations with recovery [9]. Age may be a predictive factor for poor recovery, but only few studies found this association, and recent reviews conclude that we have only limited or no evidence of age being a risk factor [8,9,26]. To sum up, the predictive value of socio-demographic factors is limited.

### **Pre-collision risk factors**

Recently, research has started to look into factors before the accident in the intention to obtain data independent of the influence of the collision and the course of the condition itself to explore if there are predisposing factors that influence recovery. It is suggested that physical and psychological vulnerability before the accident to some extent may explain the varied response to acute whiplash trauma [4,30]. With respect to pre-collision psychological factors, studies have examined the association between pre-collision psychological distress and recovery and reviews state that results are inconclusive [29,31]. The focus, however, has been on single specific psychological dimensions or disorders (e.g. anxiety or depression), and to our knowledge no studies have explored the predictive value of accumulated pre-collision psychological distress.

With respect to physical and related factors, research has indicated that some of the strongest associations regarding various outcome measures are factors that are present before the accident e.g. back pain, widespread pain, poor general health, high frequency of attendance to general practitioner, and high use of health care [4,30,32,33]. A meta-analysis showed a small but statistically significant effect of pre-collision neck pain on recovery [26]. Research has tended to focus on specific pain (e.g. neck pain) rather than broader measures such as widespread pain. Only one study has explored the prognostic value of pre-collision widespread pain and found an association with persistent neck pain [33].

Only few studies have explored social factors as risk factors for poor recovery. Education, as mentioned above, has been explored, but reviews generally report that they do not find scientifically admissible studies exploring the effect of social factors in the onset of persistent symptoms following whiplash trauma [8,10]. To our knowledge, no studies have explored pre-collision social factors over time, e.g. accumulation of weeks of sick leave or unemployment within a period of five years before the collision.

We intend to explore potential pre-collision risk factors as these factors have been less investigated compared with post-collision risk factors. In particular, broader or accumulated measures have been given minor attention in the research of whiplash

trauma. Despite various research in whiplash trauma, new studies within the epidemiology of whiplash trauma are still needed in the investigation of negative illness trajectories following whiplash trauma.

### Background at a glance

Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck and head from rear-end or side-impact motor vehicle collision. Symptoms following whiplash trauma can be e.g. neck pain, headache, dizziness, cognitive symptoms. Patients remaining symptomatic or showing residual disability after six months are considered to have chronic WAD.

The majority of individuals exposed to whiplash trauma only have momentary or no symptoms as opposed to others who develop persistent symptoms. The reason why remains largely unknown. No dose-response relationship between trauma intensity and subsequent disablement has been found. Reporting of the proportion of people with persistent symptoms after whiplash trauma is diverse. Up to 50% of whiplash-exposed are not fully recovered within the first year.

The cause of persistent symptoms following whiplash trauma is probably multifactorial and covers a wide range of intertwined bodily, psychological, and social factors including the health care system. Broadly, the involved factors can be classified into predisposing, triggering, or maintaining with respect to the development from acute to chronic WAD.

The incidence of acute whiplash injury in the Western countries varies from 1-3 per 1000 inhabitants, and in Denmark 5,000-6,000 individuals contact an emergency unit annually with neck pain after a motor vehicle collision. Persistent symptoms and disability after whiplash trauma has become an increasingly significant problem in many industrialized countries. It has comprehensive individual as well as social costs.

The first decades of research in whiplash trauma concentrated on the influence of physical factors on the development of symptoms. The biopsychosocial model introduced other risk factors stressing that pre-disposing psychological and physical vulnerabilities act together with maintaining social and psychological factors in the course of developing persistent symptoms after whiplash trauma.

Potential risk factors before the accident have been given less attention compared with post-collision risk factors. In particular, broader or accumulated measures have been given minor attention in the research of whiplash trauma.

### AIMS OF THE STUDY

To explore the following potential self-reported pre-collision risk factors for the two outcome measures: affected work capability and neck pain at 12-month follow-up after acute whiplash trauma: (a) pre-collision psychological distress, (b) pre-collision health problems (unspecified pain condition and persistent illness) and (c) socio-demographic characteristics: age, gender, education and occupation (paper 1).

To explore: 1) if persons with acute whiplash trauma experience more register-based negative change in health-related provisional situation one year post-collision compared with a matched register control group; 2) if register-based sickness benefit, social assistance, and unemployment in the five years preceding the accident predict negative change in health-related provisional situation one year after the accident in patients and

register controls; 3) if self-reported factors (education, collision-related characteristics, pre-collision unspecified pain condition) and register-based transfer benefits (sickness benefit, social assistance, unemployment) in the five years preceding the accident predict considerable neck pain one year after the accident (paper 2).

To (1) review studies examining the influence of coping strategies on outcome for whiplash-exposed, and (2) deduce results on gender differences in the use of coping strategies in whiplash-exposed when available in the selected studies (paper 3).

To examine if gender and coping strategies at 3-month follow-up interact in the prediction of neck pain one year after acute whiplash trauma (paper 4).

### GENERAL DISCUSSION OF METHODS

#### Design

##### *Sampling of patients*

In Denmark, health care, with a few exceptions, is free of charge for all citizens including visits to emergency departments and general practitioners. All health services are therefore easily accessible for every citizen. Participants were recruited from emergency units and general practitioners in four Danish counties. The study sample therefore consisted of individuals who had sought care after a whiplash trauma. A possible selection bias in our findings could be present due to the fact that we recruited our study subjects among individuals seeking help within the health care system. There may be a large group of individuals experiencing rear-end or side-impact motor vehicle collision who do not seek medical attention at all. And it may be possible that patients who seek emergency care are more uniform with respect to how they cope and recover than patients who do not seek care, seek another type of care, or seek economical compensation from insurance companies. However, source population seems not to dramatically influence the prognostic value of most risk factors [31].

