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DO RISK FACTORS FOR ACUTE WHIPLASH INJURY ALSO PREDICT NON-RECOVERY? A CASE-CONTROL STUDY

***Arthur Croft**

826 Orange Ave., #633, Coronado, California 92117

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ABSTRACT

Study Design Case-control study of persons having suffered whiplash injury. **Objective** Toassess the degree to which three putative risk factors—gender, age, and collision vector—can influence recovery after whiplash injury. **Summary of Background Data** While the extant literature is consistent with a 2:1 acute whiplash injury ratio between females and males, it is inconsistent in terms of whether adifferential risk exists between females and males for non-recovery (i.e., chronicity). It is also ambiguous in terms of the risk potential for aging and collision vector. **Methods** Binary multivariate logistic regression analysis was used to determine the effect of three predictor variables (sex, age, and collision vector) upon the binary outcome variable of recovery/non-recovery in 123 subjects previously suffering whiplash injuries. Subjects were recruited from 12 private clinics in the U.S. The sample comprised 55% females and 45% males aged 18-68 years of age. The 64% who had not recovered and the 36% who had recovered comprised the cases and controls, respectively. **Results** No statistically significant predictive regression model could be developed, nor were there any statistically significant correlations despite adequate statistical power. Varying levels of evidence exist indicating that female gender, increasing age, and rear impact vector predict acute injury risk, but, on the basis of this study, they do not appear to predict non-recovery. **Conclusions:** One earlier study demonstrated that females are injured acutely at approximately double the rate of males. But apart from their higher risk threshold, once injured, males have a roughly equivalent risk for non-recovery. The current study supports this finding and suggests, *a fortiori*, the same unidirectional relationship for age and crash vector: increasing age and a rear impact vector probably do increase the risk for acute injury, but, once an injury has occurred, these factors do not predict non-recovery.

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INTRODUCTION

In a survey commissioned by the National Highway Traffic Safety Administration (NHTSA) the total number of motor vehicle-caused injuries in the year 2010 was estimated to have been 6,356,914.(2014) NHTSA estimated that 3.5 million of these were MAIS1 (level 1 maximum Abbreviated Injury Scale) injuries, the majority of which were whiplash. This statistic approximates the3 million of whiplash injuries estimated to occur annually in the U.S.(Freeman *et al.* 2006)The economic burden of whiplash injuries has been estimated to be as high as $25 billion, and the comprehensive cost as high as $43 billion annually in the U.S.(Zaloshnja *et al.* 2004). One of the most widely studied injury risk factors in the field of collision trauma is sex.

Corresponding author:** ***Arthur Croft,
826 Orange Ave., #633, Coronado, California 92117.

All large studies of MVCs have shown that males are significantly more likely to be involved and, consequently, to be killed or injured. This disparity between males and females in this context, however, is the result of differential risk-taking and driving behaviors (Mathews *et al.* 2001). In contrast, in paired comparison studies controlling for crash severity, it has been demonstrated that females have a greater risk for injury and death in a given collision scenario as compared to males.(Ulfarsson and Mannering 2004)This is an anatomical and physiological relationship. Females have also been reported to be at higher risk of acute whiplash injury.(Borchgrevink *et al.* 1996, Mayou and Bryant 1996, Morris and Thomas 1996, Dolinis 1997a, Satoh *et al.* 1997, Brault *et al.* 1998, Bylund and Bjornstig 1998, Giguere *et al.* 1998, Temming and Zobel 1998, van den Kroonenberg *et al.* 1998, Chapline *et al.* 2000, Berglund *et al.* 2003, Cappon *et al.* 2003, Hell *et al.* 2003, Eis *et al.* 2005, Krafft *et al.* 2005, Wiles *et al.* 2005, Martin *et al.* 2008b)The consistently reported odds ratio (OR) for acute whiplash injury risk for females as

compared to males in this literature is approximately 2.0. In addition to the risk for acute whiplash injury, females who have an acute whiplash injury have also been reported to have a higher risk than males for developing long-term pain and disability.(Satoh *et al.* 1997, Krafft 1998b, Richter *et al.* 1999b, Richter *et al.* 2000, Krafft 2002, Krafft *et al.* 2002, Carlsson *et al.* 2003, Scholten-Peeters *et al.* 2003, Sterling *et al.* 2003a, Bunketorp *et al.* 2004, Hendriks *et al.* 2005, Kasch *et al.* 2008b)

We suspect that in some of the studiesreporting females as being at higher risk for non-recovery, a form of ecological fallacy may be in play, in which cross-sectionaldata may have been accordedthe undeserved influence of longitudinal data. If males and females are equally likely to develop long-term symptoms once they have been injured, one would expect to find approximately twice as many females as males suffering from chronic pain in any cross-sectional study of a representative population. This is, in fact, what one group reported,(Krafft 1998a)while another demonstrated that, once injured, females and males share the same risk for developing chronic symptoms.(Freeman *et al.* 2006)Others have also found the female sex was not predictive of poor prognosis.(Pape *et al.* 2007, Kamper *et al.* 2008, 2008a, 2008b)\l "\l "Thus, the female preponderance for acute injury risk is not in question, but the question as to whether females are more prone to develop chronic pain following whiplash remains unsettled. Age is another factor known to affect acute injury risk in MVC, and the world population is aging. In the U.S. alone, the number of persons aged 65 years and older is expected to be 63 million by the year 2025; which will have nearly doubled in just 25 years.(Austin and Faigin 2003) Injury prevention technology will benefit from the development of more informed predictive models.

