# NOTE TO USERS

**University of Alberta**

*Factors Aassociated with the Self-rated Health of People within the First Six Weeks after Traffic-related Mild Traumatic Brain Injury.*

by

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# ABSTRACT

The purpose of this research was to investigate factors associated with self-rated health after traffic-related mild traumatic brain injury (MTBI). The source of data was the claim form completed by all individuals making an injury claim through Saskatchewan Government Insurance (SGI) for a traffic injury occurring between Dec.1, 1997 and Nov.31, 1999. Claimants were included if they made a claim within 42 days of their injury and reported a head blow with certain or possible loss of consciousness (LOC) or post-traumatic amnesia (PTA), or a possible head blow with certain LOC or PTA. Of 929 cases of MTBI, factors associated with poorer post-injury health included older age, depression, neck and low back pain and low expectation for recovery. A sensitivity analysis using a more restrictive case definition for MTBI confirmed the importance of these factors. This study identifies potentially important intervention targets to decrease the negative impact of MTBI.

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# Chapter One

# INTRODUCTION

## 1.1 Statement of the Problem

Traumatic brain injury is a serious public health concern in terms of morbidity, mortality and health care costs. It is a leading cause of death and lifelong disability in the United States (National Center for Injury Prevention and Control, 1999). Among all cause traumatic brain injuries, mild traumatic brain injury (MTBI) accounts for the great majority treated in emergency departments, outpatient departments, and physicians' offices (Collins, 1986; Miller et al., 1985; Klauber et al., 1981; Rimel et al., 1981). In Canada, there were a total of 221,158 non-fatal injuries in 2001 resulting from traffic collisions (Canadian Motor Vehicle Traffic Collision Statistics, 2001). It has been reported that traffic injury is the leading cause of all injury cases (Canadian Motor Vehicle Traffic Collision Statistics, 2001). Although traffic collision is a common cause of mild traumatic brain injury, the picture of traffic-related mild brain injury is less clear because of the lack of population-based studies (Canadian Institute for Health Information, 2004). Therefore, there is a need for further investigation on the frequency and distributions of traffic-related mild traumatic brain injury on population basis.

Saskatchewan is a province of Canada with over 1,000,000 population and an average of 27,381.7 traffic collisions per year between 1999 and 2001. The majority of injury cases are non-fatal injuries (Saskatchewan Government Insurance, 2002; Saskatchewan Highways and Transportation,

2002). Since mild brain injury could potentially result from acceleration-deceleration forces (American Congress of Rehabilitation Medicine, 1993), it is very likely that there are a great number of mild traumatic mild brain injury cases among these non-fatal injuries from traffic collision. Hence, population-based research on traffic-related mild traumatic brain injury on this particular population is needed.

MTBI is frequently associated with significant, but usually short-term, complaints such as headache, dizziness, fatigue, irritability, and concentration and memory problems. Some individuals experience persistent symptoms and related functional impairments (Carroll et al., 2004a; Mayou et al., 2000; Paniak et al., 2000a). These could have negative impact on the general health of persons with MTBI. Understanding the factors associated with reduced general health of individuals with traffic-related MTBI may assist health care providers to provide targeted programs and services to minimize the negative impact of MTBI. Furthermore, although these symptoms are more common within the first month after MTBI than after other injuries or in the general population, they are not unique to MTBI (Carroll et al., 2004a). Therefore, it is necessary to consider a wide range of possible explanatory factors when investigating impaired general health of people with MTBI in order to identify which symptoms or other factors are important in the MTBI population.

In MTBI research, one major issue is the heterogeneity of case definitions of MTBI. Inclusion criteria and definitions for case definitions of MTBI vary considerably across studies. This poses difficulties in comparing and summarizing findings in the MTBI literature. Therefore there is a need for developing a universally accepted definition (Carroll et al., 2004b; Cassidy et al. 2004a). The American Congress of Rehabilitation's 1993 MTBI definition is one of the most widely used definitions (American Congress of Rehabilitation Medicine, 1993) and it was further adapted by the WHO Collaborating Centre for Neurotrauma, Prevention, Management and Rehabilitation Task Force on MTBI (Carroll et al 2004b). However, even in emergency records, some of the diagnostic information needed to identify cases is often missing (Paniak et al., 1998). Not surprisingly, in population-based epidemiological studies, clinical data are often unavailable and the case definition criteria are somewhat less clear-cut. Consequently, possible misclassification is of concern in epidemiological studies on MTBI. For example, the MTBI case definition in epidemiologic studies may be susceptible to uncertainties of self-reported data, such as uncertainty regarding loss of consciousness (LOC) or post-traumatic amnesia (PTA). In addition, when using administrative databases to identify cases, misclassification may occur due to limited or inaccurate information in these databases. Therefore, careful consideration of this issue is essential in studies on MTBI.

## 1.2 Health-related Quality of Life and Self-rated General Health

Choosing appropriate outcome measures is one of the key issues while conducting a study. Especially when studying non-fatal conditions, health-related quality of life (HRQoL) has achieved prominence as a clinically important measure instead of relying on the traditionally used mortality, morbidity, physical functioning and physiologic measures. The rationale is that HRQoL is what really matter to patients and to society. This is especially true when studying persistent conditions such as the subgroup of mild traumatic brain injury with lasting symptoms, for which there is no standard care, and therapy may be prolonged. In this situation, improving "quality of life" is often the main goal of therapy.

HRQoL is a multi-dimensional concept. The World Health Organization defines it as "an individual's perception of their position in life in the context of the culture and value systems", which is "...affected in a complex way by person's physical health, psychological state, level of independence, social relationships, and their relationships to salient features of their environment". *Steadman-Pare referred it as "a subjective or internal

* World Health Organization. Assessment of quality of life in health care: a working party report. Geneva: World Health Organization; 1991.

rating of the 'goodness' of one's life".[‡] In the literature, there are a great number of outcome instruments developed for measuring HRQoL. They are classified as disease-specific instruments and generic instruments. Disease-specific questionnaires focus clearly on particular disease-related problems and for the population with that particular disease, so they may be more responsive to treatment effects than generic instruments (Meenan et al., 1992). Their specificity, however, prevents comparisons across other conditions or populations. Generic questionnaires, on the other hand, attempt to exhaustively sample components that comprise the dimensions of HRQoL in general, rather than focusing on specific dimensions associated with a particular disease. Therefore, generic questionnaires permit comprehensive comparisons across a variety of health states, conditions, diseases and different populations (Ware et al., 1992).

When choosing an instrument, there are two important criteria that need to be considered. Firstly, feasibility of that instrument is a key issue. We need to make sure that the chosen instrument is easy for subjects to understand and easy to use in order to obtain a high response rate and accurate information. Moreover, psychometric criteria are an essential consideration. These include the validity and reliability of an instrument. An instrument is considered valid when it measures what it is supposed to

[‡] Steadman-Pare D, Colantonio A, Ratcliff G, Chase S, Vernich L. Factors associated with perceived quality of life many years after traumatic brain injury. Journal of Head Trauma Rehabilitation 2001; 16:330-342.

measure and when it yields consistent results, that is, when it has good reliability.

The Medical Outcomes Study Short Form-36 Health Survey (SF-36) is an instrument used to measure self-reported health status of subjects (Ware et al., 1993). It is a valid and reliable questionnaire widely used to measure generic health status in various populations. The SF-36 consists of 36 questions designed to capture a variety of health phenomena across eight scales: physical functioning, role limitations because of physical problems, bodily pain, general health, vitality, social functioning, role limitations because of emotional problems and mental health. Each scale is scored from 0 (poor health) to 100 (optimal health). These eight scales can be scored as two summary scales: physical health (PCS) and mental health (MCS). Higher scores reflect better function. The SF-36 is often used as part of a survey, and is a reliable and valid measure for HRQoL of persons with TBI (Findler, M. et al. 2001).

However, given the number of factors potentially of interest on a questionnaire or survey instrument administered to individuals when doing research into MTBI, a single question related to self-rated health may be more practical to include in these surveys than the entire SF-36 questionnaire. Because the single questionnaire item regarding self-rated general health in the SF-36 is highly correlated with both physical and mental health components, that single item is a reasonable alternative and simple

measure for HRQoL. Furthermore, its content is also consistent with the definition of HRQoL. This single item question measuring general health asks " In general, would you say your health is: excellent, very good, good, fair, poor?". This single question has been used in numerous self-report survey questionnaires and has been demonstrated to be a valid, reliable, holistic health measure in various population groups including the MTBI population (Klein et al. 1998; Gold et al., 1999; Eriksson et al., 2001; Steadman-Pare et al., 2001; Emanuelson et al. 2003). In addition, it has strong predictive value with respect to mortality (Lundberg et al., 1996).

## 1.3 The Goal of the Research

The main goal of this research is to investigate the factors associated with the self-rated health of Saskatchewan adults with traffic- related mild traumatic brain injury.

## 1.4 Research Objectives and Questions

To address the above research goal, there are four broad research objectives, each with specific research questions as follows:

1. To investigate and compare the frequency of traffic-related MTBI in Saskatchewan in two consecutive 12- month periods and describe characteristics of that MTBI population.

This involves the following research questions:

- What is the incidence rate for each year?
- What are the characteristics of individuals with traffic-related MTBI?

2. To describe the self-rated health within the first six weeks after a traffic-related MTBI.
3. To determine the factors associated with self-rated health (within the first six weeks) of adults with a traffic-related MTBI.

Possible explanatory factors that were assessed within the first six weeks after the collision include:

i. Demographic and socioeconomic factors (age, gender, marital status, education, income, employment status and number of dependents);

ii. Collision-related factors (injured occupant's position in the vehicle, main direction of impact, collision reported to police, hospital or emergency clinic admission, going to hospital by ambulance, admitted to hospital overnight or longer);

iii. Self-reported symptoms after the collision (dizziness, memory problem, poor concentration, irritability, vision problems, hearing problems, sleep problems, fatigue, anxiety, pain, neck movement, restricted neck movement, sore jaw, broken bones, confusion); post-collision restrictions in home,

employment, school or other activities; pain extent and intensity (neck/ shoulder pain, low back pain, headache pain, arm pain, hand pain, face pain, leg pain, foot pain, mid back pain, abdomen pain);

iiii. Health factors, including comorbid health conditions (pre-existing musculoskeletal problems, allergies, respiratory problems, high blood pressure, cardiovascular problems, gastrointestinal problems, diabetes, nephrological problems, headache, neurological problems, cancer), depressive symptoms after the collision; pre-injury factors (health the month before injury, prior head/ brain injury, chiropractic treatment, prior physical therapy, past motor vehicle injury claims in Saskatchewan government insurance, other types of injury claims)

iiiii. Number of days from the claim to injury; expectation for recovery; initial health care provider.

# Chapter Two

# OVERVIEW OF MILD TRAUMATIC BRAIN INJURY

## 2.1 Introduction

Mild traumatic brain injury (MTBI) is the most common type of traumatic brain injury (Alexander, 1995; Kraus et al., 1988). Controversial issues complicate research in this area a great deal, and pose substantial difficulties to conduct an overview on all aspects of MTBI. Therefore, only closely related contents are identified. In this chapter, I focus on terminology issues, epidemiology of MTBI and health-related quality of life (HRQoL) of MTBI population and introduce these topics by sections.

## 2.2 Terminology Issues of Mild traumatic Brain Injury

### 2.2.1 The statement of the problem

In clinical and epidemiological studies, enormous confusion has resulted from imprecise and inconsistent use of terms by health care professionals describing less severe brain injuries. For instance, the terms "mild or minor head injury" "mild or minor brain injury" and "concussion" have been used interchangeably. In addition, various definitions and criteria for each of the terms are applied differently by different researchers, and still other studies fail to provide any information on their case definition or criteria

for "caseness". Inconsistency in defining MTBI cases has resulted in difficulties in comparing studies (Carroll et al., 2004a).

### 2.2.2 The historical development of the concept

Development and adoption of a uniform case definition of mild brain injury is an ongoing process along with increasing understanding of related pathological and neuropsychological effects. It is interesting to look briefly at how the concept has developed up to the present time and to examine some of the attempts made to clarify the terminological issue, since this helps to contextualize some of the controversial issues around MTBI definition.

The earliest accounts of mild brain injury were written by Homer, in the second millennium BC, in whose writings the short term disability following a blow to the head were described as the weakness of the knees and clouding of vision and awareness which soon recovered. (Wrightson, 2000). Although this condition was continuously discussed in myth, legend and non-medical literature, no surviving medical records to distinguish mild from severe brain injury until the end of the $10^{th}$ century (McCrory et al., 2001), when a Arabic physician, Rhazes, first clearly described this entity of this condition. A Latin term "commotio cerebri" was used at that time to refer to an abnormal transient physiologic state without gross brain lesions or as a generic descriptor of brain injury, and this was seen as a critical point in the understanding of the condition (Mettler, 1947).

In the ensuing centuries, there were only a few important developments in the understanding of mild brain injuries (McCrory et al., 2001). Then, in the early 16th century, another important contribution was made by Berengario da Carpi who described the transient loss of consciousness when the head is struck with no wound or fracture, and he further extended the concept by postulating that the injury was caused by the thrust of the soft structure of the brain against the solid skull from shaking of brain (Flamm, 1996). With the development of the microscope, clinicians started trying to understand this condition from a pathophysiologic angle and attempted to explain this clinical syndrome in light of neuropathologic change. In 1674, Boirel proposed that some microscopic damage might occur in concussion (as reported in McCrory et al., 2001). At the beginning of the 18th century, Littré provided the evidence that blunt fatal head trauma could occur without any brain lesion that could be seen by autopsy (as reported in Wrightson, 2000). This is the beginning of the conceptualization of the concussion as a structural injury, which persists to the present time. The main alternative explanation for concussion is that of functional mechanisms, which refers to concussion as a transient disruption of function without permanent structural lesion. Although the debate between these two theories continues as to the degree if any of permanent effects, the definition of concussion is largely based on clinical signs and symptoms. In the late 18th century, Bell first introduced the use of clinical signs to distinguish

among different types of brain injury: concussion, compression and infection (Bell, 1786).

### 2.2.3 The most commonly used criteria for MTBI

#### 2.2.3.1 Loss of consciousness (LOC) and duration of LOC

Loss of consciousness is one of the most commonly used criteria to define mild traumatic brain injury. The Glasgow Coma Scale (GCS) was first proposed by Teasdale and Jennett in 1974 to assess and monitor the level of consciousness (Teasdale and Jennett, 1974). This scale provides a framework for assessment of patients' consciousness in terms of three aspects of responsiveness: eye opening, verbal response, and motor response. Each consists of four, five and six points or response options respectively. The lowest possible score is 3 and the highest is 15. The higher the score, the better the state of consciousness of the patient. A summary score of 13 to 15 is suggested to indicate mild brain injury. This classification system was developed primarily to describe severe and moderate injuries. Extensive studies have supported its reproducibility (Rowley et al., 1991; Teasdale et al., 1978; Braakman et al., 1977) and validity (Pal et al., 1989; Teasdale et al., 1979), especially in severe or moderate injuries.

However, the conditions under which GCS is measured, such as time, place, other injuries and sedative use, should be considered in order to obtain reliable assessment (Lezak et al., 1995). For example, an eye injury could inaccurately lead to a low GCS rating. This is why GCS score may not

always be a valid indicator of injury severity for clinical and epidemiological studies. In addition, a report of the GCS is often missing from emergency documents because many patients are not assessed soon after their injury. Not surprisingly, it is even more difficult to acquire GCS for epidemiological studies, since clinical data may be lacking or inaccessible.

One of the examples of using a GCS score of 13-15 as a criterion for mild brain injury in an epidemiological study is the study by Dacey et al. (1986). In this study it was reported that of 610 patients with an initial GCS score of 13-15, eighteen patients (3.0%) required a neurosurgical procedure. Five patients required craniotomy. As cases with an initial GCS score of 13-15 may include some more severe intracranial injuries, there is a need to consider other helpful criterion. Length of loss of consciousness is a useful criterion to consider in addition to the GCS. A study done by Rimel et al. used both loss of consciousness less than 20 minutes and GCS of 13-15 as their definition criteria (Rimel et al., 1981). At the same time they also set an upper limit, no than 48 hours hospital stay, to ensure that more severe patients were excluded.

### 2.2.3.2 Post Traumatic Amnesia (PTA) and duration of PTA

Post-traumatic amnesia refers to the condition of loss of ability to form new memores immediately following a trauma. Duration of post-traumatic amnesia is another criterion commonly used in clinical settings to define mild brain injury. PTA could last for seconds to months. However, classification of

brain injury severity varies across settings and among studies. Variously, PTA duration of no more than 1 hour and a PTA of less than 24 hours have been considered by different clinicians and researchers to indicate a mild brain injury (Bernstein, 1999).

In addition to this source of variability in classifying injury severity, it has been demonstrated by Gronwall and Wrightson that retrospective estimates of PTA duration changed over time in 25% their patients (Gronwall and Wrightson, 1980). Other authors suggested similar findings (King et al., 1997). Due to the compromised reliability, retrospective estimates of PTA should be used with caution. Duration of PTA can also be difficult for clinicians to evaluate, because of the need to distinguish "islands" of recall from continuous memory in order to define the end of PTA. These limitations illustrate the potential problems in defining MTBI.

### 2.2.3.3 Length of hospitalization

Length of hospitalization has also been used as an upper limit of mild brain injury in the literature. As suggested by Wrightson and Gronwall (1999), most patients with mild brain injuries who have been admitted to hospital for observation will be discharged within 48 hours. Therefore, this criterion could help to exclude more severe brain injuries from mild ones. Similarly, Kraus et al. (1994) reported that for patients with GCS of 13-14, the median length of stay was almost three days, whereas for patients with an initial GCS of 15, the median length of stay was about two days.

However, this criterion does not consider situations in which discharge is delayed because of other injuries or for some other practical reasons. For example, patient discharge could be delayed due to severe abdominal injuries or in cases where close observation and patient-care could not be obtained outside hospitals. Moreover, a great number of MTBI patients are not treated in hospitals (Kraus and McArthur, 1996). The usefulness and validity of this criterion alone is therefore in doubt.

### 2.2.3.4 ICD: International classification of diseases

The international classification of disease code (ICD-9 or 10) is another means of defining mild brain injury, with mild traumatic brain injury usually represented as ICD9 codes. The term "concussion' is presented in this coding system and there are a few subsets shown as follows

850 Concussion

850.0 With no loss of consciousness

850.1 With brief loss of consciousness

850.2 With moderate loss of consciousness

850.3 With prolonged loss of consciousness & return to pre-existing conscious level

850.4 With prolonged loss of consciousness, without return to pre-existing conscious level

850.5 With loss of consciousness of unspecified duration

850.9 Concussion, unspecified

Clearly, the ICD-9 850 code covers a wide range of severity in head injuries. One with diagnosed ICD-9 850 could have a very mild injury (e.g. confusion or disorientation) or could be severe enough with persisting loss of consciousness. This may pose misclassification problems in the use of the coding system for research purposes. One study reported that only 23% of MTBI cases were coded as 850 while 29% of moderate TBI were also identified as 850 (Tate et al., 1998). A similar criticism is also reported on using ICD-10 codes to define MTBI (Deb, 1999).

### 2.2.4 Terms confused with mild traumatic brain injury

**Mild or minor traumatic head injury (MTHI)** is sometimes used to refer to mild traumatic brain injury, but may also be used to refer to any mild damage to the head including damage to the brain. For example, facial lacerations or contusions can be classified as MTHI cases but in these cases patients are not necessarily brain-damaged. Therefore, MTBI is more properly considered a subset of MTHI.

**Concussion** is general term that refers to a transient disturbance in neurological function by mechanical force (Gurdjian et al., 1964). It includes a wide range of symptoms and severity, although it is rarely used to refer to very severe brain injury. A mild concussion indicated only by dizziness could be classified as a MTBI, while a severe concussion with persistent loss of

consciousness should be grouped as moderate or severe brain injury. Caution needs to be taken when applying the term "concussion" in studies.

In the sports medicine literature it is more common to see the term "concussion" used to describe an injury to the head that produces a brief alteration in neurological function such as loss of consciousness and posttraumatic amnesia. Nevertheless, the term "concussion" does not define homogenous groups across studies. Some studies have simply adopted the term as a case definition without explicit definitive criteria (Zemper, 1994), while others have presented different operational definitions for considering an injury to be a concussion. For instance, Buckly defined concussion as any brain injury that required the athlete to cease participation (Buckley, 1998) and Gerberic et al. referred to concussion as a blow to the head resulting in LOC or Loss of awareness or diagnosed by a physician (Gerbrich et al., 1983). Plainly, inconsistent use of the term "concussion" as an alternative term for MTBI makes the issues around MTBI definition even more confusing.