We do not know if any significant selection took place before referral of potential participants. Some nurses at the emergency departments may have been more committed to the idea of the study than others, and this motivation may have shone through in their encouraging patients to engage in the study. Furthermore, the nurses may have been biased towards including more patients with higher pain intensity. However, all emergency departments were visited by a project head and a project nurse in the initial phase, and during the project the departments were regularly visited by a project nurse. Furthermore, we were in daily contact with all involved emergency units to ensure that patient inclusion was as unselected as possible.

All participants were visited in their home by a project nurse within 10 days of the accident. At this visit, the inclusion procedure was carried out and baseline questionnaires regarding general health, crash-related complaints, and socio-demographic factors were filled in. This procedure was chosen to promote a high participation rate in the newly injured. About 13% of the recruited persons declined to participate. This was due to either unwillingness to receive the investigated treatments, for the large part, or very mild symptoms that were expected by the person to resolve spontaneously. A great deal declined to participate because of lack of time or travelling distance to the research center.

Among the 200 subjects declining participation, there were significantly more men than among the participants. One possible

explanation may rest on different help-seeking behaviours. In general, women are more likely to consult their GP or emergency units (our sample consisted of 60% women).

### The randomised clinical trial

The current study was part of a Randomized Clinical Trial (RCT) with 3 treatment arms. A subgroup of the overall sample was invited to participate in the RCT (458 participants). The aim was to compare the effect of three intervention strategies to prevent the development of persistent symptoms. The interventions were: (1) Immobilization of the cervical spine in a semi-rigid collar, (2) advice to "act-as-usual" (no active treatment), and (3) active mobilization. No significant improvement was observed across the three treatment groups [34]. Apart from immobilization with neck collar, the interventions are very similar to standard treatment that whiplash-exposed would have received anyway. We had a restricted amount of parameters to include in the analysis to avoid over-fitting. For these reasons, we did not include the treatment variables in the analyses in the current study. Nevertheless, the inclusion of participants may have suffered under selection bias because of the intervention study as we learned that some potential participants declined, in particular due to the risk of wearing a neck collar. Therefore, we probably lost a healthier part of the whiplash-exposed population and thereby the number of individuals with persistent symptoms after whiplash trauma in this sample may be increased. However, despite of the potentially selected population, the associations in this study are still relevant.

Factors that may have contributed to lower participation among a healthier part of the participants:

- recruitment among individuals seeking help within the health care system
- risk of being allocated to neck collar intervention
- potential bias from the nurses to include patients with higher pain intensity.

## DATA

### Processing of questionnaire data

Questionnaires were designed and processed using the TELEform software program, which allows optical reading of data. This method has been shown to have an error rate as low as double manual data entry by research secretaries [35]. Students and research secretaries were provided with thorough guidelines on how to handle cases of doubt. Project head and statistician were responsible for the further collation of data.

### Patient questionnaires

When completing the baseline questionnaire, the nurse went through the questionnaire for possible misunderstandings or missing items. This secured few missing items in baseline data. Patients received questionnaires at 3, 6, and 12 months after the accident by posted mail (see appendices for relevant questionnaires). There may be a problem in the project nurse being present when the patients filled in the baseline questionnaire as a possible social desirability bias could be introduced. However, the project nurses were thoroughly educated and instructed e.g. by participation of one project head in the first inclusion interviews for each nurse. To secure continuity, new project nurses were

educated by the former nurse together with one of the project heads.

Recall bias is a possible confounder in this study as the questionnaires to a large degree depend on retrospective answers. In particular, there may be a confounding of memory regarding questions on pre-collision variables. Unfortunately, it was not possible to obtain these variables before the collision via questionnaires. Therefore, we contacted the patients shortly after the accident. Only patients who could be examined within 10 days of the collision were included in the study, and the median time point for the first questionnaire was 5 days (q1=3, q2=6) post-collision. This is a very short time after collision compared to other studies. In that way, we hope to have minimized recall bias as much as possible.

One year after the accident, patients received a calendar scheme and a questionnaire which, among others, assessed two outcome measures 1) work capability and 2) neck pain. Non-responders were contacted by phone and asked about possible affected work capability due to the accident. Work capability is not validated in a stringent way. However, the patients' understanding of filling in the work calendar was checked by a secretary on a random sample after the patients had filled in the calendar.

### The condensed Symptom Checklist questionnaire

In this study, we applied a condensed and abridged version of the SCL-90 [36,37]. Condensing of questionnaires is an advantage if this is possible without compromising the intended measure. In recent years, the statistics of scale validation have developed quite a lot. Therefore, reduced scales with even better psychometric characteristics than the original ones have been constructed. The SCL-8 has been thoroughly internally validated by IRT techniques and externally validated to an external gold-standard [38,39]. The short version of anxiety (SCL-ANX4) and depression (SCL-DEP6) have been validated as part of the CMDQ with excellent external validity [40]. Internal validation of the SCL-ANX4 and the SCL-DEP6 subscales has not yet been published. Forthcoming results on these subscales will demonstrate their high internal validity and demonstrate homogeneity and responsiveness that are comparable to or even better than those of more established instruments (GHO-12, WHO-5 and SF-36) (unpublished data, personal communication).

