School of Population Health

An examination of crashes, long-term outcomes following motorcycle crashes in Ho Chi Minh City: Longitudinal Study

Han Thi Ngoc Doan

This thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University

June 2021

Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics The proposed research study received human research ethics approvals from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HR2017/0010 and from the University of Medicine and Pharmacy at Ho Chi Minh City Human Research Ethics Committee, Approval number 136/DHYD-HĐ.

Signature

Han Thi Ngoc Doan

Date: 04/06/2021

Acknowledgements

First and foremost, I would like to express my profound gratitude to my supervisors: Associate Professor Jonine Jancey, Doctor Justine Leavy, and Doctor Michelle Hobday for their valuable time, their constructive guidance, feedback, support, and generous commitment through this research project.

I would also like to express my deep gratitude to my ex-supervisor, Professor Lynn Meuleners, for sharing her expertise on-road safety. Thank you also to Doctor Kyle Chow, my ex-co-supervisor, for his constructive feedback during my candidacy.

Thank you very much to Curtin University and Vietnamese Ministry of Education, which provided me with financial support through a Curtin International Post-Graduate Research Scholarship (CIPRS/ MOET). My gratitude also goes to Professor Jaya Dantas Earnest for her key role as a chairperson.

I also acknowledge the assistance of my data collection team, the engaged hospitals in Vietnam and the participants of my research. Without their help, it would be infeasible for me to complete my study.

I am grateful to my friends at the Curtin-Monash Accident Research Centre and Curtin University for sharing this journey with me.

Last but not least, my special gratitude goes to my beloved husband and my daughter, my mother, and my parents-in law, who have constantly encouraged, loved and supported me.

Abstract

The high prevalence of motorcycle injuries in Vietnam and Low- and Middle-Income Countries are recognised as a major public health issue due to its substantial contribution to the burden of disease (1). Motorcycle crash survivors face life-long lasting effects from injuries, often leading to a decrease in general health, quality of life and employment status (2). With increased survival rates post-injury, research is needed to evaluate the recovery status of survivors post-discharge, and to identify residual needs. This study aimed to identify risk factors for hospitalised motorcyclists due to a motorcycle crash in Vietnam; and determine changes in health-related quality of life (HRQoL), functional status, pain, return to work/study (RTW/study), and depression at baseline (time of injury), 6 and 12 months post motorcycle injures, and factors associated with poor outcomes.

This prospective longitudinal cohort study recruited 352 adult motorcyclists who were injured as the result of a crash and were admitted to hospital for more than 24 hours between June 2017 and January 2018. The inclusion criteria were: a commuter motorcyclist involved in a motorcycle crash; aged 18 years and over; and a resident of Ho Chi Minh City (HCMC), Vietnam. Exclusion criteria were: cognitive impairment due to the crash (determined by a physician); severe physical condition (e.g., stroke, paralysis); not able to provide informed consent; unable to remember the events of the crash; referral to another hospital; did not speak Vietnamese; and the researcher unable to approach the patient at the hospital or home.

Participants were consecutively approached by the researcher after screening basic information for eligibility from the admission list at the emergency department of Gia Dinh hospital. Eligible participants were provided with information about the study including its purpose, their involvement in the study, and confidentiality of information provided. Written consent was obtained by the researcher before any data were collected. Information was collected at three time points: at the time of the hospital admission, at 6 months, and 12 months post-injury. First data collection included a review of participant's medical records and face-to-face interview. The second and the third interview were conducted by a telephone or face-to face, depending on the participant's preference.

Information related to injury details (injury severity, length of stay in the hospital, blood alcohol concentrate, and disease co-morbidities) was obtained from medical records. Socio-demographic characteristics, crash details and health outcomes were collected by a research-administrated questionnaire. Health-related quality of life (HRQoL) was assessed using the

SF12-v2 and EQ-5D-5L. Depression was assessed using the Center for Epidemiological Studies Depression Scale (CES-D). Pain intensity was assessed by Numeric pain Rating Scale (NPR). Functional status was assessed using the Lawton Instrumental Activities of Daily Living scale (LADL). The questionnaires were translated into Vietnamese and then back to English by two independent translators. A pilot study of 20 injured motorcycle patients was conducted to test the appropriateness of the questionnaire for a Vietnamese population.

Descriptive and inferential statistics were performed to describe the sample and examine differences/changes over the study period. Logistic regression analysis was undertaken to determine risk factors for injury severity following a motorcycle crash after adjusting for potential confounders. Multilevel regression models were undertaken to assess the changes in health outcomes including HRQoL, pain intensity, functional status, RTW/study, and depression.

A total of 441 participants who presented at the ED of the Gia Dinh hospital following motorcycle crash were reviewed, 378 eligible injured motorcyclists were approached by the researcher, of which 26 refused to participate. The sample at baseline was 352 participants. A total of 301 participants completed the second assessment at 6 months post-discharge (response rate: 81.3%); and 284 completed the third assessment a 12 month post-discharge (response rate: 80.7%).

The findings showed that young males accounted for 67% of hospitalised motorcyclists and their mean age was 40.9 (standard deviation (SD) =15.3) years. High-risk behaviours for motorcycle injuries were unlicenced (41%), drinking-driving (46.5%), not wearing a helmet (13%), speeding (26.4%), and using a mobile phone while riding (9%). The findings showed that the majority of crashes were multi-vehicle crashes (73.3%), of which 52.3% of crashes involved two motorcycles and 21% involved a motorcycle and car/truck.

The most common site of motorcyclist injuries was the extremities (58.2%), followed by the head (32.1%) and external (surface) (12.8%) injuries. The mean length of hospital stay was 8.1 days (SD=6.3), ranging from 1 to 51 days (median = 7; Inter quartile range (IQR) = 4-36). The mean Injury Severity Score (ISS) was 7.3 (SD=4.1), ranging from 1 to 26 (median = 8.5; IQR = 1-22). In total, 25% of patients were injured in at least two body regions and nearly 7% of hospitalised motorcyclists suffered a severe injury. The results of multiple logistic regression analysis found not being licensed to ride a motorcycle (adjusted odds ratio

(AOR) = 3.32; 95% CI: 1.18-9.34) and crashing at night-time (AOR = 4.28; 95% CI: 1.33-13.78) were significantly associated with increased injury severity among hospitalised motorcyclists.

Compared to baseline, the Physical Component Scores of the Short Form 12- version 2 (the SF12 PCS) reduced by 6.61 points (95% CI: -8.21;-5.03) at 6 months and 5.12 points (95% CI: -6.74;-3.51) at 12 months post-injury. The Mental Component Scores of the Short Form 12- version 2 (the SF12 MCS) also reduced by 4.23 points (95% CI: -5.99;-2.47) at 6 months post-injury but increased by 1.29 point (95% CI: -0.49, 3.08) at 12 months post-injury. HRQoL measuring by the EQ-5D VAS score decreased by 10.41 points (95% CI: -11.49, -9.33) at 6 months and 6.48 points (95% CI: -7.58, -5.38) at 12 months post-injury. Being female ($p<0.05$), increasing age ($p<0.05$), and length of stay in the hospital ($p<0.05$) were significantly associated with poorer HRQoL.

Of the 352 participants in the study, 318 (90.3%) were working or studying before the injury. The proportion of motorcyclist RTW/study was 59.6% at 6 months and 82% at 12 months post-injury. Results of a multiple logistic regression for risk factors of delayed RTW/study indicated that greater length of stay in the hospital (AOR=0.95, 95% CI: 0.91-0.98), lower education levels (AOR=0.51; 95% CI: 0.31, 0.85), aged between 35 and 54 years (AOR=0.21; 95% CI: 0.06, 0.72), a higher ISS (AOR=0.85; 95% CI: 0.77, 0.93) had significantly lower odds of RTW/study. Higher SF12 PCS (AOR=1.14; 95% CI: 1.09, 1.20) and SF12 MCS (AOR=1.04; 95% CI: 1.00, 1.09) had significantly higher odds of RTW/study.

Pain scores improved significantly at 6 months (β=-3.31, 95% CI: -3.61, -3.01) and 12 months post-injury (β=-3.62, 95% CI: -3.92, -3.32) compared to the time of injury. Risk factors for more pain included being female (β=0.52, 95% CI: 0.18, 0.87) and aged over 55 years (β=0.45, 95% CI: 0.38, 0.89). Participants with higher SF12 PCS (β =-0.03, 95% CI:-0.04, -0.02) and MCS (β=-0.02, 95% CI:-0.03, -0.01) had significantly lower pain scores.

Functional status also increased significantly by 2.89 points (95% CI: 2.64, 3.13) at 6 months and by 3.51 points (95% CI: 3.27, 3.75) at 12 months compared to baseline. Risk factors for lower functional status scores included aged over 55 years (β=-0.59, 95% CI: -0.93, -0.24) and higher ISS (β=-0.05, 95% CI: -0.08, -0.02). Participants with higher PCS (β=0.02, 95% CI: 0.01, 0.03) and SF12 MCS (β=0.02, 95% CI: 0.01, -0.03) had significantly higher functional status scores.

Depression scores increased significantly by 4.65 points (95% CI: 3.29, 60.2) at 6 months post-injury compared to pre-injury, but were similar to the pre-injury scores at 12 months post-injury. Females (β=3.10, 95% CI: 1.48, 4.72), those aged over 55 years (β=2.74, 95% CI: 0.38, 0.89), longer length of stay (LoS) in the hospital (β =0.16, 95% CI: 0.04, 0.29) had significantly higher depression scores.

This study highlighted risk factors, as well as the heath impact of motorcycle injuries on hospitalised motorcyclists. These findings have implications for practice, policy and research in Vietnam. In particular, the findings of this study suggest the need to improve the driving licence system, street lighting, make motorcycle traffic law enforcement more effective and ensure safe motorcycles to reduce motorcycle injuries. While post-crash care such as early access to rehabilitation centers may improve the long-term health outcomes among hospitalised motorcyclists in Vietnam. National road safety interventions need a combination of strategies including education and awareness raising; road safety management; road infrastructure; vehicle and driver; enforcement; rescue and medical aid in order to reduce the risk factors that potentially contribute to road traffic crashes in motorcycle riders in Vietnam.

Statements of Contribution

Curtin's School of Public Health provided the environment which supported the PhD candidate to undertake this research. The candidate was the investigator of the project which involved designing methodology, undertaking recruitment, and processing data. The candidate was also responsible for writing all publications presented as parts of the thesis with input from other co-authors. Details are provided below:

Associate Professor Jonine Jancey was the PhD main supervisor who oversaw and contributed to the study, participated in the drafting of papers, revising and making suggestions for improvements in the publications and thesis.

Doctor Justine Leavy was the PhD co-supervisor who participated in the drafting of papers making improvements to the publications and thesis.

Doctor Michelle Hobday was the PhD co-supervisor who provided her expertise on methodology and statistical analysis, as well as paper drafting, suggested improvements for publications and thesis.

