The association between lifetime history of a neck injury in a motor vehicle collision and future neck pain: a population based cohort study

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ABSTRACT:

The role of neck injury in a motor vehicle collision as a predisposing factor for future neck pain and disability is controversial. The purpose of this study is to determine whether a past history of neck injury in a motor vehicle collision was associated with incident troublesome neck pain. Data from the Saskatchewan Health and Back Pain Survey, a population based survey mailed to a stratified random sample of 2184 Saskatchewan adults aged 20-69 years was used for the analysis. Fifty-five percent of the eligible population participated and of those 74.8% responded to the six month and 62.9% at twelve month follow-up survey. The exposure was collected by asking participants whether they had ever injured their neck in a motor vehicle collision (n=122). The population at risk included those with no or mild neck pain at baseline (n=919). The association between the history of neck injury in a motor vehicle collision and the development of troublesome neck pain was analyzed with multivariable Cox regression with adjustment for confounders. The history of neck injury in a motor vehicle collision was positively associated with the development of troublesome neck pain at six and twelve months (crude Hazard Rate Ratio = 2.43; 95% CI 1.28-4.60). After adjusting for bodily pain and BMI, this association was reduced (Hazard Rate Ratio = 2.14; 95% CI 1.12-4.10). This prospective cohort study suggests that a history of neck injury in a motor vehicle collision was a risk factor for the development of an episode of troublesome neck pain.

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CHAPTER ONE: INTRODUCTION

Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck, usually occurring during a motor vehicle collision (Spitzer et al., 1995). The impact to the spine can result in soft tissue injuries that lead to symptoms referred to as whiplash associated disorders (WAD). Injuries to the neck are common after whiplash injuries and widespread areas of pain can develop early after injury (Holm, Carroll, Cassidy, Skillgate, & Ahlbom, 2007). For example, in a population based cohort study of Saskatchewan residents the most common road traffic injury was whiplash which affected 83% of those involved in a motor vehicle collision (Cassidy et al., 2000). Although the main symptom of a whiplash associated disorder is neck pain other symptoms can develop. These symptoms include headache, facial pain, temporo-mandibular joint pain, dysphagia, visual disturbances, dizziness, vertigo, tinnitus, concentration difficulties, memory loss, depression, interscapular pain, and upper and lower extremity numbness and pain (Carroll et al., 2008; Carroll, Cassidy & Côté, 2006; Cassidy et al., 2000; Spitzer et al., 1995).

The World Health Organization's (WHO) 2004 "World Report on Road Traffic Injury Prevention" examined the global impact of motor vehicle collision (MVC) injuries (Peden et al., 2004). They estimated that between 20 to 50 million individuals per year are injured worldwide in traffic collisions. Traffic injuries are the 9th leading cause of disease and injury. The Bone and Joint Decade 2000-2010, Task Force on Neck Pain and its Associate Disorders reported that the annual incidence of whiplash associated disorders in North America and Western Europe exceeds 300 per 100,000 inhabitants (Holm et al., 2008).

The best evidence synthesis conducted by the recent Task Force on Neck Pain and Its Associated Disorders, found that in the general population, the 12-month prevalence of neck pain ranges from 30% to 50%. The same authors reported that the 12 month prevalence of neck pain associated with activity limitation ranged from 1.7% to 11.5% (Hogg-Johnson et al., 2008). In Canada, the age and gender standardized annual incidence of neck pain in the general population of Saskatchewan was 14.6%. Neck pain is a disabling condition with a course marked by periods of remission and exacerbations (Côté, Cassidy, Carroll & Kristman, 2004). In Saskatchewan, 22.8% of a general population cohort report recurrent neck pain annually (Côté et al., 2004). The Task Force on Neck Pain and Its Associated Disorders reviewed the course of whiplash associated disorder and the factors associated with the development chronic neck pain and prognosis of neck pain (Holm et al., 2008; Carroll et al., 2008). The Task Force reported that a significant proportion of whiplash associated disorder patients have a persistent or recurrent neck pain. Specifically, more than 50% of individuals with whiplash associated disorders will report neck pain one year later (Carroll et al., 2008). Recovery was found to be negatively associated with initial symptom severity, post injury psychological distress, passive coping and the intensity of initial health care seeking (Carroll et al., 2008).

Objectives

The objective of this study was to determine whether a past history of neck injury in a motor vehicle collision was associated with incident troublesome neck pain. This study reviews the literature on neck injury in a motor vehicle collision and future neck pain and uses data from the Saskatchewan Health and Back Pain Survey in a cohort study to investigate the association between lifetime history of neck injury resulting from a motor vehicle collision and the development of troublesome neck pain.

CHAPTER TWO: LITERATURE REVIEW

Objectives

The objective of the literature review was to critically appraise the epidemiological literature on the association between neck injury in a motor vehicle collision and future neck pain.

Literature search and selection of articles

Three electronic databases were searched: MEDLINE (1990 to January 2007), EMBASE (1990 to January 2007), and CINAHL (1982 to December 2006). The search focused on the following keywords: neck injury, neck pain, whiplash, cervical, hyperextension, traffic accident, motor vehicle, car driving, traffic, automobile, vehicles, disease course, risk, diagnose, outcome, cohort, case control, prognosis, medical, treatment, outcome, disease course, survival, natural history, prospective study and cross-sectional. The review was restricted to cohort, case-control and cross-sectional studies that investigated the association between neck injury in a traffic collision and future neck pain. The search strategy was outlined in appendix 1.

The search identified 2467 articles: 923 articles from MEDLINE, 261 from CINAHL and 1283 from EMBASE. I identified 548 duplicates; 1919 articles were screened for eligibility. I discarded 1878 articles because they did not relate to neck injury in a motor vehicle accident and future neck pain. The abstract of 41 articles were reviewed to ensure that they related to the question of interest. Of those, 22 articles were reviewed and 15 articles were excluded because they were not cohort, case-control or cross-sectional studies with a control group or did not meet the review criteria (Abbott, Rounsefell, Fraser, & Goss, 1990; Atherton et al., 2006; Bovim, Schrader, & Sand, 1994; Bunketorp, Nordholm, & Carlsson, 2002; Bunketorp, Lindh, Carlsson, & Stener-Vicorin, 2006; Croft et al., 2001; Croft, Lewis, & Hannaford, 2003; Fredriksson et al., 1999; Guez, Hildingsson, Stegmayr & Toolanen, 2003; Joslin, Khan, & Bannister, 2004; Kasch, Bach, Stengaard-Perdersen, & Jensen, 2003; Li, Roberts, & Power, 2001; Marshall, O'Connor, & Hodgkinson, 1995; Tomlinson, Gargan, & Bannister, 2005; Squires, Gargan, & Bannister, 1996). Seven papers met the review criteria (Berglund, Alfredsson, Cassidy, Jensen, & Nygren, 2000; Bunketorp, Stener-Victorin, & Carlsson, 2005; Côté, Cassidy, & Carroll, 2000; Freeman, Croft, Rossignol, & Centeno, 2006; Guez, Hildingsson, Nilsson, & Toolanen, 2002; Obelieniene, Schrader, Bovim, Miseviciene, & Sand, 1999; Schrader et al., 1996)

Critical appraisal and classification of the evidence

I used the quality assessment of low back pain prognosis studies tool (QUIPS-LBP tool) to critically appraise the seven studies identified in the literature search (Hayden, Côté, & Bombardier, 2006). This tool was developed by a group of 15 experts who proposed a list of potential biases that may impact on the validity of prognostic studies: 1) study participation; 2) study attrition; 3) measurement of prognostic factors; 4) measurement of and controlling for confounding variables; and 5) measurement of outcome. The QUIPS-LBP tool was used to make an informed judgment on the level of each potential bias in prognosis studies. The probability of bias in each study was qualitatively rated as low, moderate and high. The quality assessment tool has been used to evaluate prognosis studies in topic areas such as musculoskeletal, neurological, obstetrics, rheumatology and cardiovascular research (Hayden et al., 2006).

I also classified the prognostic studies according to the classification proposed by Hayden et al. (2008). Phase I studies assess associations between potential prognostic factors and health outcomes. Results from these studies are exploratory and often test for a number of potential prognostic associations that can be used for hypothesis generating. This level of testing does not control for potential confounding and can produce conflicting results between studies. Phase I studies produces the least conclusive evidence for the independence of a variable as a valid prognostic factor. Phase II studies are used to test the strength of association between the prognostic variable on the health outcome. Confounding variables are controlled with the use of multivariable analysis. Phase III studies are explanatory and attempt to understand prognostic pathways. Phase III studies are developed from a theoretical framework that includes the prognostic construct of interest, confounding variables, effect modifiers and mediators of the association between the prognostic factor and the outcome of interest (Hayden, Côté, Steenstra, & Bombardier, 2008).

Discussion

Of the 7 papers included in the review, one was a phase II cohort study of patients recruited from hospital emergency departments (Bunketorp et al., 2005) and one a phase II case control study of chiropractic patients (Freeman et al., 2006) (Table 1). Two studies were phase II cohort studies using police records (Obelieniene et al., 1999; Schrader et al., 1996) and one was a phase II cohort study of individuals recruited form an insurance company (Berglund et al., 2000). I also reviewed two phase I cross-sectional studies of the general population (Côté et al., 2000; Guez et al., 2002).

