Chapter 1
For a long time there has been no consensus on the definition of 'whiplash'. The term whiplash was used to describe the injury mechanism, the injury itself and the various clinical manifestations as a consequence. The term 'whiplash' became a container concept, with a negative connotation. Because of the controversial definitions, the Quebec Task Force, a Canadian research group, tried to make order out of the 'whiplash' chaos and therefore introduced in 1995 the following 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 which in turn may lead to a variety of clinical manifestations (Whiplash Associated Disorders)." All patients included in this thesis were diagnosed as "sprain and strains of the neck" according to the International Classification of Diseases (ICD-9 CM) code 847.0. The code for this diagnosis has been the same for the last 25 years.

The understanding of what exactly happens to the cervical spine during a low-velocity, rear-end collision is limited, despite a wealth of experimental studies on the biomechanics of the cervical spine (Cassidy, 1995). In research of biomechanics the focus is on motor vehicle accidents, mainly car accidents. In car accidents with the impact in the sagittal plane, the neck is subject to forced flexion, extension as well as shear forces parallel to the direction of the impact. In car accidents with the impact not purely in the sagittal plane, the neck is also subject to a torsion component. It is likely that there is a complex interaction between forces, like speed and direction of impact and the position of the head and the neck. Whiplash injury has classically been attributed to rear-end impacts, but later research showed that also in other kinds of accidents whiplash injuries can take place.

The complaints after sprain of the neck are generally self-limiting. Complete recovery occurs within two or three months. However, in a substantial portion of patients, 15 to 50% these complaints become chronic. The main complaints of sprain of the neck are neck pain, frequently associated with stiffness of the neck and/or restricted range of motion. After neck pain headache is the most frequently reported complaint, followed by visual disturbances, dizziness, paresthesia and nausea. In the chronic state these initial complaints are accompanied by fatigue, nervousness, concentration disturbances, depression, emotional instability, sleeping problems and memory disturbances.

Chapter 2
Research before 1995 has shown a diversity of inclusion and/or exclusion criteria diagnosing whiplash injury. In a reaction the Quebec Task Force developed an "expert based criteria", examine the inclusion and exclusion criteria from the 82 studies described in the 1970-1974 and that still seems to have been used in the 1994. The highest prevalence and greatest changes in the number of kilometres driven. The total in years was ascertained by dividing the number of kilometres driven by the life span, the male:female ratio.

Chapter 3
During the 25-year period of the neck resulting with sprain of the neck, Emergency Room studies described the prevalence and group changes in the number of kilometres driven. The total in years was ascertained by dividing the number of kilometres driven by the life span, the male:female ratio.

Chapter 4
Over the 25-year period of the neck resulting with sprain of the neck, Emergency Room studies described the prevalence and group changes in the number of kilometres driven. The total in years was ascertained by dividing the number of kilometres driven by the life span, the male:female ratio.
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Because of the research group tried produced in 1995 the mechanism of side-impact motor mishaps. The impact lead to a variety of patients included "neck" according the 70. The code for this spine during a of experimental (1995). In research mainly car accidents. neck is subject to the direction of the sagittal plane the there is a complex act and the position been attributed other kinds of permitting. Complete substantial portion the main complaints with stiffness of the headache is the most cases, dizziness, complaints offers are twinges, depression, turbences.

For exclusion criteria, the Quebec Task Force developed

Summary

"expert based criteria", which may be considered as the gold standard. We examined the inclusion- and exclusion criteria used in research populations from the 82 studies performed during the period 1980-1998 comparing their similarities and dissimilarities with the Golden Quebec Task Force standard. None of the investigated articles satisfied the Quebec Task Force definitions completely, neither before nor after their introduction in 1995. Nevertheless, the QTTF seems to have had some impact on either the inclusion or exclusion criteria in the whiplash literature. We observed that the inclusion criteria used in this literature showed a qualitative and a quantitative shift following the Quebec Task Force publication in 1995. For the inclusion criteria we found both a statistically significant increase in use of the Quebec Task Force definition (acceleration deceleration mechanism, rear end collision, motor vehicle collision or other mishaps) and in the criterion "neck pain". The Task Force seems to have had a negligible impact on the exclusion criteria used in research after 1995.

- Chapter 3 and 4

During the 25-year period (1970-1994) 694 patients were diagnosed with sprain of the neck resulting from a car accident and 680 patients were diagnosed with sprain of the neck resulting from non car accidents (NCA) at the Emergency Room of the University Hospital Groningen. The purpose of the studies described in these chapters was to analyse trends in patients like the prevalence and groups at risk. For the car accidents we also took into account changes in the number of cars per inhabitant and the average number of kilometres driven. The binomial test was used to analyze differences between groups. The total increase (Ax) in the number of patients over the whole period was ascertained by determining the difference between the prevalence rate in 1970-1974 and that in 1990-1994.

Over the 25-year period a steady increase in the number of these patients with sprain of the neck due to car accidents (CA) was observed from 10 in 1970 to 122 in 1994. The highest prevalence was found for the age group 25-29 year olds (28.3 per 100,000), followed by 40-44 year olds (27.9 per 100,000). Across the life span, the male: female ratio was 1:0.98. Of the victims 8% were treated as inpatients.