**There is a constellation of symptoms** often reported after MTBI. This includes physical symptoms, cognitive complaints, behavioural and affective symptoms (Bernstein, 1999). Previously this has been variously referred to as post-concussive syndrome, traumatic head syndrome, post-brain injury syndrome and posttraumatic syndrome, and the term is sometimes used as an alternative to the term mild head injury (American

Congress of Rehabilitation Medicine, 1993). Various terms used in MTBI studies make any attempt to produce a unified definition of MTBI more complicated, especially when there is no precise definition for some of the terms agreed upon by researchers (Bernstein, 1999).

### 2.2.5 The American Congress Definition of MTBI

In 1993, a definition of MTBI was developed by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine (Mild Traumatic Brain Injury Committee, 1993). This is among the most commonly cited case definition in North American MTBI studies.

This definition states that "a patient with mild traumatic brain injury is a person who has had a traumatically induced physiological disruption of brain function, as manifested by a least one of the following:

1. any period of loss of consciousness;
2. any loss of memory for events immediately before or after the accident;
3. any alteration in mental state at the time of the accident (e.g. feeling dazed, disoriented, or confused);
4. focal neurological deficit(s) that may or may not be transient

But the severity of the injury does not exceed the following:

a. loss of consciousness (LOC) of approximately 30 minutes or less;

b. after 30 minutes, an initial Glasgow Coma Scale (GCS) of 13-15; and

c. posttraumatic amnesia (PTA) not greater than 24 hours." [§]

This definition not only includes a blow to the head, but also the possibility that acceleration-deceleration movement without direct external trauma to the head (ie, whiplash) is a mechanism for MTBI. For some patients, these criteria may not be documented in the acute stage. It is appropriate to consider symptomatology that can suggest the existence of a mild traumatic brain injury.

Recently, an adaptation of this definition was proposed by the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury (Carroll et al. 2004b), in which MTBI is referred to as "an acute brain injury resulting from mechanical energy to the head from external physical forces. Operational criteria for clinical identification include:

(i) one or more of the following: confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery;

(ii) Glasgow Coma Scale score of 13-15 after 30 minutes post-injury or later upon presentation for healthcare. These manifestations of MTBI must not be due to drugs, alcohol, medications, other injuries or treatment

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[§] Mild Traumatic Brain Injury Committee, American Congress of Rehabilitation Medicine, Head Injury Interdisciplinary Special Interest. Definition of mild traumatic brain injury. Journal of Head Trauma Rehabilitation 1993; 8:86-87.

for other injuries (eg. Systemic injuries, facial injuries or intubation), caused by other problems (eg. Psychological trauma, language barrier or coexisting medical conditions) or caused by penetrating craniocerebral injury." *

The Task Force further indicated that although an assessment of GCS score at 30 minutes post-injury remains the ideal, the definition permits the use of a GCS score assessed by a qualified healthcare provider at the first opportunity.

However, there are still debates regarding the lower boundary of this definition, and there remains a great need to promote the homogeneity of MTBI case definition for future studies.

## 2.3 Epidemiology of Mild Traumatic Brain Injury

### 2.3.1 Incidence of mild traumatic brain injury

As a leading cause of death, TBI has been a serious public health concern (National Center for Injury Prevention and Control, 1999). In a systematic review of the literature, Cassidy et al. (2004a) reported that 70-90% of the total cases of TBI are mild. However, due to the variability of case

* Carroll LJ, Cassidy JD, Holm L, Kraus J, and Coronado VG. Methodological issues and research recommendations for mild traumatic brain injury: the WHO collaborating centre task force on mild traumatic brain injury. Journal of Rehabilitation Medicine. 2004: suppl.43 113-125.

definition and inclusive criteria of MTBI, the findings from incidence studies vary considerably. In addition, findings are also susceptible to diverse source populations, time frame and geographical involvement. For example, Whitman et al. defined MTBI as LOC or PTA for 30 minutes or less and reported incidence rates of 163/100,1000, 227/100,000, 74/100,000 respectively for inner city African-Americans, Evanston (Illinois) African-Americans and Evanston whites (Whitman et al., 1984). Jager et al (2000) used ICD-9 850 to define MTBI cases and found an incidence rate of 60/100,000 for US population. Cassidy et al. reported that the incidence rates of MTBI traffic injury claims (using a proxy measure to identify MTBI) in Canadian Province of Saskatchewan were 72/100,000 and 54/100,1000 respectively for the years 1994 and 1995 (Cassidy et al. 2004b). The incidence of hospital admissions for MTBI for US population was about 130/100,000 population in 1980 (Thurman et al., 1999), and when non-hospitalized cases were included the figure may have been as high as 618/100,000 in 1991 (Sosin et al., 1996). Other than the influence of these factors, the difference between the hospital and non-hospital incidence rate may also suggest that a large number of MTBI cases are not admitted into hospital. In support of this, data from the National Health Interview Survey revealed that of all persons with TBI only 16% were admitted to the hospital (Fife 1987).

Given the heterogeneity of MTBI case definitions among studies, there is no summary incidence rate estimated. Based on a comprehensive literature review, Cassidy and colleagues estimated that the annual incidence of MTBI in North American adults is between 51-618 per 100,000 inhabitants The annual incidence found in non-North American studies was between 83 to 718 per 100,000 population (Cassidy et al., 2004a). However, the true incidence could be much higher than these estimates, especially when the reported rates are based only on hospital records.

### 2.3.2 Risk Factors for MTBI

There is consistent evidence suggesting that the risk for MTBI is greater for males and in teenage and young adults (Cassidy et al., 2004a). In a population-based study of hospitalized MTBI cases, Kraus et al found that the incidence for males (174.7 per 100,000) was over twice as high as that for females (85.2 per 100,000) and the peak incidence was for males between 15 and 24 (Kraus et al., 1984). The relative risk of MTBI for males vs. females in traffic collisions was 1.41 and the relative risk for ages 18-23 years compared with those over 50 years was 3.78 (Cassidy et al., 2004b).

In most countries for which data are available, the most common overall cause of MTBI is motor vehicle collisions followed by falls, although falls are the most common cause in young children and the elderly. Assaults, sports injuries and bicycle crashes comprise most of the remaining cases of MTBI. In Kraus's study, 42% of MTBI involved a motor vehicle crash, 23%

cases resulted from falls and assaults accounted for 14% of the total cases (Kraus et al., 1984). Similarly, Mackenzie et al reported that the most common cause of MTBI was motor vehicle crash that resulted in 47% of total MTBI and falls lead to 24% MTBI (MacKenzie et al., 1989). Data from Australia showed 33.9% of total MTBI cases caused by traffic collisions and 23.3% by falls, 27.2 by sports (Tate et al., 1998). However, in Sweden, falls, rather than traffic collisions, lead to more MTBI (Peloso et al., 2004).

### 2.3.3 Symptoms and Sequelae of MTBI

A great many different symptoms have been reported after MTBI. These symptoms can be roughly grouped into three categories: physical symptoms, including nausea, vomiting, dizziness, headache, blurred vision, sleep disturbance, fatigue, lethargy, or other sensory changes; cognitive deficits, such as lack of attention, problem with concentration, impaired perception, poor memory, speech or language deficits and decreased executive functions; behavioural change and affective symptoms, such as irritability, quickness to anger, disinhibition, or emotional lability (Bernstein, 1999; American Congress of Rehabilitation Medicine, 1993).

Estimates of the frequency and duration of these symptoms vary widely, likely in large part due to methodological differences in studies. These differences include variations in case definitions of MTBI, measures used to assess patients and the postinjury time (Bohnen and Jolles, 1992). Lowdon et al. (1989) followed a total of 114 adults with MTBI and reported

that 90% of patients suffered symptoms such as headache, dizziness, poor concentration, irritability, poor memory or vomiting, six weeks after the injury. Headache was the most prevalent and lasting longest symptom. The Median length of symptoms was one week (95% CI 1-3). Rimel et al. (1981) evaluated 424 adult patients three months after MTBI, and 79% complained of persistent headaches, with 59% describing problems with memory. In a Best Evidence Synthesis of the literature on MTBI, Carroll et al (2004b) concluded that the bulk of the best evidence indicates that cognitive impairments (as measured through formal cognitive assessments) resolve within three months in the overwhelming majority of patients with MTBI. However, one population-based study by Masson et al (1996) suggested that as long as five years after the injury, MTBI patients still reported a higher prevalence of headaches (43.9%), fatigue (35.1%), memory problem (32.1%), dizziness (32.5%), sleep disturbance (26.3%), depressive temper (38.6%), anxiety (47.4%) and irritability (37.7%) than lower limb-injury controls.

It is interesting that these symptoms are not unique for MTBI, although they are more common in MTBI population. Similar complaints are commonly reported by people who have not had head injuries, such as individuals in the general population, patients with other injuries and patients with chronic pain. Paniak et al. (2002a) compared 118 patients within one month of MTBI to matched controls on endorsement of symptoms using the Problem Checklist

(Kay et al., 1995). It was found that MTBI group showed higher symptom endorsements on 27 of 43 items and higher severity ratings on 35 items. Through the observational study of 71 MTBI patients and 60 matched orthopaedic controls, Bazarian et al. (1999) reported that the frequency of symptoms referred to as post-concussive syndrome, was 58% at one month, 43% at three months and 25% at six months among MTBI patients, while 34% was reported in controls at one month. In another study which used the Head Injury Symptom Checklist (Patrick et al., 1973) headaches, fatigue, being bothered by light, irritability, loss of temper, and anxiety were common in both head injured subjects and normal control subjects. However only "being bothered by noise", insomnia and memory difficulties occurred more frequently in the head injured group at one month post injury (Dikmen et al., 1986). Smith-Seemiller et al. (2003) showed that most people with chronic pain endorsed symptoms consistent with those presented in MTBI patients and there were only a few differences in the proportion of patients endorsing specific symptoms. Not surprisingly, Alexander (1995) bemoaned the lack of diagnostic specificity of these symptoms to accurately identify MTBI sequelae. Indeed, the vague and nonspecific nature of postconcussion syndrome raises great controversy over this entity.

The aetiology and pathogenesis of these symptoms are not yet clearly understood. Evidence of both psychological and organic influences have appeared in the literature (Bohnen et al., 1992) and this has become a topic

of great interest and debate over the past few decades (Binder, 1986). Many factors may be associated with persisting complaints. Trahan and colleagues (2001) investigated self-reports of postconcussional symptoms among three groups: young adults with no history of MTBI or depression, depressed adults and individuals with a history of MTBI. They found that depressed individuals exhibited substantially higher endorsement for 12 of 17 symptoms in the Postconcussional Index than other groups. Based on a recent review on prognosis of MTBI (Carroll et al. 2004a), there is reason to believe that litigation and /or compensation issues are risk factors for long-term complaints. In addition, factors such as age, gender, marital status, pre-existing physical limitations and prior head injuries, brain illness, multiple concussions and others may also play a role (Cassidy et al., 2004b; Thornhill et al., 2000; Bazarian et al., 1999; Gronwall and Wrightson, 1975).

It should be noted that patients with mild traumatic brain injury can exhibit persistent symptoms, alone or in combination, which may produce a functional disability, although it is not yet clear why these symptoms persist, what proportion of those with MTBI will experience persistent complaints or what factors contribute to persistence of symptoms. However, there are certainly reports of some patients with MTBI having difficulty returning to or maintaining employment, significant disruption of social life, and increased incidence of depression or somatic illness (Haboubi et al., 2001; Lishman et al., 1998), even when the cause of these difficulties is not clear.

## 2.4 Health-related Quality of Life after Mild Traumatic Brain Injury

Although the concept of health-related quality of life (HRQoL) has been recognised as important in medical research for over twenty years, the investigation of HRQoL in patients with traumatic brain injury (TBI) is relatively new and has primarily focussed on moderate and severe traumatic brain injury (Bullinger et al. 2002), although a large number of studies have documented problems faced by individuals with MTBI. In a comprehensive review of quality of life (QOL) after traumatic brain injury (TBI) by Berger et al. identified total 16 studies from 1991 to 1998 literature (Berger et al., 1999). None of the studies focused on MTBI, although two of the studies did not report the severity of their cases and one study included five mild cases in their study (Berger et al., 1999; Leach LR et al., 1994). The issue of HRQL is still an understudied area in MTBI. However, eight studies provide some information on MTBI-specific HRQoL and factors associated with HRQoL, and are described below. These studies all had clear criteria for classifying MTBI cases, provided at least minimal information on the ages of subjects and some indication of how soon after injury HRQoL was assessed.

In a recent prospective study, 489 patients between 16-60 years of age were identified as MTBI cases according to strict clinical criteria including

amnesia, unconsciousness, and neurological disturbance. Out of the total cases, 173 patients responded to SF-36 questionnaire at three weeks, three months and one year after a MTBI. Their data were compared with a national normative control group. The results showed that the MTBI group scored significantly lower than the control group on all subscales of the SF-36 in 3 months and 1 year after a MTBI. The decreasing SF-36 score correlated well with the increasing rate of post-concussion symptoms (Emanuelson et al., 2003). The authors suggested that the HRQoL of adult MTBI patients is significantly impaired although there is recovery between three months and one year after the injury. Persisting symptoms after MTBI may be one of the attributive factors to the declined HRQoL at three months and one year after injury.

Paniak et al. (1999) compared 120 MTBI patients, within three weeks of injury, to age, education, sex and preinjury socioeconomic status matched controls on the Problem Checking List (PCL), SF-36 and Community Integration Questionnaire (CIQ). MTBI was diagnosed according to criteria from American Congress of Rehabilitation Medicine (1993). Their findings suggest that PCL scores and SF-36 scores, but not CIQ scores, were generally worse than controls. As the large difference showed in Physical Functioning, Role Physical and Bodily Pain (effect sizes 3.5, 2.7 and 2.0, respectively) from the SF-36, the authors suggested that musculoskeletal problems might be an important factor for declined SF-36 score. Interesting

enough, their study did not reveal a significant difference on the General Health subtest between MTBI and control groups. According to the authors, this may be because the study took place too soon after the injury for patients' beliefs about their overall health to have changed.

A study by Brown et al. (1998) examined 430 self-identified TBI patients, 101 spinal cord injured and 187 normal controls in terms of two summary QOL indicators: a Global QOL Measure based on two items tapping the individual's emotion-based view of QOL, and a summary score adapted from Flanagan's Scale of Needs, reflecting the patients' perceptions of total unmet important needs. Among total TBI cases, 9% were defined as MTBI using criterion LOC less than 20 minutes. The mean year from injury was 10.1 (SD=8.9). It was reported that TBI group rated its QOL lower than either of the control groups and had significantly more unmet important needs. In addition, the QOL score correlated with ethnicity, age and marital, work status. Very interestingly, they also found that severity of injury was a powerful modulator of QOL after TBI in that those with more severe TBI rated their QOL similar to that of normal controls whereas those with MTBI rated their QOL as lower than that in spinal cord injuries and severely injured TBI. The authors explained that this finding might be attributable to cognitive deficits experienced by severely injured TBI patients, such as lack of insight into life difficulties, or alternatively, that this may be due to the heightened

appreciation of life that severe TBI patients may acquire through life-threatening events (Steadman-Pare et al. 2001).

Findler et al (2001) reported a similar finding, in a study examining the reliability and validity of the SF-36 for use in TBI population. In this study, the SF-36, Beck Depression Inventory (BDI), Health Problems List (HPL) and the Institute for Rehabilitation Research Symptom Checklist (TIRR) were administrated to 591 participants who were between 16-64 years old, among which were 98 with MTBI, 228 with moderate-severe TBI and 271 in a normal comparison group. It is likely, however, that the group considered to have MTBI included more severely injured cases since MTBI was defined as a brain injury caused by a blow to the head resulting in dizziness and confusion or having a loss of consciousness no more than one day. Moderate-severe cases were defined as a loss of consciousness for longer than one day as a result of a blow to the head. It was found that the group classified in this study as MTBI had lower SF-36 scores than the comparison group and a lower SF-36 score (except for the physical functioning scale) than the moderate-severe TBI group even after controlling for age, gender and income. As an interpretation of this finding, authors reported that the difference between the mild and the moderated-severe groups dropped below statistical significance when the effects of depression were controlled, therefore it appeared that depression may account for the differences. However, since BDI scores may also measure overall distress rather than

depression alone (Sliwinski et al., 1998), the authors suggested that depression and distress may both be attributive factors. This finding is also consistent with previous reports by Gordon et al. (2000; 1998)

A study by Friendland et al. (2001) provided evidence about the psychosocial effects on QOL after MTBI. In this study, 99 motor vehicle collision (MVC) admissions between 19-65 years old were enrolled, among which 64 had MTBI. MTBI cases were identified using American Congress of Rehabilitation Medicine criteria (1993), that is, an initial Glasgow Coma Scale Score>=13; loss of consciousness <=30minutes; or posttraumatic amnesia <= 24 hours. Subjects were assessed between six and nine months after their injury on the Sickness Impact Profile (SIP) measuring the perceived changes after the injury, Reintegration to Normal Living Scale (RNL) measuring satisfaction with reintegration to normal living and Impact of Event Scale (IES) and General Health Questionnaire (GHQ) measuring posttraumatic stress. IES in MTBI group was significantly higher than non-MTBI group, and this showed that greater posttraumatic stress appeared in MTBI group in comparison to non-MTBI MVA victims. Although the SIP overall mean and the SIP physical mean seemed relatively higher in MTBI group than in the injured comparison group, the differences did not reach statistical significance. Instead, SIP psychosocial score was significant higher for MTBI group (21.4+-19.47) than that for the non-MTBI group (10.86+-15.78) within 99% confidence interval.

Work status and marital status are considered by some to be important components of quality of life. Vanderploeg et al. (2003) extended the possible explanatory factors on MTBI outcome by exploring factors associated with post-injury work and marital status among 626 MTBI patients who experienced their injuries on an average of eight years before the study. MTBI was defined as a head injury without loss of consciousness or with a brief LOC (not further defined). Finding suggested that intellectual capacity and preexisting psychological problems play a more prominent role in work and marital status than in the uninjured population. Those MTBI cases with higher premorbid intelligence, measured by preenlistment General Technical Test, were four times more likely to be employed full time than were those with lower premorbid intelligence. Individuals without early life internalizing problems (e.g. Mental disorder of anxiety, depression, mania and psychotic symptoms), as captured by the Psychiatric Diagnostic Interview Schedule, were over twice as likely to be working full time. Older age, race (white), the absence of preexisting externalizing psychiatric difficulties (e.g. substance abuse disorders), and current full-time employment were associated with higher rates of marriage. However, in a study of 118 MTBI patients who presented to an emergency room (GCS 13-15, LOC less than 30 minutes, PTA less than 24 hours), Paniak et al. (2000b) found that at three to four months post-injury, seeking or receiving financial compensation and older age were the only factors related to not returning to work. In addition,

financial compensation factors were also prognostic of persistent symptoms and slowed recovery after MTBI (Cassidy et al. 2004b, Reynolds et al. 2003, Paniak et al. 2002b). However, the effect of financial compensation factors in the first few weeks after MTBI has not been as thoroughly investigated.

Mosenthal et al. (2004) recently investigated the effect of age on the Functional Independence Measure (FIM) in the MTBI population six months after their injuries. Two hundred and thirty five subject with TBI and GCS score of 13-15 and age of over 18 were enrolled for the study. The improvement in functional status during the six months after injury was observed in both young and older groups and the FIM score was greater for the young group (11.7 95%CI: 11.6-11.9) than that for the older group of patients (11.0 95%CI: 10.6-11.4; $P<0.001$). Since functional independence is only one of the aspects of QOL, authors also indicated that although there were statistically significant differences on FIM score between these groups, the importance of the differences to the patients' overall quality of life is less clear.

The relationship between employment and QOL (measured by Bigolow Quality of Life Questionnaire, the Flanagan's Scale of Needs, and a global quality of life measure) has also been examined (O'Neill, 1998). However, subjects in this study were TBI patients with mixed severity, among which only 18% were MTBI identified by LOC less than 20 minutes. As a result, findings from this study may not apply to MTBI population.