Table 1 – Classification of the prognostic studies that met the critical appraisal criteria for inclusion in the literature review. Studies are classified based on the target population and strength of the evidence (phase of investigation)

PHASES OF INVESTIGATION	TARGET POPULATION			
	Hospital Emergency Primary Care	**Police Records**	**Insurance**	**General Population**
Phase III – Understanding and testing prognostic pathways.				
Phase II – Testing independent associations	Bunketorp et al. (2005) Freeman et al. (2006)	Obelieniene et al. (1999) Schrader et al. (1996)	Berglund et al. (2000)	
Phase I – Exploration of associations				Côté et al., (2000) Guez et al. (2002)

All studies were critically appraised using the QUIPS-LBP tool. Overall, the current body of evidence suggests that a history of neck injury in a traffic collision is positively associated with future neck pain. Two studies with a positive association had low to moderate risks of bias and the remaining studies had higher risks of bias. The overall risk of bias for the 7 studies is shown in Table 2 and Table 3.

Five studies reported a positive association between a neck injury in a motor vehicle collision and future neck pain (Berglund et al., 2000; Bunketorp et al., 2005; Côté et al., 2000; Freeman et al., 2006; Guez et al., 2002). Both cross-sectional studies found the exposure of a neck injury in a motor vehicle collision was a potential risk factor for future neck pain (Côté et al., 2000; Guez et al., 2002).

Table 2– Assessment of levels of bias in prognostic studies using the QUIPS-LBP tool in studies on late neck pain in subjects with exposure to an injury in a motor vehicle collision.

Author, year	Study participation	Study attrition	Whiplash exposure	Neck pain Measurement	Study Confounding	Comments, odds ratio (OR)/relative risk (RR)
Freeman, 2006, case control	Moderate to high risk	n/a	Low to moderate risk	Moderate risk	Moderate risk	Men 4.0 women 2.1 (adjusted OR)
Bunketorp, 2005, cohort	Moderate to high risk	Low risk	Low risk	Moderate risk	Moderate to high risk	Persistent neck pain 3.0 (crude OR)
Guez, 2002, cross-sectional	Low risk	n/a	Moderate risk	Low to moderate risk	Moderate to high risk	Neck injury 4.39 (crude OR)
Berglund, 2000, cohort	Low risk	Low risk	Low risk	Low to moderate risk	Moderate risk	Exp/injury 2.7 Exp/no inj 1.3 (adjusted RR)
Côté, 2000, cross-sectional	Low risk	n/a	Low to moderate risk	Low risk	Low risk	Low int/dis 2.81 High int/low dis 4.46 High int/high dis 3.30 (adjusted OR)
Obelieniene, 1999, cohort	Moderate risk	Low risk	Moderate risk	Moderate risk	Moderate risk	No association
Schrader, 1996, cohort	Moderate risk	n/a	Moderate to high risk	Moderate risk	Moderate risk	No association

The study by Côté et al. (2000) was conducted in Saskatchewan in 1995. The survey included 1100 subjects (55%); of those, 175 subjects (15.9%) reported a history of neck injury in a motor vehicle collision. The outcome was six-month prevalence of graded neck pain. The authors used multivariable logistic regression to adjust for age, gender and other covariates. This phase I study found that neck injury in a motor vehicle collision was positively associated with low intensity/low disability neck pain (OR 2.81; 95% CI 1.81-4.37), with high intensity low disability neck pain (OR 4.46; 95% CI 2.49-4.99), and with disabling neck pain (OR 3.30; 95% CI 1.48-7.39). A limitation of this study was that we do not know whether the exposure to neck injury in a motor vehicle collision preceded the onset of neck pain.

Table 3– Summary of Systematic Review of studies using the QUIPS-LBP tool.

Author	Source Population	Attrition	Exposure\ Definition	Outcome Measure	Confounding	Outcome
Freeman, 2006 case control	Subjects: 419 subjects with exposure and 246 controls (proxy sample) consecutively selected from chiropractic offices	Not a prospective study.	Question: The subject was asked the attributed origin of their chronic pain (i.e. MVA).	Inclusion question: y/n, experience with at least one intrusive episode of neck pain per week, for the preceding consecutive 26 weeks (6 months) or longer.	Mantel-Haenszel Used to control for age and gender.	Men 4.0 women 2.1 (adjusted Odds Ratio)
Bunketorp, 2005, cohort	The exposed group (n=121) was recruited from subjects from hospital emergency of 2 hospitals. Matched controls (n=1500) from general population of Goteborg .	Cohort study, exposure group 89% response rate after exclusion criteria.	The diagnosis (soft tissue injury) was made with anamnestic and radiological information and the presence of neck pain and stiffness.	Questionnaire: exposed group were asked a yes or no question about persistent neck pain linked to the MVA in 1983. The control group was asked to report, y/n about the occurrence of neck pain.	Data stratified for age and gender. Chi squared used for gender differences.	Persistent neck pain 2.95 (crude Odds Ratio)
Guez, 2002, cross-sectional	4392 subjects between 25-64 years of age, randomly selected from two cities in Sweden MONICA study.	Cross-sectional study	Questionnaire: Patients seeking medical attention after a cervical spine injury with persistent post-traumatic complaint were defined as having injury related neck pain (whiplash, other neck, or no injury)	Question: If you have neck pain, how long have you had symptoms? Last week; last 6 months; more than six months. Positive: more than 6 months	No controlling for confounding	Neck injury 4.39 (crude Odds Ratio)
Berglund, 2000, cohort	Exposure to MVC: Injury (182)/ Control (697) No Injury (136)/ Control (494). Insurance data.	Response rate 76% to 79% for each group seven years after exposure.	Insurance claim reports were examined for exposure to a rear-end collision with and without claiming neck injury (two groups)	Question: Neck pain over the last 3 months? Never, occasionally, often and always. Positive: often or always	Mantel-Haenszel Used to control for age and gender.	Exp/inj 2.7 Exp/no inj 1.3 (adjusted Relative Risk)
Côté, 2000, cross-sectional	Subjects randomly selected from Saskatchewan, Canada (n=1131). Exposed (n=175)	Cross-sectional study, 55% response rate	Question: Have you ever injured your neck in a motor vehicle collision?	Graded neck pain in the previous six months (grade 0-4) Von Korff Chronic Pain Grade Questionnaire	Logistic regression model controlling for age, gender, comorbidities, general health, socioeconomic status,	Low intensity/disability 2.81 High int/low dis 4.46 High int/high dis 3.30 (adjusted Odds Ratio)
Obelieniene, 1999, Inception cohort	Exposure to MVC (277). Control group from general population, gender and age matched	Exposure group 210 (76%). Control group 210 (78%)	Subjects identified from the daily records of the traffic police that were involved in rear-end collisions	Follow up questionnaire at 1 year post MVC asked about current neck pain ≥ 1 day a month , 1 to 7 days a month or > 7 days a month (frequent neck pain)	Control group matched for age and gender.	No association between exposure and late neck pain.
Schrader, 1996, Retrospective cohort	Exposure to MVC (240), Control group from general population, gender and age matched	Response exposure, 202 (84%). Controls 202 (80%).	Names and addresses of all drivers of cars with significant rear-end impact were taken from police records made 1-3 years earlier	Questionnaire at 1 to 3 years post MVC asked about current neck pain ≥ 1 day a month , 1 to 7 days a month or > 7 days a month (frequent neck pain)	Control group matched for age and gender. Similar for education and marital status. Bivariate logistic regression controlled for age, psychological symptoms, low back pain, body weight, height and whiplash trauma	No association between exposure and late neck pain.

The second phase I study was a cross-sectional study from two northern counties in Sweden (Guez et al., 2002). The analysis included an age and gender stratified random sample of 6000 individuals (72% participation). The predictor of interest was whether the participant had visited a doctor because of neck or head injury in a traffic collision. I reanalyzed their data and found a crude positive association between seeking medical care for neck injury in a motor vehicle collision and future neck pain (OR 4.39; 95% CI 3.22-5.98).

Three phase II studies reported a positive association between exposure to a neck injury in a motor vehicle collision and future neck pain. The study by Freeman et al. (2006) was a case-control study of 419 consecutive patients recruited from 67 chiropractic offices. The case-series included subjects with neck pain or neck and low back pain and the control series included subjects reporting with low back pain to a chiropractors office. The study reported an odds ratio of 4.0 (95% CI 2.1-7.5) for men and 2.1 (95% CI 1.3-3.3) for women for neck pain associated to an injury in a motor vehicle collision. One important limitation of this study was the non random selection of controls makes it possible that the controls may not have been selected independent of their exposure (Rothman, 2002).

Two phase II cohort studies from Sweden found a positive association between neck injury in a motor vehicle collision and future neck pain. Berglund et al. (2000) studied a cohort of subjects insured by Folksam Insurance Company. The exposure was a rear-end traffic collision that occurred, seven years earlier. Two exposed groups were studied: one without whiplash injury (n=204) and the other with a whiplash injury (n=232). The control group was randomly selected for each exposed group, 1599 controls for the first group and 2089 for the second group. Participants were followed-up 7 years after the collision. Berglund et al. (2000) reported a positive association between a whiplash injury and neck pain 7 years later (Age and gender adjusted RR 2.7, 95% CI 2.1-3.5). The study found no association between a rear-end collision with no reported WAD injury and future neck pain (Age and gender adjusted RR 1.3, 95% CI 0.8-2.0).