List of publications and presentations

This thesis contains three publications. The statements of contribution of the co-authors and the published papers in the thesis are attached in Appendix A and B. I (the PhD candidate) warrant that I have obtained, where necessary, permission from the copyright owners to use any third-party copyright material reproduced in the thesis, or to use any of my own published work in which the copyright is held by another party. Copyright permissions are provided in Appendix C.

Peer reviewed publications

Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.

Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.

Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Oral presentations

Doan HTN, Hobday MB, Leavy J, Jancey J. (2020, May 11). *Health-related quality of life of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam.* Presented in the Mark Liveris Health Sciences Research Student Seminar, Faculty of Health Sciences, Curtin University, May 2020

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACEM	Association of European Motorcycle Manufacturers
ASD	Acute Stress Disorder
AIS	Abbreviated Injury Scale
BAC	Blood Alcohol Concentration
BMI	Body Mass Index
CES-D	Center for Epidemiology Studies – Depression Scale
CI	Confidence Interval
COR	Crude Odds Ratio
ED	Emergency Department
EQ-5D-5L	European Quality of Life questionnaire – 5 domains-5 levels
GEE	Generalised Estimating Equations
GLMM	Generalised Linear Mixed Models
HCMC	Ho Chi Minh City
HRQoL	Health-Related Quality of Life
HICs	High-Income Countries
ICC	Intra-class correlation coefficient
IQR	Inter-quartile Range
ISS	Injury Severity Score
km	Kilometres
Km/h	Kilometres Per Hour
LADL	The Lawton Instrumental Activities of Daily Living scale
LMICs	Low-and Middle-Income Countries
LoS	Length of stay in the hospital
MAIDS	Motorcycle Accidents In Depth Study
MCS	Mental Component Scores
MIC	Middle Income Country
MLM	Multilevel model
NPRS	Number Pain Rating Scale
OR	Odds Ratio

PCS	Physical Component Scores
PIS	Participant Information Sheet
PTSD	Post-Traumatic Stress Disorder
RTW/study	Return to work/study
SD	Standard Deviation
UK	United Kingdom
USA	United States of America
USD	United States Dollar
VAS	Visual Analogue Scale
VND	Vietnam Dong
WHO	World Health Organization

Chapter 1. Introduction

Overview

This chapter provides the rationale for the research into the long-term health outcomes of those who have experienced a motorcycle injury in low- and middle-income (LMICs) in particular, Vietnam. It outlines the significance, objectives and research gaps.

1.1 Background

Significant of road traffic injuries and motorcycle injuries in LMICs

The data show that LMICs bear about 90% of road traffic injuries (RTIs) and deaths globally, in which motorcycle crashes comprise up to 70% of RTIs and 34% of deaths (3) (4-6). Globally motorcycle riding has become a popular form of travel, particularly in large cities (7) due to increased traffic congestion, limited inner city parking, increased in petrol prices and motor vehicles are less expensive (8). Unfortunately, the increased use of motorcycles has been accompanied by an increase in the proportion of motorcycle-related injuries and fatalities, especially in LMICs (1).

Motorcycle injuries in Vietnam

In Vietnam, motorcycle crashes contribute to most RTIs and deaths. The World Health Organization (WHO) estimates that 14,000 people die from RTIs in Vietnam annually, with 59% of these deaths being motorcyclists (6, 9). In recent years, dramatic economic growth and the improvements in living standards, has resulted in Vietnam experiencing a rapid growth in motor vehicles, with motorcycles being the vehicle dominating the traffic flow on mixed road networks (Figure 1.1) (10).The large number of motorcycles in Vietnam has been accompanied by an increase in the number of motorcycle fatalities and disabilities. The national data shows that between 21 and 24 people are fatally injured on the road each day due to motorcycle crashes in Vietnam (11, 12). Because of the predominance of motorcycle injury to the overall incidence or road crash injuries in Vietnam, it is important to determine characteristics, and risk factors for motorcycle injuries in crashes. Moreover, additional research is needed to detect residual patient needs post-discharge in culturally specific contexts.

Figure 1.1. Traffic congestion in Vietnam

1.2 Measuring the long-term health outcomes following road traffic injuries

Road Traffic Injuries (RTIs) are a leading cause of fatalities and disabilities which place high demands on medical and societal costs (1). Over the past decades, improvements in trauma care, especially in high-income countries (HICs) has resulted in a significant increase in case morbidity rates, which increases the number of non-fatally injured people at risk of serious long-term disability (13, 14). Determining the long-term health outcomes following RTIs is increasingly recognised as an important milestone in evaluating the recovery status of patients post discharge, as well as identifying residual patient needs (13, 15). There are some outcomes which should be considered during the collection of trauma care data such as health related quality of life, pain, and physical activity (2, 16-18).

Health related quality of life and motorcycle injuries

Health related quality of life (HRQoL) is an excellent indicator of an individual's physical and mental health, capturing self-perceived health status among injured populations (2, 19). Research to date indicates that non-fatal injured patients often experience significantly lower HRQoL compared to other patients and the general population, and do not return to their pre-injury health (20-23). Most of these studies have found that HRQoL among injured populations improved after discharge (20, 22).

The findings reported the improvement in HRQoL of injured patients over 12 months post-injury however, is disparate. Several studies reported that HRQoL improved in the period between baseline (discharge) and 12 months post-injury (24-28) while other studies indicated that HRQoL had not changed in this period (29, 30). In addition, research into HRQoL following motorcycle injuries in LMICs and Vietnam is still limited.

Pain and motorcycle injuries

Chronic pain is commonly reported by many people involved in RTIs (31). Previous research has shown that chronic pain was present in 45% to 63% of RTI patients one year after discharge, but this was dependent on the injury severity (31-34). Although the incidence of chronic pain decreased over time compared to admission or discharge (35, 36), many of the injured patients still suffered work disability due to pain (37). Studies on pain following motorcycle injuries are limited, especially in LMICs.

Depression and motorcycle injuries

Depression and anxiety are common consequences post-injury. The prevalence of depression has been found to be 28% to 42% in injury survivors after over 12 months post-injury (38-41). However, the change in depression between pre-injury and post-injury has not been widely measured. There are few studies evaluating the change in depression before and after motor vehicle injuries in HICs (40, 42). For example, a longitudinal study investigating severity of depression following traumatic injury in Australia showed the mean score of depression reduced over the time of the study (40). In particular, 40% of patients were classified as having symptoms of depression above the normal range at 3 months post-injury, and 23.9% at 6 months following injury. Another study in Europe showed a statistically significant change in depression scores between the time of admission (baseline) and after 6 months post-injury but there were no statistically significant changes in depression scores between baseline and 12 months follow-up nor between the 6 months and 12 months follow-up.

Research describing the depression of motorcyclists involved in a motorcycle crash in LMICs is limited. In Vietnam, depression is increasingly recognised as a public health issue for all age groups, affecting up to 41% of the population (43-45). However, research examining depression following a motorcycle injury in Vietnam has not been undertaken.

Functional outcomes and return to work/study (RTW/study) and motorcycle injuries

Measuring functional outcomes and RTW/study following traffic injuries have been recognised as an important component of quantifying the burden of trauma (2) (17, 18, 46). Research to date has indicated that between 21% (47) and 70% (48, 49) of those experiencing non-fatal RTIs have functional limitations, and between 28% (50) and 85% (46, 51, 52) RTW/study after 12 months post-injury while about 20% did not return to work three years post-injury (53).

There is evidence that functional status as well as the proportion of RTW/study among those who sustained major injuries improved over time (21). Gabbe et al. (2016) (46) conducted a study following up 8844 adults with major trauma from discharge to 24 months post-injury in Victoria, Australia, measuring function and return to work/study. This study reported that despite improvement in outcomes over the study period, ongoing disability was common at 24 months post-injury.

Although there has been significant number of studies focusing on function and RTW/study among RTIs population (47, 54, 55), minimal research has been conducted into the health outcomes for injured motorcyclists, particularly on LMICs.

1.3 Research gaps on non-fatal motorcycle injuries

Motorcycles have always been one of the riskiest forms of road transport. In Vietnam, motorcycle riders are involved in more than 70% of road traffic crashes, making up more than half the traffic crash-related casualties and injuries (6). Despite the burden of injury associated with motorcycle crashes in Vietnam, few comprehensive studies have examined the types of injuries sustained by those motorcyclists' who are hospitalized. Instead, most studies have primarily focused on fatalities, comparing riders with and without helmets, and trends in head injury following the changes of motorcycle helmet laws (56, 57). Other studies have examined the cost of brain trauma sustained in motorcycle crashes but did not take into account the patterns, and risk factors of injured motorcyclists involved in motorcycle crashes (58 , 59).

Little is known about the long-term health outcomes following motorcycle injuries. Therefore, it was identified that a prospective study was needed to understand the changes in health outcomes post motorcycle injury, providing evidence to assess the burden of these injuries in Vietnam.

There are a number of limitations from previous research that need to be considered in the context of motorcycle injuries in Vietnam. Firstly, previous research has been conducted in HICs where the purpose of use, type of motorcycle and infrastructure are totally different to LMICs (60, 61). Therefore, generalisation of the findings from HICs to LMICs may not be appropriate. Secondly, studies have predominantly measured the health outcomes at one point after injuries (60), and therefore these studies were unable to examine changes in health outcomes over time. Only one study has examined the change in health outcomes six months post-injury (61), however, this follow-up period may not be adequate to assess the long-term health outcomes (28). Thirdly, the sample size of a previous study was small, only including 96 participants (60), which impacts the ability to generalise the findings to the broader population. Finally, there has been no research examining the effect of factors, such as socioeconomic characteristics, injury severity and lengths of stay in the hospital on changes in health outcomes over time post-injury. In efforts to fill this gap, this study aims to achieve the following.

1.4 Study aims and specific objectives

Aims

The overall aim of this study was to identify risk factors, and the long-term health outcomes of commuter motorcyclists aged 18 and over involved in motorcycle crashes in Ho Chi Minh City (HCMC), Vietnam.

Specific objectives:

1. Describe the characteristics (demographics, crash characteristics, injury patterns, injury severity, hospital length of stay) for commuter motorcyclists aged 18 and over who are hospitalised due to a motorcycle crash in HCMC, Vietnam.
2. Describe risk factors for a motorcycle crash and the long-term health outcomes (function, pain, depression, return to work and health-related quality of life) of commuter motorcyclists aged 18 and over who are hospitalised due to a motorcycle crash at baseline, 6 months and 12 months post-injury in HCMC, Vietnam.
3. Develop recommendations to improve the long-term health outcomes for injured commuter motorcyclists.

1.5 Significance of the study

Motorcyclists are vulnerable road users who have a higher risk of injury and death when involved in road traffic crashes compared to other road users. It has been estimated that the risk of death from a motorcycle crash is 50 times higher than cars for every kilometre travelled, or the risk of injuries is nine times higher than that of cars (62, 63). Motorcycle crash survivors may experience disfigurement by the loss of body parts and/or extreme scarring, chronic pain, decreased mobility and psychological distress. Despite this, there is minimal information about the long-term health outcomes of injured motorcyclists, especially in LMICs including Vietnam where motorcycles are the predominate means of transport.