### The distress measure

We applied a latent class analysis (LCA) [41-43] on the dichotomized scores from the psychological subscales of the SCL-90 and the Whiteley-7 [44]. This was done to investigate if patients based on their distress symptoms could be divided into meaningful groups according to level of psychological distress. We were interested in investigating a measure on a broad spectrum of common psychological distress conditions. Therefore, we included various mental conditions in the distress measure. Anxiety and depression together with somatoform disorders are the most frequent mental disturbances [45]. We chose the SCL-ANX4, SCL-DEP6, SCL-8 and SCL-OC to represent the anxiety/depression side of the distress spectrum and the SCL-SOM and the Whiteley-7 to represent the somatoform side of the spectrum. Besides these, the SCL-HOS was applied. The SCL-ANX4, SCL-DEP6, SCL-8, SCL-SOM and the Whiteley-7 have been included in research in various studies [40,46,47]. The LCA analysis resulted in three classes; 1) non-distressed, 2) medium distressed, and highly distressed.

### The Coping Strategies Questionnaire

The coping variables were assessed using the 'Coping Strategies Questionnaire' (CSQ) [48,49]. We used a derived version of the CSQ presenting five subscales [49]. This version was applied as it is validated in a cohort of whiplash-exposed. The subscales show internal consistency and construct validity [49]. There has been other factor analytic studies on the CSQ resulting in subscales similar to the applied version [50] [51]. However, not all factor analytic studies of the CSQ have presented these subscales. Had we measured coping with another version of the CSQ, the results may have been different.

The aim of paper 4 was to investigate the predictive value of a possible interaction between gender and coping with pain 3 months after the accident on recovery. After analysing our data and failing to verify the hypothesis of interaction, we recommend to measure coping within the first few days after the collision and subsequently at several time points as use of coping strategies vary over time. This variation is shown in acute whiplash-exposed on the CSQ [52,53]. Moreover, assessing coping in a broader sense like coping with other potential stress factors following whiplash trauma and not solely pain may contribute beneficially to the exploration of coping after acute whiplash trauma.

### Register data

The Danish DREAM register provides optimal conditions for conducting research into transfer benefits. Data can be obtained retrospectively and provide objective data to support the gathered self-reported data. In our study we include register data for a period of five years before and one year after the collision. DREAM is a database administered by the Labour Market Authority (Arbejdsmarkedsstyrelsen). DREAM includes all persons with a Danish civil registration number (CPR) who have received any form of transfer payment since July 1991. A transfer payment is registered in DREAM for a week if the person has received transfer benefit for at least one day during a week. The data source of a register is very strong as there is no missing data in relation to patients declining participation or failing to return questionnaires, and there is no information, recall or response bias. A comparison of DREAM data and self-reported information showed DREAM data to be the best source of information for follow-up of social and economic consequences of disease [54]. The DREAM register has almost full population coverage and no informed consent is required from those registered. A shortcoming in DREAM is that persons supported by spouse, e.g. housewives and persons 'dropped out' of society, i.e. not receiving any employer or transfer payment are not registered in DREAM and are therefore counted as employed in the database. However, these groups are considered to count a minor proportion according to the Danish Ministry of Employment. Decrease in weeks of transfer payments due to time spent abroad / migration or death was taken into account.

### Missing data

In this study, we dealt with non-completion at three levels; a) self-reported variables at baseline (socio-demographic and collision related data, data from the SCL and the Whiteley-7), b) self-reported data at three month-follow-up (the CSQ), and c) self-reported outcomes variables (neck pain and work capability). We obtained nearly all baseline data, whereas there was a substantial amount of non-completers, between 213 and 217 subjects depending on the subscales, regarding the coping questionnaire completed three months after the accident had. At least half of the items in each subscale had to be completed to calculate a

sum score, in which missing values were replaced by the mean value of completed items. There were more men than women not completing the coping questionnaire. With respect to neck pain one year after the accident, male gender and younger age was associated with non-completion. There was a tendency towards patients not completing the CSQ also being more likely to not complete the VAS on neck pain at one-year follow-up. 672 participants were still in the study 12 months after the accident of whom 651 responded to the outcome parameter 'work capability' resulting in a response rate of 96.9%, i.e. very few missings on this outcome parameter. As female gender is associated with higher emotional distress scores and older age with more disability, there is possible bias towards the more healthy patients not completing the coping questionnaire and the rating of neck pain one year after the accident. Fortunately, we had complete register-based data.

Another evident consideration with respect to the CSQ is that the current study was part of a larger study. Patients were not specifically informed about the CSQ items. The CSQ assesses coping with pain. Some may have skipped the CSQ due to not experiencing pain or only minor pain symptoms even though participants were instructed to answer all questions even if they felt that some questions were irrelevant. A global coping questionnaire not focusing specifically on coping with pain may have improved the response rate. Finally, the CSQ was the last of the questionnaires in the sequence of questionnaires at three-month follow-up, and some may have lost their patience at that time point. We made the decision not to apply imputation, but that could have been a feasible improvement of the generalisability.

### Dichotomization

In this study, we extensively dichotomized variables even though we know that we lose power and information. The dichotomized variables were: scale scores of the subscales from the SCL-90 and the Whiteley-7, collision severity, and the outcome variables. To provide an example of the rationale as to why we chose to use categorical instead of continuous data, we highlight the psychological scales from the SCL-90. We wanted to employ an LCA analysis because we were interested in an accumulation of pre-collision distress, and this could be obtained by generating classes. Our approach is of an epidemiological nature, and we were not interested in going into each of the psychological variables as there is interaction between the subscales from the SCL-90 inventory. We believed that an LCA analysis was the best choice for the investigation as this is a person-centred method providing model fit statistics as well as individual posterior probabilities of class membership. However, in employing the LCA we had to condense the variables. An LCA can be performed on data with more than two response categories, but a) the interpretation of classes becomes increasingly more complex with the number of response categories, and b) more response categories requires more participants in order to get a reliable estimation of the model.