The second phase II study followed subjects diagnosed with neck injury in a motor vehicle collision (n=108) at one of two emergency rooms and found that those who sustained a neck injury in a motor vehicle accident 13 years earlier were more likely to report neck pain than randomly selected controls from the general population (n=931) who were not exposed to a neck injury in a motor vehicle collision (Bunketorp et al., 2005). Using data from their study, I calculated a crude odds ratio for the association between neck injury in a motor vehicle collision in subjects reporting to an emergency room and neck pain 13 years later (crude OR 2.95; 95% CI 1.93-4.50). This study found a positive association between whiplash associated disorder and future neck pain. Their control group was selected from the general population matched for age and gender in the exposed group. The authors did not control for other confounders.

Two studies found no association between being exposed to a motor vehicle collision and future neck pain. Both studies recruited participants from the City of Kaunas, Lithuania. The first study was a historical cohort study (Schrader et al., 1996) and the second a prospective cohort study (Obelieniene et al., 1999). The subjects were identified from the police traffic records as having been exposed to rear-end collisions. The study by Schrader et al. (1996) had 31 accident victims (15%) who recalled acute (within 1 day) or subacute (within 1 to 7 days) neck pain after the motor vehicle collision. The Obelieniene et al. (1999) study reported only twenty two subjects (10%) with pain the first day, 2 subjects the second day and 8 the third day. Both studies, unlike the Berglund et al. study, did not differentiate between those with and without neck injury in the motor vehicle collision. The finding of no association between rear-end collision and future neck pain in the two Lithuania studies may be attributed to their exposure definition that did not include having a neck injury in a motor vehicle collision. All studies using an exposure definition of neck injury in a motor vehicle collision had a positive association with future neck pain.

Conclusion

This systematic review of the literature raises the hypothesis that a positive association exists between past neck injury in a traffic collision and future neck pain. Several biases threatened the internal validity of these studies. However, one cross-sectional study (Côté et al., 2000) supported the stronger evidence of a cohort study (Berglund et al., 2000) for a positive association between neck injury in a motor vehicle collision and future neck pain. Both studies had low to moderate risks of bias. The weaker studies had problems with selection bias, bias in the measurement of neck pain, and lack of controlling for confounding.

The prognostic framework used in this review identified the need for a phase II longitudinal cohort study from the general population. The purpose of my thesis was to fill that gap.

Definitions

Neck Pain: Pain and/or stiffness felt dorsally in the cervical region somewhere between the occipital condyles and the C7 vertebral prominence. Neck pain, however, is often accompanied by occipital headache and pain in the shoulder, the upper thoracic spine region and the jaws (Guez, 2006).

Prognostic Framework: Three phases of studies used to investigate future events looking for an association between risk factors and health outcomes. The phases are exploratory (phase I), testing strength of association (phase II), and explanatory (phase III) (Hayden et al., 2008).

QUIPS (LBP) Tool: The quality assessment of low back pain prognosis studies tool was developed by expert consensus to evaluate methodological bias in prognosis studies (Hayden et al., 2006)

SF36: The RAND's Medical Outcomes Study 36-item questionnaire (SF-36) which measures self-perceived general health (Ware, & Sherbourne, 1992)

Vanderbilt Pain Management Inventory: An eleven item likert scale questionnaire used to measure both active and passive coping. Passive coping is measured with 6 questions and active coping with 5 questions giving a score that is categorized as low, medium or high passive or active coping (Brown, & Nicassio, 1987).

von Korff Chronic Pain Grade Questionnaire: A seven item questionnaire using a Gutman scale to rate chronic pain. The questionnaire rates chronic pain into categories from no pain (grade 0) to high intensity/high disability pain (grade IV) (Côté et al., 2000; von Korff, Ormel, Keefe, & Dworkin, 1992).

Whiplash associated disorder (WAD): Whiplash is an acceleration-deceleration mechanism of energy transfer to the neck, usually occurring during a motor vehicle collision. The impact to the spine can result in soft tissue injuries that lead to symptoms referred to as a whiplash associated disorder (WAD) (Spitzer et al., 1995).

CHAPTER THREE: METHODS

Research Question

My thesis will attempt to answer the following question: In a cohort of adults with mild or no neck pain, is a past history of neck injury in a motor vehicle collision associated with the development of troublesome neck pain at six months and one year follow-up?

Design

This study was a secondary analysis of a population-based cohort study. This analysis represents a phase II prognostic study.

Source population and design

The Saskatchewan Health and Back Pain Survey was a population-based cohort study of Saskatchewan adults (Carroll, Cassidy, & Côté, 2000; Cassidy, Carroll, & Côté, 1998; Côté, Cassidy, & Carroll, 1998). The purpose of the Saskatchewan Health and Back Pain Survey was to study the epidemiology of neck pain, back pain and depression in the general population.

Saskatchewan is a Canadian province of approximately one million inhabitants that provides universal health care coverage. A weighted, age-stratified random sample of residents using the Saskatchewan Health Insurance Registration File were formed, this includes over 99% of the Saskatchewan population. Eligible for the study were Saskatchewan residents between the ages of 20 and 69 who held a valid Health Services card on August 31, 1995. Excluded were inmates of correctional facilities, residents under the Office of the Public Trustee, foreign students and workers holding employment or immigration visas, and residents of special care homes. Details on the survey methodology and sample size calculations were reported elsewhere (Carroll et al., 2000; Cassidy et al., 1998; Cote et al., 1998). Participation in the survey was voluntary. Saskatchewan Health randomly selected the subjects and mailed all surveys to protect the confidentiality of the participants. Potential subjects were contacted by mail in September 1995 and again 6 and 12 months later. Returning the completed baseline questionnaire signified implied consent for participation. The 6-month follow-up questionnaire was sent to respondents of the baseline questionnaire, and the 12-month follow-up to respondents of the 6-month follow up. There were three mailing waves for each survey period. The first wave included an introduction letter and the survey questionnaire. Non-respondents received a reminder card and later a duplicate questionnaire. The University of Saskatchewan Advisory Committee on Ethics in Human Experimentation approved this study.

Study sample

Of the eligible 593,464 individuals, 2184 were randomly selected. One hundred and nineteen baseline questionnaires were returned due to mailing errors, five because of 'health reasons', four individuals had emigrated and one had died. Of the 2055 remaining subjects, 1133 returned baseline questionnaires. Two questionnaires were completed by subjects outside of the pre-determined age range and 30 subjects did not complete the neck pain questionnaire. Therefore, the eligible sample for this analysis includes 1101 participants. A comparison of the target population and the randomly selected sample revealed no important differences in age, gender and geographic location of residence (Côté et al., 1998). A comparison of participants and nonparticipants suggested that older individuals, women, those married, individuals residing on Indian Reserves and those with intense non-disabling neck pain were slightly more likely to participate (Carroll et al., 2000; Cassidy et al., 1998; Côté et al., 1998)

Population at Risk

The population at risk for the analysis includes individuals who reported no or grade I neck pain on the Chronic Pain Grade Questionnaire. This information was collected in the baseline questionnaire of the Saskatchewan Health and Back Pain Survey.

Exposure

The exposure was a history of neck injury in a motor vehicle collision. The dichotomous exposure was determined from the question: "Have you ever injured your neck in a motor vehicle accident?" This definition was used to differentiate between the exposed and non-exposed cohort throughout this study.

Outcome

The outcome, troublesome neck pain, was defined as Grade II to IV neck pain in the prior 6 months as measured on the Chronic Pain Grade Questionnaire (CPG). The questionnaire grades pain and disability into five ordered grades (see table 4), (Côté et al., 2000; von Korff et al., 1992).

Table 4, Classification of neck pain grade (as reproduced from Côté, 2000)

Grade	Scoring	Interpretation
'0'	No pain, no disability	No chronic pain
'I'	PI<50; DP<3	Low pain intensity/low disability
'II'	PI≥50; DP<3	High pain intensity/low disability
'III'	DP= 3-4	High disability/moderately limiting
'IV'	DP= 5-6	High disability/severely limiting

PI, pain intensity; DP, disability points

The Chronic Pain Grade Questionnaire contains items able to measure each of the WHO's International Classification of Functioning, Disability and Health (ICF) (Dixon, Pollard & Johnston, 2007). The questionnaire was used in the Saskatchewan Health and Back Pain Survey for its good psychometric properties in the general population. The graded classification (grade 0 to IV) had good agreement to a 3 item scale with kappa scores of 0.79 to 0.86 for low back pain, headache and temporomandibular pain (von Korff, 1992). The questionnaire was found to have good internal consistency (Cronbach's alpha = 0.9132) and be acceptable in general population research (Smith, Penny, Purves, Munro, Wilson, Grimshaw, Chambers & Smith, 1997). The Chronic Pain Grade questionnaire was found to be good for longitudinal studies and correlated closely with the social functioning, role physical and bodily pain categories of the SF-36 (Spearman correlation coefficient; -0.32 to -0.42) (Elliott, Smith, Smith & Chambers, 2000).