Conventional wisdom suggests that older persons will have a lower tolerance to motor vehicle trauma than younger persons. World automobile collision statistics provide clear support for this conclusion.(Kockelman and Kweon 2002, Kent and Henary 2005) Compared to persons in their fourth decade, for example, collision victims in their eighth decade have a risk of fatality that is five times higher.(Bedard *et al.* 2002)It is less clear, however, whether older adults will be more vulnerable than younger adults to less severe, lower velocity crashes such as the type that commonly result in whiplash type neck and back injuries. The existing literature is divided. Some researchers have reported that, as age increases beyond the third decade, the risk of neck injury from a MVC generally increases.(Jakobsson *et al.* 2004) Studies have found that the mean age was higher for those reporting long term symptoms, indicating an increased risk with age.(Pobereskin 2005) Some smaller studies have confirmed the association of poor prognosis with advancing age. It was reported that older whiplash victims had a prolonged recovery time.(Richter *et al.* 2000) This was also reported in a large population-based Canadian cohort of whiplash victims,(Suissa *et al.* 2001, Suissa 2003) and in a moderate sized Japanese study.(Hijioka *et al.* 2001) Persons between 40 and 60 years of age required significantly more early treatment than did those in younger age groups in a large study of whiplash victims.(Satoh *et al.* 1997) In a group followed longitudinally for six months, older age predicted membership in the highest severity group.(Sterling *et al.* 2005). Kullgren(2008) did not find an age-related risk for sustaining whiplash injuries, but did find an increase in the risk for more severe injuries with increasing age. Other authors, however, have reported that whiplash injury risk is not significantly correlated with age.(Larder *et al.* 1985, Koch *et al.* 1994, Treleaven *et al.* 2003) Holm et al.(2007) found no association between age and the likelihood of developing acute neck pain after whiplash trauma among a cohort of 1187 persons. In a study of collision risk involving 7120 persons, Berglund et al.(2003) found age to have only a minor influence on the prognosis of whiplash injury, and the risk was paradoxically lowest among the highest age group.
Others have likewise concluded that age is not a predictor of poor outcome after whiplash injury.(Gozzard *et al.* 2001, Carlsson *et al.* 2003, Scholten-Peeters *et al.* 2003, Miettinen *et al.* 2004b, Kivioja *et al.* 2005, Ottosson *et al.* 2005, Tomlinson *et al.* 2005, 2006, 2008)\l "\l "\l ". Wiles et al.(2005) reported that the risk for whiplash injury was higher among younger persons. In a large European study of frontal crashes, the risk for whiplash injury was found to be higher in persons under the age of 50 years.(Jakobsson *et al.* 2004) In a more recent large scale analysis of the world literature concerning whiplash and other forms of neck pain, researchers reported that younger age and female sex were associated with whiplash injury claim filing.(Holm *et al.* 2008)Claim filing, however, may be an imperfect surrogate for incidence. In a U.S. study, age was not found to be an important factor for predicting neck pain in males, but for females the risk of injury dropped off with increasing age, with 47% of females up to age 49 reporting pain, 40% of those 50-64 years reporting pain, and only 31% of those over 65 years reporting pain.(Chapline *et al.* 2000) In a European study researchers found that risk dropped off in both males and females as age increased.(Jakobsson *et al.* 2000)Eis et al.(2005) reported that risk varied little among persons aged 18-55 years, but was lower in persons over 65 years of age. Wearing a seatbelt, being in a heavier car, and age greater than 65 years were associated with a lower risk of whiplash injury in a more recent study.(Martin *et al.* 2008a)

We located 88 papers published since 1956 which reported outcome following whiplash injury, in which the follow-up point was at least 6 months post-injury. Of these, the collision vectors (i.e., frontal, side, and rear impact) were pooled in 56 of the studies, and the mean proportion of non-recovery among those was 40.6%.(Gotten 1956, Macnab 1964, Hohl 1975, Ebbs *et al.* 1986, Deans *et al.* 1987, Maimaris *et al.* 1988, Miles *et al.* 1988, Hildingsson *et al.* 1989, Hodgson and Grundy 1989, McKinney 1989, Pearce 1989, Gargan and Bannister 1990, Hildingsson and Toolanen 1990, Pennie and Agambar 1990, Kischka *et al.* 1991, Radanov *et al.* 1991, Ettlin *et al.* 1992, Ono and Kanno 1993, Radanov *et al.* 1993a, Radanov *et al.* 1993b, Ryan *et al.* 1993, Jonsson *et al.* 1994, Radanov *et al.* 1994, Di Stefano and Radanov 1995, Spitzer *et al.* 1995, Mayou and Bryant 1996, Borchgrevink *et al.* 1997, Karlsborg *et al.* 1997, Pettersson *et al.* 1997, Borchgrevink *et al.* 1998, Olivegren *et al.* 1999, Richter *et al.* 1999a, Galasko *et al.* 2000, Partheni *et al.* 2000, Richter *et al.* 2000, Pearce 2001, Carlsson *et al.* 2003, Nederhand *et al.* 2003, Sterling *et al.* 2003a, Sterner *et al.* 2003, Bunketorp *et al.* 2004, Richter *et al.* 2004, Karnezis *et al.* 2007, Kongsted *et al.* 2007, Pape *et al.* 2007, Gabel *et al.* 2008, Geldman *et al.* 2008, Kongsted *et al.* 2008a, Kongsted *et al.* 2008b, Buitenhuis *et al.* 2009, Solarino *et al.* 2009, Stalnacke 2009, Merrick and Stalnacke 2010, Carroll *et al.* 2011, Hours *et al.* 2014, Myrtveit *et al.* 2014)

Of the 88, 21 studies included only persons injured in rear impact collision vectors,(Ellertsson *et al.* 1978, Norris and Watt 1983, Olsson *et al.* 1990, Watkinson *et al.* 1991, Parmar

and Raymakers 1993, Gargan and Bannister 1994, Borchgrevink *et al.* 1996, Squires *et al.* 1996, Gargan *et al.* 1997, Krafft *et al.* 1998, Berglund *et al.* 2000, Brison *et al.* 2000, Krafft *et al.* 2000, Kasch *et al.* 2001a, Kasch *et al.* 2001b, Hartling *et al.* 2002)\l "(Ovadia *et al.* 2002, Kasch *et al.* 2003, Krafft *et al.* 2005, Pobereskin 2005, Tomlinson *et al.* 2005)\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "\l "and in another 10 the type of collision was not specified.(Robinson and Cassar-Pullicino 1993, Voyvodic *et al.* 1997, Bunketorp *et al.* 2002, Olsson *et al.* 2002, Buitenhuis *et al.* 2003, Miettinen *et al.* 2004b, Pettersson *et al.* 2004, Gun *et al.* 2005)\l "\l "\l "\l "\l "\l "\l "(Hendriks *et al.* 2005, Ottosson *et al.* 2005) Of the rear impact only studies the mean proportion reported as failing to recover was 48.5%. Of the 10 studies in which the collision vector was not specified, the mean proportion failing to recover was 68.5%.\l " In one case-control study the attributable risk was reported to be 45% among persons with chronic neck pain indicating that about 45% of persons suffering from chronic neck pain attributed their pain to a motor vehicle collision (MVC) injury. They estimated that as much as 9-10% of adult Americans suffer may from the long-term effects of whiplash injury, underscoring the magnitude of the public health problem as well as the potential benefice of better predictive models.(Freeman *et al.* 2006)Collectively these studies serve underscore the magnitude of the problem, but offer no clear determination as to the putative higher risk for non-recovery posed by rear impact collisions. The purpose of the present study was to determine whether a regression model predictive of long-term outcome could be developed based on the three risk factors: sex, increasing age, and rear impact collision vector. Our working hypotheses were that female sex, increasing age, and a rear impact collision vector would predict non-recovery from whiplash injury.