The outcome measures were dichotomized because: 1) Our study is part of a multicentre study, and other already published papers from this multicentre study have used neck pain and work capability dichotomized with the same cut-off points [34,55]. We chose to comply with these published articles. 2) The data of the variable 'working capability' showed to be of a binary nature, i.e. in general participants worked as before the accident in the 12th month after the accident, or they were sick listed or on reduced working hours every day. 3) Negative change in provisional situation was dichotomized as we think it was the best solution and in

the intention to comply with the structure of the other outcome parameters.

Certainly, we lose power by dichotomizing variables in this study. However, we prioritized a strong statistical design (employing multivariate logistic regression, avoiding over-fitting and employing the LCA analysis).

### Statistical considerations

In spite of the non-completion rates, the study included a relatively large sample of patients compared to previous studies. Therefore, it was possible to include a larger number of covariates in the multiple regressions models. Regarding the continuous coping scales from the CSQ, we tested if a linear function, a categorical variable, or a parabola was to be preferred. Logistic multiple regression models were performed for the most important results. We avoided the use of stepwise regression models due to the inherent problems in such analyses [56]. Instead, we selected variables of interest based on previous literature and specific hypotheses. If possible, we performed full multiple models including all items preselected. An effort was made to decrease model uncertainty by carefully evaluating sample size and number of cases in logistic regressions models, i.e. to avoid over-fitting, 10 to 15 cases for each explanatory parameter should be estimated [56,57].

### Generalisability

As discussed in the design section, the population studied is a somewhat selected group as they are likely to have more symptoms compared to the entire cohort of individuals experiencing whiplash trauma. However, when comparing provisional situation at baseline in patients versus matched register controls, we find no statistically significant difference, and this points in the direction of the patient sample being representative of the general population (matched on gender, age, and location). In principle, socio-demographic bias should not influence the selection of patients as health care in Denmark is free of charge for all citizens including visits to emergency departments and general practitioners. Access to both institutions is easy as everyone can use these health services. Yet, immigrants were excluded, but they constitute less than 10% of the Danish population. Only patients aged 18-70 were included, and younger patients were less likely to complete the VAS scale of neck pain obstructing generalisability to the under-aged and the younger part of the whiplash-exposed. Men were less likely to a) engage in the study, b) complete the CSQ, and c) complete the VAS scale of neck pain, making the results less generalisable.

- Data sources in this study: Self-reported primarily well-validated patient questionnaires and transfer payment register data obtained from the DREAM database.
- Declining participation, missing data on the CSQ and missing data on neck pain 12 months post-collision was associated with male gender.
- Results from the study may be generalisable to a Nordic population between 18-70 years of age recruited from the health care system.

## GENERAL DISCUSSION OF RESULTS

### Pre-collision factors predict recovery

In this large prospective study of persons experiencing acute whiplash trauma recruited from the Danish health care system, we found results suggesting that factors before the accident

predict several aspects of recovery. We attempted to cover a biopsychosocial spectrum that we hypothesized would be the nature of a possible pre-collision vulnerability for developing persistent symptoms after acute whiplash trauma. We applied self-reported ratings together with social register-based measures of the predisposing factors. In applying register-based data, we had an excellent opportunity to gain insight into factors independent of the accident and the whiplash trauma. We expected that investigating potential predisposing vulnerability factors before the accident would add to the understanding of recovery after whiplash trauma assessed by a) a rating scale for self-rated neck pain, b) working capability from a self-completed calendar scheme and c) provisional situation obtained by register-based data. We found results to support this assumption. In multiple logistic regression models, both self-reported and register-based measures were strong predictors of the investigated outcomes. Obtaining information of factors before the accident seems to provide valuable information about recovery from acute whiplash trauma.

### Clinical significance of findings

Several associations in the multiple regression models in this study were of convincing significance. With respect to pre-collision register-based data, the impact of whiplash exposure on future provisional situation as opposed to being in the register group is compelling. The odds for negative change in provisional situation from time of accident to one year follow-up are between more than doubled to more than fourfold. Moreover, the importance of receiving transfer benefits measured by accumulating weeks of three different groups of transfer benefits during the five years preceding the accident is impressive. All three transfer benefits affect future provisional situation in a negative direction. The percentage of the patient cohort receiving sickness benefit accumulated for >4 months pre-collision are 15.5% versus 9.1% of controls, accumulated social assistance for >2 months: 10.1% for patients versus 10.2% for controls, and accumulated unemployment benefit for >14 months: 12.2% for patients versus 9.7% for controls. In particular, receiving sickness benefit shows convincing value since being sick for more than 4 months accumulated within the five years preceding the accident predicts both future neck pain and future provisional situation. Sickness benefit predicts poor outcome with consistently high odds ratios and increases risk of negative change in provisional situation from time of accident to one year after the accident up to almost sixfold. In paper 1, we showed that experiencing pain condition (but not neck pain) within the five years preceding the accident increased the risk of developing neck pain 12 months after the accident. This association showed to be robust as we could detect the same association in paper 2 when applying the objective measures of transfer benefits into the analysis. Other studies are in line with these findings as they found the following pre-collision factors to be associated with poor recovery after whiplash trauma: back pain, unspecified pain condition, poor general health, high frequency of attendance to general practitioner, and high use of health care [4,30,32,33]. The above findings are for the most part obtained with self-reported questionnaires and some via medical records or register data.