This study is the first prospective longitudinal study to measure long-term health outcomes as well as risk factors for motorcycle injuries in Vietnam. Findings from this study will provide evidence to support better understanding of the characteristics of motorcycle injuries in Vietnam and other LMICs, and highlights important information for health professionals to improve the long-term health outcomes for injured motorcyclists as part of injury management in a timely manner. This study ultimately aims to improve injured motorcyclists' health outcomes.

1.6 Outline of the thesis

This is a hybrid thesis comprising an introduction (Chapter 1); literature review (Chapter 2); methodology (Chapter 3); results (Chapter 4); discussion, conclusion and recommendations (Chapter 5), and other supplementary parts of thesis.

The organisation of the thesis is as follows:

Chapter 1 presents the rationale for the study by describing the public health issue of motorcycle injuries from LMICs perspective and within a Vietnamese context. Research gaps of long-term health outcomes among injured motorcyclists as well as recommended health outcome measurements following road traffic injuries are presented. The aim, specific objectives and significance of the study are also included in this chapter.

Chapter 2 reviews the current literature on the global burden of road traffic injuries and particularly motorcycle injuries. This chapter provides information on characteristics and risk factors for motorcycle injuries; and reviews current literature on the long-term outcomes of road traffic injuries and motorcycle injuries.

Chapter 3 provides a description of the methodology of the study, including the study design, study setting, data collection instruments and questionnaires used, statistical analysis, and ethical consideration.

Chapter 4 presents the detailed results of the study.

Chapter 5 presents the discussion, recommendations for future research and conclusion.

Chapter 2. Literature review

Overview

This chapter provides an overview of the current literature on road traffic injuries (RTIs), motorcycle injuries and long-term outcomes following these injuries, and then identifies gaps that require further research. The literature review has been divided into five sections: an overview of the global burden of road traffic injuries; an overview of the global burden of motorcycle injuries; background information on the Vietnam context; information on the characteristics and risk factors for motorcycle injuries; and reviews the current global literature on long-term outcomes of motorcycle injuries and road traffic injuries.

Search strategy

A literature search was conducted using the following electronic databases: Medline; ProQuest; PubMed; Scopus; Web of Science; ScienceDirect; the Cochrane Library; SpringerLink; Taylor & Francis; Transport Research International Documentation; Ovid; CINAHL; and Google Scholar. The search strategy consisted of a key word search either individually or combined using “AND” including: “motorcycle”, “motorcyclist”, “powered two-wheelers”, “scooters”, “injuries”, “crashes”, “accidents”, “trauma”, “road traffic”, “motor-vehicles”, “long-term outcomes”, “long-term impairment”, “health outcomes”, “health status”, “quality of life”, “health –related quality of life”, “psychological outcomes”, “physical disability”, “pain”, “return to work”, “depression”, “post-traumatic stress”, “functional status”, “mental health”, “functional limitation”, “developing countries”, “Low-, middle-income countries”, “high-income countries”, “Vietnam”.

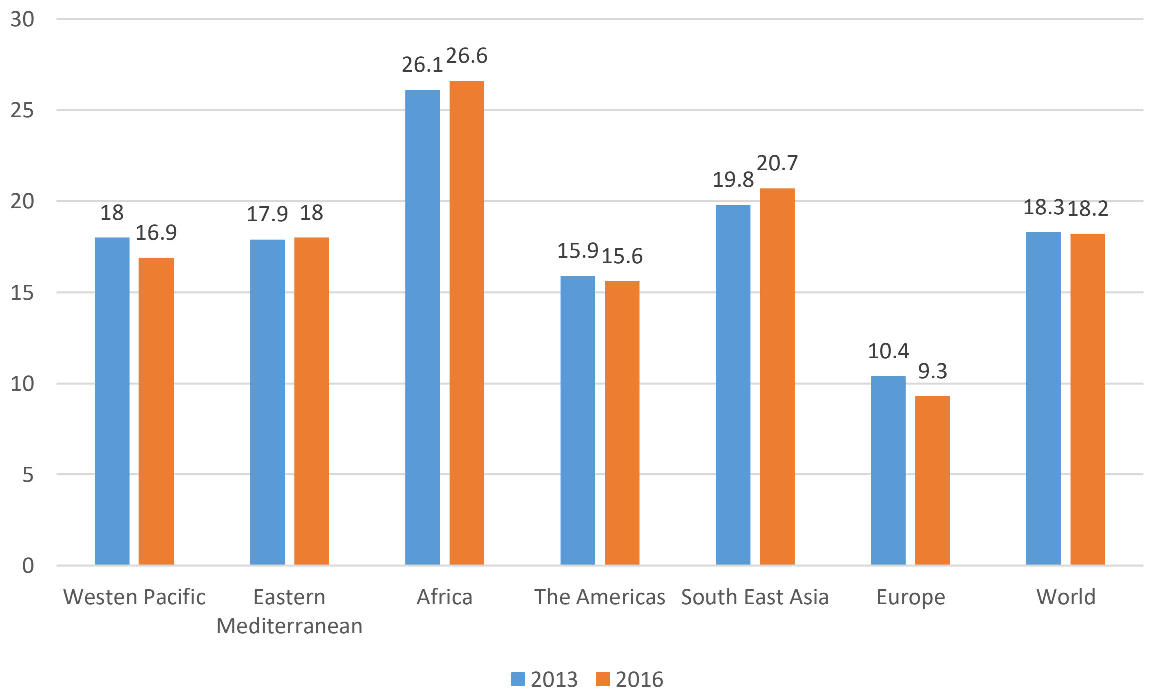
2.1 The Global Burden of Road Traffic Injuries

2.1.1 Health burden of Road Traffic Injuries

Road Traffic Injuries (RTIs) account for a substantial and increasing level of mortality and burden of disease. Globally, in 2016, approximately 1.35 million people were fatally injured and over 78 million people were non-fatally injured or disabled due to a road traffic crashes (1, 64). The World Health Organization (WHO) estimates RTIs are responsible for nearly 3,700 fatalities every day (1). Currently, RTIs are the leading cause of death worldwide for children and young adults aged between 5 and 29 years. It is also the eighth leading cause of death for all age groups surpassing infectious diseases such as diarrhea, tuberculosis and HIV/AIDS.

The WHO "*The Global status report on road safety 2018"* reports that the number of RTIs and fatalities are continuing to climb globally (1). It is estimated that the rate of fatalities from RTIs has been increasing 46% globally since 1990 and there has been a 144% increase in South Asia between 2000 and 2020 (65, 66). Current trends suggest that RTIs will become the seventh leading cause of death and disability globally by 2030 unless immediate and effective action is taken (1).

While there has been an increase in low- and middle-income countries (LMICs), there has been a downward trend in road traffic deaths in high-income countries (HICs) (see Figure 2.1). The reported reasons for this increase in LMICs include rapid urbanisation, poor safety standards, lack of road traffic enforcement, people driving distracted or fatigued, or under influence of the alcohol and drugs, speeding and failure to wear seat-belts or helmets (1, 67, 68)



Source: WHO 2018 (page 50)

Figure 2.1. Rates of road traffic fatalities per 100,000 population by regions: 2013, 2016

LMICs bear the greatest burden of RTIs and fatalities (1, 69, 70) with approximately 90% of worldwide road traffic fatalities occurring in these countries. The WHO reports a fatality rate of 27.5 per 100,000 population in LMICs RTIs, which is more than three times that of

HICs, where the fatality rate is 8.3 per 100,000 population(1). Furthermore, vulnerable road users -motorcyclists, cyclists and pedestrians - account for a much greater proportion of road traffic fatalities in LMICs than in HICs (71). Pedestrian fatalities make up about 40% of all road deaths in LMICs while motorcycle users comprise 43% and 36% the deaths in Southeast Asia and Western Pacific, respectively (72, 73).

2.1.2 Economic burden of Road Traffic Injuries

Globally, RTIs pose a substantial economic burden that can be quantified using disability adjusted life years (DALYs) and financial resources. Annually, the global cost of RTIs has been estimated to be US$518 billion, costing governments 3% of global gross domestic product (GDP), from 2.35% to 2.7% (74) of GDP in HICs and up to 5% of GDP in LMICs (72). A study that estimated global burden of injuries found that between 1990 and 2013 road injury DALY rates declined by 15.7% among high income regions such as Western Europe and Australasia but increased by 6.5% in South Asia and by 35.2% in South Sub-Saharan Africa (75).

The economic costs associated with RTIs in HICs mainly relate to medical, insurance and legal costs (76) (72) (77, 78). In LMICs, the death of a male of working-age reduces the income of the household and leads to significant direct and indirect economic losses to the country (72, 79). Recent studies on the household level economic burden of RTIs in LMICs indicated more than 50% of households with a RTI case experienced a decline in income, food consumption and an increase in debt (66, 79, 80).

2.1.3 Societal burden of Road Traffic Injuries

Societal burden of RTIs has received increasing attention globally because information can provide insight into the consequences of road crashes for the economy and social welfare, essential for evidence-based policy making. However, most of the evidence on the social impacts of RTIs is available from HICs. An international analysis showed that in HICs the social costs of RTIs ranged from 0.5% to 6.0% of the GDP (74). In 2011, European research found that there was over 30,000 fatalities and over 120,000 individuals with permanent disabilities due to RTIs, impacting nearly 150,000 families (81). In addition, since 1971 more than 130,000 individuals in England and Wales (about 1.1 percent of the total population) have lost a close family member in a fatal RTI, resulting in poor mental health and other consequences for the family unit (82).

Evidence of the long-term societal impact of RTIs in LMICs is limited. Which is mostly due to poor data from the health information system and financial records in LMICs (72, 83). Few studies examining the social impact of RTIs have demonstrated that the families and friends of people injured in crashes experienced financial, physical, social, and psychological stress (84-87). Furthermore, a study conducted by Mock et.al showed that families and friends of those sustaining a RTI had to change work patterns to provide care for their injured relative. In addition, children in some households lacked supervision or had to leave school (88).

2.2 Global burden of motorcycle related injuries

2.2.1 Definitions of motorcycles

"Motorcycles are defined as two- or three-wheeled motorcycles, off-road motorcycles, mopeds, scooters, mini bikes, and pocket bikes (p.1)" (63). The motorcycle rider is defined as the person directly operating the motorcycle and the passenger is the person who is sitting on the motorcycle but not operating the motorcycle. The motorcyclist is referred to as either the rider or passenger (63).

2.2.2 The global rise of motorcycling, diversity of motorcycle styles and uses.

Globally, the number of registered motorcyclists has grown significantly during the last decade, with the largest increase in Asia (7). According to the WHO "*Global Status Report on Road Safety 2015*", between 2010 and 2013, the number of motorcycles worldwide increased by 27% (72) and rose by a further 10% between 2013 and 2016 (1).