METHODS

In total, 123 individuals were recruited from 12 medical and chiropractic clinics in 9 states. Subjects who had sustained a whiplash injury in the past, but not necessarily being treating for that condition, were recruited and enrolled on an ongoing basis until each clinic had recruited its target of 10 subjects. The study was approved by university institutional review board and all subjects completed Informed Consent documents prior to enrollment in this study.The sample comprised 55% females and 45% males. The majority of the subjects (64%) had not fully recovered from their injuries. The ages of subjects was normally distributed, with a range from 18 years to 68 years. Fifty percent of the subjects were below the age of 40 years. The most frequent type of collision was the rear impact (52%), followed by frontal impacts (33%) and side impacts (15%). Subjects completed a Neck Disability Index (NDI) questionnaire and an Informational Questionnaire which identified the dependent and independent variables under study in this research project: recovery status, sex, age, and type of motor vehicle collision (i.e., frontal impact, side impact, or rear impact). The NDI score provided an alternative classification of recovery status. NDI scores of less than 8 has been considered the equivalent of recovery by others and we adopted this criteria.(Sterling *et al.* 2003b, Merrick and Stalnacke 2010, Vetti *et al.* 2010, Sterling *et al.* 2013)The Informational Questionnaire included a collision vector diagram, with hours of the clock representing collision types, based on previously published clock convention(Storvik *et al.* 2009)with the vehicle's nose as 12 o'clock: frontal (between 11 and 1 o'clock), rear (between 5 and 7 o'clock), andside (the segments between the frontal and rear segments). Inclusion criteria were that subjects were at least 18 years of age at the time of their injury. Subjects must have had a motor vehicle collision-induced neck injury sometime in the past and at least 24 weeks (6 months) prior to recruitment. The requirement concerning the period of time between the injury and the point of recruitment was based on longitudinal outcome studies which demonstrate that recovery from whiplash is usually achieved within 24 weeks, when it occurs, while a substantial number of victims will remain symptomatic after 12 weeks.(Radanov *et al.* 1995)Subjects must also have undergone at least three therapy sessions for treatment of their symptoms after the collision by a practitioner (including medical, chiropractic, or osteopathic), physical therapist, or acupuncturist. Fluency in English ensured that subjects could fully understand the written questionnaires and informed consent forms they were required to complete. Exclusionary criteria included prior cervical spine surgery or serious spinal disease/disorder, and chronic neck pain not related to a whiplash injury. Persons who suffered spinal cord injury, spinal fracture, or spinal dislocation in their MVC were also excluded. Although some authors have voiced concern that litigation may actually prolong symptoms and delay recovery in whiplash victims,(Cassidy *et al.* 2000) this concern has not been.(Croft 1993a, Pettersson *et al.* 2004). The data were analyzed using Pearson correlation, independent t-tests, chi-square tests of association, and binary multivariate logistic regression with recovery as the outcome variable and sex, age, and collision type as predictor variables using *SPSS 22* (IBM).

RESULTS

The Pearson correlation of sex and recovery status was not statistically significant using the Spearman rank order correlation test, r= .02, p = .80. Independent samples (2-tailed) t-test results comparing age, as a continuous variable, with recovery classification indicated there was no statistically significant difference, t = .27, p = .79. The chi-square test of association showed that the relationship between the crash type and recovery status was not statistically significant, $\chi 2$ (2) = .25, p = .75. Binary multivariate logistic regression was used to test the effect of independent variables, sex, age, and crash type, simultaneously, on the dependent variable, recovery. The ENTER procedure was used; all predictor variables were included in the regression simultaneously. The regression did not proceed beyond Step one, and results of the Hosmer and Lemeshow test were not significant, $\chi 2$ (8) = 8.52, p = .38. None of the variables reached significance at the p=.05 level.
Thus, none of the postulated hypotheses were supported. Contrary to theoriesespoused by some authors and interpretations emanating from some studies, it does not appear that sex, age, or crash type or are important predictors of recovery or non-recovery after a whiplash injury has occurred.

DISCUSSION

While there is little doubt that being female roughly doubles one's risk for acute whiplash injury, the literature is split on the question of outcome. Some authors have reported that female victims of whiplash injury are more likely to develop chronic pain as compared to male victims, (Satoh *et al.* 1997, Krafft 1998a, Richter *et al.* 1999b, Richter *et al.* 2000, Krafft 2002, Carlsson *et al.* 2003, Krafft *et al.* 2003, Scholten-Peeters *et al.* 2003, Sterling *et al.* 2003a, Bunketorp *et al.* 2004, Hendriks *et al.* 2005, Kasch *et al.* 2008c)but this conclusion was not

reached by others.(Freeman *et al.* 2006, Pape *et al.* 2007, Kamper *et al.* 2008, 2008a, 2008b)In a like manner, some authors have determined that older persons will be at greater risk for whiplash injury as compared with younger persons,(Richter *et al.* 2000, Hijioka *et al.* 2001, Suissa *et al.* 2001, Suissa 2003, Pobereskin 2005, Sterling *et al.* 2005)but these conclusionsassertions have also been refuted.(Carlsson *et al.* 2003, Scholten-Peeters *et al.* 2003, Miettinen *et al.* 2004a, Hendriks *et al.* 2005, Kivioja *et al.* 2005, Ottosson *et al.* 2005, Tomlinson *et al.* 2005) Several studies have been published which indicate that full recovery is less likely when a person is injured in a rear impact collision as compared to a side impact or frontal collision.(Ovadia *et al.* 2002, Kasch *et al.* 2003, Pobereskin 2005, Tomlinson *et al.* 2005)Here again the literature is divided, with nearly an equal volume of dissenting conclusions.(Ellertsson *et al.* 1978, Krafft *et al.* 2000, Pearce 2001, Krafft *et al.* 2005, Croft and Freeman 2006). Our data clearly did not support the sex variable as a predictor of less than sanguine outcome. Although this finding runs counter to a large body of literature, it does support an earlier study that showed that females and males have approximately equal risk for developing chronic pain.(Freeman *et al.* 2006)Because females have about twice the risk for sustaining an acute injury as compared to males, (Borchgrevink *et al.* 1996, Mayou and Bryant 1996, Morris and Thomas 1996, Dolinis 1997b, Satoh *et al.* 1997, Bylund and Bjornstig 1998, Giguere *et al.* 1998, Temming and Zobel 1998, van den Kroonenberg *et al.* 1998, Chapline *et al.* 2000, Berglund *et al.* 2003, Cappon *et al.* 2003, Hell *et al.* 2003, Eis *et al.* 2005, Krafft *et al.* 2005, Wiles *et al.* 2005, Martin *et al.* 2008b) any motorized society will contain substantially more females suffering from chronic pain attributable to whiplash than males, even when the risk for developing chronic pain is equivalent. It should be mentioned that the sex-relatedrisk differential is substantially confounded by mass, although our study made no attempt to control for this. Human subject crash test studies have demonstrated that female subjects generally experience substantially greater acceleration of the head and other body regions as compared to males.(Brault *et al.* 1998, Croft 2006b, a) This induces a more challenging biomechanical risk and kinematic response. Ultimately, though, this is a purely inertial effect, with larger accelerations also measured in smaller male subjects. In the same way that the being female is a risk factor for acute injury risk, but not for non-recovery, it is likely, based on the relatively large literature noted above, that increasing age will also increase the risk for acute injury. Once an acute injury has occurred, however, age does not afford any predictive value concerning the likelihood of recovery vs. non-recovery, a finding consistent with other studies.(Carlsson *et al.* 2003, Scholten-Peeters *et al.* 2003, Miettinen *et al.* 2004a, Hendriks *et al.* 2005, Kivioja *et al.* 2005, Ottosson *et al.* 2005, Tomlinson *et al.* 2005). There are a number of potential confounders with the age variable. Drivers gain skill and experience with age and older drivers tend to be more cautious and have fewer collisions. In the sixth decade and beyond, the proportion of retired persons will increase and they will drive fewer miles and avoid rush hour traffic where a larger proportion of whiplash injuries occur. Many of the studies cited in this report are derived from convenience samples taken from hospital EDs. The age distribution of this demographic is likely skewed towards younger drivers because of these factors, and because it is rare that crash severity it determined with any precision in these studies, making meaningful comparisons across other variables such as age is a tenuous undertaking. The age distribution of small convenience samples is not a suitable basis for the determination of relative risk. In addition to the potential lack of comparability, both within and across studies of whiplash injuries, posed by unknown magnitudes of variance in terms of*collision severity*, the actual selection of subjects with regard to*injury severity* also varies. A grading system for whiplash injury was developed in 1993,(Croft 1993b) modified slightly and promulgated further in 1995,(Spitzer *et al.* 1995) and has become a standard tool for scientists, allowing readers to judge potential sources of bias to some extent. As in the case of sex and age, however, it is likely that persons struck from the rear are at higher risk for sustaining an acute injury, but this study shows that once the injury has occurred, the collision type no longer has any inherent predictive value concerning recovery from the injury.