Although there are some variations on case definitions for MTBI, all the above studies fully or partially adapted their diagnostic criterion from commonly used criterion recommended by American Congress of Rehabilitation Medicine and WHO task force. This leads to greater comparability across studies. Although evidence is still lacking and more studies on MTBI are indicated, the studies appeared above suggest that the HRQoL after MTBI is lower than in normal controls, other injured individuals (e.g. Spinal cord injured) and non-MTBI MVA victims either in the short term or the long term. Possible explanatory factors that have been proposed include postconcussion symptoms (especially depression and distress), poor physical functioning, pain (e.g. musculoskeletal problems), limitations in usual role activities due to physical health problems, ethnicity, age, marital status, work status, intellectual capacity, preexisting psychologic problems and financial compensation. However, due to the limitations in the literature, it is impossible to draw any firm conclusions on HRQoL in the early stages of recovery after MTBI. Therefore, further research is indicated for exploring the impact of MTBI on HRQoL and to identify explanatory predictors of self-rated health in the early recovery period. This will have important implications for intervention since intervention needs to be directed at the factors that matter to the MTBI population.

# Chapter Three

# METHODOLOGY

## 3.1 Purpose

The main purpose of this research is to investigate the factors associated with the self-rated health of Saskatchewan adults with traffic-related Mild Traumatic Brain Injury. There were three objectives as follows:

- To investigate and compare the frequency of traffic-related MTBI in Saskatchewan in two consecutive 12- month periods and describe characteristics of MTBI population.
- To describe the self-rated health of Saskatchewan adults with MTBI.
- To identify the factors associated with self-rated health of adults with traffic related MTBI.

## 3.2 Background

Saskatchewan is a province of Canada with a population of approximately 1,000,000 and an average of 27,382 traffic collisions per year between 1999 and 2001 (Saskatchewan Government Insurance, 2002; Saskatchewan Highways and Transportation, 2002). All Saskatchewan drivers and vehicles are insured by Saskatchewan Government Insurance (SGI), which provides coverage for physical damage to the vehicle and coverage for individuals injured in motor vehicle collision. Therefore, the SGI

database contains all traffic injury claims within the province. On January 1, 1995, SGI implemented "no fault' coverage which eliminated the right to sue for "pain and suffering", and which provided immediate benefits and rehabilitation programmes for injured individuals.

## 3.3 Data Source

Data for this research are from the baseline data of a population-based cohort study conducted in Saskatchewan (Cassidy, Carroll, Côté, Frank, in submission). This study was intended to identify prognostic factors for recovery and to assess the short-term and long-term effectiveness of a province-wide rehabilitation program for traffic injuries in Saskatchewan.

Baseline data on all injury claimants was available from the application for benefits form filled out by the injured claimant at the time of making the injury claim. This also includes all those seeking health care for traffic injuries, since health care providers are mandated to report traffic injuries. The application for benefits form included questions about demographic and socioeconomic status, collision information, post-injury symptoms/pains, pre- and post-collision health information, post-injury treatment/rehabilitation and comorbid medical conditions. All data are self-reported.

The population for the current study is comprised of a subcohort of subjects with mild traumatic brain injury, using baseline data ascertained from the application for benefits form.

## 3.4 Population

Included subjects are all those making a personal injury claim with SGI or seeking treatment for a traffic injury, with the injury occurring between Dec.1, 1997 and Nov.31, 1999, who were residents of Saskatchewan, 18 years old or older, and who met the case definition for MTBI, as outlined below. Exclusion criteria consisted of death as a result of the injury; inability to understand English; serious disease resulting in an inability to answer the questionnaires or respond to the interview; serious associated injuries that resulted in an inability to respond to interviews and worker's compensation claims, since these claims are compensated under a different insurance system.

## 3.5 Case Definition

Cases of MTBI were identified by self-reported symptoms, since there was no access to clinical diagnoses in this study. A case definition of MTBI needs to consider two issues: First, there needs to be a minimal standard

specifying that there has been a disturbance of neurological function due to head injury. This is necessary because about half the people coming to emergency departments with an injury to the head show no sign of neurological dysfunction (e.g., facial contusions only) (Wrightson et al. 1998). The second consideration is defining an upper limit of severity, separating mild injuries from moderate and severe cases. Among the most commonly accepted criteria for defining presence and severity of traumatic brain injury are: presence of loss of consciousness (LOC), duration of LOC, presence of post-traumatic amnesia (PTA) immediately after the injury, duration of PTA and length of hospitalization (American Congress of Rehabilitation Medicine 1993; Dacey et al., 1986; O'Shaunessy et al., 1984; Rimel et al., 1981; Gronwall et al., 1980).

The following case definition, derived from self-reported information on the application for benefits form, was developed to approximate a clinical diagnosis of MTBI, and was designed to be as consistent as possible with the American Congress criteria. We applied the following inclusion and exclusion criteria for case ascertainment in the current study.

- Individuals were considered to have MTBI if they gave an answer of "yes" to the question "did you hit your head?" and either "yes" or "uncertain" to the following questions: "Did you lose consciousness immediately after the accident?" and "Immediately after the accident, did you experience amnesia or loss of memory?"

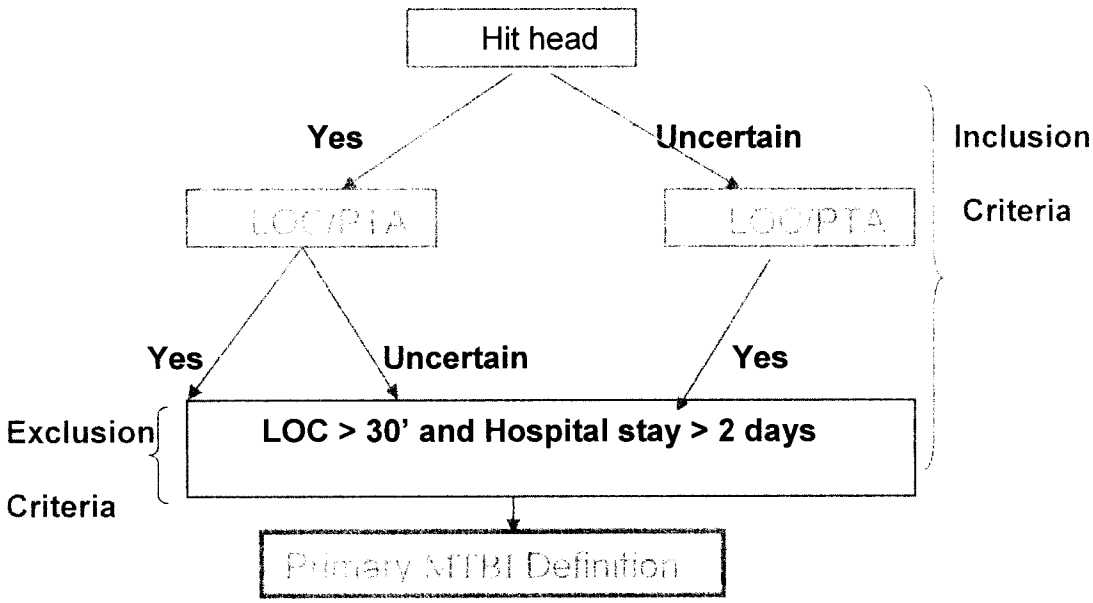
- Individuals were also classified as having suffered MTBI if they answered "uncertain" to the question "did you hit your head?" but answered "yes" to the question "Did you lose consciousness immediately after the accident?" and/or "yes" to the question "Immediately after the accident, did you experience amnesia or loss of memory?"
- Those who lost consciousness for longer than 30 minutes and those who were hospitalized for more than two days were excluded. This excludes those with more serious injuries.
- Those who claimed for injuries after 42 days post-collisions were included for the incidence calculations, but because data obtained more than 42 days after the collision can not be considered baseline data, these subjects were excluded for the remainder of the analyses.

## 3.6 Rationale

If people were certain that they had sustained a blow to the head, but uncertain whether they had LOC or PTA, this uncertainty may have been a result of actual LOC or PTA, however such subjects may only have felt "dazed". Since most criteria for MTBI include being "dazed after a head blow, we considered these cases (that is, with a blow to the head and uncertain LOC or PTA) to have been likely MTBI cases. However, in the absence of certainty about having received a head blow, we required

certainty about the presence of LOC and/or PTA. This may have resulted in some degree of misclassification, that is, missing MTBI cases, but is less likely to misclassify non-MTBI injuries as cases. This is consistent with the 1993 American Congress of Rehabilitation criteria, which specify that MTBI can occur without a blow to the head, through mechanisms such as the acceleration-deceleration force resulting from a collision. If people were certain about experiencing LOC and/or PTA and uncertain about whether they hit their head in the crash, it was considered likely that they actually did sustain a head blow leading to this altered consciousness. If, on the other hand, the individual was certain that they had not hit their heads in the collision, any subsequent altered consciousness was considered to be more likely due to other causes than a traumatic brain injury, and so these were not considered cases for this case definition. This last point is somewhat inconsistent with the American Congress of Rehabilitation criteria, which does not require a head blow; and an alternative case definition which includes those without head blows was developed and is described in the next section.

Figure 3.1 Primary Case Definition of self-reported MTBI



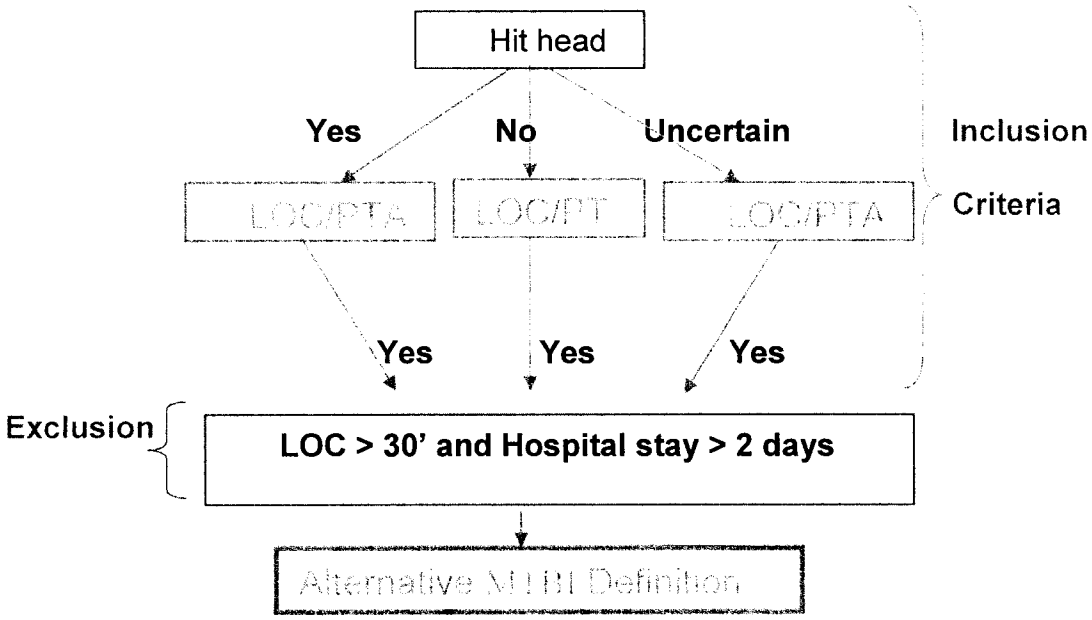

## 3.7 Alternative Case Definition

Given the unavailability of clinical diagnoses in this database, misclassification of cases as MTBI is possible. In order to assess the robustness of the primary case definition above, I performed a sensitivity analysis using an alternative case definition of MTBI. The detailed inclusion and exclusion criteria for this alternative case definition is as follows:

- Individuals were considered to have MTBI if they gave an answer of "yes" to either or both of the questions: "Did you lose consciousness immediately after the accident?" and "Immediately after the accident, did you experience amnesia or loss of memory?"
- Those who lost consciousness more than 30 minutes and those who were hospitalized for more than two days were excluded. This excludes those with more serious injuries.
- Those who claimed injuries after 42 days post-collisions were included for the incidence calculations, but because data obtained more than 42 days after the collision can not be considered baseline data, these subjects were excluded for the remainder of the analyses.

This alternative definition does not include criteria related to hitting the head in the collision, which is consistent with the American Congress (1993) and WHO (2004) diagnostic criteria.

Figure 3.2 Alternative MTBI Definition




## 3.8 Study Sample

Out of a total of 8,634 Saskatchewan residents making personal injury claims during the study period, 1,090 met the inclusion/exclusion criteria for the primary case definition of MTBI, and 850 met the criteria for the alternative case definition for purposes of the incidence calculations. After further excluding those claiming more than 42 days after their injury, 929 met the criteria for the primary definition and 723 met the criteria for the

alternative definition for purposes of modelling factors associated with self-rated general health.

## 3.9 Measures

### 3.9.1 Outcome: Self-rated Health

Self-rated health was assessed by a single item question: "in general, would you say your health is now: excellent, very good, good, fair, and poor health?"

This is an item from the SF-36 (Ware et al. 1993). It has been demonstrated that self-rated health is a valid, reliable, holistic health measure in numerous population groups including the MTBI population (Klein et al. 1998; Gold et al., 1999; Eriksson et al., 2001; Emanuelson et al. 2003). Moreover, it has predictive validity in that it has been demonstrated to strongly predict mortality (Lundberg et al. 1996).

### 3.9.2 Potential Explanatory Factors

Pain intensity was measured by the 11-point numerical rating scale (NRS-11). This is widely used, both in clinical practice and research, and has good reliability and construct validity (Breivik et al., 2000; Price et al., 1994).

The Comorbidity Scale was applied to measure comorbid medical conditions. This is a self-report questionnaire to assess the presence of

health effects of twelve comorbid health conditions, including diabetes, cardiovascular disease and gastro-intestinal disorders. This questionnaire has good reliability and has been validated against physician reports and health-related quality of life (Jaroszynski et al., 1996). It has been used in a number of studies to adjust for case mix (e.g. Carroll et al. 2002; Mercado et al. 2000; Côté et al. 2000a,b).

The presence of depression symptoms was assessed by the Center for Epidemiological Studies Depression Scale (CES-D), which is a self-report questionnaire widely used in clinical and large epidemiological studies as a screening tool for depression. The CES-D scale is a 20-item measure with a possible range of scores from 0 to 60 with higher scores indicating greater levels of depression. A CES-D score of 16 and higher is used as a screening criterion for depressive symptoms. It has been found to be valid, reliable and sensitive in the general population as well as in the TBI population (Bush et al., 2004; Bay et al., 2002; Radloff et al., 1986; Devins & Orne, 1985; Roberts et al., 1983; Radloff et al., 1977).

Other explanatory factors include demographic and socio-economic characteristics, collision-related factors, self-rated health one month before injury, prior head/ brain injury, past chiropractic treatment, prior physical therapy, past motor vehicle accident claims in SGI, other injury claims from other insurance system, post-injury symptoms (assessed by the question "Did the accident cause any of the following symptoms?"), expectations for

recovery, initial health care provider and number of days between the injury and the claim.

## 3.10 Factors and Domains

Sixty-two possible explanatory factors were included and grouped into nine domains according to their conceptual similarity. These criteria were chosen on the basis of prior literature and judgments about possible clinical relevance.

**Demographic, socioeconomic domain**

Contains seven factors

| |
|---|
| Age, gender, marital status, education, income, employment status and number of independents |

**Collision-related domain**

Contains six factors

| |
|---|
| Collision reported to police, ambulance use, position in vehicle, hospital or emergency clinic visit, direction of impact, admitted at least overnight |

**Pre-injury domain**

Contains six factors

| |
|---|
| Health one month before injury, prior head/ brain injury, past chiropractic treatment, prior physical therapy, past motor vehicle accident claims to SGI, other injury claims from other insurance system |

**Comorbidity domain**

Contains 12 factors

| |
|---|
| Presence and severity of pre-existing musculoskeletal problems allergies, respiratory problems, high blood pressure, cardiovascular problems, gastrointestinal problems, diabetes, nephrological problems, headache, neurological problems, cancer, depression scores |

**Symptom/consequence domain**

Contains 17 factors

| |
|---|
| Post-injury symptoms of dizziness, memory problems, poor concentration, irritability, confusion, vision problems, hearing problems, sleep problems, fatigue, anxiety, painful neck movement, restricted neck movement, sore jaw, broken bones, restricted home, work, educational or other activities |

**Pain domain**

Contains 11 factors

| |
|---|
| Pain drawing-percentage, neck/ shoulder pain, low back pain, headache pain, arm pain, hand pain, face pain, leg pain, foot pain, mid back pain, abdomen pain |

**Single factors as individual domains**

Three factors as three domains

| |
|---|
| Expectation for recovery |
| Initial health care provider |
| Number of days from claim to injury |

## 3.11 Statistical Analysis

I report the cumulative incidence of self-reported MTBI for each case definition, stratified by year, age and gender. For the denominator, I used the midyear population of Saskatchewan inhabitants in 1998 and 1999 (Saskatchewan Health.1998; 1999). I also report the incidence of MTBI using the number of vehicle damage claims and million-vehicle-kilometers driven in Saskatchewan as denominators. In addition, I present the distribution (% or mean) of potential explanatory factors.

Multinomial regression was used to identify factors associated with self-rated health. First of all, variables were checked as follows. Conceptually related variables were assessed for collinearity. When correlation coefficient was more than 0.3, two or more variables were considered to be highly associated and a decision based on research and clinical importance was made about which variable to use in the multivariable models. The categorical variables were checked for small cell sizes. If necessary, a decision was made to collapse categories. For example, in terms of the outcome variable "self-rated health", the numbers of respondents who answered 'excellent" and "very good" only account for 3% and 5.3% respectively, therefore, they were combined into one category. In addition, for continuous variables, the linear assumptions were checked for

each level of self-rated health. If the plot was not linear, this potential explanatory variable was recoded into categories.

Multivariate models were then built to identify the factors associated with self-reported general health. Because the outcome variable was polytomous categorical, multinomial regression was chosen for this purpose. Although multivariable models built to explore associations between potential explanatory factors and an outcome of interest frequently retain in the model all explanatory factors of interest regardless of their association with the outcome, I did not follow this procedure because of the large number of factors of interest and the relatively small sample size. In order to maximize statistical power and the precision of our estimates, I used the following analysis strategy. First, potential explanatory factors were divided into "domains" of conceptually related factors, as above. I then built a crude model of self-rated health with each explanatory factor, and those related to self-rated health at a significance level of $p <= 0.1$ (using the Wald statistic) were retained in domain-specific multivariable models. For variables with $P > 0.1$, I further checked their effect by calculating the changes of –2 Log Likelihood for the domain specific model caused by taking out the variable from this model. If the change in the estimate of the effect was greater than 15% after removing that factor, it was retained in the domain-specific model. Thirdly, I checked the significance of possible interaction terms of plausible variables. These were first-order interactions between the explanatory

variables and interactions between gender and all included variables. A final model was then built using important variables retained from previous procedures. Factors associated with self-reported health at a $p<0.05$ level of significance were retained in the final model.

Finally, I performed a sensitivity analysis to assess whether these identified explanatory factors were important using the dataset utilizing the alternative case definition of MTBI.

# Chapter Four

# RESULTS

## 4.1 Cumulative Incidence

Of 8,634 traffic collisions, 1,090 injured individuals met the primary case definition and 850 met the alternative case definition for MTBI. Age and gender-specific incidence were calculated for each consecutive 12-month period using midyear Saskatchewan adult population (18 years of age and above) in 1998 and 1999. The results are presented in Table 4.1 and Table 4.2. The incidences were also calculated using the number of vehicle damage claims and million-vehicle-kilometres driven in Saskatchewan in 1998 and 1999 as denominators.

Table 4.1 Cumulative Incidence of MTBI with the Primary MTBI Definition for Two 12-month Periods

| MTBI claims (N = 1090) | First 12-Month (N = 525) Incidence; (95%CI) | Second 12-Month (N = 565) Incidence; (95%CI) |
|---|---|---|
| Per 100,000 adult population | 69 (63, 75) | 74 (68, 80) |
| Per 10,000 vehicle-damage claims | 96 (88, 104) | 99 (91, 108) |
| Per billion kilometres driven | 55 (51, 60) | 60 (55, 65) |
| Sex-stratified | | |
| Per100,000 men | 71 (63, 80) | 76 (67, 85) |
| Per 100,000 women | 66 (59, 75) | 72 (64, 81) |
| Age-stratified | | |
| Per100,000 18-24 yrs old | 137 (115, 161) | 147 (125, 172) |
| Per 100,000 25-34 yrs old | 97 (81, 115) | 84 (70, 101) |
| Per 100,000 35-44 yrs old | 61 (50, 75) | 78 (65, 93) |
| Per100,000 45 and above yrs old | 42 (35, 49) | 46 (39, 53) |

The cumulative incidences for the second 12-month period were slightly higher than that for the first 12-month period per 100,000 population, per 10,000 vehicle-damage claims and per billion kilometers driven. The same was true to gender-specific incidences, however the confidence intervals overlapped, and the differences are not likely meaningful. The highest incidence was in the youngest age group, and decreased with

increasing age. Frequency of MTBI was slightly higher in males than in females, but the magnitude of this difference is small and may be due to random variation.