Direct comparison between previous studies and the current study are difficult as outcome and pre-collision factors to a large degree are defined differently. Overall, the results point to a clinical relevance of pre-accident factors on several aspects of recovery after acute whiplash trauma. Also, the results reflect

that pre-accident multifactorial vulnerability participates in the development of persisting symptoms after the collision.

#### **Unemployment – the chicken or the egg?**

To our knowledge, no studies have examined the predictive value of unemployment on future recovery after whiplash trauma. In this study, self-reported unemployment at the time of accident highly predicts future affected self-reported work capability due to the accident, but not future self-reported neck pain. In line with this, accumulated register-based long-term unemployment within the five years preceding the accident predicts future negative health-related provisional situation, but not future neck pain in whiplash-exposed. That is, unemployment (self-reported and register-based) seems to be of importance for health-related attachment to labour market (self-reported and register-based), but not for developing neck pain. Thus, being unemployed (social vulnerability factor) before the accident may predict other future health disabilities than neck pain. However, we have a problem of circular cause and consequence. We do not know if pre-collision unemployment simply is leading to future health disabilities or the reason for pre-collision unemployment is pre-collision health disabilities that lead to pre-collision unemployment. In general, we have to be very careful about drawing conclusions concerning direct causality in this study. However, due to the longitudinal origin of the study, we can point out specific mechanisms of interaction between factors or point out predictive risk factors that explain part of the cause of poor recovery. We evaluate the above finding of significant bearing. The measures of unemployment are assessed at different time points and with both register-based and self-reported measures. And still, the results are consistent pointing to unemployment as a social vulnerability factor relevant for future health-related attachment to labour market regardless of how the concepts are measured.

#### **Education – mediated by occupation?**

We found that low educational level increased the risk of future self-reported affected work capability and neck pain 12 months after the accident. Research is disputing this potential risk factor. Some research point to low education being a risk factor for poor recovery [26,58], others emphasize lack of evidence or diverging results [9]. A group of researchers suggest the possibility of occupation (including unemployment) being a mediating factor between educational level and recovery as some evidence suggests that occupation influences the prognosis of persistent neck pain in a non-whiplash population [59]. The mediating role of occupation between education and recovery has not been examined with appropriate statistical methods in whiplash-exposed. However, in our study, we found that low educational level predicted future neck pain in whiplash-exposed with equal predictive value regardless of occupation being applied in the analysis (paper 1) or not (paper 2).

#### **Female gender as predictive factor**

In this study, female gender showed consistent associations with future neck pain and future self-reported reduced work capability in whiplash-exposed, but not with provisional situation from register-based data. Previous research on this subject is somewhat inconclusive as some studies found female gender to be a risk factor for poor recovery [26]. Others emphasize lack of evidence of the association, only modest predictive value or diverging results for female gender being a predictive factor for poor recovery [8-10]. It is known that in general, women report more symptoms than men and the difference is particularly seen in the

reporting of very bothersome symptoms. The two outcome measures 'neck pain' and 'work capability' are both self-reported ratings, and gender differences in how symptoms and distress are expressed and reported could be the explanation as to why solely the self-reported outcome measures were predicted by female gender in this study.

#### **Coping with pain – gender differences?**

We examined if gender may have explanatory value in the development of persistent symptoms after whiplash trauma with gender being a mediating factor between stressor, coping and outcome. We measured coping with pain. However, we did not find statistically significant gender differences in the relation between any of the coping strategies and future neck pain. As mentioned in the methods section, more men a) declined participation, b) were lost during follow-up, and c) did not complete coping questionnaires. It is possible that had we included these men in the analysis, we may have had enough power to show these potential interactions.

In general, we found no gender differences in the use of coping strategies, i.e. men and women use approximately the same pain coping strategies and to the same degree. This is in line with studies exploring patients with persistent symptoms following whiplash trauma [60-63]. However, one study found that acute whiplash-exposed women reported more use of several coping strategies measured within the first week after collision [64]. Therefore, we cautiously suggest possible gender differences in the use of coping strategies very early after the accident, but this difference declines during the first few weeks. Furthermore, gender differences in coping may not be measurable via questionnaires like the CSQ as the very early attempts to cope with the accident takes place already at the scene of accident.

#### **Coping with pain – circularity?**

In our study, four out of the five coping strategies show increasing risk of future neck pain. The use of a questionnaire assessing coping with pain involves a possible risk of circularity in that the more you use pain coping strategies, the more pain you may have. Only 'ignoring' does not affect future neck pain, and that is the only strategy not focusing or giving attention to pain. Therefore, this coping questionnaire may not be the best choice in evaluating the appropriateness of specific coping strategies, but can be used in describing how individuals cope with pain.

#### **Only accumulated psychological distress predicts recovery**

We anticipated that experiencing psychological distress as depression or anxiety before the collision would predict poor recovery. Surprisingly, we found that poor recovery was predicted solely if distress was accumulated of several psychological distress factors. The majority of the highly distressed individuals showed symptoms of more than five out of seven psychological problems. 11.4% (n=84) of the patient cohort had pre-collision high psychological distress. Furthermore, high psychological distress was only found to predict future neck pain, but we could not iterate this finding in relation to affected work capability. Therefore, we only consider this risk factor of limited to moderate significance.