Confounders

The following potential confounders were identified a priori: demographic characteristics (age, gender, marital status, location of residence), socioeconomic variable (education, income, employment status), general health (SF36), comorbidities, baseline graded neck pain, depression, cigarette smoking, BMI and exercise. We did not test the confounding of baseline neck pain grade because it lies on the casual pathway between the exposure and the outcome. Therefore, it is an intermediate variable and does not meet the definition of a confounder.

Comorbidities

Comorbidities were measured with the Comorbidity Questionnaire which included questions about allergies, arthritis, high blood pressure, heart/circulation, digestive disorders, headache, and mental/emotional disorders. The self-perceived impact of each comorbidity on one's health was rated on a four point ordinal scale as: 1) not at all, 2) mild, 3) moderate and 4) severe. The Comorbidity Questionnaire has reliability and validity and has been used in a number of studies (Côté et al., 2000; Côté, Cassidy, & Carroll, 2001; Mercado et al., 2000; Mercado et al., 2005).

General Health

Self perceived general health related quality of life was measured using the Medical Outcomes Study 36-item short form questionnaire (SF-36). The questionnaire assesses health related quality of life in eight domains. These domains were physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to emotional health, mental health, social functioning, vitality, and general health. The SF-36 has been shown to have high internal consistency with a Cronbach's alpha great than 0.85 and a reliability coefficient greater than 0.75 (Brazier et al., 1992). The reliability in each domain was between 0.81 to 0.93, except for social functioning which was 0.68 (Ware & Gandek, 1998). The validity of the SF-36 was tested using the longer Medical Outcome Survey and other widely used generic health surveys (Ware, 2000). The Mental Health, Role-Emotional, and Social Functioning scales have been shown to be valid for mental health measures. The Physical Functioning, Role Physical, and Bodily Pain scales have been shown to be valid for physical health measures. The SF-36 has been used to measure disease burden in multiple studies on low back pain, arthritis and depression (Ware, 2000). The questionnaire was a valid and reliable measure of self-perceived general health (Ware, Snow, Kosinski, & Gandek, 1993).

Exercise

Exercise frequency was measured with a question about the average number of days per week participating in a minimum of 30 minutes of exercise. The question asked about the frequency of exercise during the previous six months.

Smoking

Current smokers were identified with the question "Do you still smoke cigarettes? No/yes."

Depression

Depressive symptomatology was measured with the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977). This questionnaire has a possible score of 60 with 16 as the cut-off score for depression in the general population. This questionnaire has been used widely and has been shown to be reliable, valid and have internal consistency (Boyd, Weissman, Thompson, & Myers, 1992; Carroll Cassidy, & Côté, 2004; Devins et al., 1988; Radloff, 1977). Internal consistency has been measured in a study across five groups showing alpha coefficients ranging from 0.63 to 0.93. Test-retest reliability over 3 months was 0.61 (Devins et al., 1988). Validity of the Center of Epidemiological Studies Depression Scale was compared in an older population (55 to 85 years) with the Diagnostic Interview Schedule. Using a 16 point cut-off in the Center for Epidemiological Studies Depression Scale the sensitivity for major depression was 100% and the specificity was 88%. The positive predictive value with the DSM-III criteria for major depression was 13.2% (Beekman et al., 1997).

Socio-demographics

Gender, age, marital status, education level, income, employment status, job satisfaction and location of residence (city, town, village, rural municipality and Indian Reserve) were included in the analysis.

Anthropometric variables

Height and weight were used to calculate the body mass index.

Analysis

Frequency distribution of the baseline demographic socioeconomic characteristics was reported by exposure history. Baseline comorbidities were reported for frequency distribution by exposure history. Descriptive characteristics of the sample's baseline health related characteristics were reported for exposure categories. Neck pain days and disability days were described at baseline for both neck pain grade and exposure category.

Analysis of attrition compared responders and non-responders at six and twelve months in both the group exposed to neck injury in a motor vehicle collision and those not exposed. These groups were compared at baseline for demographic socioeconomic characteristics and comorbidities.

Cox regression was used in the analysis of the data at 6 and 12 months for the association between exposure to a neck injury in a motor vehicle collision and troublesome neck pain. Multiple regression modeling was incorporated into 3 steps. The first step used a univariable model to calculate a crude hazard rate ratio. The second step used a bivariable model to determine the confounders that were included in the final model. Variables that led to a 10% change in the exposure coefficient were included in the final step. In the final step, the exposure effect was estimated from the coefficient of exposure in a multivariable model (Rothman, 2002). The association was reported as hazard rate ratio (HRR) with 95% confidence intervals. The Statistical Package for the Social Sciences (SPSS), version 15 was used for the analysis.

Ethics Approval

The Saskatchewan Health and Back Pain Survey was originally approved by the University of Saskatchewan Advisory Committee on Ethics in Human Experimentation. The current study was submitted to the University Health Network Research Ethics Board and was approved on April 28th, 2008 (appendix 4).

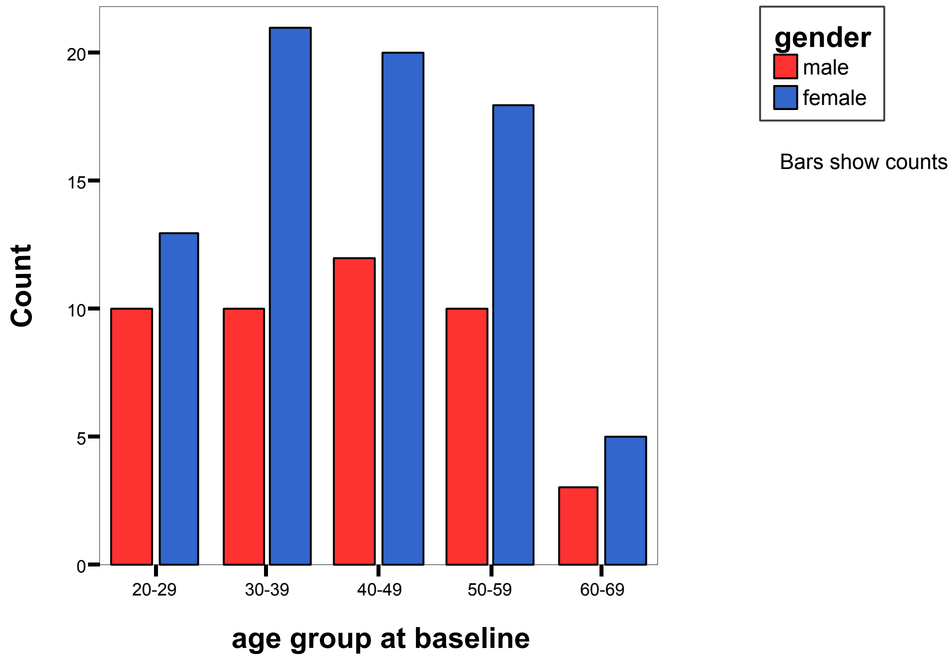
CHAPTER FOUR: RESULTS

Sample Characteristics

A total of 919 participants were at risk of developing troublesome neck pain at baseline (503 with no neck pain and 416 subjects with grade I neck pain). The follow-up rate was 73.5% (676 participants) at the six-month follow-up and 63.1% (580 participants) at twelve months.

Of the 919 eligible adults with no or mild neck pain at baseline, 122 (13.3%) reported a history of neck injury in a motor vehicle collision. The characteristics of the study sample stratified by exposure history are presented in Tables 5-8. A history of neck injury in a motor vehicle collision was more common in females in all age groups (Figure 1). Fewer subjects with a history of neck injury in a motor vehicle collision were married and a higher percentage lived in urban Saskatchewan (Table 5). A higher proportion of exposed than unexposed individuals reported a household income of less than $20,000 and fewer reported incomes over $60,000 (Table 5). Further, more subject with a history of neck injury worked part-time or were unemployed but fewer were retired (Table 5).

Figure 1. Age-group and gender specific distribution at baseline of a history of neck injury in a motor vehicle collision (n = 122).



With the exception of hypertension and low back pain, all commorbidities were more common among participants with a history of neck injury in a motor vehicle collision (Table 6). Further, the self-perceived impact of comorbidities was more pronounced in individuals who had a neck injury in a motor vehicle collision. This difference in health status was not seen in the General Health question of the SF-36 (Table 7). These results suggest that the general health status of individuals with a history of neck injury was lower than those without a history of a neck injury in a motor vehicle collision.

The health related characteristics of the group with a history of neck injury in a motor vehicle collision had a higher number of current smokers and a lower number that had never smoked compared to those not exposed. The exposure group had a lower percentage of subjects in the 3rd quartile and a higher percentage in the 2nd quartile of the

BMI (Table 7). Both the exposed and non-exposed group had a similar distribution of total neck pain days and disability days in the grade 0 and grade I neck pain groups (Table 8).