Study Limitations

As a case-control design this study and does not allow us to draw longitudinal conclusions from the results. The 123 subjects who ultimately participated self-selected. None of the statistical results were close to significance levels, indicating that sample size and statistical power were not limitations. An obvious limitation to this study is the potential disparity in crash severities across all of the 123 subjects' MVCs. The ideal in research it to ensure that cases are comparable, but in retrospective research into motor vehicle trauma, it is quite rare to have reliable and accurate measures of crash severity.(Croft and Freeman 2005)

Conclusion

The results of this study challenge three long-standing and widely held views concerning recovery after whiplash injury: specifically, that female sex, advancing age, and a rear impact crash type are predictive of non-recovery after whiplash injury.It is likely that these theories have been based largely on ecological fallacy in which cross-sectional (and frequently also skewed) data has been interpreted as longitudinal data. We encourage other researchers to repeat this study on other injury populations. In the meantime this updated view of these putative risks should encourage researchers and automobile manufacturers to redouble efforts to focus on known acute injury risk factors and ways to minimize these risks. Because women have twice the acute injury risk as men, yet share the same risk as men for non-recovery, the results of this study underscore the need to focus our crashworthiness protection efforts on women. Car seats and head restraints need to have the capacity to be adjusted in a fully optimized configuration so as to provide maximum protection for men and women.

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Key Points

- In general, females are known to have about double the risk for acute injuries as compared to males.The literature is

split, however, as to whether being female also portends a less favorable outcome once an injury has occurred.

- The literature is ambiguous concerning the risk imposed by advancing age and the rear impact crash vector—both in terms of acute injury risk and the risk for non-recovery.
- The results of this binary multivariate logistic regression analysis are that these three risk factors have no ability to predict outcome.
- There are several potential sources of bias and confounding that challenge the interpretation of existing literature. Chief among these is the fact that crash severity is rarely known or reported and the fact that injury severity is difficult to quantify and varies across studies.

REFERENCES

Anon, 2014. The economic and societal impact of motor vehicle crashes, 2010. DOT HS 812013.

Austin, R., Faigin, B., Year. Effect of vehicle and crash factors on older occupant injury. . In: Proceedings of the Proceedings 18th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Nagoya, Japan.

Bedard, M., Guyatt, G.H., Stones, M.J., Hirdes, J.P., 2002. The independent contribution of driver, crash, and vehicle characteristics to driver fatalities. Accid Anal Prev34, 717-727.

Berglund, A., Alfredsson, L., Cassidy, J.D., Jensen, I., Nygren, A., 2000. The association between exposure to a rear-end collision and future neck or shoulder pain: A cohort study. J Clin Epidemiol53 (11), 1089-94.

Berglund, A., Alfredsson, L., Jensen, I., Bodin, L., Nygren, A., 2003. Occupant- and crash-related factors associated with the risk of whiplash injury. Ann Epidemiol13 (1), 66-72.

Borchgrevink, G.E., Kaasa, A., Mcdonagh, D., Stiles, T.C., Haraldseth, O., Lereim, I., 1998. Acute treatment of whiplash neck sprain injuries. A randomized trial of treatment during the first 14 days after a car accident. Spine23 (1), 25-31.

Borchgrevink, G.E., Lereim, I., Royneland, L., Bjorndal, A., Haraldseth, O., 1996. National health insurance consumption and chronic symptoms following mild neck sprain injuries in car collisions. Scand J Soc Med24 (4), 264-71.

Borchgrevink, G.E., Stiles, T.C., Borchgrevink, P.C., Lereim, I., 1997. Personality profile among symptomatic and recovered patients with neck sprain injury, measured by mcmi-i acutely and 6 months after car accidents. J Psychosom Res42 (4), 357-67.

Brault, J.R., Wheeler, J.B., Siegmund, G.P., Brault, E.J., 1998. Clinical response of human subjects to rear-end automobile collisions. Arch Phys Med Rehabil79 (1), 72-80.

Brison, R.J., Hartling, L., Pickett, W., 2000. A prospective study of acceleration-extension injuries following rear-end motor vehicle collisions. Journal of Musculoskeletal Pain8, 97-113.

Buitenhuis, J., De Jong, P.J., Jaspers, J.P., Groothoff, J.W., 2009. Work disability after whiplash: A prospective cohort study. Spine (Phila Pa 1976)34 (3), 262-7.

Buitenhuis, J., Spanjer, J., Fidler, V., 2003. Recovery from acute whiplash: The role of coping styles. Spine28 (9), 896-901.

Bunketorp, L., Nordholm, L., Carlsson, J., 2002. A descriptive analysis of disorders in patients 17 years following motor vehicle accidents. Eur Spine J11 (3), 227-34.

Bunketorp, O., Jakobsson, L., Norin, H., Year. Comparison of frontal and rear-end impacts for car occupants with whiplash-associated disorders: Symptoms and clinical findings. In: Proceedings of the Proceedings of the International IRCOBI Conference, Graz, Austria, pp. 245-256.

Bylund, P.O., Bjornstig, U., 1998. Sick leave and disability pension among passenger car occupants injured in urban traffic. Spine23 (9), 1023-8.

Cappon, H., Van Ratingen, M., Wismans, J., Hell, W., Lang, D., Year. Whiplash injuries, not only a problem in rear-end impact. . In: Proceedings of the Proceedings 18th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Nagoya, Japan.

Carlsson, G., Bunketorp, O., Jakobsson, L., Norin, H., Year. Medical and car impact-related risk factors for the prognosis of wad. . In: Proceedings of the 47th Annual Proceedings, Association for the Advancement of Automotive Medicine, pp. 598-600.

Carroll, L.J., Liu, Y., Holm, L.W., Cassidy, J.D., Cote, P., 2011. Pain-related emotions in early stages of recovery in whiplash-associated disorders: Their presence, intensity, and association with pain recovery. Psychosom Med73 (8), 708-15.

Cassidy, J.D., Carroll, L.J., Côté, P., Lemstra, M., Berglund, A., Nygren, A., 2000. Effect of eliminating compensation for pain and suffering on the outcome of insurance claims for whiplash injury. N Egl J Med342 (16), 1179-86.

Chapline, J.F., Ferguson, S.A., Lillis, R.P., Lund, A.K., Williams, A.F., 2000. Neck pain and head restraint position relative to the driver's head in rear-end collisions. Accid Anal Prev32 (2), 287-97.