It is estimated that there were over 380 million motorcycles worldwide (89), of which 77% were in Asia, 16% in North America and Europe, 5% in Latin America, 1% in Africa and 1% in the Middle East (90). In Asian cities, it is estimated that that there are 196 motorcycles per 1,000 individuals, which is seven times the average for the rest of the world (7).

Motorcycles come in different forms and are used for different purposes by those living in HICs and LMICs. The majority of motorcycles in Asia are 'scooters' with an engine capacity from 50cc to 250cc. They are used for commuting in both urban and rural areas, and are often a family vehicle because of their suitability for travelling on narrow streets, their low purchase price, low insurance premiums, and ease of parking (12). In contrast, in HICs motorcycles are primarily used for recreation or sport (3, 90, 91).

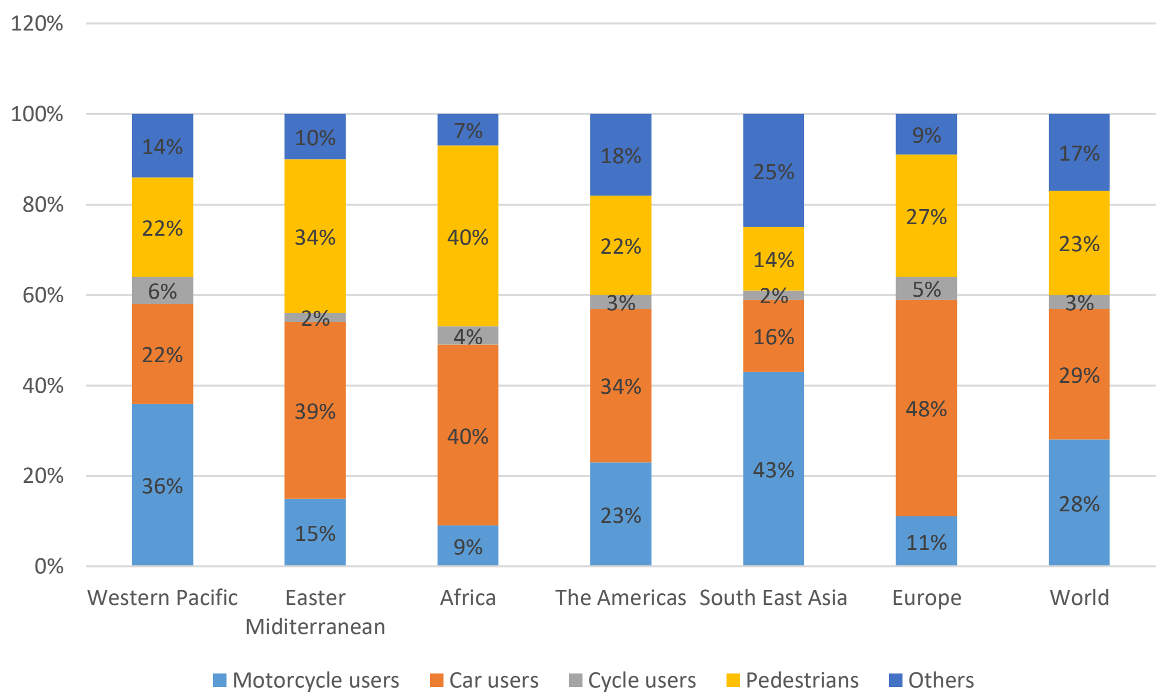
2.2.3 Excessive risk for injuries and deaths of motorcyclists

Motorcyclists are vulnerable road users who have a higher risk of injury and death compared to those driving other motor vehicles (e.g. cars, trucks) due to less protection, making them vulnerable at even relatively low velocity collisions (62) According to Department for Transport (2017) (63), globally motorcyclists were nearly 50 times more likely to experience a RTI, and per kilometre of road travelled, were between nine and 35 times more likely to die in road crashes compared to car drivers. In Malaysia, a Middle Income Country (MIC) it is estimated that motorcycle fatalities were three times higher than car fatalities, six times higher than pedestrian fatalities and about 50 times higher than bus passenger fatalities (62, 92).

Riding a motorcycle is associated with intrinsic challenges, such as the necessity to balance the vehicle, lower friction capacity, and increased sensitivity to environmental perturbation (wind, gravel, poor road maintenance, and road surface damage). An important factor reported as influencing the high crash rate and the severity of injury experienced by motorcyclists is their lower visibility to other vehicle drivers (90). Previous studies have shown that motorcyclists are more likely to experience severe injuries in a night crash or in diminished lighting (3, 62, 93, 94).

2.2.4 The global burden of motorcyclist's crashes and their injuries

The rapid growth globally in the number of motorcycles in recent years has been accompanied by a growth in crashes resulting in fatal and non-fatal injuries. In 2018, 28% of all road deaths worldwide were motorcyclists, a five percent increase since 2015 (72) (1). An international comparison found that countries in Southeast Asia have highest fatality rates from motorcycle crashes per population (43%), followed by countries in Western Pacific (36%) (see Figure 2.2) (1). Specifically, in Southeast Asia motorcycles comprised 70% of all RTIs and 34% of road traffic fatalities (3-6, 9, 72). Motorcyclists comprised between 5% and 18% of all road traffic fatalities in HICs, but comprise a significantly higher proportion in LMICs (e.g. more than 50% in Malaysia (95); 58% in Vietnam (6)) (72).



Source: WHO, 2018

Figure 2.2. Road traffic fatalities by user types and regions

2.2.5 Overview Vietnam and motorcycle injuries in Vietnam

Overview Vietnam

Geographic and demographic information

Vietnam is located in Southeast Asia, and is a MIC. The country borders China to the north, Cambodia to the Southwest, Laos to the west, and Pacific Ocean to the Southeast. It is a long, narrow country with an area of about 331,000 km^2. The major population centres are Ho Chi Minh City and Hanoi (the capital of Vietnam). Geographically, the country has three main zones: Delta, Midland and Highland. Vietnam is in the tropical belt and experiences high temperatures and humidity throughout the year. There are two seasons in the south: dry and wet; and four seasons in the north: spring, warm summer, autumn and cool winter (96).

The population of Vietnam in 2019 was more than 96.7 million, the third highest population in Southeast Asia and ranked 15th in the world. The population density of the whole country is 31people/km^2. The Delta has a population density of 994 people/km2; the Midland 124 people/km2 and Highland 106 people/km2 (96). The country has a market economy following a program of economic "renovation" in 1986 (referred as "*Doimoi*"), resulting in dramatic economic and social changes which lead to the growth in the number of motorcycles. According to the World Bank, Vietnam is the sixth largest market economy in the Southeast Asia (after Indonesia, Thailand, Malaysia, Philippine and Singapore) and 36th largest in the world (64). With an annual Gross Domestic Product (GDP) growth of 5.1% the GDP in Vietnam was $271.16 billion USD in 2020 (97).

Motorised road vehicles

The number of motorised road vehicles has grown rapidly in Vietnam during the past ten years (see Table 2.1). According to the Vietnamese National Transportation Safety Committee (NTSC), the number of registered vehicles dramatically increased from 19,670,689 in 2006 to 50,535,727 in 2016, of which motorcycles accounted for 94.3% of all motor vehicles. Motorcycles are the main mode of transport used for commuting in Vietnam because they are less expensive, use less petrol, are easy to park and less affected by traffic congestion (98).

Vietnam has the highest proportion of motorcycles (94.3%) compared to other Southeast Asia countries. The proportions of motorcycles in other Southeast Asia countries are as follows: Cambodia 84%; Indonesia 82%; the Lao People's Democratic Republic 77.8%; Thailand 59%; the Philippines 55%; Malaysia 46%; and Singapore 14.8%. A population-based survey in Vietnam found that 75% of the population over the age of 14 regularly used a motorcycle as a rider or passenger (5).

Table 2.1. Motorised road vehicles in Vietnam, 2006-2016

Year	**No. of cars registered**	**Increase rate /year**	**No. of motorcycles/mopeds registered**	**Increase rate /year**	**Total vehicles**
2006	972,912	9.18	18,615,960	15.72	19,670,689
2007	1,106,617	13.74	21,721,282	16.68	22,961,618
2008	1,361,654	23.05	25,481,039	17.31	27,097,735
2009	1,535, 987	12.80	28,431,079	11.58	30,141,421
2010	1,713,908	11.58	31,452,503	10.63	33,344,344
2011	1,882,972	9.86	33,925,839	7.86	35,977,885
2012	1,992,589	5.82	36,102,943	6.42	37,205,155
2013	2,147,750	7.79	38,643,091	7.04	40,946,010
2014	2,349,667	9.40	41,212,965	6.65	43,764,558
2015	2,663,269	13.35	44,128,822	7.08	47,105,166

2016	3,033,527	13.90	47,131,928	6.87	50,535,727

Source: Department of Traffic Police (10)

Health status and Public health care systems

The health status of the Vietnamese population has improved substantially over the last two decades, with the average life expectancy increasing from 71 years in 1990 to 75.4 years in 2018 (99). Meanwhile, non-communicable disease (NCDs) such as stroke and ischemic heart disease are the leading causes of death in Vietnam (100). Moreover, a rise in the cost of health care for traffic-related injuries has occurred over the last 10 years (101). Hospital-based data found that RTIs were the eighth leading cause of death in Vietnam in 2017 (100).

Public health services in Vietnam are organised in four levels: central (level 1), provincial (level 2), district (level 3) and communal (level 4) (102). There are 47 hospitals at level 1 that are owned by the Ministry of Health. Level 2 consists of 419 hospitals that cover a population of 1-2 million. Level 3 includes 648 hospitals with an average of 100 beds, covering a population of 100,000-200,000. While level 4 is responsible for the provision of primary preventive care such as antenatal, immunisation and child delivery services; primary curative care such as treatment for common symptoms and diseases, provision of first aid and implementation of vertical health programmes, covering a population around 500-10,000. Level 2, 3, and 4 hospitals are owned by local provincial government (102, 103).

Overall rate of road traffic injuries and motorcycle injuries in Vietnam

Vietnam has a disproportionately high burden of RTIs and deaths compared to other countries in the same regions There were approximately 26.4 deaths per 100,000 population compared to 12.7 deaths per 100,000 in Timor-Leste, 18.2 deaths per 100,000 in China, and 23. 6 deaths per 100,000 in Malaysia (1). According to the WHO’s report in 2018, annually there were 8,417 road traffic fatalities and 19,280 RTIs in Vietnam (10, 72). Motorcycles crashes are responsible for 70% of road traffic fatalities and non-fatal injuries in Vietnam (104). They are also the leading cause of mortality among those aged 15 to 49 years (58%) (6).

In response the burden of RTIs among motorcycle users, the Vietnamese Government introduced helmet laws in 2007 aimed at reducing fatalities and injuries related to motorcycles (105). Consequently, serious motorcycle injuries dropped from 253.2 to 125.3 per 100,000 population, fatalities dropped from 22.3 to 15.4 per 100,000 population, and head injuries dropped from 183.4 to 64.7 per 100,000 population (56). It is estimated that more than 1,500 lives have been saved and 2,500 serious head injuries prevented annually since the introduction of these helmet laws (106).

