# Motorcycle-related spinal injury: Crash characteristics

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## ARTICLE INFO

## ABSTRACT

This study presents an analysis of crash characteristics of motorcyclists who sustained spinal injuries in motorcycle crashes. The aim of the study is to identify the salient crash characteristics that would help explain spinal injury risks for motorcyclists. Data were retrospectively collected from police case reports that were archived at MIROS from year 2005 to 2007. The data were categorized into two subcategories; the first group was motorcycle crashes with spinal injury (case) and the second group was motorcycle crashes without spinal injury (control). A total of 363 motorcyclists with spinal injury and 873 motorcyclists without spinal injury were identified and analyzed. Descriptive analysis and multivariate analysis were performed in order to determine the odds of each characteristic in contributing to spinal injury. Single vehicle crash, collision with fixed objects and crash configuration were found to have significant influence on motorcyclists in sustaining spinal injury ($p < 0.05$). Although relatively few than other impact configurations, the rear-end impacted motorcyclist shows the highest risk of spinal injury. Helmets have helped to reduce head injury but they did not seem to offer corresponding protection for the spine in the study. With a growing number of young motorcyclists, further efforts are needed to find effective measures to help reduce the crash incidents and severity of spinal injury. In sum, the study provides some insights on some vital crash characteristics associated with spinal injury that can be further investigated to determine the appropriate counter-measures and prevention strategies to reduce spinal injury.

## 1. Introduction

Parallel to the rapid growth of motor vehicles in Malaysia is the occurrence of spinal injury. As evidence, motor vehicle accidents (MVA) accounted for 58% of spinally injured patients admitted to the hospital in 1998 (Roohi et al., 2006), and in the period 2003–2006, about 39% of spinal cord injury (SCI) as a result of MVA was reported (Joseph et al., 2009). Internationally, traffic accident accounted for 52% of spinal cord injury (SCI) cases in Australia (Cripps, 2008), 43% in the USA (NSCISC, 2010) and averagely more than 50% in the European countries (ETSC, 2007). In developed countries, spinal injury occurs more frequently to passenger car occupants, but the situation is possibly different for developing countries such as Malaysia. This is because 55% of the registered vehicles on Malaysian roads are motorcycles (Sharifah Allyana et al., 2010) and the spinal injury pattern also could be different as motorcyclists are likely to be injured more severely compared to car occupants (Pang et al., 2000).

Although spinal injuries sustained during motorcycle crashes are relatively low (ranging from 1% to 11% of all injuries) compared to lower extremity or head injuries (Roohi et al., 2006; Ankarath et al., 2002; Robertson et al., 2002; Begg et al., 1994; Braddock et al., 1992; Drysdale et al., 1975), injuries to the spine and spinal cord, however, often lead to death, or severe impairment and disability. The long term impairment makes social burden immense as spinal injury may generate a massive cost in hospital care, rehabilitation, in addition to personal or family grief and suffering. Furthermore, epidemiological studies show that spinal injury usually affects young people (Leucht et al., 2009); thus they occur at the beginning of a period of highest financial productivity of human resources. The overall statistics on the reported incidence of motorcycle spinal injury may be underestimated as many crash victims do not survive the accident and their deaths are attributed to more pronounced visible lethal injuries such as head injuries (Pang et al., 2000; Kasantikul et al., 2002). As a result, spinal injury as a cause of death often goes unreported.

In the last few years, many studies have been conducted worldwide on motorcycle-related spinal injuries, including the study of the patterns and characteristics of spinal injuries in motorcycle

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crash, the influence of helmets on spinal injury, demographic characteristics and injury mechanisms (Leucht et al., 2009; Goslar et al., 2008; Moskal et al., 2008; Roche et al., 2008; Ooi et al., 2005; Ankarath et al., 2002; Robertson et al., 2002; Kupferschmid et al., 1989). However, surprisingly, none of these existing studies have investigated factors linked to motorcycle crashes in terms of vehicle, environmental and crash characteristics that may potentially increase the risk of spinal injury.

The aim of this study was to investigate the characteristics of motorcycle crashes that have been reported as resulting in fatal or serious injuries, with a focus on the relationship between spinal injury and crash characteristics.

## 2. Materials and methods

### 2.1. Data source

In order to conduct this study, it was necessary to obtain information involving motorcyclists with injury descriptions that relate to spinal injury. To analyze the incidence of spinal injury, a large database was needed and one obvious approach was to carry out a hospital-based study. However, retrospective hospital-based studies typically were unable to provide enough information on motorcycle crash circumstances, and thus, offer very little understanding on crash characteristics. Therefore, this retrospective study attempted to utilize police crash reports as the primary source of data.