Table 5, Frequency distribution of the demographic socioeconomic characteristics by exposure category at baseline

Characteristic	History of neck injury in motor vehicle collision			
	Yes	%	No	%
Age (years) Mean (S.D.)	42.0	(12.3)	44.9	(14.4)
Gender (no; %)				
Male	45	36.8	406	50.9
Female	77	63.2	391	49.1
Marital Status (no; %)				
Married	86	71.7	605	76.6
Divorced	14	11.6	49	6.2
Widowed	3	2.5	20	2.5
Single	18	14.9	116	14.7
Location of Residence (no; %)				
Urban	65	53.3	278	35.0
Rural	57	46.7	517	65.0
Annual household income (no;%)				
$0-20,000	27	23.7	140	19.1
$20,001-40,000	38	33.3	263	35.8
40,001-60,000	28	24.6	171	23.3
Over 60,000	21	18.4	160	21.8
Education (no; %)				
Less than grade 8	7	5.8	44	5.6
High school	29	24.0	171	21.6
High school grad	36	29.8	207	26.2
Post-secondary	36	29.8	248	31.4
University Grad	13	10.7	120	15.2
Full time worker (no; %)				
Yes	60	50.0	408	51.8
No	60	50.0	380	48.2
Part time worker (no; %)				
Yes	22	18.3	118	15.0
No	98	81.7	669	85.0
Unemployed (no; %)				
Yes	11	9.2	38	4.8
No	109	90.8	750	95.2
Retired (no; %)				
Yes	3	2.5	106	13.5
No	117	97.5	682	86.5
Homemaker (no; %)				
Yes	23	19.2	134	17.0
No	97	80.8	654	83.0
Student (no; %)				
Yes	7	5.8	30	3.8
No	113	94.2	758	96.2

Table 6, Frequency distribution of comorbidities by exposure category at baseline

Characteristics	History of neck injury in motor vehicle collision			
	Yes (no; %)		No (no; %)	
Comorbidities				
Allergy				
Absent	57	47.1	472	60.8
No/Min impact on Health	45	37.2	227	29.3
Mod./Sev. impact on Health	19	15.7	77	9.9
Arthritis				
Absent	85	71.4	579	75.1
No/Min impact on Health	17	14.3	129	16.7
Mod./Sev. impact on Health	17	14.3	63	8.2
Breathing disorders				
Absent	80	66.7	565	72.4
No/Min impact on Health	29	24.2	169	21.7
Mod./Sev. impact on Health	11	9.2	46	5.9
Cardiovascular disorders				
Absent	98	80.3	687	87.9
No/Min impact on Health	19	15.6	74	9.5
Mod./Sev. impact on Health	5	4.1	21	2.7
Hypertension				
Absent	103	85.1	666	85.4
No/Min impact on Health	13	10.7	84	10.8
Mod./Sev. impact on Health	5	4.1	30	3.8
Digestive disorders				
Absent	88	73.9	596	76.0
No/Min impact on Health	18	15.1	141	18.0
Mod./Sev. impact on Health	13	10.9	47	6.0
Low back pain				
Absent	31	25.8	254	32.3
Low intensity/low disability	68	56.7	394	50.1
High intensity/low disability	8	6.7	81	10.3
High disability	13	10.8	57	7.3
Depressive symptomatology				
Absent	90	75.6	628	83.0
Present	29	24.4	129	17.0
Graded neck pain				
Grade 0	36	29.5	467	58.6
Grade 1	86	70.5	330	41.4

Table 7, Descriptive characteristics of the sample's health related characteristics by exposure category at baseline

Characteristic	History of neck injury in motor vehicle collision			
	Yes (no, %)		No (no, %)	
Cigarette smoking				
Never smoked	53	44.9	417	54.0
Past smoker	31	26.3	191	24.7
Current Smoker	34	28.8	164	21.2
Body mass index (Kg/m²) –quartiles				
> 28.71	31	26.1	196	25.2
25.77-28.71	28	23.5	203	26.1
23.42-25.76	32	26.9	186	23.9
≤ 23.41	28	23.5	193	24.8
General health				
Mean (S.D.)	63.7	(14.5)	65.3	(12.6)
No. of days of exercise/week				
Mean (S.D.)	2.93	(2.07)	2.83	(2.16)

Table 8, Neck pain grade-specific number of neck pain days and disability days by neck pain grade at baseline.

	Grade 0 neck pain		Grade 1 neck pain	
Number of disability days				
History of neck injury (no, %)				
0-6 days	36	100	83	96.5
7-14 days	0	0	3	3.5
15-30 days	0	0	0	0
>31 days	0	0	0	0
No history of neck injury (no, %)				
0-6 days	466	100	321	97.3
7-14 days	0	0	9	2.8
15-30 days	0	0	0	0
>31 days	0	0	0	0
Total neck pain days				
History of neck injury (no, %)				
0 days	36	100	0	0
1-30 days	0	0	76	88.4
31-89 days	0	0	9	10.5
90-180 days	0	0	1	1.2
No history of neck injury (no, %)				
0 days	461	98.9	3	.9
1-30 days	4	.9	297	88.4
31-89 days	0	0	22	6.7
90-180 days	1	.2	8	2.4

Analysis of Attrition

Comparison of baseline data between responders and non-responders in subjects both exposed and not exposed to a neck injury in a motor vehicle collision can be seen in Tables 9 to 12. In the group exposed to a neck injury in a motor vehicle collision the responders tended to be older at the six month survey than non-responders (4.2 years). They were more likely to have an income between $20,000 to $60,000 a year. They were more likely to work part-time and less likely to be unemployed than the non-responders. They were more likely to be a high school or university graduates. They were less likely to have comorbidities and depressive symptoms.

At the twelve month survey the exposed responders tended to be older than non-responder (6.3 years). They were more likely to be widowed and less likely to be married. They were more likely to have an income between $20,000 to $60,000 a year. They were less likely to have digestive disorders, headaches and depressive symptoms.

In the group not exposed to a neck injury in a motor vehicle collision, six month responders tended to be older than non-responders (5.3 years) and were more likely to be female. They were more likely to be widowed and less likely to be single. They were less likely to live in rural areas than non-responders. They were less likely to earn under $20,000 a year and more likely to earn over $60,000. They were more likely to have higher education, were less likely to work full-time and more likely to be retired or homemakers.

In the twelve month survey non-exposed responders tended to be older (6.1 years) and were more likely to be female. They were more likely to be married or widowed and less likely to be single. They were more likely to earn higher income and have higher education. They were less likely to work full time, to be unemployed or a student and more likely to be retired, a homemaker or work part-time. The non-exposed responders were less likely to have depressive symptoms than non-responders.

Attrition was related to exposure in this study in some socio-demographic characteristics and comorbidities. A higher percentage of females in the non-exposed group responded to the six and twelve month survey compared to non-responders. There were a lower percentage of subjects in the exposed group with depression that responded at six months. The exposed non-responder group had a higher percentage of subjects with headaches that had moderate to severe impact on health at six and twelve months than the group that responded. These headache differences were not seen between the responders and non responders in the non-exposed group. There was a higher percent of high school graduates that responded in the exposed group and didn't respond in the non-exposed group. Subjects with post-secondary education were more likely to be non-responders within the exposed group and be responders in the non-exposed group.

Table 9, Comparison of responders and non-responders at six months for frequency distribution of the demographic socioeconomic characteristics by exposure category at baseline

Characteristic	Exposure to neck injury in a MVC				Not exposed to neck injury in MVC			
	Responder		Non-responder		Responder		Non-responder	
Age (years)								
Mean (S.D.)	43.5 (12.38)		39.3 (11.67)		46.1 (13.30)		40.8 (14.04)	
Gender (no; %)								
Male	28	36.4	17	37.8	304	49.0	102	58.0
Female	49	63.6	28	62.2	317	51.0	74	42.0
Marital Status (no; %)								
Married	54	70.1	32	72.7	480	77.8	125	72.3
Divorced	8	10.4	6	13.6	39	6.3	10	5.8
Widowed	2	2.6	1	2.3	20	3.2	0	0.0
Single	13	16.9	5	11.4	78	12.6	38	22.0
Location of Residence (no; %)								
Urban	41	53.2	24	53.3	224	36.1	54	30.9
Rural	36	46.8	21	46.7	396	63.9	121	69.1
Annual household income (no;%)								
$0-20,000	13	17.3	14	35.9	102	17.6	38	24.4
$20,001-40,000	29	38.7	9	23.1	208	36.0	55	35.3
40,001-60,000	19	25.3	9	23.1	134	23.2	37	23.7
Over 60,000	14	18.7	7	17.9	134	23.2	26	16.7
Education (no; %)								
Less than grade 8	4	5.2	3	6.8	32	5.2	12	6.9
High school	16	20.8	13	29.5	128	20.7	43	24.9
High school grad	26	33.8	10	22.7	154	25.0	53	30.6
Post-secondary	21	27.3	15	35.1	199	32.3	49	28.3
University Grad	10	13.0	3	6.8	104	16.9	16	9.2
Full time worker (no; %)								
Yes	39	51.3	21	47.7	306	49.8	102	58.6
No	37	48.7	23	52.3	308	50.2	72	41.4
Part time worker (no; %)								
Yes	16	21.1	6	13.6	94	15.3	24	13.8
No	60	78.9	38	86.4	519	84.7	150	86.2
Unemployed (no; %)								
Yes	4	5.3	7	15.9	25	4.1	13	7.5
No	72	94.7	37	84.1	589	95.9	161	92.5
Retired (no; %)								
Yes	2	4.0	1	2.3	98	16.0	8	4.6
No	74	97.4	43	97.7	516	84.0	166	95.4
Homemaker (no; %)								
Yes	14	18.4	9	20.5	111	18.1	23	13.2
No	62	81.6	35	79.5	503	81.9	151	86.8
Student (no; %)								
Yes	4	5.3	3	6.8	21	3.4	9	5.2
No	72	94.7	41	93.2	593	96.6	165	94.8