Table 4.2 Cumulative Incidence of MTBI using the Alternative MTBI Definition for Two 12-month Periods

| MTBI claims (N = 850) | First 12-Month (N = 420) Incidence; (95%CI) | Second 12-Month (N = 430) Incidence; (95%CI) |
|---|---|---|
| Per 100,000 adult population | 55 (50, 61) | 56 (51, 62) |
| Per 10,000 vehicle-damage claims | 77 (69, 84) | 76 (78, 83) |
| Per billion kilometres driven | 44 (40, 48) | 45 (41, 50) |
| Sex-stratified | | |
| Per100,000 men | 55 (47, 63) | 57 (50, 66) |
| Per 100,000 women | 56 (48, 63) | 55 (48, 63) |
| Age-stratified | | |
| Per100,000 18-24 yrs old | 98 (80, 119) | 117 (97, 139) |
| Per 100,000 25-34 yrs old | 71 (57, 86) | 58 (46, 72) |
| Per 100,000 35-44 yrs old | 47 (37, 58) | 59 (48, 72) |
| Per100,000 45 and above yrs old | 40 (34, 47) | 36 (30, 43) |

When incidence was calculated using the alternative case definition for MTBI, there were few differences across the two study periods and no

differences in MTBI occurrence between males and females. Again, the highest incidence was in the younger age group, and frequency of MTBI injury decreased as age increased.

## 4.3 Self-rated Health

Of the 1090 traffic-related MTBI claims (using the primary case definition for MTBI) among adult residents in Saskatchewan during the study period of December 1, 1997 to November 31, 1999, 929 (85.2%) made their injury claim within 42 days of the collision, and form the study sample for modelling health. In these subjects, median time between the injury and completing the claim form was 11 days.

At the time of making their claim (within six weeks after the collision), 27 (2.9%) reported excellent health, 47(5.1%) reported very good health, 196 (21.1%) reported good health 374 (40.3%) reported fair health and 283 (30.5%) reported poor health (Table 4.3 and Figure 4.1).

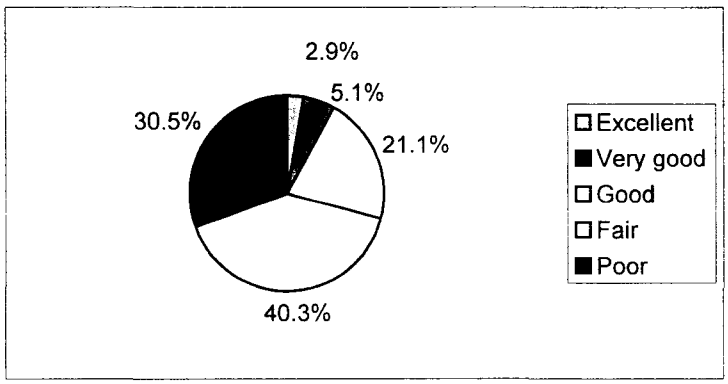
Since only a small number of subjects reported excellent self-rated health, the categories of "excellent" and "very good" were combined into one category, resulting in four categories of self-rated health for the purpose of analysis.

Table 4.3 Self-Rated Health of People with MTBI (N=929)

| Self-rated Health n (%) | N* (%) |
|---|---|
| Excellent | 27 (2.9) |
| Very good | 47 (5.1) |
| Good | 196 (21.1) |
| Fair | 374 (40.3) |
| Poor | 283 (30.5) |

*Missing data: 2 cases did not complete this item on the claim form.

Figure 4.1 Self-Rated Health of People with MTBI (N=929)




## 4.4 Sample Characteristics

The demographic and socio-economic characteristics of the study sample are reported in Table 4.4. The age range of those with MTBI was 18 to 94 years, and the average age of the study participants was 38.2, with

slightly greater proportions in the older (45-94; 28.5%) and younger (18-24; 27.1%) age groups. Frequency of MTBI was similar among males (50.2%) and females (49.8%). Most had no dependents (60.5%), 44.5% were married or living common law and 27.2% had education higher than grade eight but no high school diploma. The annual income of 0-$20,000 was the most common income range reported by the subjects (41.7%). The greatest proportion of subjects employed full-time (45.5%), followed by working part-time (13.6%).

As the association between age and the outcome variable was not linear, age was categorized into four categories: ages 18 to 24; 25 to 34; 35 to 44; and 45 and above. This categorization met the linearity assumption. The categories of separated/divorced and widowed were combined because of small cell sizes. Likewise, number of dependants was categorised as "none" or "one or more", the two categories of education level less than grade 12 were combined, and the employment categories of "unemployed" and "off work not due to injury" were also combined due to small cell sizes.

Table 4.4 Sociodemographic Characteristics of Subjects (N=929)

| **Sociodemographic Factors** | N* (%) |
|---|---|
| Age: mean (s.d.**) | 38.2 (16.7) |
| 18-24 | 252 (27.1) |
| 25-34 | 211 (22.7) |
| 35-44 | 201 (21.6) |
| 45-94 | 265 (28.5) |
| Female gender | |
| Female | 463 (49.8) |
| Male | 466 (50.2) |
| Marital status | |
| Single | 371 (39.9) |
| Married/Common Law | 413 (44.5) |
| Widowed | 33 (3.6) |
| Separated/Divorced | 112 (12.1) |
| Number of Dependants | |
| 0 Dependents | 562 (60.5) |
| 1-2 Dependents | 237 (25.5) |
| 3 or more dependents | 130 (14.0) |
| Education | |
| Grade 8 or less | 75 (8.1) |
| < Grade 12 | 252 (27.2) |
| High school | 228 (24.6) |
| Some post-secondary | 188 (20.3) |
| Technical school | 111 (12.0) |
| University graduate | 74 (8.0) |
| Annual income | |
| $0- $20,000 | 378 (41.7) |
| $20,001 – $40,000 | 268 (29.5) |
| $40,001 –$ 60,000 | 149 (16.4) |
| above $60,000 | 112 (12.3) |
| Employment status | |
| Full time | 423 (45.5) |
| Part time | 126 (13.6) |
| Student | 59 (6.4) |
| Homemaker | 54 (5.8) |
| Retired | 79 (8.5) |
| Unemployed | 49 (5.3) |
| Off work (not due to injury) | 20 (2.2) |
| Other | 119 (12.8) |

*Missing data: 1 case missing from education; 22 cases missing from annual income.
** s.d.: refers to standard deviation

Collision-related factors are reported in Table 4.5. Most of the injured individuals (63.4%) were driving when the collisions occurred, followed by front seat passengers (21.6%). The most common direction of impact from collisions was from the front (31.6%). Almost all subjects reported the collision to the police (98.0%) and most went to hospital emergency departments (85.6%), although only small proportion was admitted overnight (19.4%). Over half of the subjects going to emergency (55.6%) were transported by ambulance.

Due to small cell sizes, the categories of cyclist, pedestrian and "other" were combined.

Table 4.5 Collision-related Factors of Subjects (N=929)

| **Collision-related factors** | N* (%) |
|---|---|
| Position in the vehicle | |
| Driver | 589 (63.4) |
| Front seat passenger | 201(21.6) |
| Back seat passenger | 65 (7.0) |
| Cyclist | 14 (1.5) |
| Pedestrian | 46 (5.0) |
| Other | 14 (1.5) |
| Direction of impact | |
| Front | 270 (31.6) |
| Rear | 140 (16.4) |
| Diver side | 174 (20.4) |
| Passenger side | 138 (16.1) |
| Other | 133 (15.6) |
| Report to police | 909 (98.0) |
| Hospital or Emergency visit | 793 (85.6) |
| Go by ambulance | 515 (55.6) |
| Admitted to hospital overnight | 180 (19.4) |

*Missing data: 1 case missing from "report to police"; 3 from "hospital or emergency visit', "go by ambulance", "admitted to hospital overnight" and 74 from "direction of impact".

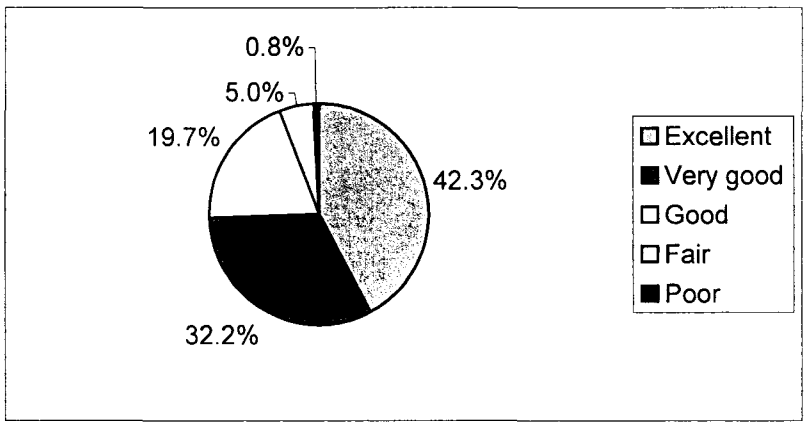
Collision-related factors are presented in Table 4.6. When subjects were asked their general health one month before injury, a larger proportion of them reported excellent health (42.3%) and very good health (32.2%), while only 0.8% subjects rated their prior health as poor (Figure 4.2). Because of small cell sizes, two categories ("excellent " and non-excellent") for the variable "health month before injury" were developed. This new binary variable was used in the analysis. Among all subjects, a small proportion of subjects reported prior head or brain injury (12.2%). Prior to this collision; 30.3% reported having had chiropractic treatment and 20.9% had physical therapy in the past five years; 20.3% had made prior motor vehicle injury claims to SGI and 25.6% had made other injury claims before this collision.

Table 4.6 Pre-injury Factors of subjects (N=929)

| **Pre-injury factors** | N* (%) |
|---|---|
| Health month before injury | |
| Excellent | 393 (42.3) |
| Very good | 299 (32.2) |
| Good | 183 (19.7) |
| Fair | 46 (5.0) |
| Poor | 7 (0.8) |
| Past head/brain injury | 113 (12.2) |
| Past chiropractic treatment | 281 (30.3) |
| Past physical therapy | 194 (20.9) |
| Past motor vehicle injury claims | 188 (20.3) |
| Past other injury claims † | 238 (25.6) |

*Missing data: 1 case missing from "health month before injury", "past head/brain injury", "past physical therapy", "past motor vehicle injury claim" and "past other injury claim'. 2 cases missing from "chiropractic treatment".
† Other injury claim includes worker's compensation claims, other non-motor vehicle injury claims

Figure 4.2 Self-rated Health One Month Before Injury (N=929)




Comorbid medical conditions are presented in Table 4.7. The most common comorbid conditions were headache (29.6%), allergies (29.3%); musculoskeletal problems (29.2%); respiratory problems (19.3%) and gastro-intestinal problems (12.3%). Musculoskeletal problems (other than those sustained in the collision) were the most common comorbid condition with moderate or severe effects on the health of subjects (11.9%). The least common comorbid conditions were cancer (1.9%); neurological problems (3.5%); diabetes (4.1%); cardiovascular problems (5.9%); kidney or genito-urinary problems (7.1%) and high blood pressure (9.5%). Cancer was the least common comorbid condition with moderate or severe effects on the health of subjects (0.6%). Depression scores ranged between 0 and 58 with the mean score of 22.0 on the CES-D scale, which has a possible range of 0-60.

The following comorbid conditions had zero cell or small cell problems: respiratory problems; high blood pressure; cardiovascular problems; gastro-intestinal problems; diabetes; kidney, genito-urinary problems; neurological problems, cancer. For respiratory problems, headache and high blood pressure, recoding of the categories of "no effect or mild effect on health" and "moderate or severe effect on health" to form a "yes" category resulted in adequate numbers for analysis. The variables "cardiovascular problems", "gastro-intestinal problems", "diabetes", "kidney", "genito-urinary problems", "neurological problems" and "cancer" were excluded from the analysis because too few subjects reported these conditions.

Table 4.7 Comorbidities of Subjects (N=929)

| **Comorbid factors** | N* (%) |
|---|---|
| Prior musculoskeletal problems | |
| No | 656 (70.8) |
| Yes with No or mild effect on health | 160 (17.3) |
| Yes with Moderate or severe effect on health | 110 (11.9) |
| Allergies | |
| No | 656 (70.6) |
| Yes with No or mild effect on health | 189 (20.3) |
| Yes with Moderate or severe effect on health | 84 (9.0) |
| Respiratory problems | |
| No | 748 (80.7) |
| Yes with No or mild effect on health | 133 (14.3) |
| Yes with Moderate or severe effect on health | 46 (5.0) |
| High blood pressure | |
| No | 838 (90.5) |
| Yes with No or mild effect on health | 66 (7.1) |
| Yes with Moderate or severe effect on health | 22 (2.4) |
| Cardiovascular problems | |
| No | 872 (94.1) |
| Yes with No or mild effect on health | 40 (4.3) |
| Yes with Moderate or severe effect on health | 15 (1.6) |
| Gastro-intestinal problems | |
| No | 814 (87.7) |
| Yes with No or mild effect on health | 71 (7.7) |
| Yes with Moderate or severe effect on health | 43 (4.6) |
| Diabetes | |
| No | 889 (95.9) |
| Yes with No or mild effect on health | 20 (2.2) |
| Yes with Moderate or severe effect on health | 18 (1.9) |

Table 4.7 Comorbidities of Subjects (cont.)

| **Comorbid factors** | N* (%) |
|---|---|
| Kidney, genito-urinary problems | |
| No | 860 (92.9) |
| Yes with No or mild effect on health | 39 (4.2) |
| Yes with Moderate or severe effect on health | 27 (2.9) |
| Neurological problems | |
| No | 896 (96.6) |
| Yes with No or mild effect on health | 22 (2.4) |
| Yes with Moderate or severe effect on health | 10 (1.1) |
| Headache before the collision | |
| No | 651 (70.4) |
| Yes, with No or mild effect on health | 202 (21.8) |
| Yes, with Moderate or severe effect on health | 72 (7.8) |
| Cancer | |
| No | 910 (98.1) |
| Yes, with No or mild effect on health | 12 (1.3) |
| Yes, with Moderate or severe effect on health | 6 (0.6) |
| Depression score: mean (s.d**);range | 22.0 (13.5) 0-58 |

*Missing data: 1 case missing from "gastro-intestinal problems", "neurological problems", and from "cancer"; 2 from "respiratory problems", "cardiovascular problems", and from "diabetes"; 3 from "prior musculoskeletal problems", "high blood pressure", "kidney, genito-urinary problems", 4 from "headache" and 36 from "depression score".

** s.d.: refers to standard deviation

Symptoms and injury-related limitations are presented in Table 4.8. Immediately after the injury, 67.8% reported experiencing disorientation or confusion, and 12.5% were not sure if they had disorientation or confusion. The most common symptoms after the collision were headache (89.2%), sleep problems (75.9%), pain during neck movement (72.3%), dizziness (67.7%), restricted neck movement (61,7%), fatigue (59.4%) and anxiety (55.6%). These were followed by memory problems, irritability, poor concentration, jaw pain, vision problems, broken bones, hearing problems. The injury resulted in restriction of daily home activities in 70.6% subjects, prevented employment activities in 65.0% subjects, and affected educational activities in 8.6% subjects.

Few subjects endorsed hearing problems, and since the number of students was small, restriction of education activities was irrelevant for most, therefore, these two factors were not considered in the analysis. For the variable "broken bones", the categories of "uncertain" and "yes" were combined to form a "yes/uncertain" category for analysis.

Table 4.8 Symptoms/Consequence After Injury Among Subjects (N=929)

| Symptoms/Consequence after injury | N* (%) |
|---|---|
| Headache | 779(84.2%) |
| Dizziness | 628 (67.7) |
| Memory problems | 401 (43.3) |
| Poor concentration | 366 (39.5) |
| Irritability | 387 (41.7) |
| Vision problems | 234 (25.2) |
| Hearing problems | 106 (11.4) |
| Sleep problems | 704 (75.9) |
| Fatigue | 551 (59.4) |
| Anxiety | 515 (55.6) |
| Jaw pain | 243 (26.2) |
| Pain with neck movement | 670 (72.3) |
| Restricted neck movement | 572 (61.7) |
| Broken bones | |
| No | 721(77.7) |
| Yes | 138 (14.9) |
| Uncertain | 69 (7.4) |
| Activity restriction after injury | |
| Daily home activities | 656 (70.6) |
| Working activities | 604 (65.0) |
| Educational activities | 80 (8.6) |
| Confused | |
| No | 183 (19.7) |
| Yes | 630 (67.8) |
| Uncertain | 116 (12.5) |

*Missing data: 1 case missing from 'broken bone"; 2 from "dizziness", "memory problem', "concentration", "irritability", "vision problem", "hearing problem', "sleep problem", "fatigue", "anxiety", "sore jaw'; 4 from "headache".

Pain intensity is presented in Table 4.9. The average percentage of body in pain was 29%, with a range of 0 to 99% reported by subjects. Neck and shoulder pain was rated with the highest intensity (mean=6.1) out of a possible range of 0 to10. This was followed by headache (5.8), low back pain

(4.2), mid-back pain (3.9), leg pain (3.4), arm pain (3.3) and abdominal pain (3.3). Hand pain (1.9) and foot pain (1.2) were scored the lowest.

Table 4.9 Pain Due to Injury Among Subjects (N=929)*

| **Pain due to collision: mean (s.d**)** | |
|---|---|
| % of body in pain | 29.0 (18.4) |
| Neck/ shoulder pain | 6.1 (2.9) |
| Low back pain | 4.2 (3.6) |
| Headache pain | 5.8 (3.3) |
| Facial pain | 2.5 (3.5) |
| Arm pain | 3.3 (3.5) |
| Hand pain | 1.9 (3.0) |
| Leg pain | 3.4 (3.6) |
| Foot pain | 1.2 (2.7) |
| Mid-back pain | 3.9 (3.6) |
| Abdominal pain | 3.3 (3.7) |

*Missing data: 4 cases missing from "% of body in pain"; "low back pain "; 6 from "neck/ shoulder pain"; 8 from "Facial pain"; 9 from "Headache pain" and "hand pain"; 10 from "leg pain"; 11 from "foot pain""; 12 from "abdominal pain" and 14 from "mid-back pain".

** s.d.: refers to standard deviation

Of the three conceptually related neck pain variables (pain with neck movement, less neck movement and neck pain intensity), neck pain intensity was chosen for inclusion in the model.

Table 4.10 Correlation among Pain with Neck Movement, Restricted Neck Movement, Neck/Shoulder Pain

| Variables | Pain with neck movement | Restricted neck movement | Neck/shoulder pain |
|---|---|---|---|
| Pain with neck movement | 1.00 | 0.66* | 0.48* |
| Restricted neck movement | 0.66* | 1.00 | 0.48* |

*Correlation is significant at 0.01 level (2-tailed).

Descriptive statistics for expectations for recovery, initial health care provider and days between the injury to the date of injury claim is shown in Table 4.11. Most expected that they would get better slowly (43.6%), 37.7% subjects were uncertain about their recovery, 16.6% thought that they get better soon and there was small number of subjects (n=19, 2%) who expected that they would never get better. After the injury, most of subjects sought health care from medical physicians only (65.4%), 9.0% obtained health care from both medical physicians and physical therapists; 5.5% from both medical physicians and chiropractic doctors and 5.1% from both medical physicians and massage therapists. A small proportion of subjects visited chiropractic doctors only (1.3%), both chiropractic doctors and massage therapists (1.7%), or a combination of medical physicians, chiropractic doctors and massage therapists (0.3%). Another 5.9% chose other single or combination of health care providers. A few subjects (n=53, 5.7%) didn't seek any health care treatments.

Due to small cell problems, the categories of "never get better" and "don't know" for the variable "expectation about recovery" were grouped into one category of "never get better/ don't know" for analytic use. For the same reason, "initial health care provider" was reorganised into to three categories: "M.D. only"; "MD plus one or more others" and "other" for analysis purpose. As the relationship between the continuous variable "days from injury" and outcome was not linear, four categories were developed as follows: 15 to 42 days, 8-14 days and 7 days or less. This categorization yielded a linear relationship.