Croft, A., 1993a. The case against litigation neurosis in mild brain injuries and cervical acceleration/deceleration trauma. J Neuromusculoskeletal System1 (14), 149-155.

Croft, A., 1993b. Treatment paradigm for cervical acceleration/deceleration injuries (whiplash). Journal of the American Chiropractic Association30 (1), 41-45.

Croft, A.C., 2006a. Biomechanical and kinematic differences between rear impact and frontal impact automobile crashes at low velocities. Journal of Biomechanics39 (Supplement 1), S145.

Croft, A.C., 2006b. Human subjects exposed to very low velocity frontal collisions. Journal of Biomechanics39 (Supplement 1), S146.

Croft, A.C., Freeman, M.D., 2005. Correlating crash severity with injury risk, injury severity, and long-term symptoms in low velocity motor vehicle collisions. Medical Science Monitor11 (10), RA316-321.

Croft, A.C., Freeman, M.D., 2006. Chronic neck pain and whiplash: A case-control study of the relationship between acute whiplash injuries and chronic neck pain Pain Research and Management11 (2), 79-83.

Deans, G.T., Magalliard, J.N., Kerr, M., Rutherford, W.H., 1987. Neck sprain–a major cause of disability following car accidents. Injury18, 10-12.

Di Stefano, G., Radanov, B.P., 1995. Course of attention and memory after common whiplash: A two-years prospective study with age, education and gender pair-matched patients. Acta Neurol Scand Audiol91, 346-352.

Dolinis, 1997a. Risk factors for 'whiplash' in drivers: A cohort study of rear-end traffic crashes. Injury28 (3), 173-9.

Dolinis, J., 1997b. Risk factors for 'whiplash' in drivers: A cohort study of rear-end traffic crashes. Injury28 (3), 173-9.

Ebbs, S., Beckly, D., Hammonds, J., Teasdale, C., 1986. Incidence and duration of neck pain among patients injured in car accidents. Br Med J292, 94-95.

Eis, V., Sferco, R., Fay, P., Year. A detailed analysis of the characteristics of european rear impacts. In: Proceedings of the 19th Interational Technical Conference of the Enhanced Safety of Vehicles (ESV), Washington, D.C.

Ellertsson, A., Sigurjousson, K., Thorsteinsson, T., 1978. Clinical and radiographic study of 100 cases of whiplash injury. Acta Neurol Scan (Suppl)67, 269.

Ettlin, T.M., Kischka, U., Reichmann, S., Radii, E.W., Heim, S., Wengen, D., Benson, D.F., 1992. Cerebral symptoms after whiplash injury of the neck: A prospective clinical and neuropsychological study of whiplash injury. J Neurol Neurosurg Psychiatry55 (10), 943-8.

Freeman, M.D., Croft, A.C., Rossignol, A.M., Centeno, C.J., Elkins, W.L., 2006. Chronic neck pain and whiplash: A case-control study of the relationship between acute whiplash injuries and chronic neck pain. Pain Res Manag11 (2), 79-83.

Gabel, C.P., Burkett, B., Neller, A., Yelland, M., 2008. Can long-term impairment in general practitioner whiplash patients be predicted using screening and patient-reported outcomes? International J Rehabilitative Research31 (1), 79-80.

Galasko, C.S.B., Murray, P.A., Pitcher, M., 2000. Prevalence and long-term disability following whiplash-associated disorder. Journal of Musculoskeletal Pain8, 15-27.

Gargan, M., Bannister, G., Main, C., Hollis, S., 1997. The behavioural response to whiplash injury. J Bone Joint Surg79B (4), 523-6.

Gargan, M.F., Bannister, G.C., 1990. Long-term prognosis of soft-tissue injuries of the neck. J Bone Joint Surg72B (5), 901-3.

Gargan, M.F., Bannister, G.C., 1994. The rate of recovery following whiplash injury. Eur Spine J3 (3), 162-4.

Geldman, M., Moore, A., Cheek, L., 2008. The effect of pre-injury physical fitness on the initial severity and recovery from whiplash injury at six-month follow-up. Clinical Rehabilitation22, 364-376.

Giguere, J.F., St-Vil, D., Turmel, A., Di Lorenzo, M., Pothel, C., Manseau, S., Mercier, C., 1998. Airbags and children: A spectrum of c-spine injuries. J Pediatr Surg33 (6), 811-6.

Gotten, N., 1956. Survey of one hundred cases of whiplash injury after settlement of litigation. J Am Med Assoc162 (9), 865-7.

Gozzard, C., Bannister, G., Langkamer, G., Khan, S., Gargan, M., Foy, C., 2001. Factors affecting employment after whiplash injury. J Bone Joint Surg Br83 (4), 506-9.

Gun, R.T., Osti, O.L., O'riordan, A., Mpelasoka, F., Eckerwall, C.G., Smyth, J.F., 2005. Risk factors for prolonged disability after whiplash injury: A prospective study. Spine30 (4), 386-91.

Hartling, L., Pickett, W., Brison, R.J., 2002. Derivation of a clinical decision rule for whiplash associated disorders among individuals involved in rear-end collisions. Accid Anal Prev34 (4), 531-9.

Hell, W., Hopfl, F., Langweider, K., Lang, D., Year. Cervical spine distortion injuries in various car collision directions and injury incidence of different car types in rear-end collisions. In: Proceedings of the International IRCOBI Conference on the Biomechanics of Impact, Lisbon, Portugal, pp. 193-206.

Hendriks, E.J., Scholten-Peeters, G.G., Van Der Windt, D.A., Neeleman-Van Der Steen, C.W., Oostendorp, R.A., Verhagen, A.P., 2005. Prognostic factors for poor recovery in acute whiplash patients. Pain114 (3), 408-16.

Hijioka, A., Narusawa, K., Nakamura, T., 2001. Risk factors for long-term treatment of whiplash injury in japan: Analysis of 400 cases. Arch Orthop Trauma Surg121 (9), 490-3.

Hildingsson, C., Toolanen, G., 1990. Outcome after soft-tissue injury of the cervical spine. Acta Orthop Scand Audiol61 (4), 357-359.

Hildingsson, C., Wenngren, B.I., Bring, G., Toolanen, G., 1989. Oculomotor problems after cervical spine injury. Acta Orthop Scand60 (5), 513-6.

Hodgson, S., Grundy, M., 1989. Whiplash injuries: Their long-term prognosis and its relationship to compensation. Neuro Orthop7, 88-99.

Hohl, M., 1975. Soft tissue injuries of the neck. Clinical Orthopaedics and Related Research(109), 42-9.

Holm, L.W., Carroll, L.J., Cassidy, J.D., Hogg-Johnson, S., Côté, P., Guzman, J., Peloso, P., Nordin, M., Hurwitz, E., Van Der Velde, G., Carragee, E., Haldeman, S., 2008. The burden and determinants of neck pain in whiplash-associated disorders after traffic collision. Spine 33 (4 Suppl), S52-S59.

Holm, L.W., Carroll, L.J., David Cassidy, J., Ahlbom, A., 2007. Factors influencing neck pain intensity in whiplash-associated disorders in sweden. Clin J Pain23 (7), 591-7.