Table 10, Comparison of responders and non-responders at six months for frequency distribution of comorbidities by exposure category at baseline

Characteristics	Exposure to neck injury in a MVC				Not exposed to neck injury in MVC			
	Responder		Non-responder		Responder		Non-responder	
Comorbidities (no; %)								
Allergy								
Absent	36	46.8	21	47.7	361	59.3	111	66.5
No/Min impact on Health	29	37.7	16	36.4	185	30.4	42	25.1
Mod./Sev. impact on Health	12	15.6	7	15.9	63	10.3	14	8.4
Arthritis								
Absent	53	69.7	32	74.4	445	73.7	134	80.2
No/Min impact on Health	10	13.2	7	16.3	106	17.5	23	13.8
Mod./Sev. impact on Health	13	17.1	4	9.3	53	8.8	10	6.0
Breathing disorders								
Absent	56	73.7	24	54.5	444	72.8	121	71.2
No/Min impact on Health	14	18.4	15	34.1	129	21.1	40	23.5
Mod./Sev. impact on Health	6	7.9	5	11.4	37	6.1	9	5.3
Hypertension								
Absent	68	88.3	35	79.5	517	84.5	149	88.7
No/Min impact on Health	7	9.1	6	13.6	69	11.3	15	8.9
Mod./Sev. impact on Health	2	2.6	3	6.8	26	4.2	4	2.4
Cardiovascular disorders								
Absent	62	80.5	36	80.0	534	87.3	153	90.0
No/Min impact on Health	12	15.6	7	15.6	61	10.0	13	7.6
Mod./Sev. impact on Health	3	3.9	2	4.4	17	2.8	4	2.4
Digestive disorders								
Absent	57	75.0	31	72.1	456	74.3	140	82.4
No/Min impact on Health	12	15.8	6	14.0	121	19.7	20	11.8
Mod./Sev. impact on Health	7	9.2	6	14.0	37	6.0	10	5.9
Low back pain								
Absent	21	27.6	10	22.7	196	31.9	58	33.7
Low intensity/low disability	43	56.6	25	56.8	308	50.2	86	50.0
High intensity/low disability	3	3.9	5	11.4	66	10.7	15	8.7
High disability	9	11.9	4	9.1	44	7.2	13	7.5
Headache								
Absent	32	42.1	14	31.8	303	49.5	88	51.5
No/min. impact on health	32	42.1	16	36.4	235	38.4	63	36.8
Mod./Sev. impact on health	12	15.8	14	31.8	74	12.1	20	11.7
Depressive symptomatology								
Absent	59	77.6	31	72.1	493	83.4	135	81.3
Present	17	22.4	12	27.9	98	16.6	31	18.7
Graded neck pain								
Grade 0	23	29.9	13	28.9	361	58.1	106	60.2
Grade 1	54	70.1	32	71.1	260	41.9	70	39.8

Table 11, Comparison of responders and non-responders at twelve months for frequency distribution of the demographic socioeconomic characteristics by exposure category at baseline

Characteristic	Exposure to neck injury in a MVC				Not exposed to neck injury in MVC			
	Responder		Non-responder		Responder		Non-responder	
Age (years)								
Mean (S.D.)	45.1	(12.62)	38.8	(11.14)	46.9	(12.96)	40.8	(13.40)
Gender (no; %)								
Male	23	37.7	22	36.1	259	48.5	147	55.9
Female	38	62.3	39	63.9	275	51.5	116	44.1
Marital Status (no; %)								
Married	42	68.9	44	73.3	417	78.7	188	72.3
Divorced	7	11.5	7	11.7	32	6.0	17	6.5
Widowed	3	4.9	0	0.0	20	3.8	0	0
Single	9	14.8	9	15.0	61	11.5	55	21.2
Location of Residence (no; %)								
Urban	33	54.1	32	52.5	188	35.2	90	34.5
Rural	28	45.9	29	47.5	346	64.8	171	65.5
Annual household income (no;%)								
$0-20,000	9	15.3	18	32.7	75	15.2	65	27.2
$20,001-40,000	22	37.3	16	29.1	185	37.4	78	32.6
40,001-60,000	16	27.1	12	21.8	120	24.2	51	21.3
Over 60,000	12	16.4	9	16.4	115	23.2	45	18.8
Education (no; %)								
Less than grade 8	3	4.9	4	6.7	27	5.1	17	6.5
High school	12	19.7	17	23.3	112	21.1	59	22.7
High school grad	22	36.1	14	27.0	129	24.3	78	30.0
Post-secondary	16	26.2	20	33.3	172	32.5	76	29.2
University Grad	8	13.1	5	8.3	90	17.0	30	11.5
Full time worker (no; %)								
Yes	36	59.0	24	40.7	261	49.4	147	56.5
No	25	41.0	35	59.3	267	50.6	113	43.5
Part time worker (no; %)								
Yes	14	23.0	8	13.6	82	15.6	36	13.8
No	47	77.0	51	86.4	445	84.4	224	86.2
Unemployed (no; %)								
Yes	1	1.6	10	16.9	16	3.0	22	8.5
No	60	98.4	49	83.1	512	97.0	238	91.5
Retired (no; %)								
Yes	2	3.3	1	1.7	90	17.0	16	6.2
No	59	96.7	58	98.3	438	83.0	244	93.8
Homemaker (no; %)								
Yes	10	16.4	13	22.0	95	18.0	39	15.0
No	51	83.6	46	78.0	433	82.0	221	85.0
Student (no; %)								
Yes	1	1.6	6	10.2	14	2.7	16	6.2
No	60	98.4	53	89.8	514	97.3	244	93.8

Table 12, Comparison of responders and non-responders at twelve months for frequency distribution of comorbidities by exposure category at baseline

Characteristics	Exposure to neck injury in a MVC				Not exposed to neck injury in MVC			
	Responder		Non-responder		Responder		Non-responder	
Comorbidities (no; %)								
Allergy								
Absent	28	45.9	29	48.3	312	59.5	160	63.5
No/Min impact on Health	24	39.3	21	35.0	158	30.2	69	27.4
Mod./Sev. impact on Health	9	14.8	10	16.7	54	10.3	23	9.1
Arthritis								
Absent	41	68.3	44	74.6	383	73.5	196	78.4
No/Min impact on Health	10	16.7	7	11.9	91	17.5	38	15.2
Mod./Sev. impact on Health	9	15.0	8	13.6	47	9.0	16	6.4
Breathing disorders								
Absent	44	73.3	36	60.0	386	73.5	179	70.2
No/Min impact on Health	11	18.3	18	30.0	108	20.6	61	23.9
Mod./Sev. impact on Health	5	8.3	6	10.0	31	5.9	15	5.9
Hypertension								
Absent	54	88.5	49	81.7	444	84.3	222	87.7
No/Min impact on Health	5	8.2	8	13.3	60	11.4	24	9.5
Mod./Sev. impact on Health	2	3.3	3	5.0	23	4.4	7	2.8
Cardiovascular disorders								
Absent	50	82.0	48	78.7	465	88.4	222	86.7
No/Min impact on Health	8	13.1	11	18.0	49	9.3	25	9.8
Mod./Sev. impact on Health	3	4.9	2	3.3	12	2.3	9	3.5
Digestive disorders								
Absent	46	76.7	42	71.2	394	74.6	202	78.9
No/Min impact on Health	10	16.7	8	13.6	101	19.1	40	15.6
Mod./Sev. impact on Health	4	6.7	9	15.3	33	6.3	14	5.5
Low back pain								
Absent	14	23.0	17	28.8	172	32.6	82	31.8
Low intensity/low disability	39	63.9	29	49.2	263	49.8	131	50.8
High intensity/low disability	2	3.3	6	10.2	52	9.8	29	11.2
High disability	6	9.8	7	11.9	41	7.7	16	6.2
Headache								
Absent	25	42.4	21	34.4	262	49.8	129	50.2
No/min. impact on health	27	45.8	21	34.4	204	38.8	94	36.6
Mod./Sev. impact on health	7	11.9	19	31.1	60	11.4	34	13.2
Depressive symptomatology								
Absent	47	78.3	43	72.9	433	84.7	195	79.3
Present	13	21.7	16	27.1	78	15.3	51	20.7
Graded neck pain								
Grade 0	16	26.2	20	32.8	307	57.5	160	60.8
Grade 1	45	73.8	41	67.2	227	42.5	103	39.2

Association between history of neck injury in a motor vehicle collision and troublesome neck pain

Our Cox model demonstrates a positive crude association between a history of neck injury in a motor vehicle collision and the development of troublesome neck pain at six and twelve months (Hazard Rate Ratio = 2.43; 95% CI 1.28-4.60). The multivariable Cox model suggests that this association was mildly confounded by bodily pain and body mass index. The other potential confounders in the data did not meet the criteria to be included as confounders. The adjusted hazard rate ratio suggests that individuals with a history of neck injury in a traffic collision are more likely to report troublesome neck pain during a one-year follow-up (Hazard Rate Ratio = 2.14; 95% CI 1.12-4.10).