Table 4.11 Expectations for Recovery, Initial Health Care Provider and Days from Injury to Claim among Subjects (N=929)

| **Expectations for recovery** | N* (%) |
|---|---|
| Get better soon | 154 (16.6) |
| Get better slowly | 405 (43.6) |
| Never get better | 19 (2.0) |
| Don't know | 350 (37.7) |
| **Initial health care provider †** | N* (%) |
| M.D. only | 608 (65.4) |
| M.D. plus P.T. | 84 (9.0) |
| M.D. plus D.C. | 51 (5.5) |
| M.D. plus massage | 47 (5.1) |
| D.C. only | 12 (1.3) |
| M.D. plus D.C. plus massage | 16 (1.7) |
| D.C. plus massage | 3 (0.3) |
| None | 53 (5.7) |
| Other | 55(5.9) |
| Initial health care provider (new) | |
| M.D. only | 608 (65.4) |
| MD+ one or more others | 238 (25.6) |
| Other | 83(8.9) |
| **Days from injury:** mean (s.d.**); range | 14 (9.3) 1-42 |
| 15 – 42 days | 356 (38.3) |
| 8 –14 days | 304 (32.7) |
| 7 days or less | 269 (29.0) |

*Missing data: 1 case missing from 'expectations for recovery".

** s.d.: refers to standard deviation

† Health care providers consulted within first few days after injury; MD refers to medical doctor, DC refers to doctor of chiropractic, and PT refers to physical therapist

## 4.5 Results from Modelling

### 4.5.1 Crude models

Crude models were built to identify the factors related to self-rated health of people with MTBI. Out of fifty variables considered, forty two variables met the p <= 0.10 criteria for statistical significance. The odds ratios and confidence intervals are shown in Tables 4.12-4.18.

Table 4.12 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Sociodemographic Variables Associated with Self-rated Health of People with MTBI*

| **Sociodemographic factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Age Group (yr) | | | | |
| 18-24 | 1 | *2.5 (1.4, 4.3)* | *2.4 (1.6, 3.7)* | *2.3 (1.6, 3.4)* |
| 25-34 | 1 | 0.7 (0.4, 1.4) | 1.3 (0.9, 2.0) | 1.1 (0.8, 1.6) |
| 35-44 | 1 | 0.8 (0.4, 1.5) | 1.0 (0.7, 1.7) | 1.3 (0.9, 1.9) |
| 45 and above | 1 | 1 | 1 | 1 |
| Female gender | | | | |
| Male | 1 | *1.9 (1.2, 2.9)* | *1.4(1.1, 2.0)* | 1.2 (0.9,1.5) |
| Female | 1 | 1 | 1 | 1 |
| Marital status | | | | |
| Single | 1 | *2.8 (1.4,5.7)* | *2.5 (1.5, 4.2)* | *1.6 (1.1, 2.3)* |
| Married/Common Law | 1 | 1.7 (0.8, 3.4) | *2.4 (1.5, 3.9)* | 1.4 (0.9, 2.0) |
| Widowed/Separated/ Divorced | 1 | 1 | 1 | 1 |

Table 4.12 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Sociodemographic Variables Associated with Self-rated Health of People with MTBI* (cont.)

| **Sociodemographic factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Number of Dependants | | | | |
| 0 Dependents | 1 | *1.8 (1.1, 2.8)* | 1.1 (0.8, 1.5) | 1.2 (0.9, 1.5) |
| 1 or more dependents | 1 | 1 | 1 | 1 |
| Education | | | | |
| < Grade 12 | 1 | 0.5 (0.2, 1.3) | *0.3 (0.2, 0.6)* | *0.5 (0.3, 0.8)* |
| High school | 1 | 1.4 (0.6, 3.6) | 0.9 (0.5, 1.8) | 0.9 (0.5, 1.7) |
| Some post-secondary | 1 | 0.9 (0.3, 2.3) | 0.8 (0.4, 1.4) | 0.7 (0.4, 1.3) |
| Technical school | 1 | 1.6 (0.6, 4.5) | 0.9 (0.4, 1.8) | 0.8 (0.4, 1.8) |
| University graduate | 1 | 1 | 1 | 1 |
| Annual income | | | | |
| <$20,000 | 1 | *0.4 (0.2, 0.7)* | *0.4 (0.2, 0.6)* | *0.6 (0.4, 1.0)* |
| $20 – 40,000 | 1 | *0.4 (0.2, 0.9)* | 0.7 (0.4, 1.2) | 0.8 (0.5, 1.2) |
| $40 – 60,000 | 1 | 0.7 (0.4, 1.6) | 0.7 (0.4, 1.3) | 0.9 (0.5, 1.6) |
| >$60,000 | 1 | 1 | 1 | 1 |
| Employment status | | | | |
| Full time | 1 | 1 | 1 | 1 |
| Part time | 1 | 1.4 (0.7, 2.6) | 0.9 (0.6, 1.5) | 1.1 (0.7, 1.7) |
| Student | 1 | 0.5 (0.2, 1.6) | 0.7 (0.4, 1.3) | 0.9 (0.5. 1.5) |
| Homemaker | 1 | 0.3 (0.1, 1.1) | 0.5 (0.3, 1.0) | 0.7 (0.4, 1.1) |
| Retired | 1 | 1.0 (0.5, 2.1) | *0.4 (0.2, 0.7)* | *0.6 (0.4, 1.0)* |
| Unemployed/ Off work | 1 | 0.4 (0.2, 1.1) | *0.3 (0.1, 0.5)* | *0.5 (0.3, 0.7)* |
| Other | 1 | 1.0 (0.5, 1.9) | 0.7 (0.4, 1.1) | 1.0 (0.6, 1.5) |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

Table 4.13 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Collision-related Factors Associated with Self-rated Health of People with MTBI*

| **Collision-related factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Position in the vehicle | | | | |
| Driver | 1 | 1 | 1 | 1 |
| Front seat passenger | 1 | 1.0 (0.6, 1.6) | 0.7 (0.4, 1.1) | 0.9 (0.5, 1.5) |
| Back seat passenger | 1 | 0.7 (0.3, 1.7) | *0.6 (0.4, 1.0)* | 0.9 (0.7, 1.3) |
| Other | 1 | 0.8 (0.4, 1.8) | *0.4 (0.2, 0.8)* | *0.6 (0.4, 1.0)* |
| Direction of impact | 1 | | | |
| Front | 1 | 1 | 1 | 1 |
| Rear | 1 | 0.6 (0.3, 1.1) | 0.7 (0.4, 1.2) | *0.6 (0.4, 0.9)* |
| Diver side | 1 | 0.7 (0.3, 1.3) | 1.1 (0.7, 1.7) | 0.9 (0.6, 1.4) |
| Passenger side | 1 | 0.5 (0.2, 1.2) | 1.1 (0.7, 1.8) | 1.0 (0.7, 1.5) |
| Other | 1 | 1.2 (0.6, 2.3) | 1.2 (0.7, 1.9) | 0.8 (0.5, 1.3) |
| Hospital or Emergency visit | | | | |
| No | 1 | 1 | 1 | 1 |
| Yes | 1 | 1.2 (0.7, 2.3) | 1.5 (0.9, 2.2) | *1.7 (1.2, 2.4)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

Table 4.14 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Pre-injury Variables Associated with Self-rated Health of People with MTBI*

| **Pre-injury factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Health month before injury | | | | |
| Excellent | 1 | *3.8 (2.4, 6.0)* | *1.6 (1.1, 2.1)* | 1.0 (0.8,1.4) |
| Not excellent | 1 | 1 | 1 | 1 |
| Past physical therapy | | | | |
| No | 1 | 2.2 (1.2, 4.0) | 1.4 (1.0, 2.1) | 1.4 (1.0, 1.9) |
| Yes | 1 | 1 | 1 | 1 |
| Past motor vehicle injury claim | | | | |
| No | 1 | *4.3 (2.0, 8.9)* | *2.1 (1.4, 3.1)* | *1.5 (1.1, 2.0)* |
| Yes | 1 | 1 | 1 | 1 |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

Table 4.15 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Comorbid Factors Associated with Self-rated Health of People with MTBI*

| **Comorbid factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Prior musculoskeletal problems | | | | |
| No | 1 | 1.5 (0.8, 2.9) | *3.2 (1.8, 5.8)* | 1.3 (0.9, 2.0) |
| No/mild effect on health | 1 | 0.6 (0.2, 1.4) | *2.4 (1.2, 4.6)* | 1.0 (0.6, 1.5) |
| Moderate/severe effect on health | 1 | 1 | 1 | 1 |
| Respiratory problems | | | | |
| No | 1 | 1.6 (0.9, 2.8) | *1.5 (1.0, 2.3)* | 1.1 (0.8, 1.5) |
| Yes | 1 | 1 | 1 | 1 |
| High blood pressure | | | | |
| No | 1 | 2.2 (1.0, 4.9) | *2.6 (1.5, 4.7)* | *1.6 (1.1, 2.4)* |
| Yes | 1 | 1 | 1 | 1 |
| Depression score ** | 1 | *0.88 (0.86, 0.90)* | *0.91 (0.90, 0.93)* | *0.95 (0.94, 0.96)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

** Due to the narrow confidence intervals, 2 decimals were kept for illustration.

Table 4.16 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Symptoms/Consequence Variables Associated with Self-rated Health of People with MTBI *

| **Symptoms /Consequence after injury** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Symptoms** | | | | |
| Dizziness | 1 | *5.6 (3.5, 8.9)* | *3.8 (2.7, 5.4)* | *2.0 (1.5, 2.8)* |
| Memory problems | 1 | *3.0 (1.9, 4.8)* | *2.6 (1.9, 3.6)* | *1.5 (1.1, 1.9)* |
| Poor concentration | 1 | *6.2 (3.6, 10.6)* | *3.1 (2.3, 4.3)* | *2.3 (1.8, 3.0)* |
| Irritability | 1 | *3.7 (2.3, 6.0)* | *2.7 (1.9, 3.7)* | *1.7 (1.3, 2.2)* |
| Vision problems | 1 | *8.3 (3.8, 18.3)* | *3.0 (2.0, 4.3)* | *1.9 (1.4, 2.5)* |
| Sleep problems | 1 | *8.0 (4.8, 13.3)* | *5.7 (3.8, 8.6)* | *2.9 (2.0, 4.3)* |
| Fatigue | 1 | *5.2 (3.3, 8.2)* | *4.0 (2.9, 5.6)* | *2.1 (1.6, 2.8)* |
| Anxiety | 1 | *6.9 (4.3, 11.2)* | *3.2 (2.3, 4.4)* | *2.2 (1.6, 2.9)* |
| Jaw pain | 1 | *1.8 (1.1, 3.1)* | 1.4 (1.0, 2.0) | *1.5 (1.1, 2.0)* |
| Activity restriction after injury** | | | | |
| Daily home activities | 1 | *4.5 (2.8, 7.0)* | *3.0 (2.1, 4.2)* | *1.5 (1.1, 2.1)* |
| Confused | | | | |
| Yes | 1 | 1 | 1 | 1 |
| Uncertain | 1 | *2.2 (1.1, 4.1)* | 1.0 (0.6, 1.7) | 1.1 (0.7, 1.6) |
| No | 1 | *5.9 (3.5, 9.8)* | *2.0 (1.4, 3.1)* | *1.5 (1.0, 2.1)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

**The categories of "Yes" for these factors were set as reference.

Table 4.17 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Pain Variables Associated with Self-rated Health of People with MTBI*

| **Pain due to collision**** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| % of body in pain | 1 | *0.95* | *0.96* | *0.99* |
| | | *(0.93, 0.96)* | *(0.95, 097)* | *(0.99, 1.00)* |
| Neck/ shoulder pain | 1 | *0.64* | *0.70* | *0.80* |
| | | *(0.59, 0.69)* | *(0.66, 0.75)* | *(0.75, 0.85)* |
| Low back pain | 1 | *0.75* | *0.78* | *0.89* |
| | | *(0.71, 0.81)* | *(0.74, 0.82)* | *(0.85, 0.92)* |
| Headache pain | 1 | *0.68* | *0.76* | *0.82* |
| | | *(0.64, 0.74)* | *(0.72, 0.80)* | *(0.79, 0.86)* |
| Facial pain | 1 | *0.94* | *0.93* | 0.97 |
| | | *(0.88, 1.00)* | *(0.89, 0.97)* | (0.93, 1.00) |
| Arm pain | 1 | *0.83* | *0.88* | *0.90* |
| | | *(0.78, 0.89)* | *(0.83, 0.92)* | *(0.81, 0.93)* |
| Hand pain | 1 | *0.89* | *0.88* | *0.92* |
| | | *(0.82, 0.96)* | *(0.83, 0.92)* | *(0.88, 0.96)* |
| Leg pain | 1 | *0.82* | *0.87* | *0.91* |
| | | *(0.78, 0.88)* | *(0.83, 0.91)* | *(0.88, 0.94)* |
| Foot pain | 1 | *0.78* | *0.91* | *0.93* |
| | | *(0.70, 0.90)* | *(0.86, 0.96)* | *(0.89, 0.98)* |
| Mid-back pain | 1 | *0.72* | *0.78* | *0.85* |
| | | *(0.67, 0.78)* | *(0.74, 0.82)* | *(0.82, 0.87)* |
| Abdominal pain | 1 | *0.78* | *0.85* | *0.93* |
| | | *(0.72, 0.84)* | *(0.81, 0.89)* | *(0.90, 0.96)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

** Due to the narrow confidence intervals, 2 decimals were kept for illustration.

Table 4.18 Results of Crude Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Variables "Expectations about recovery"; "Initial health care provider" and "Days from the injury" Associated with Self-rated Health of People with MTBI*

| Factors | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Expectations of recovery | | | | |
| Get better soon | 1 | *12.6 (6.2,25.9)* | *6.4 (3.4, 12.1)* | *3.1 (1.7,5.8)* |
| Never get better / Don't know | 1 | *0.3 (0.2, 0.5)* | *0.2 (0.1, 0.3)* | *0.4 (0.3, 0.5)* |
| Get better slowly | 1 | 1 | 1 | 1 |
| Initial health care provider | | | | |
| M.D. only | 1 | 1 | 1 | 1 |
| M.D. + one or more others | 1 | 0.6 (0.3, 1.1) | 1.3 (0.9, 1.8) | 1.4 (1.0, 1.8) |
| Other | 1 | *5.2 (2.5, 10.9)* | *4.5 (2.3, 8.5)* | *3.0 (1.6, 5.5)* |
| Days from the injury | | | | |
| 15 – 42 days | 1 | 1 | 1 | 1 |
| 8 –14 days | 1 | *0.5 (0.3, 0.9)* | 0.7 (0.5, 1.1) | 0.8 (0.6, 1.1) |
| 7 days or less | 1 | *0.5 (0.3, 0.8)* | 0.8 (0.6, 1.2) | 0.7 (0.5, 1.0) |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic.

### 4.5.2 Domain-specific models

Because of the large number of factors with crude associations with self-reported health, domain specific models were built and are reported in

Tables 4.19 to 4.24. The six domain-specific multivariate models resulted in thirty possible explanatory variables to retain in building the final model.

After adjusting for all other variables in the same domain-specific models, "number of dependants", "respiratory problems", "memory problems", "jaw pain", "irritability", "% of body in pain", "facial pain ", "arm pain" and "hand pain" were not significantly associated with self-rated health at $P \leq 0.10$, and each changed the –2 Log likelihood less than 15%, so these nine variables were excluded from further step of analysis. Although "past physical therapy" did not have association with self-rated health at $p \leq 0.10$ level, it did change the -2 Log likelihood more than 15% (32.6%), therefore it was retained in the final model.

Table 4.19 Results of Domain-Specific Models. Odds Ratio (OR) and 90% Confidence Intervals (CI) for Sociodemographic Variables Associated with Self-rated Health of People with MTBI*; (N =904)

| **Sociodemographic factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Age Group (yr) | | | | |
| 18-24 | 1 | *3.2 (1.3, 7.7)* | *3.5 (1.9, 6.6)* | *3.2 (1.9, 5.5)* |
| 25-34 | 1 | 0.8 (0.3, 1.8) | 1.4 (0.8, 2.4) | 1.3 (0.8, 2.0) |
| 35-44 | 1 | 0.8 (0.4, 1.9) | 0.9 (0.5, 1.6) | 1.3 (0.9, 2.1) |
| 45 and above | 1 | 1 | 1 | 1 |
| Female gender | | | | |
| Male | 1 | *1.8 (1.1, 3.0)* | *1.4(1.0, 2.0)* | 1.1 (0.8,1.4) |
| Female | 1 | 1 | 1 | 1 |
| Marital status | | | | |
| Single | 1 | 1.7 (0.7,4.0) | *1.2 (0.7, 2.3)* | 0.9 (0.6, 1.4) |
| Married/Common Law | 1 | 1.2 (0.6, 2.6) | *2.0 (1.1, 3.3))* | 1.2 (0.8, 1.8) |
| Widowed/Separated/ Divorced | 1 | 1 | 1 | 1 |
| Education | | | | |
| < Grade 12 | 1 | 0.6 (0.2, 1.6) | *0.3 (0.2, 0.7)* | *0.5 (0.3, 0.9)* |
| High school | 1 | 1.2 (0.4, 3.3) | 0.7 (0.4, 1.4) | 0.8 (0.5, 1.5) |
| Some post-secondary | 1 | 0.9 (0.3, 2.6) | 0.7 (0.3, 1.3) | 0.6 (0.3, 1.2) |
| Technical school | 1 | 2.2 (0.7, 6.2) | 0.8 (0.4, 1.8) | 0.9 (0.5, 1.7) |
| University graduate | 1 | 1 | 1 | 1 |
| Annual income | | | | |
| <$20,000 | 1 | *0.3 (0.2, 0.7)* | *0.5 (0.3, 0.9)* | 0.7 (0.4, 1.1) |
| $20 – 40,000 | 1 | *0.4 (0.2, 1.0)* | 0.9 (0.5, 1.7) | 0.9 (0.5, 1.5) |
| $40 – 60,000 | 1 | 0.8 (0.4, 1.7) | 0.8 (0.4, 1.6) | 1.0 (0.6, 1.7) |
| >$60,000 | 1 | 1 | 1 | 1 |
| Employment status | | | | |
| Full time | 1 | 1 | 1 | 1 |
| Part time | 1 | 2.0 (1.0, 3.9) | 1.2 (0.7, 2.0) | 1.2 (0.8, 1.9) |
| Student | 1 | 0.5 (0.1, 1.8) | 0.8 (0.4,1.8) | 1.0 (0.5, 1.8) |
| Homemaker | 1 | 1.0 (0.3, 4.1) | 1.0 (0.5, 2.2) | 1.0 (0.5, 1.9) |
| Retired | 1 | *2.8 (1.1, 7.0)* | 0.8 (0.4,1.7) | 1.1 (0.6, 2.1) |
| Unemployed/ Off work | 1 | 0.7 (0.2, 1.9) | *0.4 (0.2, 0.9)* | 0.7 (0.4, 1.1) |
| Other | 1 | 1.4 (0.7, 3.0) | 1.0 (0.6, 1.7) | 1.2 (0.8, 1.9) |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

Table 4.20 Results of Domain-Specific Models- Odds Ratio (OR) and 90% Confidence Intervals (CI) for Collision-related Factors Associated with Self-rated Health of People with MTBI *; (N=853)

| **Collision-related factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Position in the vehicle | | | | |
| Driver | 1 | 1 | 1 | 1 |
| Front seat passenger | 1 | 0.9 (0.5, 1.6) | *0.6 (0.4, 0.9)* | 0.9 (0.5, 1.5) |
| Back seat passenger | 1 | 0.7 (0.3, 1.7) | 0.6 (0.3, 1.2) | 0.9 (0.6, 1.2) |
| Other | 1 | 3.2 (0.6, 17.8) | 1.1 (0.2, 5.9) | 1.5 (0.3, 6.2) |
| Direction of impact | 1 | | | |
| Font | 1 | 1 | 1 | 1 |
| Rear | 1 | 0.6 (0.3, 1.1) | 0.7 (0.4, 1.2) | *0.6 (0.4, 0.9)* |
| Diver side | 1 | 0.7 (0.3, 1.3) | 1.1 (0.7, 1.7) | 0.9 (0.6, 1.4) |
| Passenger side | 1 | 0.5 (0.2, 1.2) | 1.1 (0.7, 1.8) | 1.0 (0.7, 1.5) |
| Other | 1 | 1.2 (0.6, 2.3) | 1.2 (0.7, 1.9) | 0.8 (0.5, 1.3) |
| Hospital or Emergency visit | | | | |
| No | 1 | 1 | 1 | 1 |
| Yes | 1 | 1.0 (0.6, 1.9) | 1.4 (0.9, 2.2) | *1.7 (1.1, 2.5)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