Hours, M., Khati, I., Charnay, P., Chossegros, L., Tardy, H., Tournier, C., Perrine, A.L., Luaute, J., Laumon, B., 2014. One year after mild injury: Comparison of health status and quality of life between patients with whiplash versus other injuries. J Rheumatol41 (3), 528-38.

Hughes, M.C., Moss, R.T., Happer, A.J., Year. Occupant injury symptom duration resulting from low speed collisions. In: Proceedings of the International IRCOBI Research Conference on the Biomechanics of Impact, Madrid, Spain, pp. 20-22.

Jakobsson, L., Lundell, B., Norin, H., Isaksson-Hellman, I., 2000. Whips--volvo's whiplash protection study. Accid Anal Prev32 (2), 307-19.

Jakobsson, L., Norin, H., Svensson, M.Y., 2004. Parameters influencing ais 1 neck injury outcome in frontal impacts. Traffic Inj Prev5 (2), 156-63.

Jonsson, H., Jr., Cesarini, K., Sahlstedt, B., Rauschning, W., 1994. Findings and outcome in whiplash-type neck distortions. Spine19 (24), 2733-43.

Kamper, S.J., Rebbeck, T.J., Maher, C.G., Mcauley, J.H., Sterling, M., 2008. Course and prognostic factors of whiplash: A systematic review and meta-analysis. Pain 138, 617-629.

Karlsborg, M., Smed, A., Jespersen, H., Stephensen, S., Cortsen, M., Jennum, P., Herning, M., Korfitsen, E., Werdelin, L., 1997. A prospective study of 39 patients with whiplash injury. Acta Neurol Scand95 (2), 65-72.

Karnezis, I.A., Drosos, G.I., Kazakos, K.I., 2007. Factors affecting the timing of recovery from whiplash neck injuries: Study of a cohort of 134 patients pursuing litigation. Arch Orthop Trauma Surg127, 633-636.

Kasch, H., Bach, F.W., Jensen, T.S., 2001a. Handicap after acute whiplash injury: A 1-year prospective study of risk factors. Neurology56 (12), 1637-43.

Kasch, H., Bach, F.W., Stengaard-Pedersen, K., Jensen, T.S., 2003. Development in pain and neurologic complaints after whiplash: A 1-year prospective study. Neurology60 (5), 743-9.

Kasch, H., Qerama, E., Kongstead, A., Bach, F.W., Bendix, T., Jensen, T.S., 2008a. Deep muscle pain, tender points and recovery in acute whiplash patients: A 1-year follow-up study. Pain 140 (1), 65-73.

Kasch, H., Qerama, E., Kongstead, A., Bendix, T., Jensen, T.S., Bach, F.W., 2008b. Clinical assessment of prognostic factors for long-term pain and handicap after whiplash injury: A 1-year prospective study. Eur J Neurol 15 (11), 1222-1230.

Kasch, H., Qerama, E., Kongsted, A., Bendix, T., Jensen, T.S., Bach, F.W., 2008c. Clinical assessment of prognostic factors for long-term pain and handicap after whiplash injury: A 1-year prospective study. Eur J Neurol.

Kasch, H., Stengaard-Pedersen, K., Arendt-Nielsen, L., Staehelin Jensen, T., 2001b. Pain thresholds and tenderness in neck and head following acute whiplash injury: A prospective study. Cephalalgia21 (3), 189-97.

Kent, R., Henary, B., Year. On the fatal crash experience of older drivers. In: Proceedings of the Proceedings of the 49th Association for the Advancement of Automotive Medicine Conference, Boston, Massachusetts, pp. 371-391.

Kischka, U., Ettlin, T., Heim, S., Schmid, G., 1991. Cerebral symptoms following whiplash injury. Eur Neurol31 (3), 136-40.

Kivioja, J., Jensen, I., Lindgren, U., 2005. Early coping strategies do not influence the prognosis after whiplash injuries. Injury36 (8), 935-40.

Koch, V., Nygren, A., Tingvall, C., Year. Impairment pattern in passenger car crashes, a follow-up of injuries resulting in long-term consequences. In: Proceedings of the Presented at the 14th International Technical Conference on Enhanced Safety of Vehicles, Munchen.

Kockelman, K.M., Kweon, Y.-J., 2002. Driver injury severity: An application of ordered probit models. Accid Anal Prev34 (3), 313-321.

Kongsted, A., Jorgensen, L.V., Laboeuf-Yde, C., Qerama, E., Bendix, T., 2008a. Are altered smooth pursuit eye movement related to chronic pain and disability following whiplash injuries? A prospective trial with one-year follow-up. Clinical Rehabilitation22, 468-479.

Kongsted, A., Qerama, E., Kasch, H., Bendix, T., Bach, F.W., Korsholm, L., Jensen, T.S., 2007. Neck collar, "act-as-usual" or active mobilization for whiplash injury? A randomized parallel-group trial. Spine 32 (6), 618-626.

Kongsted, A., Sorensen, J.S., Andersen, H., Keseler, B., Jensen, T.S., Bendix, T., 2008b. Are early mri findings correlated with long-lasting symptoms following whiplash injury? A prospective trial with 1-year follow-up. Eur Spine J17, 996-1005.

Krafft, M., Year. A comparison of short- and long-term consequences of ais 1 neck injuries, in rear impacts. In: Proceedings of the International IRCOBI Conference on the Biomechanics of Impact, Goteborg, Sweden, pp. 235-248.

Krafft, M., 1998b. Non-fatal injuries to car occupants–injury assessment and analysis of impacts causing short- and long-term consequences with special reference to neck injuries, doctoral thesis. Karolinska Institute.

Krafft, M., 2002. When do ais 1 neck injuries result in long-term consequences? Vehicle and human factors. Traffic Injury Prevention3 (2), 89-97.

Krafft, M., Kullgren, A., Lie, A., Tingvall, C., Year. The risk of whiplash injury in the rear seat compared to the front seat in rear impacts In: Proceedings of the International IRCOBI Conference on the Biomechanics of Impact, Munich, Germany, pp. 203-210.

Krafft, M., Kullgren, A., Lie, A., Tingvall, C., 2003. The risk of whiplash injury in the rear seat compared to the front seat in rear impacts. Traffic Injury Prev4, 136-140.

Krafft, M., Kullgren, A., Malm, S., Ydenius, A., Year. Influence of crash severity on various whiplash injury symptoms: A study based on real-life rear-end crashes with recorded crash pulses. In: Proceedings of the 19th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, D.C.

Krafft, M., Kullgren, A., Tingvall, C., Year. Crash pulse recorders in rear impacts - real life data. Swedish national road administration, paper no. 98-s6-o-10. In: Proceedings of the IRCOBI Course on Whiplash Associated Disorders., Goteborg, Sweden, pp. 1-7.

Krafft, M., Kullgren, A., Tingvall, C., Bostrom, O., Fredriksson, R., 2000. How crash severity in rear impacts influences short- and long-term consequences to the neck. Accid Anal Prev32 (2), 187-95.