Impact of RTIs in Vietnam

RTIs have substantial economic impact in terms of the individual, the household and the national economy. It is estimated that RTIs cost at least 2% of gross domestic product (GDP) (10) (72, 107). A study on the economic burden of unintentional injuries in one province (Bavi) of Vietnam found that the total cost of RTIs over one year was estimated to be 3,412,539,000 VND (US$235,347), in which 90% of the treatment costs were paid for by individuals and their families, 8% by the government and 2% by health insurance agencies (108). Another study on economic impact of RTIs in Vietnam found that a hospitalisation related to a RTI cost approximately US$420 on average, which is equivalent to six months salary for Vietnamese workers (58). In terms of impoverishment, 30.8% of patients and their families were pushed below the national poverty line due to these injuries (109).

2.3 Risk factors for motorcyclist's crashes and their severity

This section discusses the most frequent risk factors contributing to motorcycle crashes in the traditional interaction between three basic components of the traffic system: (1) human factors; (2) road environment factors; and (3) vehicle factors.

2.3.1 Human factors

Road safety research indicates that the human factors are predominant in motorcycle crashes, contributing to 50% of motorcycle crashes (3, 91, 110).

This section presents human factors (riders and other road users) and some countermeasures aimed at addressing human factors in particular.

Helmet wearing

Motorcycle helmets have been the principal countermeasure for preventing or reducing fatalities and injuries in motorcycle crashes (111). Therefore, helmet use has increased in most countries. For example, in the United States, helmet use increased from 54.3% in 2010 to 70.8% in 2019 among motorcyclists. In Vietnam, the prevalence of helmet use also increased from around 30% in 2011 up to 90-99% in 2017 (5, 112).

The safety benefits of protective helmets have been well documented with their use associated with a risk reduction of fatal injury and severe traumatic brain injuries by 40% and 70%, respectively (72, 113, 114). After adjusting for age, crash characteristics, crash type, posted speed limits, and environmental factors, non-helmeted motorcycle riders odds of traumatic brain injuries and fatal injury compared with helmeted motorcycle riders was 2.4 to 4.7 times greater (115-118). Studies in Vietnam have shown the effectiveness of helmet use by a reduction of the risk of fatalities and non-fatal injuries. In particular, wearing a motorcycle helmet reduced by 16% the risk of a fatality and 18% non-fatal injuries (56, 119).

While there is overwhelming evidence that wearing a helmet protects a motorcyclist from the risk of death and severe head injuries, the use of non-standard motorcycle helmets and incorrect use of helmets is an issue in many LMICs (72, 120). Studies on the quality of motorcycle helmets in nine LMICs indicated that 54% of motorcyclists wore non-standard helmets. In Vietnam, approximately99% of motorcycle users currently wear a helmet during travel (106) however, only 4.4% of these helmets comply with helmet standards (121)(120). Li et al. (122) found that 34% of motorcycle riders and 71% of passengers in LMICs did not have their helmet fastened while riding. Reason for this included the helmet being uncomfortable or an assault on their hairdos. This has been reported as the reason for nearly one-fourth of helmets coming off during crashes in Thailand (123).

Alcohol use and other drugs

Alcohol and drug use are frequently identified in motor vehicle crashes and they have also been shown to play an important role in a motorcycle crash (124, 125). In addition, drivers with blood alcohol concentrations (BAC) of between 0.02g/dl and 0.05g/dl have a three times greater risk of dying in a vehicle crash and those with a BAC between 0.05g/dl and 0.08g/dl are at a six times greater risk (1). In addition, several international studies have shown that riders with a high BAC have an increased probability of other risk taking behaviours, such as speeding or not wearing a helmet (1, 126-128).

The BAC of motorcyclists impacts balance, motor coordination, and judgment more than that of a motor vehicle driver because of the need for greater skills to operate the inherently unstable vehicle (3). On average, motorcycle riders involved in fatal crashes have a higher BAC than those involved in injury crashes (126) (129). Between 13% and 75% of motorcycle rider fatalities were detected having a BAC (130). Alcohol-related motorcycle crashes involve young men more frequently (131), occur at night-time, during the weekend, and are often combined with high speed (126-128).

Road traffic crashes involving alcohol in Vietnam predominantly involve males(36.2%) and females (0.7%) to a much lesser extent (10). A study by WHO indicated that among 18,412 hospitalised traffic crash victims, 36% of motorcyclists had a BAC exceeding 50mg/l, while the largest surgical centre in Vietnam (Viet Duc hospital) reported that more than 50% of 600 traffic crashes resulting in hospitalisation involved alcohol (10).

Similar to alcohol, drug use is a risk factor for road traffic crashes due to the resulting driving impairment (132). However, the effect of drugs on motorcycle crashes has received less attention than alcohol (130). Very few studies have examined the relationship between drug use and motorcycle crashes. Studies have shown that between 5% and 30% of motorcycle riders are under the influence of drugs (3, 133-135). Drug prevalence has been found to be the highest among riders who were not wearing a helmet, aged between 25 and 34 years, and crashed during the weekend (133, 136, 137).

Inexperience and licences

The association between less driving experience and higher risk of motorcycle crashes and injuries has been well examined, with the first study undertaken more than 50 years ago in the United Kingdom (138). This study found that motorcyclists with less than 6 months experience were twice as likely to be involved in a crash (138). A more recent study examined four populations of motorcyclists in terms of experience: professional riders (e.g., policemen); experienced riders; and young and novice riders. The study assessed cognitive abilities in both hazard detection and situational criticality and analysed the finding by stratifying the level of experience. The results showed that professional and experienced riders were better at hazard detection than novice and young riders. Further, the latter underestimated the situational risk and seemed overconfident in their abilities to manage the risk.

Increased crash and fatal risk were often found among those who did not hold a valid driving licence (110, 139, 140). For example, a study in Taiwan indicated that motorcycle riders with suspended licences had the highest fatality rates (236 fatal injuries per 10,000 crashes each), followed by unlicenced motorcycle riders (143 per 10,000 crashes) and licenced riders (53 per 10,000 crashes) (140). The National Highway Traffic Safety Administration (NHTSA) (2017) (63) reported that in 2015, 27% of motorcycle riders without valid motorcycle licences involved in fatal crashes compared with only 13% of motor vehicle drivers.

Excessive and inappropriate riding speed

Excessive and inappropriate speed is a known risk factor for motorcycle crashes, and serious injuries (3, 90, 141, 142). Research has indicated that riding at a high speed leads to a reduction in the drivers' ability to respond when necessary due to lack of time to react.. Moreover, energy increases quadratically with respect to speed, therefore, the risk of fatalities increased exponentially with increasing speed (143, 144). A study on 89 fatal crashes found that 16.7% occurred at 0-20 mph, 21.3% at 21-30, 37.1% at 31-40 mph, and 24.9% at 41 mph or more (141). WHO cited a study that found that for every 1% increase in mean speed, there was an increase of 4% in fatal crash risk and a 3% increase in serious crash risk (145), while a 5% reduction in average speed decreased the number of fatalities by 30% (1).

The Motorcycle Accident In-Depth Study (146) of 523 motorcycle and 398 moped crashes was conducted between 1999 and 2000 in France, Germany, the Netherlands, Spain, and Italy. The study found that injury severity based on MAIS (maximum injury severity) level 3 (seriously injured) increased with crash speed as follows: 13% at less than 30 km/h; 24% at 31–50 km/h; 45% at 51–60 km/h; and 50% at more than 60 km/h.

Mobile phone use

The use of mobile phones can adversely affect driver behaviour through distraction, which can lead to the increased risk of crash occurrence with serious consequences (147, 148). Mobile phone use can result in visual; auditory; physical; and cognitive distraction. A meta-analysis of the impact of mobile phone use on driver performance reported an effect on maintaining correct lane position; maintaining an appropriate speed; and judging and accepting safe gaps in the traffic (148). Furthermore, it has been reported that distracted driving resulting from the use of mobile phones can increase the risk of being involved in a road traffic crash by as much as 4 times (149).

A recent systematic review of 60 studies publishing from 1994 to 2013 indicated that using a mobile phone while driving had a nine time increased risk of fatality, and using a hands-free mobile phone while driving was not found to provide greater safety as compared to the use of hand-held mobile phones while driving (147). A population-based study of 15,000 drivers in Finland found that 13.7% of participants had an accident or close call situation, in which the mobile phone had a partial effect (150). Younger male drivers who use mobile phones while driving, have a significantly higher rate of involvement in road crashes when compared to older drivers and female drivers (151) (152).

Although most of the research investigating the relationship between using a mobile phone and RTI has been explored primarily among drivers of 4-wheeled vehicles, the role of mobile phone use in motorcycle crashes is becoming an increasing concern (72). For example, a study by Perez-Nunez (153) in Mexico found that 64% of motorcyclists use mobile phones while riding (154). A recent survey of 549 motorcycle taxi drivers in Vietnam reported that approximately 95.3% of motorcycle taxi used a mobile phone on the road and approximately 32.3% of them have been involved in a crash related mobile phone use (155). Another survey undertaken in 2016 reported that the prevalence of mobile phone use among motorcyclists in Vietnam was 9% (156).

Recent research has showed that different types of mobile phone use while riding a motorcycle was associated with the likelihood of crashes and injuries. In particular, texting or searching for information while riding a motorcycle increased the likelihood of crash involvement, whilst calling while riding a motorcycle doubled the likelihood of being injured in a crash (157). Therefore, it would be important to consider the specific type of mobile phone use while riding a motorcycle. Furthermore, mobile phone use while riding a motorcycle was associated with other risky riding behaviours e.g. reckless and drink riding (158). A coordinated and intensive approach to enforcement may help to contribute to reducing the prevalence of risky mobile phone behaviour whilst riding a motorcycle.

Age

The relationship between age and RTIs is complex. Younger riders may participate in riskier behaviours and combined with a lack of experience can lead to an increased crash risk (159), while older riders may have a higher risk of severe injuries in a crash due to their physical fragility (3, 110, 160). This highlights the need for comprehensive targeted policies and strict legislation to tackle road safety. Countermeasures such as licence restrictions or harsher penalty for younger or older drivers may reduce RTIs. Moreover, institution-based (school, college and workplace) and family-based interventions could focus on promoting road safety awareness and the implications of road traffic crashes. Studies have shown that the number of road traffic fatalities among the 40 to 60 year old riders increased significantly during the last decade, mainly due to a significant increase in the number of motorcycle riders in this age group (161). Research has found motorcycle riders over 60 years of age have increased crash and fatality risks (3, 162, 163). This can be explained by a decrease in their ability and riding performance and difficulty in managing complex riding situations (164).

2.3.2 Road and Environmental factors

Motorcycle riders are more sensitive to road design and maintenance than car drivers (62). Therefore, road infrastructure is a particularly important factor in crashes and motorcycle fatal and serious injury (165). According to the Motorcycle Accidents In Depth Study (MAIDS) (91) the road and its environment were a primary cause in 8% of all motorcycle crashes. Some factors of road infrastructure and its environment has been linked to motorcycle crashes, injuries and fatalities are described below.