#### **Pre-collision unspecified pain condition – sensitization?**

Unspecified pain condition during the five years preceding the accident is considered a risk factor of great significance in this study. 23.5% (n=169) of the patient cohort had pre-collision pain condition. Pain condition predicted all of our three outcome



measures one year after the accident; 1) future neck pain, 2) reduced work capability, and 3) negative change in provisional situation. Pre-collision accumulated register-based sickness benefit corroborates the association with poor recovery as experiencing a pain condition or being on sickness benefit before the accident may mirror the same biopsychosocial vulnerability. A prior pain condition increasing the probability for developing a pain condition again if exposed to acute pain can be due to sensitisation as previously reported in whiplash-exposed [7,16,17].

#### **The collision – a triggering factor of predisposing factors?**

Throughout the analyses, we found no impact of experiencing a severe contrary to a less severe collision on any of the outcome parameters. This is in line with previous research which points to collision severity being of minor importance [10]. In our study, we found between more than doubled to more than fourfold risk of negative change in provisional situation for individuals exposed to whiplash trauma compared to register controls. Moreover, several pre-collision factors predicted poor outcome in this study. We propose the hypothesis of the collision being a triggering factor for predisposing factors to ignite the development of health disabilities, regardless of severity of collision. This is also a general paradigm in the research of health psychology; it is not the illness per se or the biomedical characteristics that are important for recovery, it is how one copes with the illness.

#### **Whiplash trauma – a social decline for some**

Our results show that experiencing whiplash trauma and developing persistent symptoms can be a social decline for some. One year after the collision, we find that the whiplash-exposed to a much higher degree are on sick leave (9.9%) compared to register controls (3.3%). The increase in number of patients receiving temporary health related benefit (sickness benefit and rehabilitation) from time of the collision to one year follow-up is 6.1%. In comparison, the increase is 0.1% for the register control group. At one year follow-up, 4.2% of the patients receive permanent health related benefit compared to 5.7% of the controls. The increase in persons receiving permanent health related benefit from baseline to one year follow-up in the patient group is 1.4% and 0.6% for the control group. We learn that the patients are similar to the control group at baseline, and one year after, they are to a much higher degree on temporary health-related benefit and less on permanent health-related benefit compared to controls. In Denmark, it is not possible to receive sickness benefit for more than 1-2 years after which you are transferred to permanent health-related benefit or social assistance if you are still sick. Leth-Petersen et al. showed that 5 years after the accident, 16% of the patient group still had lower employment propensity than controls in the general population. Therefore, following our patient group for more than one year may show an increase in permanent health-related benefit or social assistance the following years.

#### **Recovery**

10% of the whiplash-exposed had negative change in health-related provisional situation one year after the accident versus 3% of the register controls. This strongly shows the impact of experiencing whiplash trauma on future provisional situation. Our results correspond with another Danish study similar to ours. They reported that 16-21% of chronic WAD patients had lower employment propensity one year post-collision compared to a matched register control group from the general population [4]. They show a higher prevalence, but that may be due to the sam-

pling of patients (whiplash claimants) and the somewhat different outcome measure. 36% of our patient cohort reported considerable neck pain and 15% affected work capability one year after the accident. Altogether, our results show that 10-15% of whiplash-exposed are affected one year after the accident on health-related working ability, and 36% has considerable neck pain. Thus, some of the individuals developing persistent symptoms after the whiplash trauma may have considerable neck pain, but still work as they did before the collision. However, neck pain is a common symptom in the general population ranging from 20-40% [12]. It is possible that some of the symptoms simply reflect the background prevalence of neck pain in the general population. Nevertheless, some studies assessing prevalence of neck pain in the general population include minor neck pain. If we had presented results including all patients with neck pain at follow-up (from 1 to 10 on a VAS scale), 65% of all patients completing that outcome measure, reported neck pain. Thus differences in measuring methods and cut points are likely to account for some of the variability in incidence rates.

#### **Circularity**

There may be circularity in some of the measures employed, particularly since some of the risk and outcome measures are self-reported ratings and some are related or interacting. For example, neck pain 12 months after the accident could be another measure of distress, and this may explain why pre-collision high distress is a substantial predictor for neck pain. The research within whiplash trauma is complicated as the disorder is not determined by objectively defined measures, and various definitions of recovery are used. No definition of recovery has yet been generally established [65]. However, in paper 2 we have applied both register-based and self-reported measures, and the findings correspond. For instance, pre-collision unspecified pain is a predictive factor of future neck pain and affected work capability as well as accumulated long-term sickness benefit predicts future neck pain and negative change in provisional situation.

#### **Not a model of cause**

Altogether, this study suggests that pre-collision biopsychosocial vulnerability has a substantial predictive value of recovery after whiplash trauma. This means that for individuals with this predisposing vulnerability, a motor vehicle collision can have a pervasive role in their lives, whereas for others the collision is just a brief interlude of acute pain. We can not draw conclusions concerning direct causality in this study, but we can point out predictive risk factors explaining part of the cause of poor recovery. This study is one of the first to explore pre-collision distress, unspecified pain, and transfer income. Further studies are needed in the attempt to work out a specific model of cause. We hope our findings may facilitate the development of new hypotheses or models that can be tested in future studies.