Kullgren, A., Year. Dose-response models and edr data for assessment of injury risk and effectiveness of safety systems. In: Proceedings of the International IRCOBI Conference Proceedings, Bern, Switzerland, pp. 3-14.

Larder, D., Twiss, M., Mackay, G., Year. Neck injury to car occupants using seat belts. In: Proceedings of the 29th Annual Proceedings of the American Association of Automotive Medicine, pp. 153-165.

Macnab, I., 1964. Acceleration injuries of the cervical spine. Journal of Bone & Joint Surgery46A (8), 1797-1799.

Maimaris, C., Barnes, M.R., Allen, M.J., 1988. 'Whiplash injuries' of the neck: A retrospective study. Injury19 (6), 393-6.

Martin, J.-L., Perez, K., Mari-Dell'olmo, M., Chiron, M., 2008a. Whiplash risk estimation based on linked hospital-police road crash data from france and spain. Injury Prevention 14 (3), 185-190.

Martin, J.L., Perez, K., Mari-Dell'olmo, M., Chiron, M., 2008b. Whiplash risk estimation based on linked hospital-police road crash data from france and spain. Inj Prev14 (3), 185-90.

Mathews, J., Zollinger, T., Przybylski, M., Bull, M., Year. The association between risk-taking behavior and the use of safety devices in adolescents. . In: Proceedings of the 45th Annual Proceedings of the Association for the Advancement of Automotive Medicine, San Antonio, TX, pp. 23-36.

Mayou, R., Bryant, B., 1996. Outcome of 'whiplash' neck injury. Injury27 (9), 617-23.

Mckinney, L.A., 1989. Early mobilization and outcome in acute sprains of the neck. British Medical Journal299, 1006-1008.

Merrick, D., Stalnacke, B.M., 2010. Five years post whiplash injury: Symptoms and psychological factors in recovered versus non-recovered. BMC Res Notes3, 190.

Miettinen, T., Airaksinen, O., Lindgren, K.A., Leino, E., 2004a. Whiplash injuries in finland--the possibility of sociodemographic and psychosocial factors to predict the outcome after one year. Disability and Rehabilitation26 (23), 1367-1372.

Miettinen, T., Airaksinen, O., Lindgren, K.A., Leino, E., 2004b. Whiplash injuries in finland--the possibility of some sociodemographic and psychosocial factors to predict the outcome after one year. Disabil Rehabil26 (23), 1367-72.

Miles, K.A., Maimaris, C., Finlay, D., Barnes, M.R., 1988. The incidence and prognostic significance of radiological abnormalities in soft tissue injuries to the cervical spine. Skeletal Radiol17 (7), 493-6.

Morris, A., Thomas, P., 1996. Neck injuries in the uk co-operative crash study. SAE 962433, 317-329.

Myrtveit, S.M., Skogen, J.C., Petrie, K.J., Wilhelmsen, I., Wenzel, H.G., Sivertsen, B., 2014. Factors related to non-recovery from whiplash. The nord-trondelag health study (hunt). Int J Behav Med21 (3), 430-8.

Nederhand, M.J., Hermens, H.J., Mj, I.J., Turk, D.C., Zilvold, G., 2003. Chronic neck pain disability due to an acute whiplash injury. Pain102 (1-2), 63-71.

Norris, S.H., Watt, I., 1983. The prognosis of neck injuries resulting from rear-end vehicle collisions. J Bone Joint Surg65B (5), 608-11.

Olivegren, H., Jerkvall, N., Hagstrom, Y., Carlsson, J., 1999. The long-term prognosis of whiplash-associated disorders (wad). Eur Spine J8 (5), 366-70.

Olsson, I., Bunketorp, O., Carlsson, G., Gustafsson, C., Planath, I., Norin, H., Year. An in-depth study of neck injuries in rear end collisions. In: Proceedings of the International IRCOBI Conference, Lyon, France, pp. 269-280.

Olsson, I., Bunketorp, O., Carlsson, S.G., Styf, J., 2002. Prediction of outcome in whiplash-associated disorders using west haven-yale multidimensional pain inventory. Clin J Pain18 (4), 238-44.

Ono, K., Kanno, M., Year. Influences of the physical parameters on the risk to neck injuries in low impact speed rear-end collisions. In: Proceedings of the International IRCOBI Conference on the Biomechanics of Impacts, Eindhoven, Netherlands, pp. 201-212.

Ottosson, C., Nyren, O., Johansson, S.E., Ponzer, S., 2005. Outcome after minor traffic accidents: A follow-up study of orthopedic patients in an inner-city area emergency room. J Trauma58 (3), 553-60.

Ovadia, D., Steinberg, E.L., Nissan, M.N., Dekel, S., 2002. Whiplash injury--a retrospective study on patients seeking compensation. Injury33 (7), 569-73.

Pape, E., Brox, J.I., Hagen, K.B., Natvig, B., Schirmer, H., 2007. Prognostic factors for chronic neck pain in persons with minor or moderate injuries in traffic accidents. Accid Anal Prev39 (1), 135-146.

Parmar, H.V., Raymakers, R., 1993. Neck injuries from rear impact road traffic accidents: Prognosis in persons seeking compensation. Injury24 (2), 75-8.

Partheni, M., Constantoyannis, C., Ferrari, R., Nikiforidis, G., Voulgaris, S., Papadakis, N., 2000. A prospective cohort study of the outcome of acute whiplash injury in greece. Clin Exp Rheumatol18 (1), 67-70.

Pearce, J.M., 1989. Whiplash injury: A reappraisal. J Neurol Neurosurg Psychiatry52 (12), 1329-31.

Pearce, J.M., 2001. Headaches in the whiplash syndrome. Spinal Cord39 (4), 228-33.

Pennie, B.H., Agambar, L.J., 1990. Whiplash injuries. A trial of early management. J Bone Joint Surg72B (2), 277-9.

Pettersson, K., Brandstrom, S., Toolanen, G., Hildingsson, C., Nylander, P.O., 2004. Temperament and character: Prognostic factors in whiplash patients? Eur Spine J13 (5), 408-14.

Pettersson, K., Hildingsson, C., Toolanen, G., Fagerlund, M., Bjornebrink, J., 1997. Disc pathology after whiplash injury. A prospective magnetic resonance imaging and clinical investigation. Spine22 (3), 283-7; discussion 288.

Pobereskin, L.H., 2005. Whiplash following rear end collisions: A prospective cohort study. J Neurol Neurosurg Psychiatry76 (8), 1146-51.

Radanov, B.P., Di Stefano, G., Schnidrig, A., Ballinari, P., 1991. Role of psychosocial stress in recovery from common whiplash [see comment]. Lancet338 (8769), 712-5.

Radanov, B.P., Di Stefano, G., Schnidrig, A., Sturzenegger, M., 1993a. Psychosocial stress, cognitive performance and disability after common whiplash. J Psychosom Res37 (1), 1-10.

Radanov, B.P., Di Stefano, G., Schnidrig, A., Sturzenegger, M., Augustiny, K.F., 1993b. Cognitive functioning after common whiplash. A controlled follow-up study. Arch Neurol50 (1), 87-91.