Road surface quality

Bad road surface quality is a risk factor for motorcycle crashes because motorcycle riders are more sensitive to roadway surface conditions. Elements of the road surface such as drainage grates, manhole covers, holes in the road and tram rails have been identified as risk factors for motorcycles because of their effect on riders' movement, leading to loss of stability (91). Studies in Europe indicated that the road environment increased the injury severity (166).

Weather condition

Motorcycle riders are directly influenced by weather conditions because they are lack of protection. Studies in Europe, Australia, and the United States suggest that adverse weather condition such as high temperatures, rain, or wind account for approximately one in ten of motorcycle crashes (91, 165). Interestingly, increased motorcycle crashes, injuries, and fatalities were strongly associated with sunny weather (160).

Conspicuity

Studies have found that poor visibility and darkness are associated with great motorcycle injury severity, because of the motorcyclists' ability to see and be seen (165). Conspicuity has two aspects: the visibility of the motorcycle itself; and the ability of rider of the motorcycle to see. Interventions to improve the conspicuity of the motorcycle include daytime headlight laws and clothing that increases conspicuity, including reflective vests and other high visibility clothing.

Curves and intersections

Road curves and intersections are factors for higher crash risk because of their strong impact on the ability to control the trajectory of a motorcycle. According to Association of European Motorcycle Manufactures ACEM (2006), approximately 30% of motorcycle crashes occurred on a curve, compared to 21% of motor vehicle crashes, while about one third of fatal motorcycle crashes occur at an intersection, compared to only 14% for cars (90). Motorcycle crashes at an intersection are more likely to increase the injury severity (125, 167) because road signs or other roadside furniture near intersections can significantly reduce visibility and make it more difficult to detect road users coming from other directions (91). Therefore, it is important to remove obstacles such as signs or vegetation that potentially obstruct other road users from seeing motorcycles, in particular in the vicinity of intersections or within curves. Intersection and roundabout design should have good sight lines and approach angles of between 30 and 40 degrees (168).

2.3.3 Vector/ vehicle factors

Tyre and brake defects are the most common vehicle factor contributing to motorcycle crashes, accounting for 12% of motorcycle crashes (81, 91). Motorcycle characteristics and engine size can also contribute to a motorcycle crash. However, these factors do not cause crashes in themselves; they are often associated with other factors such as the riders' age, experience, sex and kilometres travelled (110).

2.4 Interventions to improve motorcyclists' road safety

The section discusses countermeasures targeting human behaviour, including education, training, licensing, and enforcement legislation on key risk factors in-term of international and Vietnam context.

2.4.1 Education, training and licensing

Education and training are important components of a multi-strategy approach to influence behaviour change. For example, voluntary rider training and education programs (called pre-licensing training and education) aimed at enhancing the risk awareness skills of new motorcycle riders have been implemented in HICs such as Canada, United States and Europe (90). A licensing system is a national or a state system that consists of different conditions for new riders that must be fulfilled in order to obtain a licence. Requirements for obtaining a driving licence consist of age, medical status, theoretical knowledge and practical skills. There are also requirements for keeping the driving licence which varies as a person learns such as alcohol level, speed at which they can travel, who can be in the motor vehicle, capacity of the vehicle.As previously mentioned, motorcycle riders are more vulnerable to environmental factors compared to other motor vehicles. Therefore, people who want to ride a motorcycle are required to achieve specific competencies (e.g., tactical and operational choices).

2.4.2 Enforcement legislation

Enacting and enforcing legislation on five key risk factors including speed; drinking-driving; seat-belt; motorcycle helmet use; and child restraint systems are key components of an integrated strategy to prevent road traffic fatalities (1). Research has indicated that improved legislation and enhanced enforcement has led to lower RTI rates (169, 170). Although legislation on these five key risk factors has been enacted in most countries, enforcement remains a major challenge (1). Currently, 123 out of 180 countries have national laws that address the key risk factors but only five countries have laws meeting best practice for these key risk factors; 20 countries have laws that meet best practice for four risk factors; 22 have laws meeting best practice for three risk factors; 31 have laws meeting best practice for two risk factors; and 45 countries have laws meeting best practice for one risk factor (1). Best practice criteria were used to assess key risk factors based on a WHO' report (1).

2.4.3 Managing speed

Reducing the speed on urban and non-urban roads by motorcycle users is a priority in all countries (171). Currently, 169 countries have national speed limit laws; however, only 46 meet three best practice criteria) (1).

Three best practice criteria (1)

- Presence of a national speed limit law;
- Urban speed limits not exceeding 50km/h; and
- Local authorities having the power to modify speed limits.

Although enforcement legislation plays an important role in ensuring compliance with speed limits, it remains a major challenge in most LMICs due to the lack of resources. According to a WHO report, only 13% of LICs and 35% of Middle-Income Countries (MICs) present the best practice laws in comparison with 50% of HICs (1). To improve the compliance of all road users with traffic rules and increase safety levels, police enforcement is crucial (172). A combination of traditional (on-the spot roadside checks by police) and automated enforcement (red light, fixed camera and mobile in –vehicle fitted devices) can increase the probability of detecting violations (173).

A study by Christie et al., (2003), demonstrated a 63% decrease in injury crashes involving motorcyclists after setting up a network of 101 mobile speed cameras (mostly on roads where the speed limit was 30 mph) in Wales, in the United Kingdom. A systematic review by Vecino-Ortiz (2008) (169) showed that speed enforcement saved more than 80,000 lives annually in LMICs.

Despite the necessity and effectiveness of traditional and automated enforcement methods for all motorised vehicle users, these methods are more challenging for motorcycle users. For example, it can be difficult to catch and stop motorcyclists when an offence is detected by traditional enforcement. Furthermore, automatic enforcement such as photographic enforcement is more difficult to detect motorcyclists because the identity of the rider is hard to establish. Therefore, police officers need to be well trained to detect dangerous manoeuvers and equipped to interrupt the riders quickly and safely (172) (174).

2.4.4 Managing speed regulations in Vietnam

Vietnam has speed limit legislation that meets one of the best practice criteria with enforcement methods being both manual and automated (10).

Speed regulation is shown in Table 2.2, according to Circular No.91/2015/TT-BGTVT dated 31 December 2015, effecting on 1 March 2016 (175).

Table 2.2. Maximum speed of road vehicles in Vietnam

Type of vehicle	**Populated areas**	**Maximum speed (km/h)**	
All road vehicles excluding specialised vehicles, mopeds and similar	Inside densely populated areas	60 km/h apply for two-way roads (with central reservations); one-way roads with at least two lanes	50 km/h apply for two-way roads (without central reservations); one-way roads with at least one lane
Buses, trailers, semi-trailers, specialized	Outside of densely polluted areas	70km/h	60km/h

vehicles, motorcycles	

Source: The Ministry of Transportation and Communications (175)

Fines for speeding violations in Vietnam are shown in Table 2.3.

According to Decree No. 46/2016/ND-CP dated 26 May 2016, fines for speeding violations as follows:

Table 2.3. Fine for speed violation in Vietnam

Violations	**Fines**	**Additional penalties**
From 5km/h up to 10km/h	VND* 600,000-800,000	
From 10km/h up to 20km/h	VND* 200,000-3,000,000	
From 20km/h up to 35km/h	VND* 5,000,000-6,000,000	Suspension of driving licence for 1-3 months
Over 35km/h	VND* 7,000,000-8,000,000	Suspension of driving licence for 2-4 months

*Source: The Ministry of Transportation and Communications (175) * VND – Vietnam Dong*

2.4.5 Drink-driving

Research has found that reducing BAC from 0.1g/dl to 0.08g/dl may result in a reduction of 5-16% of alcohol-related road traffic crashes, injuries and fatalities (176). In addition, drivers with BAC between 0.05 and 0.08g/dl are at 7 to 21 times increased risk of being involved in a fatal crash compared to drivers with BACs of 0.00 (177). Motorcyclists who consume lower amounts of alcohol are still more likely to be involved in a crash than car drivers (127, 178).

While nearly all of countries have national drink-driving laws, only 45 countries representing 2.3 billion people have drink-driving laws that align with best practice. More HICs (58%) have laws that meet best practice criteria for drink-driving than MICs and LICs (40% and 2%, respectively) (1)

The three best practice criteria for assessment of drinking-driving law are: (1)

- Presence of a national drink-driving law;
- BAC limit for the general population not exceeding 0.005g/dl; and

- BAC limit for young and novice drivers not exceeding 0.02g/dl.

Although most countries have BAC limits, enforcement of these limits is still a challenge. Widespread and random breath testing (RBT) are very effective strategies in reducing the prevalence of drink-driving by road users. However, most RBT tests are conducted at the time of day when riders often drink. At night, and particularly on weekends (90). Therefore, RBT tests should conducted frequently at night-time and on the weekends.

2.4.6 Drink-driving regulations in Vietnam

The first drink-driving legislation on BAC limits in Vietnam was introduced in 2001. The law prohibited "driving motorcycles or mopeds with BAC exceeding 50 mg/100 ml of blood, or 0.25 mg/l of breath". Despite the introduction of the legislation difficulties in testing equipment, alcohol breath analysers, led to the legislation not being fully implemented. The Government issued Decree No 46/2016/ND-CP dated 26 May 2016 (179), outlining that the fines given to motorcycle riders operating motorcycle under influence of alcohol are as follows (Table 2.4):

Table 2.4. Alcohol content and respective fine levels for motorcycles in Vietnam

Level of fine for motorcycles and mopeds (including electric motorcycles)	Alcohol content	Fine	Additional penalties	Notes
1	BAC exceeds 50-80mg per 100ml of blood, or BAC exceeds 0.25-0.4mg per litre of breath	VND* 1,000,000-2,000,000	Suspension of the driving licence for 1-3 months	
2	BAC exceeds 80mg per 100ml of blood, or BAC exceeds 0.4mg per litre of breath Disobeying the law enforcement officer's order for alcohol or drug testing	VND 3,000,000-4,000,000	Suspension of the driving licence for 3-5months	

*Source: The Ministry of Transportation and Communications (179) *VND – Vietnam Dong*

2.4.7 Helmet wearing

All countries should aim for 100% helmet wearing compliance (1). However, there are 167 countries that currently have mandatory helmet laws for motorcyclists, of which there are only 49 countries, representing 2.7 billion people, which have laws on motorcycle helmet use that align with the best practice.

There are five best practice criteria for motorcycle helmet laws are: (1):

- Presence of national motorcycle helmet law;
- Applies to both drivers and passengers;
- Applies to all road and engine types;
- Specifies that helmets should be fastened; and
- Refers to a standard for helmets.