CHAPTER FIVE: DISCUSSION

This study was the first North American cohort study to investigate the association between a lifetime history of neck injury resulting from a motor vehicle collision and the development of troublesome neck pain. Our results suggest that, independent of known confounders, the incidence of troublesome neck pain was higher in individuals who have a history of neck injury in a motor vehicle collision.

The results for the risk of developing recurrent troublesome neck pain during the one year of our study, adjusted HRR= 2.14 (95% CI 1.12-4.10), was similar to the results of three studies which found a positive association between neck injury in a motor vehicle collision and future neck pain. In a cohort study by Berglund et al. (2000), they found an increased risk of having neck pain seven years after neck injury in a motor vehicle collision, age and gender adjusted RR= 2.7 (95% CI 2.1-3.5). In a cohort study by Bunketorp et al. (2005), they found a positive odds ratio for the association between neck injury in a motor vehicle collision in subjects reporting to an emergency room and neck pain 13 years later (OR 2.95; 95% CI 1.93-4.50). A case control study by Freeman et al., (2006) found neck pain positively associated to an injury in a motor vehicle collision. The study reported an odds ratio of 4.0 (95% CI 2.1-7.5) for men and 2.1 (95% CI 1.3-3.3) for women.

Two cross-sectional studies found higher odds ratios, than the values reported in the present study, for an association between neck injury in a motor vehicle collision and future neck pain. This may be due to the present study excluding subjects with troublesome neck pain. Côté et al. (2000) found a positive association between a neck injury in a motor vehicle collision and future neck pain with high intensity low disability

(OR 4.46; 95% CI 2.49-4.99) and with disabling neck pain (OR 3.30; 95% CI 1.48-7.39). Guez et al. (2002) found a positive association between seeking medical care for neck injury in a motor vehicle collision and future neck pain (crude OR 4.39; 95% CI 3.22-5.98).

The present study included only subjects who reported being injured in a motor vehicle collision in the exposure group. The present study had a different exposure definition than two cohort studies that found no association between a motor vehicle collision and future neck pain (Schrader et al., 1996; Obelieniene et al., 1999). These studies had an exposure definition of a rear end collision in a motor vehicle collision. Many subjects in these studies did not report neck pain after the motor vehicle collision (85% and 90% respectively). This is in keeping with the findings of Berglund et al. (2000) which only found a positive association between a group that had a neck injury in a motor vehicle collision and neck pain seven years later. They did not find an association between a motor vehicle collision (with no neck injury) and future neck pain seven years later (RR 1.3, 95% CI 0.8-2.0). It was therefore important that the exposure group in our study was defined as subjects that reported a neck injury in the motor vehicle collision.

Factors contributing to the validity of our results include the use of a large prospective cohort of Saskatchewan adults and our ability to assess the effect of several confounders. This study uses a valid, reliable and meaningful outcome that allowed us to discriminate between trivial and troublesome neck pain.

The attrition analysis suggests that the effect of our exposure may have been underestimated. Overall, this analysis suggests that the distribution of risk factors for troublesome neck pain was higher among non-exposed compared to exposed. A higher percentage of females responded to the follow-up surveys in the non-exposed group and females are more likely to report neck pain than males (Hogg-Johnson et al., 2008). There were a lower percentage of responders in the exposed group with depression at six months. Depression is a risk factor for the development of neck pain (Hogg-Johnson et al., 2008). Finally, in the exposed group, subjects with headaches that had a moderate to severe impact on health were less likely to respond to the survey at both six and twelve months. It is unclear whether socioeconomic differences in attrition biased the results of this study. The difference in attrition was varied for employment, education and income.

Strength and Weaknesses

One strength of this study was the use of a large sample of Saskatchewan adults. Second, our study includes a sample at risk of developing troublesome neck pain. Third, we tested the effect of several potential confounders and used a valid and reliable outcome.

This study was able to establish the temporality between neck injury in a motor vehicle collision and an episode of future troublesome neck pain. In defining a population at risk of individuals with no or mild neck pain, we could establish that our outcome of troublesome neck pain followed being exposed to neck injury in a motor vehicle collision. This issue could not be addressed in an early cross-sectional study using the Saskatchewan Health and Back Pain Survey (Côté et al., 2000).

Our study also has limitations. The exposure, neck injury in a motor vehicle collision, could suffer from misclassification bias as subjects are asked to recall a history of neck injury in a motor vehicle collision. However, we believe that this bias had minimal impact on our results because it is likely that subjects remember an event such as being injured in a motor vehicle collision. Data from two studies support the view that individuals can recall injuries sustained in recent motor vehicle collision. Self reported motor vehicle collision injuries 12 months earlier in the Canadian National Population Health Survey were not significantly different from the police reported data from Transport Canada (Roberts, Vingilis, Wilk & Seeley, 2008). Moreover, in a small sample of young adults, self reported injury over the previous 3 years was comparable to hospital discharge file data and police motor vehicle collision reports (Begg, Langley & Williams, 1999).

In this study we do not have medical histories about the severity of injuries sustained in the motor vehicle collisions. It is likely that with our population at risk, which eliminates subjects with troublesome neck pain at baseline, most of our subjects would have sustained only mild neck sprains (whiplash). It is not possible to exclude subjects with more severe neck injuries such as fractures or dislocations of the cervical spine, but it would be reasonable to assume they would have been excluded from our population at risk. The more severe injuries would be more likely to complain of ongoing troublesome neck pain and would have been excluded from our population at risk (Dvorak et al., 2007).

We were able to test for the confounding effects of demographics, socioeconomic status, general health, comorbidities, cigarette smoking, anthropometric variables and exercise frequency. In doing so, we considered most domains of risk factors that were proposed by the Task Force on Neck Pain and Its Associated Disorders (Holm et al., 2008). We used multivariable regression modeling to control for confounding in our final model. However we were not able to control for collision and societal factors.

Our study augments the evidence of a positive association between neck injury in a motor vehicle collision and future neck pain. The strength of our phase II cohort study was in our ability to test for the confounding effect of more variables than prior studies which mostly controlled for age and gender (Berglund et al., 2000; Bunketorp et al., 2005; Freeman et al., 2006; Guez et al., 2002; Obelieniene et al., 1999; Schrader et al., 1996).

Our study is important for patients, clinicians and insurers. It suggests that those who sustained a neck injury in a motor vehicle collision will have an increased risk of developing troublesome neck pain in the future compared to those who have never experienced such an injury. However, the mechanisms that explain this association are not known and require further investigation.

CHAPTER SIX: CONCLUSION

This study was the first North American cohort study to investigate the association between a lifetime history of neck injury resulting from a motor vehicle collision and the development of troublesome neck pain. This phase II study found a history of neck injury in a motor vehicle collision was a risk factor for an episode of troublesome neck pain during the one year follow-up.

CHAPTER SEVEN: REFERENCES

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Appendix 1

Literature search strategy of EMBASE.
Database: EMBASE <1980 to 2007 Week 02>

Search Strategy:

1 exp Neck Injury/ (4528)

2 Neck Pain/ (4345)

3 cervical spine/ (9495)

4 exp neck/ (6548)

5 (neck or necks).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name] (85599)

6 whiplash$.mp. (1607)

7 whip-lash$.mp. (12)

8 cervical.mp. (85174)

9 hyperextension$.mp. (1050)

10 or/1-9 (162160)

11 traffic accident/ (14433)

12 exp motor vehicle/ (10403)

13 exp car driving/ (6262)

14 traffic$.mp. (41804)

15 (car or cars).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name] (10742)

16 automobile$.mp. (3225)

17 vehicle$.mp. (50845)

18 (collide$ or collision$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name] (7542)

19 (rear-end$ or rearend$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name] (216)

20 or/11-19 (107551)

21 exp disease course/ (664088)

22 risk:.mp. (751314)

23	diagnos:.mp. (1361962)
24	follow-up.mp. (370238)
25	ep.fs. (316876)
26	outcome.tw. (276483)
27	cohort analysis/ (38783)
28	case control study/ (14921)
29	prognosis/ (147971)
30	disease free survival/ (1620)
31	exp treatment outcome/ (357055)
32	disease-free survival.mp. (11889)
33	prognos$.mp. (223266)
34	medical$ futil$.mp. (126)
35	treatment outcome$.mp. (277841)
36	treatment failure$.mp. (35261)
37	exp disease course/ (664088)
38	(disease adj1 progress$).mp. (24943)
39	exp morbidity/ (73635)
40	exp mortality/ (188677)
41	fatal outcome$.mp. (3350)
42	hospital mortality.mp. (7689)
43	exp survival/ (186007)
44	natural histor$.mp. (19794)
45	prospective study/ (61565)
46	(cross-sectional adj2 stud$).mp. (22278)
47	or/21-46 (2976004)
48	10 and 20 (2739)
49	47 and 48 (1422)
50	limit 49 to yr="1990 - 2007" (1283)