Table 4.21 Results of Domain-Specific Models- Odds Ratio (OR) and 90% Confidence Intervals (CI) for Pre-injury Variables Associated with Self-rated Health of People with MTBI *; (N =926)

| **Pre-injury factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Health month before injury | | | | |
| Excellent | 1 | *3.2 (2.0,5.1)* | *1.4 (1.0, 2.0)* | 1.0 (0.7,1.3) |
| Not excellent | 1 | 1 | 1 | 1 |
| Past physical therapy | | | | |
| No | 1 | 1.3 (0.7, 2.4) | 1.1 (0.7, 1.6) | 1.2 (0.9, 1.7) |
| Yes | 1 | 1 | 1 | 1 |
| Past motor vehicle injury claims | | | | |
| No | 1 | *3.1 (1.4, 6.6)* | *1.8 (1.2, 2.8)* | *1.4 (1.0, 2.0)* |
| Yes | 1 | 1 | 1 | 1 |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

Table 4.22 Results of Domain-Specific Models- Odds Ratio (OR) and 90% Confidence Intervals (CI) for Comorbid Factors Associated with Self-rated Health of People with MTBI *; (N =888)

| **Comorbid factors** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Prior musculoskeletal problems | | | | |
| No | 1 | 1.3 (0.7, 2.7) | *3.7 (1.9, 7.3)* | 1.3 (0.9, 2.0) |
| Yes with No/mild effect on health | 1 | 0.5 (0.2, 1.3) | *2.5 (1.2, 5.4)* | 0.9 (0.5, 1.4) |
| Yes with Moderate/severe effect on health | 1 | 1 | 1 | 1 |
| High blood pressure | | | | |
| No | 1 | 2.1 (0.8, 5.6) | *2.2 (1.1, 4.3)* | 1.5 (1.0, 2.4) |
| Yes | 1 | 1 | 1 | 1 |
| Depression score ** | 1 | *0.88 (0.86, 0.90)* | *0.91 (0.90, 0.93)* | *0.95 (0.94, 0.96)* |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

** Due to the narrow confidence intervals, 2 decimals were kept for illustration.

Table 4.23 Results of Domain-Specific Models- Odds Ratio (OR) and 90% Confidence Intervals (CI) for Symptoms/Consequence Variables Associated with Self-rated Health of People with MTBI*; (N =926)

| **Symptoms /Consequence after injury** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Symptoms** | | | | |
| Dizziness | 1 | *1.9 (1.2, 3.3)* | *2.0 (1.3, 3.0)* | 1.3 (0.9, 1.8) |
| Poor concentration | 1 | 1.8 (0.9, 3.5) | 1.3 (0.8, 1.9) | *1.6 (1.2, 2.3)* |
| Vision problems | 1 | *3.4 (1.5, 7.9)* | *1.5 (1.0, 2.3)* | 1.3 (1.0, 1.8) |
| Sleep problems | 1 | *3.3 (1.9, 5.8)* | *3.0 (1.9, 4.7)* | *2.1 (1.4, 3.1)* |
| Fatigue | 1 | 1.6 (1.0, 2.8) | *1.9 (1.3, 2.7)* | 1.4 (1.0, 1.9) |
| Anxiety | 1 | *2.7 (1.6, 4.6)* | *1.5 (1.1, 2.2)* | *1.5 (1.1, 2.0)* |
| Activity restriction after injury | | | | |
| Daily home activities** | 1 | *2.6 (1.6, 4.2)* | *1.9 (1.3, 2.8)* | 1.2 (0.9, 1.7) |
| Confused | | | | |
| Yes | 1 | 1 | 1 | 1 |
| Uncertain | 1 | 1.3 (0.6, 2.7) | 0.7 (0.4, 1.2) | 1.0 (0.7, 1.6) |
| No | 1 | *2.7 (1.5, 4.8)* | 1.0 (0.6, 1.6) | 0.9 (0.7, 1.3) |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

**The categories of "Yes" for these factors were set as reference.

Table 4.24 Results of Domain-Specific Models- Odds Ratio (OR) and 90% Confidence Intervals (CI) for Pain Variables Associated with Self-rated Health of People with MTBI*; (N =875)

| **Pain due to collision**** | Poor Health | Excellent + Very Good Health OR (90%CI) | Good Health OR (90%CI) | Fair Health OR (90%CI) |
|---|---|---|---|---|
| Neck/ shoulder pain | 1 | *0.75* | *0.79* | *0.90* |
| | | *(0.68, 0.81)* | *(0.73, 0.85)* | *(0.84, 0.96)* |
| Low back pain | 1 | *0.87* | *0.87* | 0.97 |
| | | *(0.80, 0.95)* | *(0.81, 0.92)* | (0.92, 1.02) |
| Headache pain | 1 | *0.75* | *0.83* | *0.87* |
| | | *(0.69, 0.82)* | *(0.78, 0.89)* | *(0.82, 0.91)* |
| Leg pain | 1 | *0.88* | *0.92* | *0.93* |
| | | *(0.81, 0.96)* | *(0.87, 0.93)* | *(0.89, 0.98)* |
| Foot pain | 1 | *0.* | 1.00 | 0.93 |
| | | *(0.74, 0.99)* | (0.92, 1.10) | (0.89, 0.98) |
| Mid-back pain | 1 | *0.89* | 0.95 | *0.92* |
| | | *(0.81, 0.98)* | (0.89, 1.01) | *(0.88, 0.97)* |
| Abdominal pain | 1 | *0.88* | *0.94* | 0.99 |
| | | *(0.80, 0.95)* | *(0.89, 0.99)* | (0.95, 1.03) |

* Significant (at $P \leq 0.10$). OR and 90% CI shown as Italic. The model is adjusted for all the other variables in the model.

** Due to the narrow confidence intervals, 2 decimals were kept for illustration.

### 4.5.3 Final model

Variables meeting the criteria of having an adjusted odds ratio that was statistically significant at $p< 0.1$, or whose removal from the model

caused a greater than 15% change in the –2 Log likelihood of the domain specific models, were entered into the final model. Of these, 12 factors met the criteria for retention in the final model. The adjusted odds ratios for the association between the various level of self-rated health and their important associated factors are presented at Table 4.25. None of the interactions produced a change in the –2 Log likelihood of main effect model by over 15%, so no interaction terms were included in the final model.

The factors associated with poorer self-rated health at the time of the claim include older age, not seeking health care immediately after the collision at a hospital or emergency clinic, poorer health one month before injury, past motor vehicle injury claim, depression, dizziness, sleep problems, restriction of daily home activities, greater neck/ shoulder pain, greater low back pain, lower expectation for recovery and those going to a medical doctor alone for initial health care provision.

Age was the only sociodemographic variable associated with self-rated health. After adjusting for all other factors in the model, younger individuals with MTBI rated their health as better than older individuals.

Those who went to hospitals or emergency clinics immediately after the injury were more likely to have fair self-rated health (compared to poor health) compared to those who did not go to hospital or emergency clinic.

Two factors from "pre-injury" domain-specific model were associated with self-rated health. These are "health one month before injury" and "past

motor vehicle injury claim". Individuals who reported excellent health before the injury were more likely to rate their post-collision health as excellent/very good or good, while this association does not appear for the level of fair self-rated health. Similarly, weak associations are present between "past motor vehicle injury claim" and the levels of excellent/very good or good self-rated health.

Depression appears to be the only comorbidity associated with self-rated health. Depressed individuals are less likely to report excellent/very good, good and fair self-rated health as opposed to poor self-rated health. A one point increase in depression score is associated with a 4-9% increase in the odds of experiencing poor self-rated health.

Dizziness, sleep problems and restriction of daily home activities, are the three factors identified having an association with self-rated health in the symptoms/consequence domain. Individuals without dizziness (self-reported as being caused by the collision) are more likely to rate their health as excellent/very good and good as opposed to poor. Those who have no sleep problems (self-reported as being caused by the collision) are more likely than those with sleep problems to rate their health as good. Individuals without restriction of home activities are over twice as likely to report excellent/good health than those having problems with daily home activities.

From the "pain after injury" domain, neck/shoulder pain and low back pain are associated with self-rated health on every level. Individuals with

neck/shoulder pain and low back pain are more likely to have worse self-rated health than individuals who do not have the pain.

Expectation for recovery is strongly associated with self-rated health. Individuals who expected a quick recovery were much more likely to report better current health as opposed to poor health, whereas individuals who did not expect recovery or were uncertain about their expectations were likely to report poor health.

Finally, initial health care provider was also moderately associated with self-rated health. Individuals who sought care from medical physicians and one or more other types of health care providers, such as chiropractor, physical therapists and massage therapist were more likely to report fair health than poor health. Individuals, who did not seek health care from medical physicians, were likely to rate their health as excellent/very good, good or fair compared to individuals who visited only physicians.

Table 4.25 Results of Final Model: Odds Ratio (OR) and 95% Confidence Intervals (CI) for Variables Associated with Self-rated Health of People with MTBI * (N =888)

| Factors | Poor Health | Excellent + Very Good Health OR (95%CI) | Good Health OR (95%CI) | Fair Health OR (95%CI) |
|---|---|---|---|---|
| Age Group (yrs) | | | | |
| 18-24 | 1 | *2.5 (1.1, 6.0)* | *2.9 (1.5, 5.7)* | *2.7 (1.6, 4.5)* |
| 25-34 | 1 | 1.2 (0.5, 3.1) | *2.5 (1.3, 4.9)* | 1.5 (0.9, 2.5) |
| 35-44 | 1 | 1.0 (0.4, 2.5) | 1.4 (0.7, 2.8) | 1.5 (0.9, 2.4) |
| 45 and above | 1 | 1 | 1 | 1 |
| Hospital or Emergency | | | | |
| No | 1 | 1 | 1 | 1 |
| Yes | | 0.8 (0.3, 2.0) | 1.2 (0.6, 2.4) | *1.6 (1.0, 2.8)* |
| Health one month before injury | | | | |
| Excellent | 1 | *3.2 (1.6, 6.4)* | *1.9 (1.0, 2.4)* | 0.9 (0.6,1.4) |
| Not excellent | 1 | 1 | 1 | 1 |
| Past motor vehicle injury claim | | | | |
| No | 1 | *2.9 (1.0, 8.0)* | *2.1 (1.1, 3.9)* | 1.4 (0.9, 2.1) |
| Yes | 1 | 1 | 1 | 1 |
| Depression score mean | 1 | *0.91 (0.87, 0.94)* | *0.94 (0.92,0.96)* | *0.96 (0.95, 0.98)* |
| Dizziness | | | | |
| No | 1 | *2.4 (1.2, 4.8)* | *2.0 (1.2, 3.4)* | 1.5 (0.9, 2.3) |
| Yes | 1 | 1 | 1 | 1 |
| Sleep problems | | | | |
| No | 1 | 1.6 (0.7, 3.4) | *1.9 (1.0, 3.6)* | 1.6 (1.0, 2.8) |
| Yes | 1 | 1 | 1 | 1 |

Table 4.25 Results of Final Model: Odds Ratio (OR) and 95% Confidence Intervals (CI) for Variables Associated with Self-rated Health of People with MTBI * (cont.)

| Factors | Poor Health | Excellent + Very Good Health OR (95%CI) | Good Health OR (95%CI) | Fair Health OR (95%CI) |
|---|---|---|---|---|
| Daily home activities | | | | |
| No | 1 | *2.1 (1.0, 4.2)* | 1.7 (1.0, 2.9) | 1.0 (0.5,1.6) |
| Yes | 1 | 1 | 1 | 1 |
| Neck/ shoulder pain | 1 | *0.74* | *0.79* | *0.86* |
| | | *(0.66, 0.84)* | *(0.72, 0.86)* | *(0.80, 0.93)* |
| Low back pain | 1 | *0.87* | *0.83* | *0.92* |
| | | *(0.78, 0.97)* | *(0.77,0.90)* | *(0.87, 0.97)* |
| Exception for recovery | | | | |
| Get better soon | 1 | *13.6* | *8.5* | *4.3* |
| | | *(4.7, 39.7)* | *(3.3, 21.8)* | *(1.7, 10.4)* |
| Never get better / Don't know | 1 | *0.4 (0.2, 0.8)* | *0.3 (0.1, 0.4)* | *0.5 (0.4, 0.8)* |
| Get better slowly | 1 | 1 | 1 | 1 |
| Initial health care provider † | | | | |
| M.D. only | 1 | 1 | 1 | 1 |
| M.D+ one or more others | 1 | 1.0 (0.4, 2.5) | 1.7 (1.0, 3.0) | *1.8 (1.2, 2.8)* |
| Other | 1 | *3.3 (1.1, 9.8)* | *3.1 (1.3, 7.8)* | *2.3 (1.0, 5.1)* |

* For continuous variables, 2 decimals were kept for illustration.

† Health care providers consulted within first few days after injury; MD refers to medical doctor.

In order to assess whether these factors were still important in health when using the alternative case definition of MTBI (that is, a case definition that required certainty about loss of consciousness or post-traumatic amnesia), this model was reproduced when including those subjects meeting the criteria for that alternative MTBI definition. As can be seen in Table 4.25 and Table 4.26, findings were similar, with similar estimates of association. Since there were fewer subjects, the precision of the estimates is lower, that is, the confidence intervals are wider.

Table 4.26 Results of sensitivity analysis. Odds Ratio (OR and 95% Confidence Intervals (CI) for Variables Associated with Self-rated Health of People with MTBI * (N =693)

| Factors | Poor Health | Excellent + Very Good Health OR (95%CI) | Good Health OR (95%CI) | Fair Health OR (95%CI) |
|---|---|---|---|---|
| Age Group (yr) | | | | |
| 18-24 | 1 | 2.5 (0.9, 6.5) | *4.7 (2.0,10.1)* | 2.5 (1.4, 4.5) |
| 25-34 | 1 | 2.1 (0.7, 6.1) | *4.1 (1.9, 9.0)* | 1.7 (0.9, 3.0) |
| 35-44 | 1 | 1.0 (0.4, 3.1) | 2.1 (1.0, 4.6) | 1.7 (1.0, 3.1) |
| 45 and above | 1 | 1 | 1 | 1 |
| Hospital or Emergency | | | | |
| No | 1 | 1 | 1 | 1 |
| Yes | | 0.9 (0.3, 2.5) | 0.7 (0.3, 1.4) | 1.1 (0.7, 2.0) |
| Health month before injury | | | | |
| Excellent | 1 | *6.1 (2.7, 3.8)* | 1.4 (0.8, 2.5) | 1.1 (0.7,1.6) |
| Not excellent | 1 | 1 | 1 | 1 |
| Past motor vehicle injury claim | | | | |
| No | 1 | 2.0 (0.7, 5.7) | *2.1 (1.1, 4.1)* | 1.2 (0.8,2.0) |
| Yes | 1 | 1 | 1 | 1 |
| Depression score mean | 1 | *0.91 (0.88, 0.94)* | *0.93 (0.90,0.95)* | *0.97 (0.96, 0.99)* |
| Dizziness | | | | |
| No | 1 | *2.3 (1.0, 4.9)* | *2.0 (1.1, 3.6)* | 1.8 (1.1,3.0) |
| Yes | 1 | 1 | 1 | 1 |
| Sleep problems | | | | |
| No | 1 | 1.9 (0.8, 4.6) | 2.0 (1.0, 3.9) | 1.5 (0.8,2.8) |
| Yes | 1 | 1 | 1 | 1 |

Table 4.26 Results of sensitivity analysis. Odds Ratio (OR and 95% Confidence Intervals (CI) for Variables Associated with Self-rated Health of People with MTBI * (Cont.)

| Factors | Poor Health | Excellent + Very Good Health OR (95%CI) | Good Health OR (95%CI) | Fair Health OR (95%CI) |
|---|---|---|---|---|
| Daily home activities | | | | |
| No | 1 | 2.2 (1.0, 4.8) | 1.1 (0.6, 2.1) | 1.0 (0.6,1.7) |
| Yes | 1 | 1 | 1 | 1 |
| Neck/ shoulder pain | 1 | *0.80* | *0.83* | *0.86* |
| | | *(0.70, 0.91)* | *(0.75, 0.92)* | *(0.79, 0.93)* |
| Low back pain | 1 | 0.89 | *0.87* | *0.92* |
| | | (0.80, 1.00) | *(0.80,0.94)* | *(0.87, 0.98)* |
| Expectations for recovery | | | | |
| Get better soon | 1 | *15.6* | *9.8* | *3.1* |
| | | *(4.8, 51.5)* | *(3.5, 27.7)* | *(1.2, 8.4)* |
| Never get better / | 1 | | | |
| Don't know | | *0.3 (0.1, 0.8)* | *0.2 (0.1, 0.4)* | *0.5 (0.3, 0.7)* |
| Get better slowly | 1 | 1 | 1 | 1 |
| Initial health care provider | | | | |
| M.D. only | 1 | 1 | 1 | 1 |
| M.D. + one or more others | 1 | 0.6 (0.2, 1.5) | 1.0 (0.5, 1.9) | 1.2 (0.7, 1.9) |
| Other | 1 | 2.2 (0.7, 7.2) | 1.9 (0.7, 4.9) | 1.9 (0.8, 4.1) |

* For continuous variables, 2 decimals were kept for illustration.

† Health care providers consulted within first few days after injury; MD refers to medical doctor.

# Chapter Five

# DISCUSSION

## 5.1 Incidence of MTBI

The incidence of self-reported MTBI from traffic collisions was 69 per 100,000 population in the first 12-month period (December 1, 1997 to November 30, 1998) and was slightly higher at 74 per 100,000 population for the following 12-month period. This small increase also appeared when incident cases were assessed against vehicle-damage claims and kilometers driven in Saskatchewan highway. While the adult population and the vehicle-damage claims increased in the second 12-month period, the kilometers driven in Saskatchewan highway actually decreased. However, despite people driving less, there were still 45 more self-reported MTBI cases in the second 12-month period. In fact, it was reported that the total number of traffic-related injury claims and traffic-related non-fatal injuries increased from 1998 to 1999 in Saskatchewan (Saskatchewan traffic accident facts, 2002). Not surprisingly, MTBI cases increased accordingly. Although this is a small increase and may be due to random yearly variation in rates of traffic injuries, the incidence increase found in this study is worth monitoring further.

The cumulative incidence of self-reported MTBI using the primary case definition was slightly higher than that of the alternative MTBI definition, which is not surprising given that the alternative definition is more restrictive. However, it is difficult to determine whether the primary definition misclassified non-MTBI injuries as MTBI, or whether the alternative definition,

which required loss of consciousness and/or post-traumatic amnesia, missed cases of MTBI. This illustrates the problems occurring in MTBI research as outlined by Carroll et al. (2004b) and Cassidy et al. (2004a). The variability of case definitions and inclusion criteria of MTBI are of important reasons for variability in findings from incidence studies. Therefore having a uniform case definition of MTBI for epidemiological research is still an area that urgently needs to be addressed.

Males had a roughly equivalent risk of traffic-related MTBI (RR=1.1) as females among MTBI cases using the primary MTBI definition, this finding was also confirmed when using the alternative MTBI definition. In contrast a previous study of traffic-related MTBI in Saskatchewan showed that males were at 40% greater risk of MTBI in a traffic collision (Cassidy et al., 2004b). It is possible that these discrepant findings are an artifact of the in case definitions for MTBI, or may reflect a true difference occurring over time. The consistent aspect of this finding with Cassidy's is that the increased risk of traffic-related MTBI for males vs. female is lower than the increased risk for males from all cause MTBI (Kraus et al., 1984).

The most consistent finding from the incidence calculations for the primary MTBI and alternative MTBI are that the peak incidence was among individuals of between 18-24 year old and the lowest incidence was among individuals at the age group of 45 and above. Not surprisingly, individuals between 18 and 24 years old are at the greatest risk for traffic-related MTBI,

just as they have highest incidence for all cause MTBI (Cassidy et al., 2004a). The relative risk for ages 18-24 years compared with those over 45 years was about 3.2, which is similar to a previous estimate (3.78) (Cassidy et al., 2004b).

## 5.2 General Health of Subjects with MTBI

Self-rated general health is one of the most frequently used measures of HRQoL. It is a powerful predictor of clinical outcome and mortality in a wide range of medical conditions (Lundberg et al. 1996; Coates et al., 1997; Klein et al. 1998) and has also been shown to be a significant predictor of health services utilization (Fylkesnes & Forde, 1991). Despite this importance, there have been few studies examining the self-rated general health of people with MTBI, for whom the main treatment goal is improvement of HRQoL.

This study shows that 70.8% of individuals with traffic-related MTBI reported fair or poor current general health and only 8% rated their health as excellent or very good within six weeks after the injury. In contrast, 74.5% individuals estimated their health as excellent or very good during the month before the injury and only 5.8% rated it as fair or poor. This suggests that the majority of claimants considered their general health to have declined within the first six weeks after their traffic-related MTBI. Since it is possible that this

retrospective rating of health suffers from recall bias, prospective studies with a control group are indicated for further confirmation of this finding. In addition, there is a need to identify the factors associated with the general health of individuals with traffic-related MTBI as a very first step to contribute to the improvement of overall general health of traffic-related MTBI patients.