- This study suggests that data on factors before the accident provide valuable information on recovery from acute whiplash trauma.
- The results confirm the clinical significance of predisposing factors on several aspects of recovery.
- Being unemployed before the collision is important for future health-related attachment to labour market, but not for future neck pain.
- Low education level increases the risk of future affected work capability and neck pain.
- Female gender showed to be a predictive factor for poor recovery when recovery was assessed with self-reported measures, but not when assessed with register-based measures.
- The impact of the way of coping on future neck pain was the same for both men and women, thus different coping strategies did not explain the different prognosis observed in men and women.
- Most examined coping strategies showed maladaptive coherence to future neck pain. This may be due to the nature of the questionnaire measuring coping with pain.
- Surprisingly, only if distress was accumulated as opposed to a single distress factor (e.g. depression), poor recovery was predicted.
- Experiencing a pain condition pre-accident increases the probability for developing a pain condition again if exposed to acute pain. This may be due to sensitisation.
- Findings support our hypothesis that the collision may be a triggering factor for predisposing factors to ignite the development of health disabilities, regardless of severity of the collision.
- Provisional situation at time of accident is similar between patient and control cohort. One year later, the patient cohort is to a much higher degree on temporary health-related benefit (e.g. sick-listed) compared to controls.
- Our findings strongly show the impact of experiencing whiplash trauma on future provisional situation compared to register controls. 10-15% of whiplash-exposed show affected health-related working ability, and 36% show considerable neck pain one year after the collision.
- There may be circularity in some of the measures employed as some risk and outcome measures are self-reported ratings and may be related or interacting.
- We can not draw conclusions concerning direct causality in this study, but we can point out predictive risk factors explaining part of the cause of poor recovery.

## CONCLUSIONS

### Main conclusions in relation to aims

1. ***The impact of pre-collision psychological distress, health problems and socio-demographics on future affected work capability and neck pain after acute whiplash trauma:***  
Pre-collision unspecified pain condition, female gender, low educational level, unemployment and blue collar work were associated with future self-reported affected work capacity. Furthermore, pre-collision unspecified pain, pre-collision high psychological distress, female gender and low educational level were associated with future neck pain. Characteristics before the collision are important for recovery after acute whiplash trauma.

2. ***(a) The impact of acute whiplash trauma on future negative change in provisional situation compared to a matched register control group:***

Whiplash-exposure is a major risk factor for future negative change in provisional situation.

- (b) The predictive value of pre-collision transfer benefits on future negative change in provisional situation in patient and control cohorts:***

Being unemployed, sick-listed, and receiving social assistance pre-accident were all associated with future negative change in provisional situation. In particular, sick-listing before the accident has major predictive value as this factor furthermore predicted future neck pain and negative provisional situation with only a few weeks of sick-listing.

- (c) The predictive value of pre-collision self-reported factors and transfer benefits on future neck pain in the patient cohort:***

Pre-collision pain condition, sick-listing, female gender and low educational level predict future persistent neck pain.

Whiplash-exposed were socially marginalised to a higher degree than controls before as well as after the accident. These findings suggest a complicated interrelationship of various factors before the collision constituting a predisposing vulnerability that may be triggered by the whiplash trauma and act together with maintaining factors after the accident in the course of developing persistent pain and disability after whiplash trauma.

3. ***Reviewing the influence of coping strategies on recovery following whiplash trauma and gender differences in coping:***

Coping strategies are shown to affect recovery after whiplash trauma, but little information is available about which strategies are adaptive or maladaptive at different times in recovery. However, there is evidence of catastrophizing and reinterpreting pain sensations being maladaptive for patients exposed to whiplash trauma. There was not enough evidence to draw conclusions on the possible impact of gender in the use of coping strategies in whiplash patients as only six studies contributed with findings. Generally, the quality of the recent studies are good, however there is still a lack of knowledge about use of coping strategies in whiplash patients, in particular research within this area taking gender differences into account.

4. ***The interaction between gender and coping strategies in the prediction of future neck pain following acute whiplash trauma:***

No interaction between gender and the five examined coping subscales on future neck pain were found, thus different coping strategies 3 months post-collision did not explain the different prognosis observed in men and women. Four out of five coping strategies predicted future neck pain in both men and women (distraction, reinterpreting, catastrophizing, and praying and hoping). Catastrophizing and praying and hoping were found to have a clinically relevant influence on prognosis, and therefore we should identify patients predominantly using these strategies.

## PERSPECTIVES FOR FUTURE RESEARCH

This large prospective study on whiplash trauma primarily focused on the predictive value of factors before the motor vehicle

collision. This study is one of the first to explore pre-collision distress, unspecified pain, and transfer income and contributes with valuable new knowledge on the associations between pre-collision factors and poor recovery following whiplash trauma. This study suggests that pre-collision multifactorial vulnerability has a substantial predictive value of recovery after whiplash trauma. We can not draw conclusions concerning direct causality in this study, but we can point out predictive risk factors explaining causal pathways to poor recovery. Further studies are needed in the attempt to work out a specific model of multifactorial causality or looking into possible mediating relationships. We hope our findings may facilitate the development of new hypotheses or models that can be tested in future studies.

Sick-listing before the accident was a consistent predictive factor for poor recovery in our study. Another study showed that pre-collision high frequency of attendance to general practitioner and high use of health care was associated with poor recovery. Further research into use of health care before the collision and examination of which type of health care that may be associated with future poor recovery could be highly interesting.

It may be interesting to explore change in provisional situation for a longer period post-collision. A major proportion of whiplash-exposed individuals compared to controls went from being self-supported or being on labour-market-related benefit right before the accident to being on temporary health-related benefit one year post-collision. In Denmark, it is only possible to be on a temporary health-related benefit for 1-2 years. Therefore, these individuals' provisional situation is bound to change after that period, but whether they get a different kind of transfer payment or become self-supported remains to be explored. Our results indicate that measures accumulated over time may have a higher predictive value than measures assessed at a specific point in time. Future studies are needed to confirm our findings and may focus on unspecified as opposed to localised pain, accumulated psychological distress as opposed to depression, anxiety, etc. alone.