Globally enforcement of national helmet wearing laws are still weak (1). For example, in the United States, only 19 out of 50 States have a universal helmet law (1). In the other States wearing a helmet is either not compulsory or compulsory for specific segments of the population. In LMICs, helmets may be compulsory but the actual helmet standards may be poor (120, 122). The WHO published a road safety manual on helmet wearing for LMICs' decision makers and practitioners in 2006 (180) in which it recommended that government administrations and motorcycling stakeholders should strongly promote the correct fitting and wearing of certified helmets (1).

2.4.8 Helmet wearing laws in Vietnam

Helmet wearing legislation was introduced to Vietnam in 2000, mandating the wearing helmets for motorcycle riders in specific roadways, including national highways and other assigned routes (181, 182). Then in June 2007, the Vietnamese government released Resolution 32 mandating the wearing of helmets for all motorcycle riders and passengers on all roads from 15 December 2007 (183)

Although helmet wearing laws and their enforcement have contributed to a reduction in road traffic fatalities and head injuries in Vietnam, a number of issues remain (10):

- Wearing the helmets is still low in rural and mountainous regions;
- Use of helmets that do not meet safety standards; and
- Parents are not interested in their children wearing helmets.

2.4.9 Communication campaigns (mass media campaigns)

Communication campaigns are one of the strategies used by WHO and the United Nations (UN) to raise motorcycle riders awareness of injury prevention strategies to reduce RTIs (184). There is limited evidence on the effectiveness of communication campaigns (185) to influence attitudes and behaviours, particularly in regard to increasing enforcement acceptability (186, 187). These communication campaigns aim to promote harmonious car and motorcycle co-existence and safe behaviour by all road users (184, 188) and typically focus on:

- Vulnerability of road users, highlighting common crash scenarios and risks factors (90);
- Risky behavioural factor (189, 190).

2.5 Consequences of motorcycle crashes

2.5.1 Injury patterns following a motorcycle crash

Patterns of injury are usually classified by body region. There are six main body regions that include the head or neck, face, chest, abdominal or pelvic contents, extremities and external (191). Motorcyclists involved in a crash may suffer injury to more than one body region. A study conducted by Fouda (2017)(192) among seriously injured motorcyclists in Egypt showed that 72% sustained injuries to one body region and 28% sustained multi-system trauma .

Traumatic brain injuries are the most frequent cause of death in motorcycle crashes (3, 6, 193-196). Previous research has found that in the United States and Europe, motorcycle deaths due to head injury ranged from 59% to 75% of all motorcycle deaths (197, 198), while this proportion was estimated to be as high as 88% in LMICs (120). Chest, abdominal and multiple body region injuries were the second highest cause of fatality (120, 194, 196). Cervical spinal injuries are also a common cause of motorcycle fatalities (194).

Following non-fatal motorcycle crashes in both HICs and LMICs, lower extremity injuries such as fractures of tibia, patella and the foot were the most common injuries, affecting between 23% and 73% of motorcyclists (91, 193, 199). These injuries can cause permanent disability, and can have economic and social life implications. In addition, musculoskeletal and facial injuries from motorcycle crashes were the second most common injuries (3, 193, 199).

2.5.2 Health outcomes following a motorcycle crash

Motorcycle users are vulnerable road users. They represent an important group to target to reduce road trauma, especially in LMICs where motorcycles are the main mode of transportation. However, most studies on long-term outcome following trauma have focused on injuries to all road users, rather than specifically motorcyclists. There have been no studies investigating changes to health-related quality of life following motorcycle crashes in any LMICs, including Vietnam. The literature search identified only four studies relating to health outcomes following motorcycle crashes. These four studies were undertaken in Australia, USA, and Europe where the type, capacity and purpose of motorcycles are different (3). The details of each study are presented in Table 2.5.

Limitations of outcome studies

Previous research measured shorter follow-up times (6 months) (61) or at one follow-up at 12 months post-injury (42, 60). Finally, sample sizes were small (n=96) (42, 60), which may impact the ability to generalise the findings.

Table 2.5. Long-term outcomes of motorcyclists following a motorcycle crash

Author/year	Article title	State/ Country	Aim	Study design/ Sample size	Variables/ tools	Key findings
Hotz (2008) (60)	Outcome of motorcycle riders at one year post-injury	Florida, (US)	Describe the long-term outcomes of injured motorcyclists, effect of wearing helmet during riding on the long-term outcomes.	Prospective study of 94 participants involved in motorcycle-related accidents. Data collected one year post- injury	- Return to work - Physical deficits, - Pain - Psychological and cognitive problems	45 participants contacted at 1-year post-motorcycle injury, study found that: - 86% (n=39) returned to work. - 51% (n=23) sustained physical deficits. - 22% (n=10)) reported pain issues. - 4% (n=2) had psychological/cognitive problems.
de Rome (2012) (61)	Effectiveness of motorcycle protective clothing: Riders' health outcomes in the 6 months following a crash	Australia Capital Territory, Australia	Determine association between use of protective clothing and subsequent impairment and disability.	212 injured motorcyclists collected at baseline, two and 6 months post-crash.	- Injury severity, and days in hospital, - Functional disability, - Quality of life, - Return to work, and - Residual pain.	- Protected groups had less days in hospital, less pain, less disabilities and reductions in physical function compared to unprotected riders at two months. - Fully recovered and returned to pre-crash work at 6 months post-crash at protected group were higher than unprotected group. - Disabilities and physical function at 6 months post-crash at protected group were not significant difference with unprotected group.
Papadakaki (2018) (42)	Physical, psychological and economic burden of two-	Greece, Italy and Germany	Assess physical, psychological functioning, and economic burden	Power two – wheel users in seven public hospitals.	- Physical and psychological functioning,	Physical disability did not change at 6 and12 months post-injury but statistically significant changes in baseline.

Author/year	Article title	State/ Country	Aim	Study design/ Sample size	Variables/ tools	Key findings
	wheel users after a road traffic injury: Evidence from intensive care units of three European countries		of severely injured two-wheel users.	Participants were interviewed at one, six, and twelve months.	- Depression, -Cost-related injuries.	No statistically significant changes in depression between baseline and 12 months? Or the first and the second follow-up. Hospitalisation costs were estimated at € 19,112 per person. Women, aged 50-64 years, and severe injuries, accounted for higher hospitalisation costs per person.
Forman (2012) (200)	*Injuries among powered two-wheeler users in eight European countries: Descriptive analysis of hospital discharge data*	Bulgaria, Hungary, Netherlands, Norway, Portugal, Slovenia, Spain, and Sweden.	Examine Frequencies and patterns of injury among power two-wheel users. Loss of functional ability at one year post-injury was predicted. The study also found the mechanism of head injuries observed.	Descriptive study of 12,994 injured powered two-wheelers was conducted, using available data from eight countries in European. 7561 non-fatally injured participants was assessed functional limitation at one year post-injury.	Functional capacity Index (FCI).	The three injury types with the largest predicted losses functional capacity score were crush injuries, internal injuries, and amputations. 46.4% of participants were expected to have some functional limitation at one year post-injury. Three body region injuries including spinal cord injuries, traumatic brain injuries, and neck injuries lost the largest average functional capacity score.

Limitations to research motorcycle injuries in Vietnam

There are barriers to road safety research, especially motorcycle injury research in LMICs, such as Vietnam. One of the main barriers is economic resources, with almost half of the world's nations not having systems to capture morbidity and mortality data (72). Collecting the data and trained personnel to evaluate interventions also needs funds. In addition, variations among data collection systems can result in underestimations of the magnitude of RTIs. For example, in Vietnam, between 2000 and 2004, the police reported 13,730 non-fatal RTIs but hospitals recorded only half this number (6,069 cases) of motorcycle injuries during this time (201).

2.5.3 Long-term outcomes following trauma due to road traffic injuries

Improvements in advanced trauma systems has led to an increased likelihood of survival after serious injuries (20). The WHO estimates that over 50 million people suffer non-fatal injuries from road traffic crashes each year, many of whom incur a disability as a result of their injuries (1). This has resulted in a need for greater emphasis on investigating the disabilities associated with injury. The majority of research on the long-term outcomes of RTIs has focused on the consequences of severe injuries. However, minor injuries account for the majority of injuries sustained in road traffic crashes and can have ongoing consequences (24, 202). These non-fatal injuries can lead to substantial personal, social, and economic costs and an increased public health burden (75, 203).

2.6 Health outcomes following RTIs

2.6.1 Health related quality of life following RTIs

Definition of HRQoL

The health-related quality of life (HRQoL) is multi-dimensional and is defined as the physical, social, psychological and emotional functioning of the individual(204). Generally, the definition of HRQoL is classified into two levels: individual and population levels. At the individual level, HRQoL includes self-perceived health function and health status including physical health, mental health, function status, social support and socioeconomic status, while at population level it includes resources, conditions, policies, and practices that influence a population's health perception and functional status (205). Therefore, the assessment of HRQoL following a traumatic injury is recognised as a benchmark in trauma outcome research (2).

Current studies on HRQoL following road traffic injuries

Research to date suggests that those injured in road crashes experience lower HRQoL compared to other injured persons and the general population (21-23, 206).

The findings on changes in HRQoL of road injured adults who were hospitalised vary over time. Several studies found that HRQoL improved between discharge and 12 months post-injury (24-28) while other studies indicated that HRQoL did not change in this period (29, 30). Notably, most studies reported improvement in HRQoL between discharge and six months post-injury (30, 206, 207) (208). More importantly, HRQoL did not return to pre-injury status even the follow-up time up to 3 years post-injury (22). The differences may be due to the type of injury sustained, sample population (eg. people with or without compensation claims) and differences in sample size between studies.

The literature has found a number of factors that predict changes in HRQoL over time, including age, being female (25, 209), type of injury (29), and comorbidities (48, 210). However, the link between injury severity and HRQoL was inconsistent across populations. Tan et al. (2018) (211) examined predictors of change in HRQoL at 6 months and 12 months after severe injury among 478 patients using the Singapore National Trauma Registry data of the period of 2011-2013. This study found that injury severity was not significant predictor of change in HRQoL. In contrast, injury severity has been found as a predictor of poor HRQoL by other studies (22, 212).

Most of studies measuring the long-term outcomes following RTIs were conducted in HICs countries. However, a study of a Thai Cohort Study conducted by Yiengprugsawan and colleagues (2014) (213), investigated quality of life using the Medical Outcome Study Short-Form (MOS SF-8™) Health Survey with 569 Thai students aged 15 to 87 years who experienced RTIs in the last 12 months. This study found that injured participants had a lower score for mental health and physical health than those not injured. Although this was the first study investigating the association between injuries and health in LMICs in Southeast Asian countries, the study population was highly educated which (214), therefore, the findings may not be generalisable.

2.6.2 Pain following road traffic injuries

Definition of pain and measurement

Pain is described as "*an unpleasant sensory and emotional experience beginning with a peripheral stimulus that undergoes a physiological process ultimately resulting in the sensation of pain (p.119)*" (215).

Many scales exist to measure pain but three rating scales predominate in clinical practice and trauma research: the visual analogue scale (VAS); the numeric rating score (NRS); and the verbal rating scale (VRS) (32, 37, 216, 217). All three pain-rating scales have been shown to be valid, reliable and appropriate for measuring pain in trauma population (216, 217) but NRS is considered to be excellent because inter-rater reliability has been reported 100% agreement between two raters (218) and this scales has been used to measured pain among Vietnamese population (219).