## 5.3 Description of MTBI Claimants

### 5.3.1 Sociodemographic Characteristics

About half of all traffic-related MTBI cases in this sample occurred between the ages of 18 and 34 years, which is consistent with findings in the U.S. (Kraus et al 1988). This magnitude of excess risk for injury in this age group is found, not only for all causes of mild brain injuries, but also for severe and moderate brain injuries (Kraus et al. 1988). Therefore, the risk of MTBI in the younger adult age group deserves a special attention.

In 1998 and 1999, the population in Saskatchewan was just over 1 million, with less than half of the population being members of the labor force (Saskatchewan bureau statistics, 2000 Economic Review). In this sample, over 59% of the MTBI cases were working part-time or full-time. The differences in these rates are likely a function of the fact that most individuals in this study were in the working age range (over 18 years). However the annual family income was $0- 20,000, which is slightly less than the average

personal income of Saskatchewan residents, which was $21,065 in 1998 and $21,754 in 1999 (Saskatchewan bureau statistics, 2000 Economic Review). In the current study, 35% of those making a claim for MTBI had less than high school education. So, although the proportion with full time and part time employment was high, they would appear to be employed in poorly paying jobs.

44.5% of cases in this sample were married or common law, followed by 39.9% single, with only 12.1% being separated or divorced. The same pattern also appeared in Cassidy et al., (2004b), which used a cohort of Saskatchewan traffic injury claimants three years prior to the current study.

### 5.3.2 Collision-related Characteristics

Not surprisingly, traffic injury claims for MTBI were mostly drivers (63.4%) and passengers (28.6%) of vehicles, among which the direction of impact most often came from the front (31.6%). However there was still a small proportion of cyclists (1.5%) and it should be noted that pedestrians accounted for 5.0% of total claims, which was even more than the proportion of cyclists. It is unclear whether this is due to a larger number of pedestrians, or whether cyclists might be more likely to sustain more serious injuries than MTBI.

Almost all collisions resulting in MTBI were reported to police (98.0%) and the majority of injured individuals (85.6%) went to hospital or emergency clinic immediately after the injury. However, just over half of the injured

individuals were transported by ambulance and no overnight medical observations were indicated for the majority of MTBI injuries (80.6%).

### 5.3.3 Pre-injury Characteristics

Other than the factor of "health one month before the injury" that was discussed in section 5.2, factors such as "past head/brain injury", "past chiropractic treatment", "past physical therapy", "past motor vehicle injury claim" and "past other injury claim" were also studied as they might affect the self-rated general health of individuals with MTBI. Past chiropractic treatment appears to be most prevalent factor, and was reported by 30.3% of all MTBI claimants.

### 5.3.4 Comorbid Characteristics

Comorbid medical conditions were considered possible factors that might affect the self-rated health of people with MTBI. As suggested by another study (Paniak et al. 1999), musculoskeletal problems may have an important impact on the declined HRQoL of individuals with MTBI. In this study, musculoskeletal problems (29.2%) was one of the most common comorbid conditions and had greatest impact on the health of these subjects. Given the fact that young people accounted for about half of the cases in this sample, not surprisingly, only a few subjects reported other comorbid medical conditions. And for this reason, factors such as "cardiovascular problems", "gastro-intestinal problems", "diabetes", "kidney", "genito-urinary problems",

"neurological problems" and "cancer" did not show predictive value in this study.

Depression is significant problem following TBI (Bush et al. 2004). In this MTBI cohort, the average depression score at the time of completing the claim was 22, and 63.9% subjects had a 16 or higher CES-D score, which is considered to indicate depressive symptomatology in the general population. This is similar with findings in Bay's study (Bay et al. 2002), which reported CES-D score of 20.45 and 64% depression rate after moderate or mild TBI.

### 5.3.5 Symptoms/Consequence Characteristics

Consistent with the finding from the study of Lowdon et al (1989), headache was the most common symptom (84.2%) in this MTBI cohort. Estimates of the frequency of these symptoms vary in the literature, likely in large part due to methodological differences in studies such as variations in case definitions of MTBI, measures used to assess patients and the post-injury time (Bohnen and Jolles, 1992). In this study, the frequency of a number of symptoms such as headache, dizziness, memory problems, poor concentration, vision problems, are similar to those reported in the study of Cassidy et al (2004b).

It appeared that daily home activities and working activities were affected by the MTBI for majority of subjects within six weeks of the injury and since the number of students was small, the restriction of education activities was irrelevant for most.

### 5.3.6 Pain Characteristics

Pain is a common consequence from traffic-related injuries. For this cohort, subjects reported 29% of body in pain on average and neck /shoulder pain was rated with the highest intensity, followed by headache and low back pain. These findings are easily understandable. As indicated in a population-based cohort study on low back pain after traffic collisions (Cassidy et al. 2003), low back pain was very common (41%) among all traffic injury claims and neck pain and headaches appeared having the highest prevalence among this traffic-related injury cohort.

### 5.3.7 Other Characteristics

Given the relatively mild nature of MTBI, only a very small number of subjects thought they would never get better after the traffic collision. However, most of the subjects perceived that their recovery was going to be slow or they were not sure about it. This may be explained by depression. Depression can lead to lack of motivation and feelings of hopelessness, leading to negative expectations of recovery. In this sample, depressed cases accounted for majority (73.2%) of all cases without positive expectations of recovery (that is, they thought they would never recover from the injury or they didn't know what to expect.).

After traffic collision, the majority (94.3%) of subjects sought health care services, 65.4% of subjects got treatment from medical doctors only. Physical therapy, chiropractic and message were less frequent initial health

care choices. Similar pattern of health care use was also appeared in other studies of traffic injury (Cassidy et al., 2003, 2000).

As subjects with MTBI within six weeks after the injury were included in this study and the mean time from injury was two weeks, the reported characteristics of subjects in terms of symptoms and pain caused by MTBI may be less susceptible to recall bias than information captured long after the injury.

## 5.4 Factors Associated with Self-rated Health

Among total 62 factors that were considered in this study as potentially associated with the self-rated health of individuals with traffic-related MTBI, twelve emerged as important in the multivariable analysis. The following factors were associated with poorer self-reported health: older age, not going to hospital or emergency clinic after the collision, impaired health one month before injury, past motor vehicle injury claim, depression, dizziness, sleep problems, restricted daily home activities, neck/shoulder pain, low back pain, low expectation for recovery and choosing medical doctor as the only initial health care provider.

Of the demographic and socioeconomic factors having a crude (unadjusted) association with health after the injury, including age, gender, marital status, number of dependants, education, annual income,

employment status, only age was important in the multivariable analysis. The importance of age in self-rated health after MTBI has been underscored in past findings, as well (Mosenthal et al., 2004; Findler et al., 2001; Paniak et al., 1999; Brown et al., 1998). In the current study, those aged 18-34 were very likely to rate themselves as having better health than people in older ages.

These findings also suggest that fair health rather than poor health is more prevalent among individuals who went to hospital or emergency immediately after the collision. This may be a result of available early intervention as reviewed by Borg et al. (2004). However, due to limited information on clinical treatment that subjects actually received initially, no certain conclusions could be made from this study. Interestingly, initial health care provider also has a significant association with the post-injury health of individuals with MTBI. Those who sought health care from medical doctor alone were more likely to report poor health. Unfortunately, there is no further conclusion could be made regarding which initial health care exactly or combination of health care contribute to the better health through this study since people sought various health care providers after their injury.

People who reported excellent health for one month before the injury were likely to report excellent/very good or good post-injury health, regardless of injury severity factors. This suggests that prior health is an important factor to assess, both in a clinical setting and for research purpose

as it is predictor of post-injury health. During intervention of MTBI, subjects with previous excellent health status may be more likely to expect a positive outcome. Although we can not be certain about the causative association between these two factors, physicians should be aware of patients' previous health status during patient assessment and intervention since prior health is an important predictive factor of post-injury health as shown in this sample.

Further more, there was a strong association (OR=2.1, 2.9) between absence of prior motor vehicle injury and good to excellent health. This suggests that prior injuries are a risk factor for poorer short-term outcome after MTBI, possibly due to the continued existence of complications from prior injuries, such as neck pain from previous motor vehicle collision suggested by Pierre et al (2000). Depression was found to have a mild association with poor self-rated general health. Although self-perceived poor health status was associated with onset of the new episode of depression in a general adult population (Carroll et al. 2003), we can not draw the same conclusion from this study because both factors are ascertained at the same time in the current study, that is, in this study, it is not clear whether depression leads to, or results from, poor health. An association between depression and HRQoL is also supported by findings from other studies on MTBI subjects (Vanderploeg et al., 2003; Findler et al., 2001; Friendland et al., 2001). Whether a cause or effect of poor health, however, this study

suggests that depression is an important factor to consider during intervention after MTBI.

Emanuelson et al. suggested that persisting symptoms after MTBI might be a causal factor in the declined HRQoL of people with MTBI (Emanuelson et al. 2003). Findings from our study support the suggested association. Dizziness and sleep problems are associated with poorer post-injury health. However, other physical symptoms such as headache and fatigue; cognitive deficits such as lack of attention, problems with concentration, poor memory and speech problems, and affective symptoms such as irritability had no independent association with post-injury health after MTBI. However, ability to carry on daily home activities was associated with excellent/very good health. Therefore, daily home activities may be a simple variable to assess instead of a variety of subjective symptoms of MTBI when monitoring the general health of MTBI patients.

In addition, expectation of recovery is very strong factor that significantly related to all levels of self-rated general health. Expecting to recover quickly is associated with excellent/very good/good health rather than poor health and expecting to recover slowly or not at all is associated with poor general health. This finding raises the possibility that encouragement about the likelihood of recovery may be a simple means of improving general health of individuals with MTBI. However, given the concurrent measurement of these factors, it may also mean that individuals

took their current perceived health into consideration when making judgements about how quickly and how well they would recover.

Pain is important component of HRQoL. In our study, neck/shoulder pain (OR=1.2, 1.3, 1.4) and low back pain (OR=1.2, 1.2, 1.1) were found to have weak but statistically significant associations with poor health. However, given the high prevalence of neck/shoulder pain and low back pain in traffic-related MTBI cohorts (Cassidy et al., 2004b) and the high degree of pain reported after a whiplash injury, (Cassidy et al., 2000), these factors are worth attention when studying HRQoL of MTBI or MVA samples. Neck/shoulder and low back pain may be effective factors to target in order to improve the HRQol of individuals with MTBI.

Finally, all the findings above were further supported when using the alternative MTBI definition. Therefore, we are confident that these findings are relevant regardless of the operational definition used to identify cases of MTBI injuries in traffic collisions.

## 5.5 Strengths and Limitations of the Present Study

One important strength of this study is that all MTBI traffic injury claims in the province of Saskatchewan were included in this study, which eliminates sampling bias. The reasons are that a single insurer, Saskatchewan Government Insurance Corporation, provides insurance

coverage for all registered vehicles in the province and, in addition, health care providers in Saskatchewan are obligated to report all traffic-related injuries. The MTBI cases for the calculation of cumulative incidence were captured only if the injury occurred during the two 12-month study periods. Therefore, this ensures the findings on the cumulative incidence reflect the real risk of traffic-related MTBI among adult residents of Saskatchewan. Our explanatory models included only those who made their claim within 42 days of the collision. This ensured that our measure of health related to the first few weeks after the injury, since health and other factors are likely to change over the course of recovery. However, excluding those individuals who made injury claims more than six weeks after the injury may be a source of selection bias, although the proportion excluded is small (14%), and we do not believe that this is likely to have affected our findings. It should also be noted that our findings on factors related to health are relevant to the short-term after a traffic-related MTBI, but should not be generalized to long-term health.

Secondly, the injury claim form addressed a wide range of demographic, socioeconomic, health, collision and injury related factors. This permitted the consideration of many potential explanatory factors. Among these variables, a number of them, such as health the month before the injury and expectation for recovery, have been rarely considered in the MTBI literature. Although some researchers (Vanderploeg et al., 2003;

Brown et al., 1998) have considered that race may be an important factors that associated with HRQol of people with MTBI, this characteristic was not captured in the claim form and therefore was not considered as a potential explanatory factor for health after a collision. In addition, although financial compensation factors (such as type of insurance system in place or whether or not the injured individual is seeking compensation) have been shown to be important in recovery (Cassidy et al. 2004b, Reynolds et al. 2003, Paniak et al. 2002b), this potentially important explanatory factor could not be explored in the current context, since all subjects in this study were seeking compensation. In addition, all were covered under the same insurance system (a no fault system with no payment for pain and suffering and little scope for litigation), with the same insurance provider, and all information reported in this study was captured at the beginning of the claim process, thus no compensation decisions had yet been made. Thus, although compensation issues may be important even in the early stages of recovery from MTBI, the current study could not explore the impact of these factors.

Thirdly, the current study employed a cross-sectional design to explore the association between the wide range of factors and self-rated general health of individuals with MTBI. It provides us with a valid "snapshot" of this population's health and characteristics. However it limits our ability to infer a causal or predictive relationship between many of the factors and self-rated general health. Still, there is a clear temporal relationship between such

factors as prior health and post-injury health, and so some factors can be considered as predictors of this outcome. It is possible that good or poor health status after the collision might differentially impact on recall/reporting of prior health status. This would result in information bias, although it is difficult to be certain of the direction of this bias. In addition, there may be non-differential errors in recall of prior health status, but the effect of this random error would have been to minimize the observed relationship between prior health and post-injury health. Prospective longitudinal studies would more clearly establish a temporal link between pre-injury health factors and post-injury health, although accurate measures of pre-injury global health are difficult to obtain other than through self-report after the injury.

Finally, possible misclassification of MTBI cases and non-cases could have occurred in this study. For example, our MTBI case definitions may be susceptible to uncertainty or inaccuracies of self-reported criteria, such as uncertainty of loss of consciousness (LOC) or uncertainty of post-traumatic amnesia (PTA). Epidemiological studies of this sort rarely have access to the kind of valid and detailed clinical data necessary to be assured of an accurate clinical diagnosis of MTBI. However, the fact that modifying our case definition for MTBI yielded no important differences in the factors associated with self-rated post-injury health increases our confidence in the validity of these findings.

## 5.6 Summary

This population-based study provides important information on post-injury health after MTBI within the first six weeks of the injury.

Findings suggest that the general health of individuals with traffic-related MTBI declines, at least in the short term, after MTBI. This indicates the need for further studies to identify the predictors of general health of individuals with traffic-related MTBI.

Our findings indicate that older age, hospital or emergency visit, health one month before injury, past motor vehicle injury claim, depression, dizziness, sleep problems, daily home activities, neck/shoulder pain, low back pain, expectation for recovery and initial health care provider were associated with post-injury health within the first six weeks after a traffic-related MTBI injury. This is the first step in determining important predictors of short-term outcome after MTBI. These findings also identify potentially useful intervention targets for decreasing the negative impact of MTBI injuries.

## 5.7 Implications

This study has important research and clinical implications. First of all, because associations between various factors and each category of self-

rated general health were examined, this study provides helpful information to clinicians when assessing and treating MTBI patients within the first few weeks after the injury. Secondly, these findings suggest prospective studies to determine the temporal relationships between these identified factors and self-rated general health. Finally, although exploring the issues of MTBI definition is outside the scope of this research, it provides some insights regarding practical reply of the commonly used definitive criteria. Further studies focusing on this issue still remain a great need to promote the homogeneity of MTBI case definition in MTBI literature.

# Chapter Six

# CONCLUSION

The main purpose of this research was to investigate the factors associated with the self-rated health of Saskatchewan adults with traffic-related Mild Traumatic Brain Injury (MTBI). There were three main objectives: investigating the frequency of traffic-related MTBI in Saskatchewan in two consecutive 12-month periods; describing the characteristics, including self-reported health, of adults with traffic-related MTBI, and identifying the factors associated with self-rated health of adults with traffic-related MTBI.

This population-based study displayed a slight increase of cumulative incidence of MTBI in second 12-month periods and patients' characteristics were also comprehensively described. This provides more information on current knowledge of traffic-related MTBI in terms of the frequency and distributions of traffic-related MTBI on population basis.

Findings also suggest that the general health of individuals with traffic-related MTBI was considered to have declined by majority of the claims. However, prospective studies on similar MTBI groups are indicated to confirm that MTBI patients realize their declined general health as soon as six weeks after the injury.

After examining a wide range of possible explanatory factors through a multivariate model, older age, not going to hospital or emergency clinic after the injury, impaired health one month before injury, past motor vehicle injury claim, depression, dizziness, sleep problems, restricted daily home activities, neck/shoulder pain, low back pain, negative expectation of

recovery and medical doctor as the only initial health care provider were found to have an association with poor health of this MTBI sample. This provides health care providers and researchers with new information regarding which symptoms or other internal/external factors matter to MTBI patients.

This study supports some of the evidence on explanatory factors that have been previously reported and also provides fresh information on the HRQoL of MTBI population.

Research and clinical implications were discussed. Clinicians and health care researchers should be aware of the important factors while conducting further research or treating patients with MTBI. Understanding the factors associated with general health of traffic-related MTBI population may assist health care providers to provide programs and services targeting modifiable factors to minimise the negative impact on the general health of particular MTBI subgroup with persisting symptoms and complains.

Although exploring the issues around the definition of MTBI was not an object of this research, this study provided an example of the convergence of findings even when using disparate case definitions for MTBI. Further studies on this issue are in great need.

It has been widely noted that heterogeneity of MTBI case definition in MTBI literature posed great difficulties in comparing or combining results across studies. Using commonly accepted criteria is practical step to promote

the homogeneity of MTBI definition in the literature. Much of the existing literature mixes mild, moderate and severe TBI when describing outcome after the injury, which creates difficulties in understanding or applying the findings. Consequently, comparing or combining results across studies is often not feasible. As mild MTBI and moderate/severe TBI have different natures and follow different recovery courses, this point should be considered by researchers and clinicians when selecting study cases.

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# APPENDIX A:

## University of Alberta and University of Saskatchewan Ethics Approvals

# APPENDIX B:

## Application Form for Injury Benefits of Saskatchewan Government Insurance

*PERSONAL INJURY PROTECTION PLAN*

# APPLICATION FOR BENEFITS

**LAST NAME:** _____ **FIRST NAME:** _____ **MIDDLE INITIAL:** _____

**CLAIM NUMBER:** _____

**ADJUSTER:** _____

**TODAY'S DATE:** _____ _____ _____
(day) (month) (year)

**ACCIDENT DATE:** _____ _____ _____
(day) (month) (year)

**DATE OF BIRTH:** _____ _____ _____
(day) (month) (year)

PLEASE PRINT ALL ANSWERS

**SECTION A: PERSONAL INFORMATION**

1. Current Address: (please include street address, town or city, postal code)

_____
(Street Address)

_____
(Town or City) (Postal Code)

Mailing Address (if different from above):

_____

_____

2. Phone Number: _____ (home) _____ (work)
3. Social Insurance Number: _____
4. Driver License Number: _____
5. Are you a Saskatchewan Resident? ☐ .. No (Skip to question #8)
   ☐ .. Yes (Continue below)
6. Saskatchewan Health Number: _____
7. Have you lived outside Saskatchewan during the twelve months prior to the accident?

   ☐ .. No (Skip to question #8)
   ☐ .. Yes , from _____ (day / month / year) to _____ (day / month / year)

   I lived outside of Saskatchewan for the following reason:

   ☐ .. Student ☐ .. Work assignment ☐ .. New residence

   ☐ .. Extended holiday ☐ .. Other reason _____

   During this time, did you maintain a permanent home in Saskatchewan?

   ☐ .. No ☐ .. Yes

8. If you were the driver of the vehicle → Do you or any of your immediate family members (living in the same residence) currently hold an automobile insurance policy with SGI CANADA or any other private insurance company in addition to your plate insurance?

☐ .. No ☐ .. Yes → Policy Number _____

Name of Company _____

If you were a passenger in the vehicle → Was there insurance for the vehicle you were in in addition to the plate insurance?