This dissertation reviewed the predictive value of the use of coping strategies after the collision on future recovery in whiplash-exposed and found, in accordance with previous studies, that coping strategies affect recovery, but little information is available about which strategies are adaptive or maladaptive at different times in recovery. Results indicate that coping is a dynamic process affecting the course of recovery differently in the acute and chronic phases. Therefore, it seems apparent in future interventions to promote reducing of maladaptive coping strategies such as catastrophizing and reinterpreting pain sensations as these contribute to poor outcome.

Reviewing the impact of gender on coping in whiplash patients, there was not enough evidence to draw conclusions as only 6 studies contributed with data on this issue, and these studies varied greatly in source population, coping measurements and assessment of recovery. We performed an analysis examining a possible interaction between coping and gender on future neck pain. We did not find a statistically significant interaction, but only trends regarding ignoring and praying and hoping. The analysis should be replicated. Nevertheless, when adding up findings from our study and the reviewed studies, it seems that there may be gender differences in coping very shortly after the accident. Therefore, assessing coping quite early after the accident and

measuring coping in a broader sense than just coping with pain, may show gender differences in coping with whiplash trauma in future studies.

Future research within coping after whiplash trauma should preferably 1) include psychological distress in the analysis as distress may interact with gender, and 2) implement prospective studies as (a) there are indications of coping strategies being changeable over time, (b) coping should be examined both in acute and chronic phases of whiplash, preferably examining the development of symptoms between these stages.

In this study, a proportion of individuals with considerable neck pain after the whiplash trauma still work as they did before the collision. Our results, in accordance with previous studies, support the use of a broad definition including more than one outcome measure when measuring recovery after whiplash trauma in future studies. This enables comparison of results across recovery dimensions. Neck pain as the only definition of recovery after whiplash trauma is too narrow.

Finally, we hope that findings in our study will contribute a) to further research, b) to promote identification of patients at risk, c) to future preventive interventions and treatment that may decrease impairment in health-related quality of life and persistent symptoms and thereby prevent the social decline that is a risk for some whiplash-exposed. This will in turn result in reduced economical and social costs, not only for the individual, but also for society.

#### SUMMARY

Persistent pain and disability after whiplash trauma has become an increasingly significant problem in many industrialized countries entailing comprehensive individual as well as social costs.

The dissertation includes two areas of research within whiplash trauma. The first part contains two empirical articles focusing on risk factors for poor recovery. The second part contains a systematic review and an empirical article and concerns the influence of coping strategies on recovery with a special emphasis on possible gender differences. All empirical articles in the dissertation are based on self-reported questionnaire data on a patient cohort of whiplash-exposed. Patients are consecutively included in the study within the first 10 days of collision recruited from emergency departments and general practitioners in four counties in Denmark from April 2001 to June 2003. One of the empirical articles in the dissertation is supplemented with data from a social register of transfer benefits on the patient cohort as well as on a matched register control cohort in the general population.

In this dissertation we wish to answer the following questions: 1) Do self-reported pre-collision health-related and socio-demographic factors affect self-reported work capability and neck pain one year after acute whiplash trauma? 2) Do transfer benefits before the accident predict negative change in future health-related provisional situation and future neck pain? 3) Do persons with acute whiplash trauma experience more negative change in future health-related provisional situation compared to a matched register control group? 4) Does research in the use of coping strategies after whiplash trauma show that these predict poor restitution and is there any research on gender differences in the use of coping strategies in whiplash-exposed? 5) Do gender

and coping strategies interact in the prediction of future neck pain following acute whiplash trauma?

Self-reported unspecified pain, female gender, low educational level, unemployment and blue collar work before the collision predicted future self-reported affected work capacity. Pre-collision self-reported unspecified pain, high psychological distress, female gender and low educational level predicted future self-reported neck pain. Self-reported characteristics before the collision are shown to be important for recovery after acute whiplash trauma.

Whiplash exposure was a major risk factor for future negative change in provisional situation as whiplash-exposed more than tripled their risk of negative change in provisional situation compared to matched controls in the general population.

Being unemployed, sick-listed, and receiving social assistance pre-accident were all associated with future negative change in health-related provisional situation. Sick-listing before the accident not only predicted negative change in provisional situation, but future neck pain as well. Furthermore, as few as 1-18 weeks of sick-listing within the five years preceding the collision more than doubled the risk of future negative provisional situation.

Coping strategies are shown to affect recovery after whiplash trauma, but little information is available about which strategies are adaptive or maladaptive at different times in recovery. However, there is evidence of catastrophizing and reinterpreting pain sensations being maladaptive for patients exposed to whiplash trauma. There was not enough evidence to draw conclusions on the possible impact of gender in the use of coping strategies in patients exposed to whiplash trauma as only six studies contributed with findings, and only two studies treat the subject at some length.

No interaction between gender and the five examined coping subscales on future neck pain were found. That is, use of coping strategies three months post-collision did not explain the different prognosis observed in men and women. However, we found that distraction, reinterpreting, catastrophizing, and praying and hoping predicted future considerable neck pain in both men and women.

In conclusion, we propose that a complicated interrelationship of various factors before the collision constitutes a pre-disposing vulnerability that may be triggered by the whiplash trauma and act together with multifactorial maintaining factors after the accident in the course of developing persistent pain and disability after whiplash trauma.

The findings from our study will make for further research and promote identification of patients at risk and hopefully contribute to preventive interventions and treatment that may decrease impairment in health-related quality of life and persistent symptoms and prevent the social decline that is a risk for some whiplash-exposed. This will in turn result in reduced social and economical costs not only for the individual, but also for society.

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