These reports were obtained from the Royal Malaysian Police (RMP) and were archived at the MIROS Accident Database and Analysis Unit which maintains a centralized national traffic accident database, the MIROS Road Accident Database (MROADS) (Hizal Hanis and Sharifah Allyana, 2009). The police crash reports were the preferred source of information as they provided a sufficiently large amount of data set regarding vehicle accidents to allow meaningful analysis to be performed. Included in the reports were narratives of the accidents which often could provide further information on injury and crash circumstances. The injury information, although limited, was sufficient to identify the type of injury and its corresponding injury severity of the crash victims.

### 2.2. Data selection

The data for this study was extracted from police crash reports related to motorcycle crashes that occurred in Malaysia over the period of 2005–2007. The study utilized a case control study design in evaluating the association between crash characteristics and the risk of spinal injury. The case group consisted of motorcyclists who had suffered from fatal or serious spinal injury while the control group was defined as motorcyclists who suffered fatal or serious injuries with the exclusion of spinal injury. Both case and control groups could have multiple injuries.

A two-stage filtering process was used in selecting the sample data (Fig. 1). First, all the available police crash reports were filtered to identify the case motorcyclists (with spinal injury). The case group was rigorously selected based on the following criteria identified based on the accident reports:

1. The reports contain keywords such as "serious injury" or "fracture/broken" in relation to the "neck", "backbone", "cervical", "thoracic", "lumbar", "spinal cord" and other parts which indicated that the spine was seriously injured.
2. The motorcyclists were reported to have been admitted to the hospital for treatment or to the mortuary for post mortem.

Then, the same data set of police crash reports was filtered for the second time to identify the control group of motorcyclists
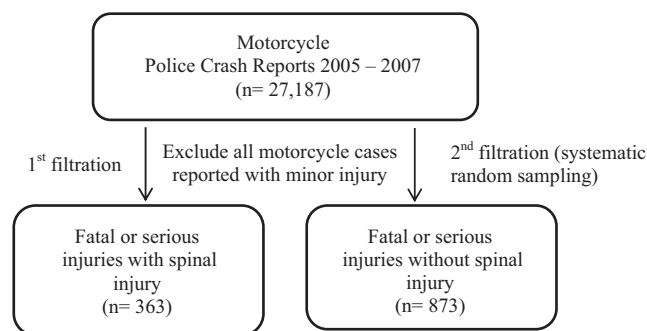


**Fig. 1.** Data selection of the study.

(non-spinal injury). The same criteria used for selecting motorcyclists with spinal injury were applied for this process except that the keywords related to spinal injury were discarded. Due to a large sampling frame; the motorcyclists with non-spinal injury were selected using a systematic random sampling technique. Only motorcycle crashes resulting in fatalities or serious injuries were selected. Motorcyclists with minor injuries were excluded and they included reported incidents that had scant or insufficient information for the ascertainment of spinal injury.

Out of the available and archived 27,187 police crash reports relating to motorcycle crashes at MIROS, from the year 2005 to 2007, 363 motorcyclists who suffered fatal or serious injuries connected to the spine were identified. Eight hundred and seventy-three (873) other motorcyclists who suffered fatal or serious injuries were randomly sampled out of the total police crash reports as the group for comparison.

### 2.3. Study variables

Guided by literature review, we identified all the variables associated as risk factors for motorcyclists who suffered serious injuries (Zarir et al., 2010). In addition, for every selected case, Clarke et al.'s (2007) method of accident case study using police crash reports was used to further clarify and derive crash related variables associated with motorcycle crashes. Instead of relying solely on the coded variables based on standard police records, the method utilized the approach of analysing brief accident stories (prose accounts) as described by the attending police officer as an additional source to identify accident causal patterns. The brief accident story contains a range of additional information which will help to explain the often complex circumstances of the accident. The story might include police sketch diagrams, photographs, statements from forensic reports and, more importantly, interviews and witness statements which could give rich information. However for our case study, photographs were not made available in every police crash report. Some discrepancies did occur between information provided by coded police variables found in the standard reports and information given in the brief accident story. These differences were usually resolved by considering all statements together and consensus was arrived at after weighing the information. In other words, a form of expert judgment was arrived at after discussion and consultation if necessary. The final identified variables were then classified as motorcyclist and motorcycle characteristics, environment characteristics and crash characteristics.

The motorcyclist variables used in the analysis included age, gender, position of the motorcyclist who sustained spinal injury, pillion occupancy, helmet use and license possession. Improper use of the helmet could not be determined as the information was unavailable in the police report. Other features pertaining to motorcyclist safety system, such as the use of airbag jacket and back protector are not commonly used by motorcyclists in this