Radanov, B.P., Sturzenegger, M., De Stefano, G., Schnidrig, A., 1994. Relationship between early somatic, radiological, cognitive and psychosocial findings and outcome during a one-year follow-up in 117 patients suffering from common whiplash. Br J Rheumatol33 (5), 442-8.

Radanov, B.P., Sturzenegger, M., Stefano, G.D., 1995. Long-term outcome after whiplash injury: A two-year follow-up considering features of injury mechanism and somatic, radiologic, and psychosocial factors. Medicine74 (5), 281-297.

Richter, M., Ferrari, R., Otte, D., Kuensebeck, H.W., Blauth, M., Krettek, C., 2004. Correlation of clinical findings, collision parameters, and psychological factors in the outcome of whiplash associated disorders. J Neurol Neurosurg Psychiatry75 (5), 758-64.

Richter, M., Otte, D., Blauth, M., 1999a. Acceleration injuries of the cervical spine in seat-belted automobile drivers. Determination of the trauma mechanism and severity of injury. Orthopade28 (5), 414-23.

Richter, M., Otte, D., Blauth, M., 1999b. Acceleration related injury of the cervical spine in restrained car drivers. Investigations on the trauma mechanism and severity of injury. Orthopade28, 414-423.

Richter, M., Otte, D., Pohlemann, T., Krettek, C., Blauth, M., 2000. Whiplash-type neck distortion in restrained car drivers: Frequency, causes and long-term results. Eur Spine J9 (2), 109-17.

Robinson, D.D., Cassar-Pullicino, V.N., 1993. Acute neck sprain after road traffic accident: A long-term clinical and radiological review. Injury24 (2), 79-82.

Ryan, G.A., Taylor, G.W., Moore, V.M., Dolinis, J., 1993. Neck strain in car occupants. The influence of crash-related factors on initial severity. Med J Aust159 (10), 651-6.

Satoh, S., Naito, S., Konishi, T., Yoshikawa, M., Morita, N., Okada, T., Kageyama, T., Matsuzaki, I., 1997. An examination of reasons for prolonged treatment in japanese patients with whiplash injuries. J Musculoskel Pain5 (2), 71-84.

Scholten-Peeters, G.G., Verhagen, A.P., Bekkering, G.E., Van Der Windt, D.A., Barnsley, L., Oostendorp, R.A., Hendriks, E.J., 2003. Prognostic factors of whiplash-associated disorders: A systematic review of prospective cohort studies. Pain104 (1-2), 303-22.

Solarino, B., Coppola, F., Di Vella, G., Corsalini, M., Quaranta, N., 2009. Vestibular evoked myogenic potentials (vemps) in whiplash injury: A prospective study. Acta Otolaryngol129 (9), 976-81.

Spitzer, W.O., Skovron, M.L., Salmi, L.R., Cassidy, J.D., Duranceau, J., Suissa, S., Zeiss, E., 1995. Scientific monograph of the quebec task force on whiplash-associated

disorders: Redefining "whiplash" and its management. Spine20 (8 Suppl), 1S-73S.

Squires, B., Gargan, M.F., Bannister, G.C., 1996. Soft-tissue injuries of the cervical spine. 15-year follow-up. J Bone Joint Surg78B (6), 955-7.

Stalnacke, B.M., 2009. Relationship between symptoms and psychological factors five years after whiplash injury. J Rehabil Med41 (5), 353-9.

Sterling, M., Elliott, J.M., Cabot, P.J., 2013. The course of serum inflammatory biomarkers following whiplash injury and their relationship to sensory and muscle measures: A longitudinal cohort study. PLoS One8 (10).

Sterling, M., Jull, G., Vicenzino, B., Kenardy, J., 2003a. Sensory hypersensitivity occurs soon after whiplash injury and is associated with poor recovery. Pain104 (3), 509-17.

Sterling, M., Jull, G., Vicenzino, B., Kenardy, J., 2003b. Sensory hypersensitivity occurs soon after whiplash injury ands is associated with poor memory. Pain104, 509-517.

Sterling, M., Jull, G., Vicenzino, B., Kenardy, J., Darnell, R., 2005. Physical and psychological factors predict outcome following whiplash injury. Pain114 (1-2), 141-8.

Sterner, Y., Toolanen, G., Gerdle, B., Hildingsson, C., 2003. The incidence of whiplash trauma and the effects of different factors on recovery. J Spinal Disord Tech16 (2), 195-9.

Storvik, S.G., Stemper, B.D., Yoganandan, N., Pintar, F.A., 2009. Population-based estimates of whiplash injury using nass cds data - biomed 2009. Biomedical Sciences Instrumentation45, 244-9.

Suissa, S., 2003. Risk factors of poor prognosis after whiplash injury. Pain Res Manag8 (2), 69-75.

Suissa, S., Harder, S., Veilleux, M., 2001. The relation between initial symptoms and signs and the prognosis of whiplash. Eur Spine J10 (1), 44-9.

Temming, J., Zobel, R., Year. Frequency and risk of cervical spine distortion injuries in passenger car accidents: Significance of human factors data. In: Proceedings of the International IRCOBI Conference on the Biomechanics of Impact, Göteborg, Sweden, pp. 219-233.

Tomlinson, P.J., Gargan, M.F., Bannister, G.C., 2005. The fluctuation in recovery following whiplash injury 7.5-year prospective review. Injury36 (6), 758-61.

Treleaven, J., Jull, G., Sterling, M., 2003. Dizziness and unsteadiness following whiplash injury: Characteristic features and relationship with cervical joint position error. J Rehabil Med35 (1), 36-43.

Ulfarsson, G., F., Mannering, F.L., 2004 Differences in male and female injury severities in sport-utility vehicle, minivan, pickup and passenger car accidents. Accid Anal Prev36 (2), 135-147.

Van Den Kroonenberg, A., Phillipens, H., Cappon, J., Wismans, J., Hell, W., Langweider, K., Year. Human head-neck response during low-speed rear end impacts. In: Proceedings of the Proceedings of the 42nd Stapp Car Crash Conference, pp. 207-221.

Vetti, N., Krakenes, J., Eide, G.E., Rorvik, J., Gilhus, N.E., Espeland, A., 2010. Are mri high-signal changes of alar and transverse ligaments in acute whiplash injury related to outcome? BMC Musculoskelet Disord11 (1), 260.

Voyvodic, F., Dolinis, J., Moore, V.M., Ryan, G.A., Slavotinek, J.P., Whyte, A.M., Hoile, R.D., Taylor, G.W., 1997. Mri of car occupants with whiplash injury. Neuroradiology39 (1), 35-40.

Watkinson, A., Gargan, M.F., Bannister, G.C., 1991. Prognostic factors in soft tissue injuries of the cervical spine. Injury22 (4), 307-9.

Wiles, N.J., Jones, G.T., Silman, A.J., Macfarlane, G.J., 2005. Onset of neck pain after a motor vehicle accident: A case-control study. J Rheumatol32 (8), 1576-83.

Zaloshnja, E., Miller, T., Council, F., Persaud, B., Year. Comprehensive and human capital crash costs by maximum police-reported injury severity within selected crash types. In: Proceedings of the 48th Annual Proceedings of the Association for the Advancement of Automotive Medicine, Key Biscayne, Fl, pp. 251-264.

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