Over the same period a steady increase in the number of patients (NCA) was observed from 55 in 1970-1974 to 241 in 1990-1994. The highest prevalence was found among 15- to 19-year-olds (39.2 per 100,000), followed by 10 to 14-year olds (34.0 per 100,000). The major causes of neck sprain NCA were accidental falls (25%), sports injuries (24%) and bicycling injuries (14%). Across the life span, the male: female ratio was 1:0.63. Ten percent of the patients were
treated as inpatients. The increase in the number of victims with sprain of the neck due to car accidents as well as due to non car accidents may be partly attributed to increased media attention and awareness of both physicians and patients. For the group victims with sprain of the neck due to car accidents a parallel rise in the number of cars per inhabitannts and average increase in kilometres driven was found. No direct effect was observed of seat belt legislation and the increase in sprain of the neck. For the group victims with sprain of the neck NCA the reduction of working hours resulting in more leisure time activities, which in turn increases the exposure time in at risk situations, may be responsible for the increase in sprain of the neck.

- **Chapter 5**
  Neck sprain is a general term denoting a soft tissue injury of the neck, which seldom causes major disability. 'Whiplash' is considered a modern epidemic. In this chapter the prevalence of sprain of the neck injury due to car accidents was described, for drivers and passengers. In addition, the degree of seat belt wearing in both driver and passenger was analysed. A second aim was to identify groups at risk by analysing the age and gender distribution of patients with neck sprain. The results of this study revealed a sharp increase in neck sprain from 1989 through 1995, whereas a more or less stable pattern was found for seat belt use. The sharp increase in sprain of the neck was found to be attributable to outpatients. Finally, we found a driver predominance. Especially at risk for sprain of the neck were 20-to-24 year old drivers and 15 to 19-year old passengers.

- **Chapter 6**
  This 14 year retrospective study focussed on the different types of car accidents during the period 1982-1995 for both drivers and passengers. All inpatients (who were treated clinically) diagnosed with “sprains and strains of the neck”, from all hospitals of the Netherlands were included. The data was retrieved from the data base of the Institute of Information on Healthcare (SIO) which covered all inpatients (99.6%) of the hospitals in the Netherlands. The binomial test was used to analyse differences between groups. The predominant category of car accidents was a collision with another car in drivers as well in passengers. The second major type of the accidents was the 'unspecified' category. Of the inpatients from the collision with vehicle, the proportion of passengers (77%) was statistically significantly greater than the proportion of drivers (45%). This may be attributed to the fact that drivers and passengers show different behaviour just before or during the moment of car crash. Maybe the driver pays more attention to the traffic than the passenger. In that case the driver may have better reaction to the sudden event of the car crash and
Sprain of the neck may be caused by car accidents but also by accidental falls, sports accidents, bicycle accidents, motor accidents, and violence. Whiplash Associated Disorders (WAD), i.e. persisting complaints after sprain of the neck, may develop after such accidents. Many risk factors for the development of WAD have been studied: accident characteristics, pre-injury complaints, previous accidents, type and severity of initial complaints after the accident, and socio-demographic factors. The role of stressful life events in initiating WAD or in aggravating severity and duration of complaints has been investigated scarcely.

Aim of this study was to analyze the influence of stressful life events on the development of physical and/or psychological complaints after sprain of the neck (WAD). A cohort of patients from the University Hospital of Groningen with the diagnosis sprain of the neck (n=655) in the period 1993-1997 were asked to fill out a questionnaire. In total 193 subjects returned the questionnaire of which, too subjects, 54 females and 46 men, mean age 34 years (sd: 14.6) did not have complaints before the accident and were therefore at risk for the development of complaints as a result of the sprain of the neck. Physical complaints were experienced by 77% of the subjects. Psychological complaints were experienced by 42% of the subjects. Physical and/or psychological complaints were experienced by 78% of the subjects. Neither the number of stressful life events nor the impact values of the life events were related to complaints after the accident. The number of stressful life events and the impact values of the life events were not related to the number, the frequency and duration of complaints after the accident. From the results of this study it is concluded that stressful life events do not play a role in the development of WAD.

In this chapter quality of life and psychological functioning in patients with sprain of the neck were analyzed. Furthermore, the relationship between complaints, quality of life, psychological functioning and personality factors, and the profile of patients with whiplash associated disorders (WAD) was
analyzed, four years after trauma. The same group of patients described in chapter 7 were included. Quality of life and psychological functioning were assessed using the RAND-36 and the SCL-90, respectively. Personality was assessed by means of two sub scales ('inadequacy' and 'social inadequacy') of the Dutch Personality Questionnaire. Of the group at risk (56% women and 44% men, mean age 33.9, sd 4.6) quality of life was significantly worse in subjects with complaints (mean: 78.4, sd: 15.5) compared to subjects without complaints (mean: 87.5, sd: 8.7). Subjects with complaints reported a lower level of psychological functioning as subjects without complaints. However, the difference was not statistically significant. Personality did not differ between the groups with complaints versus without complaints. Personality and complaints together were significantly related to quality of life ($R^2$ sum: 0.60) and psychological functioning ($R^2$ sum: 0.73). No specific profile of WAD patients was found.

In conclusion, personality and complaints influence quality of life and psychological functioning to a considerable extent.

- Chapter 9

In the general discussion the problems with respect to the impact of sprain of the neck and whiplash associated disorders are described and a global overview of prevalences of sprain of the neck is given. The results are discussed with respect to cause, diagnosis and patient characteristics.