Literature search strategy of MEDLINE

Ovid MEDLINE(R) 1950 to January Week 1 2007

#	Search History	Results
1	exp neck injuries/	4611
2	neck pain/	1727
3	exp cervical vertebrae/	20545
4	neck muscles/	3262
5	neck/	17152
6	(neck or necks).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	110770
7	whiplash$.mp.	2296
8	whip-lash$.mp.	23
9	cervical.mp.	128914
10	hyperextension$.mp.	1233
11	or/1-10	227447
12	accidents, traffic/	24812
13	automobiles/	3467
14	automobile driving/	8451
15	traffic$.mp.	49870
16	(car or cars).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	8400
17	automobile$.mp.	14408
18	vehicle$.mp.	56770
19	(collide$ or collision$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	7551
20	(rear-end$ or rearend$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	256
21	or/12-20	119156
22	incidence/	102437
23	exp mortality/	174131
24	follow-up studies/	328801
25	mortality.fs.	262695
26	prognos$.tw.	204895
27	predict$.tw.	435078
28	course$.tw.	306699
29	cross-sectional studies/	71487
30	exp cohort studies/	590998
31	prospective studies/	212734

32	exp case control studies/	331972
33	exp prognosis/	530714
34	disease-free survival.mp.	25862
35	medical futility.mp.	1616
36	medical: futil:.mp.	1622
37	treatment outcome:.mp.	277400
38	exp disease progression/	43269
39	(disease adj1 progress:).mp.	63882
40	exp morbidity/	203107
41	exp mortality/	174131
42	fatal outcome:.mp.	33076
43	hospital mortality.mp.	15263
44	exp survival analysis/	72977
45	natural history.mp.	22917
46	or/22-45	2189903
47	11 and 21	3286
48	46 and 47	1105
49	limit 47 to yr="1990 - 2007"	2369
50	limit 48 to yr="1990 - 2007"	923

Literature search strategy of CINAHL

Database: CINAHL - Cumulative Index to Nursing & Allied Health Literature <1982 to December Week 2 2006>

Search Strategy:

1 exp Neck Injuries/ (817)

2 Neck Pain/ (975)

3 Cervical Vertebrae/ (1936)

4 Neck Muscles/ (205)

5 Neck/ (980)

6 (neck or necks).mp. [mp=title, subject heading word, abstract, instrumentation] (7084)

7 whiplash$.mp. (530)

8 whip-lash$.mp. (2)

9 cervical.mp. (7346)

10 hyperextension$.mp. (129)

11 or/1-10 (13586)

12 Accidents, Traffic/ (3679)

13 Motor Vehicles/ (1069)

14 Automobile Driving/ (1584)

15 traffic$.mp. (4506)

16 (car or cars).mp. [mp=title, subject heading word, abstract, instrumentation] (1784)

17 automobile$.mp. (1796)

18 vehicle$.mp. (3550)

19 (collide or collision$).mp. [mp=title, subject heading word, abstract, instrumentation] (581)

20 (rear-end$ or rearend$).mp. [mp=title, subject heading word, abstract, instrumentation] (45)

21 or/12-20 (9269)

22 exp study design/ (182770)

23 diagnos:.mp. (78959)

24	prognos$.mp. (7800)
25	exp prognosis/ (39057)
26	exp "outcomes (health care)"/ (51996)
27	exp morbidity/ (13981)
28	exp mortality/ (10744)
29	exp survival analysis/ (9740)
30	disease progression/ (4763)
31	time factors/ (20848)
32	recurrence/ (5595)
33	research.pt. (311803)
34	natural histor:.mp. (1073)
35	predict:.mp. (36139)
36	inception cohort:.mp. (170)
37	prognostic factor:.mp. (708)
38	clinical course:.mp. (1207)
39	outcome:.mp. (97942)
40	course.mp. (16729)
41	or/22-40 (439402)
42	11 and 21 (436)
43	41 and 42 (261)
44	limit 43 to yr="1990 - 2007" (261)
45	from 44 keep 1-261 (261)

Appendix 2

Von Korff Chronic Pain Questionnaire:

1. How would you rate your neck pain on a 0-10 scale at the present time, that is right now, where 0 is "no neck pain" and 10 is "neck pain as bad as could be"?

2. In the past 6 months, how intense was your worst neck pain rated on a 0-10 scale where 0 is "no neck pain" and 10 is "neck pain as bad as could be"?

3. In the past 6 months, on the average, how intense was your neck pain rated on a 0-10 scale where 0 is "no neck pain" and 10 is "neck pain as bad as could be"?

4. About how many days in the last 6 months have you been kept from your usual activities (work, school or housework) because of neck pain? A) 0-6 days; B) 7-14 days; C) 15-30 days or D) 31 or more days

5. In the past 6 months, how much has your neck pain interfered with your daily activities rated on a 0-10 scale where 0 is "no interference" and 10 is "unable to carry on any activities"?

6. In the past 6 months, how much has your neck pain changed your ability to take part in recreational, social and family activities where 0 is "no change" and 10 is "extreme change"?

7. In the past 6 months, how much has your neck pain changed your ability to work (including housework) where 0 is "no change" and 10 is "extreme change"?

(reproduced from Cassidy, Carroll, Yong-Hing, & Côté, 1995)

Appendix 3

Scoring of the Von Korff Chronic Pain Grade Questionnaire.

Pain Intensity: a 0-100 score derived from question 1-3, calculated as follows:
Mean (question 1 + question 2 + question 3) x 10

Disability Score: a 0-100 score derived from question 5-7, calculated as follows:
Mean (question 5 + question 6 + question 7) x 10

Disability Points: a score from 0-6 derived from the disability score re-coded plus question 4 recoded

Re-coding for disability scored:	0-29	0 points
	30-49	1 point
	50-69	2 points
	70+	3 points

Re-coding for question 4:	0-6 days	0 points
	7-14 days	1 point
	15-30 days	2 points
	31+ days	3 points

Chronic Pain Grade Classification

Grade 0	Pain Intensity = 0, and Disability Points = 0
Grade I	Pain Intensity <50, and Disability Points <3
Grade II	Pain Intensity >50, and Disability Points >3
Grade III	Disability Points = 3 or 4, regardless of Pain Intensity
Grade IV	Disability Points = 5 or 6, regardless of Pain Intensity

(Reproduced from Smith, Penny, Purves, Munro, Wilson, Grimshaw, Chambers & Smith, 1997)

Appendix 4

UHN Ethics Approval

University Health Network
Toronto General Toronto Western Princess Margaret

University Health Network
Research Ethics Board
8th Floor South, Room 8-23
700 University Ave
Toronto, Ontario, M5G 1Z5
Phone: (416)946-4438

Notification of REB Approval for Access to Retrospective Data for Research Purposes

To: Dr. Pierre Cote
124, 4th floor, TWH

Re: 08-0310-AE
The Association Between Lifetime History of Neck Injury in a Motor Vehicle Collision and Future Neck Pain: A Population Based Cohort Study (Chart Review)

REB Review Type:	Expedited
REB Initial Approval Date:	April 28th, 2008
REB Expiry Date:	April 28th, 2009

We wish to remind you that access to personal health records for research purposes without patient consent is a privilege granted by the REB. Please be sure to adhere at all times to the UHN Policy on Information and Data Security as noted in the Confidentiality Agreement signed as part of this submission.

If, during the course of the research, there are any confidentiality concerns, changes in the approved project, or any new information that must be considered with respect to the project, these should be brought to the immediate attention of the REB. In the event of a privacy breach, you are responsible for reporting the breach to the UHN REB and the UHN Corporate Privacy Office (in accordance with Ontario health privacy legislation - Personal Health Information Protection Act, 2004). Additionally, the UHN REB requires reports of inappropriate/unauthorized use of the information.

Please be aware that it is UHN policy that research-related activities involving an external party require a research agreement. An 'external party' refers to a corporation other than UHN or an individual who is not UHN personnel. Should a research agreement be required in this case, the study may not begin at UHN until the agreement has been signed by all parties. Should the negotiation process raise concerns, the REB reserves the right to reconsider its approval.

Please note that approval for this study will expire on this date unless the UHN REB is otherwise notified.

The UHN Research Ethics Board operates in compliance with the Tri-Council Policy Statement, ICH/GCP Guidelines, the Ontario Personal Health Information Protection Act (2004), and Part C, Division 5 of the Food and Drug Regulations of Health Canada.

Sincerely,

Ronald Heslegrave, Ph.D.
Chair, University Health Network Research Ethics Board

Printed on: 2008-04-30 16:53:21

There's always an answer. *We'll find it.*

Appendix 5

Lakehead University, Research Ethics Board Review

Lakehead
UNIVERSITY

Office of Research

(807) 343-8283
(807) 346-7749

MEMORANDUM

Date: July 16, 2008

To: Mr. Paul Nolet, Dr. Pierre Côté & Dr. Darlene Steven

From: Dr. Richard Maundrell

Subject: Research Ethics Board Review

Thank you for your correspondence regarding your research project entitled, "The association between a lifetime history of neck injury in a motor vehicle collision and future neck pain: a population based cohort study". This correspondence has been reviewed in accordance with Article 3.3 of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* which states, "If identifying information is involved, REB approval shall be sought for secondary uses of data".

Since you will not be collecting data from human subjects, and because the data to be analyzed by will not contain any identifying information, this project will not require review and approval from the Lakehead University Research Ethics Board.

Best wishes for a successful project.

Sincerely,

Dr. Richard Maundrell
Chair, Research Ethics Board

955 Oliver Road Thunder Bay Ontario Canada P7B 5E1 www.lakeheadu.ca