☐ .. No ☐ .. Yes → Policy Number _____

Name of Company _____

9. Sex: ☐ .. Male ☐ .. Female

10. Height: _____ ft _____ in Weight: _____ lbs

11. Marital Status:

☐ .. Single ☐ .. Widowed

☐ .. Married/Common Law ☐ .. Separated/Divorced

12. Number of Dependents: _____ (Skip to question #13 if you have no dependents)

☐ .. I am able to care for my dependents (Skip to question #13)

☐ .. Due to the accident, I am no longer able to care for my dependents (continue below)

Number of dependents under 16 years of age you are unable to care for due to the accident: _____

Name _____ (last name/first name/initial) Age _____ Birthdate _____ (day / month / year)

Name _____ Age _____ Birthdate _____

Name _____ Age _____ Birthdate _____

Name _____ Age _____ Birthdate _____

Name _____ Age _____ Birthdate _____

Number of dependents over 16 years of age you are unable to care for due to the accident: _____

Name _____ (last name/first name/initial) Age____ Birthdate _____ (day / month / year)

Name _____ Age____ Birthdate _____

Name _____ Age____ Birthdate _____

Name _____ Age____ Birthdate _____

Name _____ Age____ Birthdate _____

Please explain why you are unable to care for the above people, and what arrangements you have made to have someone else care for them:

_____

_____

_____

13. Please check your highest level of education:

- ☐ .. Grade 8 or less
- ☐ .. Higher than grade 8, but did not graduate from high school
- ☐ .. High school graduate
- ☐ .. Post secondary or some university
- ☐ .. Technical school graduate
- ☐ .. University graduate

14. What is your combined total family unit/household income per year?

- ☐ .. $0 - $20,000
- ☐ .. $20,001 - $40,000
- ☐ .. $40,001 - $60,000
- ☐ .. Above $60,000

**SECTION B: ACCIDENT CIRCUMSTANCES**

1. Time of accident: _____ ☐ .. am ☐ .. pm

2. Location of the accident: _____

3. I was:

   ☐ .. the driver ☐ .. a front seat passenger ☐ .. a back seat passenger

   ☐ .. a cyclist ☐ .. a pedestrian ☐ .. other (please specify) _____

4. If you were in a vehicle when you were injured, from which direction was the "main" impact to the vehicle you were in? (please check one)

   ☐ .. front ☐ .. rear ☐ .. driver side ☐ .. passenger side ☐ .. not applicable

   ☐ .. other (please specify) _____

5. Has the accident been reported to the police?

   ☐ .. No → If no, please report

   ☐ .. Yes → Police Officer Name _____

   Police Force Name _____

   Were charges laid? ☐ .. No

   ☐ .. Yes (please specify) _____

**If you were a pedestrian or cyclist, skip to #11**

6. Identity of the driver of the vehicle you were in:

   Last name _____ First name _____

   Address _____

7. Identity of the owner of the vehicle you were in:

   Last name _____ First name _____

   Address _____

8. Description of the vehicle you were in:

   Licence Plate Number: _____ Make/Model _____

   Year _____ Prov/State _____

9. Identity of the other vehicle's driver:

Last name _____ First name _____

Address _____

10. Description of the other vehicle in the accident:

Licence Plate Number: _____ Make/Model _____

Year _____ Prov/State _____

Owner's Name _____

11. Give a brief description of the facts surrounding the accident:

_____

_____

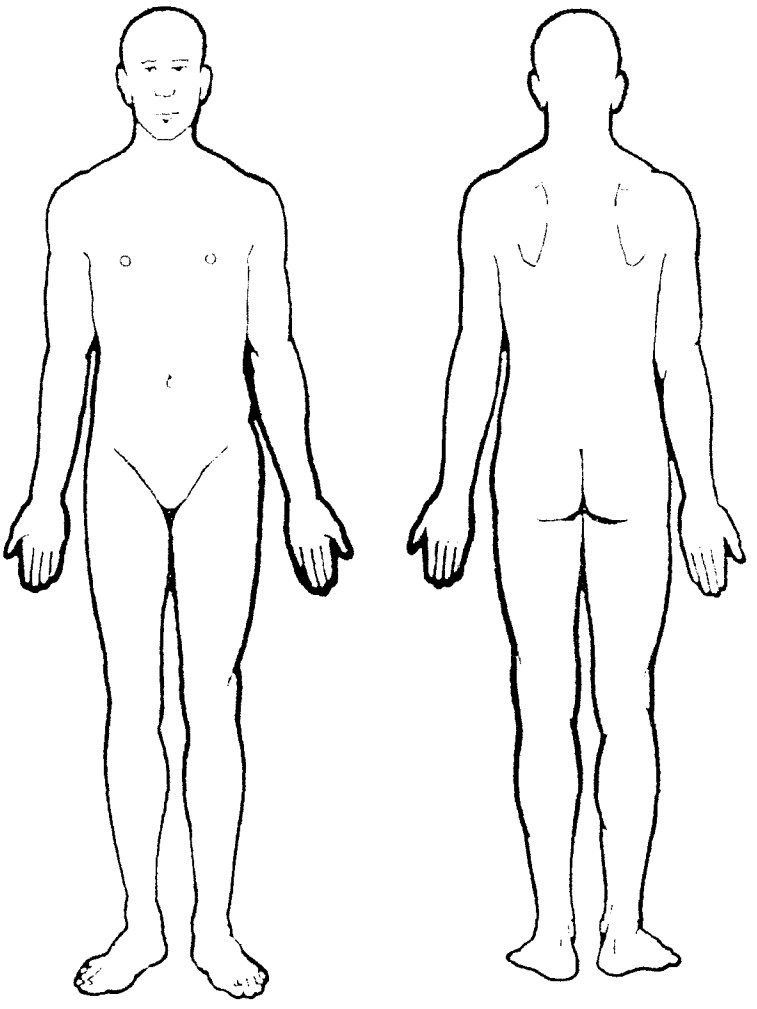
_____

_____

SECTION C: ABOUT YOUR INJURIES

1. *Do you have pain as a result of this accident?* ☐ No (Skip to question #7)
☐ Yes (Continue below)

2. Carefully shade in or mark the areas where you feel any pain on the drawings below.



3. Did the accident cause **neck or shoulder** pain?

☐ .. No (skip to #4)

☐ .. Yes (continue below)

Please rate your average **neck or shoulder** pain on a scale of 0 to 10 where 0 means no pain at all and 10 means pain as bad as it could be.

| No Pain | | | | | | | | | | Pain as bad as could be |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

4. Did the accident cause **low back** pain?

☐ .. No (skip to #5)

☐ .. Yes (continue below)

Please rate your average **low back** pain on a scale of 0 to 10 where 0 means no pain at all and 10 means pain as bad as it could be.

| No Pain | | | | | | | | | | Pain as bad as could be |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

5. Did the accident cause **headache** pain?

☐ .. No (skip to #6)

☐ .. Yes (continue below)

Please rate your average **headache** pain on a scale of 0 to 10 where 0 means no pain at all and 10 means pain as bad as it could be.

| No Pain | | | | | | | | | | Pain as bad as could be |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

6. Did the accident cause pain in **other parts of your body**?

☐ .. No (skip to #7)

☐ .. Yes (continue below)

Pain in **Arm(s)**? ☐ .. No (skip to next question)

☐ .. Yes (please rate pain below)

| No Pain | | | | | | | | | | Pain as bad as could be |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Pain in **Hand(s)?** ☐ No (skip to next question)
☐ Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bac as could be 10

Pain in **Face**? ☐ No (skip to next question)
☐ Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bad as could be 10

Pain in **Leg(s)**? ☐ .. No (skip to next question)
☐ .. Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bad as could be 10

Pain in **Foot/feet?** ☐ No (skip to next question)
☐ Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bad as could be 10

Pain in **Mid Back?** ☐ No (skip to next question)
☐ Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bad as could be 10

Pain in **Abdomen, Chest, Groin?** ☐ No (skip to next question)
☐ Yes (please rate pain below)

No Pain 0 1 2 3 4 5 6 7 8 9 Pain as bad as could be 10

7 Did you go to a hospital or emergency clinic immediately after the accident?

☐ .. No (skip to question #8)

☐ .. Yes → Name of Hospital _____

Did you go by ambulance? ☐ No ☐ Yes

Admitted overnight? ☐ .. No

☐ .. Yes → How many days were you in hospital?

8. Since the accident, have you seen health care practitioners?

☐ .. No (Skip to question #9)

☐ .. Yes → ☐ .. Physician → # of visits: _____; Name _____

☐ .. Chiropractor → # of visits: _____; Name _____

☐ .. Physiotherapist → # of visits: _____; Name _____

☐ .. Massage therapist → # of visits: _____; Name _____

☐ .. Other → type: _____ # of visits: _____; Name _____

9. Did the accident cause any of the following symptoms? (check any that apply)

☐ .. Feeling of numbness, tingling or pain in arms or hands
☐ .. Feeling of numbness, tingling or pain in legs or feet
☐ .. Dizziness or unsteadiness
☐ .. Memory problems or forgetfulness
☐ .. Concentration or attention problems
☐ .. Irritability
☐ .. Vision problems
☐ .. Hearing problems
☐ .. Sleep problems
☐ .. Unusual fatigue or tiredness
☐ .. Anxiety or worry
☐ .. Pain when neck is moved
☐ .. Reduced ability to move neck
☐ .. Sore jaw

10. Did you break any bones? ☐ .. No ☐ .. Yes ☐ .. Uncertain

11. Did you hit your head? ☐ .. No ☐ .. Yes ☐ .. Uncertain

12. Did you lose consciousness immediately after the accident?

☐ .. No
☐ .. I don't know
☐ .. Yes → for how long? ☐ .. less than 30 minutes
☐ .. more than 30 minutes
☐ .. don't know

13. Immediately after the accident, did you experience:

a) amnesia or loss of memory? ☐ .. No
☐ .. I don't know
☐ .. Yes → for how long? ☐ .. less than 1 hour
☐ .. more than 1 hour
☐ .. don't know

1C

b) disorientation or confusion? ☐ .. No
☐ .. I don't know
☐ .. Yes → for how long? ☐ .. less than 1 hour
☐ .. more than 1 hour
☐ .. don't know

14. Have the injuries resulting from the accident prevented you from carrying out any of the following activities? (check all that apply)

☐ .. Daily home activities (Explain: _____)

☐ Employment (Explain: _____)

☐ .. Education (Explain _____)

☐ .. Other (Explain: _____)

15. Have you had an **SGI** injury claim due to a motor vehicle accident in the past?

☐ .. No

☐ .. Yes → Which part(s) of your body were injured in the accident in the past?

☐ .. Head ☐ .. Neck/shoulder
☐ .. Face ☐ .. Arm(s)
☐ .. Lower back ☐ .. Leg(s)
☐ .. Other part(s) of the body

16 Have you had an injury claim through **any other insurance or disability plan** (such as the Workers Compensation Board) in the past?

☐ .. No

☐ .. Yes → Which part(s) of your body were injured in the accident in the past?

☐ .. Head ☐ .. Neck/shoulder
☐ .. Face ☐ .. Arm(s)
☐ .. Lower back ☐ .. Leg(s)
☐ .. Other part(s) of the body

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## SECTION D: ABOUT YOUR HEALTH

1. Please check the circle "O" if you **currently** have any of the following health problems. If you do, to what extent have these problems affected your health in the last six months?

   **Not at all**: the problem **does not** affect my health.
   **Mild**: the problem makes my health **a little worse** than it should be.
   **Moderate**: the problem makes my health **worse** that it should be.
   **Severe**: the problem makes my health **much worse** than it should be.

| Health Problem | Have it? | Affects your health? |
|---|---|---|
| a. **Muscle, bone or joint problems before the accident** (such as rheumatoid arthritis, osteoarthritis, back or neck pain, fibromyalgia, thin bones or osteoporosis, fracture, infection, others) | Yes O → | Not at all O<br>Mild O<br>Moderate O<br>Severe O |
| | No O ↓ | |
| b. **Allergies** (such as hay fever, dermatitis, eczema, allergies to medication, food allergy, others). | Yes O → | Not at all O<br>Mild O<br>Moderate O<br>Severe O |
| | No O ↓ | |
| c. **Breathing problems** (such as asthma, emphysema, bronchitis, fibrosis, lung scarring, TB, pneumonia, infection, common cold, others). | Yes O → | Not at all O<br>Mild O<br>Moderate O<br>Severe O |
| | No O ↓ | |
| d. **High blood pressure** (hypertension) | Yes O → | Not at all O<br>Mild O<br>Moderate O<br>Severe O |
| | No O ↓ | |
| e. **Heart and circulation problems** (such as angina, heart attack, heart failure, heart valve problem, hardening of arteries, varicose veins, claudication, foot or leg ulcers, others) | Yes O → | Not at all O<br>Mild O<br>Moderate O<br>Severe O |
| | No O ↓ | |

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| Health Problem | Have it? | Affects your health? |
|---|---|---|
| f. **Digestive system problems** (such as ulcer, gastritis, inflammatory or irritable bowel disease, colitis, Crohn's disease, hiatus hernia, gall stones, pancreatitis, others) | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| g. **Diabetes** | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| h. **Kidney, Genitourinary problems** (such as kidney failure, nephritis, kidney stones, gynecological or prostrate problems, endometriosis, dysmenorrhea or menstrual problems, fibroids, urinary tract infection, prostate problems, bladder control problems, others). | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| i. **Neurological problems <u>before the accident</u>** (such as stroke, seizures, multiple sclerosis, Parkinson's, paraplegia, quadriplegia, paralysis, Alzheimer's, dizziness, others). | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| j. **Headaches <u>before the accident</u>** (such as migraine, tension, stress, sinus, others). | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| k. **Mental or emotional problems' <u>before the accident</u>** (such as depression, anxiety, substance abuse: alcohol or drugs, others). | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |
| l. **Cancer** (such as breast, lung, prostate, cervix, stomach, colon, kidney, bone, metastasis or spread, lymphoma, leukemia, others). | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |

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| Health Problem | Have it? | Affects your health? |
|---|---|---|
| m. **Other Problems:** Please list | Yes ○ → | Not at all ○<br>Mild ○<br>Moderate ○<br>Severe ○ |
| | No ○ ↓ | |

2. Circle the number for each statement which best describes how often you felt or behaved this way -- DURING THE PAST WEEK.

**DURING THE PAST WEEK:**

| | Rarely or none of the time (less than 1 day) | Some or a little of the time (1-2 days) | Occasionally or a moderate amount of time (3-4 days) | Most or all of the time (5-7 days) |
|---|---|---|---|---|
| a. I was bothered by things that usually don't bother me. | 0 | 1 | 2 | 3 |
| b. I did not feel like eating; my appetite was poor. | 0 | 1 | 2 | 3 |
| c. I felt that I could not shake off the blues even with help from my family or friends. | 0 | 1 | 2 | 3 |
| d. I felt that I was just as good as other people. | 0 | 1 | 2 | 3 |
| e. I had trouble keeping my mind on what I was doing. | 0 | 1 | 2 | 3 |
| f. I felt depressed. | 0 | 1 | 2 | 3 |
| g. I felt that everything I did was an effort. | 0 | 1 | 2 | 3 |
| h. I felt hopeful about the future. | 0 | 1 | 2 | 3 |
| i. I thought my life had been a failure. | 0 | 1 | 2 | 3 |
| j. I felt fearful. | 0 | 1 | 2 | 3 |
| k. My sleep was restless. | 0 | 1 | 2 | 3 |
| l. I was happy. | 0 | 1 | 2 | 3 |
| m. I talked less than usual. | 0 | 1 | 2 | 3 |
| n. I felt lonely. | 0 | 1 | 2 | 3 |
| o. People were unfriendly. | 0 | 1 | 2 | 3 |
| p. I enjoyed life. | 0 | 1 | 2 | 3 |
| q. I had crying spells. | 0 | 1 | 2 | 3 |
| r. I felt sad. | 0 | 1 | 2 | 3 |
| s. I felt that people disliked me. | 0 | 1 | 2 | 3 |
| t. I could not get "going". | 0 | 1 | 2 | 3 |

3. How was your health the month before the accident? (choose one)

- ☐ .. Excellent
- ☐ .. Very good
- ☐ .. Good
- ☐ .. Fair
- ☐ .. Poor

4. In general, would you say your health is now: (that is, since the accident)

- ☐ .. Excellent
- ☐ .. Very good
- ☐ .. Good
- ☐ .. Fair
- ☐ .. Poor

5. Compared to one year ago, how would you rate your health in general now? (choose one)

- ☐ .. Much better now than one year ago
- ☐ .. Somewhat better now than one year ago
- ☐ .. About the same as one year ago
- ☐ .. Somewhat worse now than one year ago
- ☐ .. Much worse now than one year ago

6. Have you ever suffered a head or brain injury in the past?

☐ .. No ☐ .. Yes → When? _____

7. Have you had any chiropractic treatments in the past 5 years?

☐ .. No ☐ .. Yes → Name of Doctor: _____

Date of last treatment: _____

8. Have you had any physical therapy treatments in the past 5 years?

☐ .. No ☐ .. Yes → Name of Therapist: _____

Date of last treatment: _____

9. Do you think that your injury will ...

- ☐ .. get better soon
- ☐ .. get better slowly
- ☐ .. never get better
- ☐ .. don't know

**SECTION E: ABOUT YOUR WORK**

1. Work Status (check all that apply)

☐ .. Employed full-time ☐ .. Self-employed ☐ .. Workers' Compensation
☐ .. Employed part-time ☐ .. Unemployed ☐ .. Homemaker
☐ .. Employed temporarily ☐ .. Maternity leave ☐ .. Social Assistance
☐ .. Disability leave ☐ .. Student
☐ .. Retired ☐ .. Employment Insurance (formerly UIC)

2. If you checked any of the following - Employed full-time, Employed part-time, Employed temporarily, Workers' Compensation, Disability Leave, or Self-employed - please complete the following questions If you did not check any of these, skip to next section called Income Replacement.

a) Were you off work due to the accident?

☐ .. No (skip to b)
☐ .. Yes → How many days have you been off work so far? _____ days
Are you still off work due to the accident? ☐ .. No
☐ .. Yes (skip to c)

b) Are you working reduced hours or modified/different duties because of the accident?

☐ .. No (skip to c)
☐ .. Yes (please explain) _____

c) If you are off work or if your work has changed because of the accident, do you think you will recover enough to return to your usual job?

☐ .. No ☐ .. Yes ☐ .. Don't know ☐ .. Not applicable

d) How satisfied would you say you are with your job?

☐ .. Very dissatisfied
☐ .. Dissatisfied
☐ .. Neither satisfied or dissatisfied
☐ .. Satisfied
☐ .. Very satisfied

# IMPORTANT

## PLEASE PROVIDE THESE DOCUMENTS TO YOUR ADJUSTER

1. ***If you are paid a wage or salary**, please have a Verification of Earnings form (SGI will provide the form) completed by each current employer. You must also provide a pay stub for the most current full pay period prior to the automobile accident.

2. ***If you are self-employed**, please provide copies of the last 3 annual income and expense statements from your business and the last 3 income tax returns, including the Notice of Assessment.

3. ***If declaring maintenance or alimony or receiving Infirm Tax Deduction**, please provide a copy of your most current tax return.

***Please Note***

You may qualify for Canada Pension Plan (CPP) Disability pension if your disability is **severe** (your condition prevents you from doing any job) and **prolonged** (your condition is long term or may result in death).

## IMPORTANT!!

## PLEASE READ BEFORE YOU SIGN.

1. I am applying to Saskatchewan Government Insurance (SGI) for any compensation to which I may be entitled under the Automobile Accident Insurance Act (the Act) and Regulations.
2. The information on this form is true and correct in every respect and I agree to let my adjuster know right away if anything changes that may affect my claim, including any return to work or income earned from employment.
3. I understand that the Criminal Code makes it an offense, punishable by fine and/or imprisonment to obtain or attempt to obtain, money or property (including compensation or services under the Automobile Accident Insurance Act) by deceit, falsehood or other fraudulent means; and that anyone who does so is also liable to reimburse SGI, in full, for any payment obtained this way.
4. I understand that holding back information about income, interfering with or delaying my recovery or not cooperating with rehabilitation or with reasonable requests for medical examination may cause my benefits to be cut back or cancelled altogether.
5. I understand and agree that SGI may share the information regarding my claim for benefits with health care professionals, vocational rehabilitation professionals, Saskatchewan Social Services and the Institute for Health and Outcomes Research at the University of Saskatchewan. I further understand and agree to better facilitate the administration of my claim, medical or vocational information may be exchanged directly between health care professionals or vocational rehabilitation professionals, and I hereby authorize such direct exchange or provision of information.
6. I authorize SGI to undertake whatever investigations are necessary with respect to my claim for compensation, including examination of any medical and employment information that SGI deems as relevent.
7. I give permission to the medical assessment teams to contact my primary care practitioner directly.

*SIGNED AT* _____ *THIS* _____ *DAY OF* _____, *19*____

*CLAIMANT/REPRESENTATIVE SIGNATURE* _____

*PRINT CLAIMANT'S NAME* _____

*WITNESS* _____

*WITNESS* _____

**Note: A photocopy of this form is to be accepted as if it were an original.**

*Thank you for your help in completing this application.*