Global current studies on pain following road traffic injuries

Acute pain is most common symptom in road traffic trauma patients due to the tissue damage caused by crash (215). Ninety-one percent of non-fatal injuries were experiencing pain on admission, and 86% at discharge (36). Although improved treatment has increased survival rates following trauma, a proportion of survivors may go on to develop chronic pain. Chronic pain is defined as pain that exceeds three or six months duration (215). Acute and chronic pain can lead to varying degrees of dysfunction or disability (216). Chronic pain is present in 45% and up to 63% of patients with RTIs 12 months post hospital discharge, depending on the severity of the injury (31, 33, 36, 220, 221). Longer follow-up studies have shown that chronic pain was present in 44% of patients after three years (222), and 45-80% of patients with severe pelvic fractures after five years (223).

Previous research has identified a number of factors leading to chronic pain after injuries (32, 37, 224). For example, a systematic review by Rosenbloom and colleagues 2013 (32) showed that older age, lower education, eligible for compensation, alcohol consumption prior to trauma, symptoms of anxiety and depression, and fear of pain were associated with chronic pain. The study demonstrated a significant relationship between injury severity and chronic pain. In addition, Wynne-Jones et al. (2006) (224) found that predictors of the onset of pain in individuals following a motor vehicle collision were older age, pre-injury adverse health behaviours and somatic symptoms, post-injury symptom count, and perceived injury severity. Psychological and emotional factors such as fear, anxiety or depression do not cause pain but they have significant association (216).

To date, very few studies have measured pain of those injured in a motorcycle crash. A case study following 45 injured motorcyclists in Florida, United State, found that one in five were experiencing pain 12 months post-injury (60). Another study examining the effectiveness of motorcycle protective clothing on health outcomes following a motorcycle crash in Australia and found that more than 60% motorcyclists who had not worn protective clothing suffered from pain at 2 months and until 6 months post-discharge (61).

2.6.3 Psychological distress following road traffic injuries

Traumatic injuries are a leading cause of psychological distress for all age groups (41, 72). Research has found that people experiencing non-fatal injuries can develop psychological conditions such Acute Stress Disorder (ADS), Post-traumatic Stress Disorder (PTSD) or/ and depression have poorer long-term physical health (225), disability (226), pain (226, 227), as well as reporting reduced daily activities (228). Unfortunately, psychological distress may remain stable from one to three years post-injury (229, 230).

Depression is common in the general population and frequent consequence of injury. It is characterised by a despondent mood, disinterest in general areas of life and continual feelings of loss and helplessness (228). The prevalence of depression has been found to occur in 17.3% to 42% of injury survivors between 3 month and over 12 months after road injury (38, 39, 231). However, depression has not been investigated as frequently as other mental heal issues. For example, a systematic review on mental health outcomes following traumatic injury, that included 41 studies, found that only one study investigated depression (39).

This study was a longitudinal study investigating the severity of depression following traumatic injury of 201 hospitalised patients in a Metropolitan Trauma Centre in Australia. It showed 36.8% of patients had symptoms of depression during the time in the hospital and this rose to 40.2% at three months post-injury and then significantly decreased to 24% at 6 months post-injury (40). In Vietnam, depression is increasingly recognised as a public health issue across all ages, affecting up to 41% of the population (43-45). However, there is no research examining depression following a motorcycle injury in Vietnam.

2.6.4 Return to work following road traffic injuries

Return to work (RTW) after trauma is a frequently used measure for a recovery (232). However, the RTW definition remains elusive (233). It is utilised as both an outcome and a process measure (234). Therefore, RTW outcomes may include a return to the pre-injury job and/or employer; or a new job and/or employer; and work with or without accommodation (235). There is no study on RTW following motorcycle injuries in LMICs; however, studies conducted in HICs have indicated that RTW rates range from 60% (61) to 86% (60), 6 to 12 months post-injury among injured motorcyclists.

There is significant body of literature examining rates and factors associated with RTW among RTIs population. The proportion of RTW at 12 month ranged from 28% (50) to 70% (46) (236) after serious injuries, from 30% to 63% (51, 237) after traumatic brain injuries, and from 42% to 85% for orthopaedic patients (52). RTW among these populations was influenced by being younger, male (238), higher educational level (214, 220), type of injury (239) and injury severity (48, 236, 240).

There is evidence that RTW rates among populations experiencing a RTI improved over time. Gabbe et al. (2016) examined RTW rates among adult major trauma survivors 24 months post-discharge (46). This study found that RTW rates at 12 months were 14% higher compared with 6 months (adjusted RR 1.14, 95% CI: 1.12-1.16) and 8% higher at 24 months compared with 12 months (adjusted RR 1.08, 95% CI: 1.06-1.10). A study by Mackenzie et al. (1998) also found that the cumulative proportions of RTW at 3, 6, 9, and 12 months post-injury was 0.26, 0.49, 0.60 and 0.72 (238).

2.6.5 Functional outcomes following motorcycle injuries

Trauma survivors may suffer from activity limitation, reduced or inability to work or changes in employment (48, 209). Measuring functional outcomes of patients following injuries is important to evaluate the burden to society. To date, there is minimal information about the functional outcomes for injured motorcyclists. One case study that followed-up 45 injured motorcyclists in Florida found that 51% had physical deficits and 44% visited clinics for rehabilitation programs, such as physical therapy, occupational therapy, and speech therapy (60). Another study examining the effectiveness of motorcycle protective clothing on health outcomes following a crash in Australia found that approximately 11% of unprotected riders had "much difficulty" in performance on normal daily activities (61).

However, similarities with functional outcomes following RTIs provide a picture of the overall burden of this injured population. A multicentre study by Haider et al. (2018) (241) examining functional recovery of 1,736 trauma survivors from three level one centres in America. They found that more than half of these patients (62%) suffered physical limitations and most of them needed support for at least one activity. This study reported functional outcomes were influenced by socio-demographic factors such as education and sex. Gabbe et al. (2016) (46) described functional recovery of major trauma patients in Victoria, Australia over 24 months post-injury. This study found that functional outcomes at 12 months were better than 6 months (adjusted OR: 1.27, 95% CI: 1.06-1.10), and 24 months was better than 12 months (adjusted OR: 1.09, 95% CI: 1.02-1.17). However, ongoing disability was common at 24 months (only 23% of 8128 participants had achieved a good function at 24 months).

Although motorcycle injuries are a public health issue in Vietnam and other LMICs, there are currently no investigations on functional outcomes and return to work of motorcycle-related in such countries.

Summary and conclusion

RTIs are a significant public health issue in LMICs, particularly in Vietnam. Risk factors for motorcycle crashes in HICs include being male, speed, not having a motorcycle licence, and drinking alcohol but there is limited evidence on risk factors in LMICs. Moreover, although the long-term impact of general RTIs has been extensively studied including health-related quality of life, physical outcomes (e.g. pain), psychological outcomes (e.g. post-traumatic stress disorder, depression, anxiety), and social outcomes (e.g. return to work), there are limited published studies on long-term health outcomes among injured motorcyclists involving in a motorcycle crash, especially in LMICs and in Vietnam where they have the highest rates of motorcycle crashes. Therefore, in order to understand the overall burden of injuries as well as improve the health outcomes of motorcyclists who are hospitalised as a result of motorcycle crash in LIMCs and Vietnam, it is essential to conduct prospective studies.

Chapter 3. Methodology

This chapter summarises the research methods used in the study including the study design, study setting, recruitment criteria, sample size, data collection, instruments, statistical analysis and ethical considerations.

3.1 Study Design:

The study was a prospective longitudinal design which examined the characteristics, risk factors and changes in long-term outcomes of 350 injured patients due to a motorcycle crashes in Ho Chi Minh City (HCMC), Vietnam. Outcomes were measured at three time points: while in hospital (or one week after discharge); and at 6 months; and 12 months post-hospital discharge.

3.2 Study setting

Figure 3.1. The map of Vietnam

The study was undertaken in HCMC, Vietnam. Vietnam is a developing country located in Southeast Asia. It has a population of more than 93 million people as of 2015 and a total land area of 331,000 km^2 (96). HCMC is the largest city and the economic capital of Vietnam (see Figure 3.1). It is subdivided into 19 urban districts and five suburban districts. The city area comprises approximately 2,095 square kilometres with a population of 8.4 million in 2017 resulting in a population density of 4,500 persons per square kilometres (96).

Operational Definitions:

Motorcycles were defined as all types of power two-wheeled motorised vehicles including scooters and single- and multiple-cylinder motorcycles (10).

Motorcycle rider was defined as a person who rode a motorcycle as an operator on a public road.

A commuter motorcyclist was defined as a motor cycle rider who regularly commuted to and from work (at least three days a week) or used a motorcycle for conducting daily errands (242).

Resident of Ho Chi Minh City (HCMC) was defined as a person residing in HCMC for at least 6 months prior to the hospital admission for an injury due to a motorcycle crash and who continued to live in HCMC after hospital discharge.

The time of a crash was classified into four groups in accordance with the time of day, namely, early morning (1:00 AM to 5:00 AM), the morning (5:01 AM to 12:00 AM), the afternoon (12:01 PM to 6:00 PM) and evening/ at night (6:01 PM to 12:00 PM)

The weather variable was assigned into two categories: dry and wet conditions based on HCMC's weather (243)

Motorcyclist's licence: A licence is mandatory for all riders aged from 16 years of motorcycles with a capacity of more than 50cc to less than 175cc (Pursuant to Circular No. 12/2017/TT-BGTVT of the Ministry of Transport dated 15 April 2017 (244), this Circular shall be of full force and effect as from 1st June 2017, replacing Circular 58/2015/TT-BGTVT dated October 20, 2015 of the Minister of Transport of Vietnam, 2015).

There are four levels of motorcycle licences available in Vietnam: A1, A2, A3 and A4

- Level A1 is issued to riders of motorcycles with capacity of more than 50cc to less than 175cc or disabled persons riding a powered three-wheeler
- Level A2 is issued to riders of motorcycles with capacity of more than 175cc and vehicles prescribed for the A1 rider's licence
- Level A3 is issued to riders of three-wheeled motorcycles, including tricycles, cyclo-machines and vehicles prescribed for the A1 rider's licence
- Level A4 is issued to riders who drive tractors up to 1,000kg

In this study, motorcycle licences were classified into two groups: i) Level A1 and ii) others types levels (A2, A3 A4)

3.3 Prospective longitudinal motorcycle crash study

3.3.1 Study design

This prospective longitudinal study was undertaken at Gia Dinh Hospital located in HCMC between June 2017 and January 2018. All the participants were assessed at three time points:

1. At the time of the hospital admission due to a motorcycle crash or one week after discharge
2. At 6 months post-motorcycle injury
3. At 12 months post-motorcycle injury.

3.3.2 Study sample

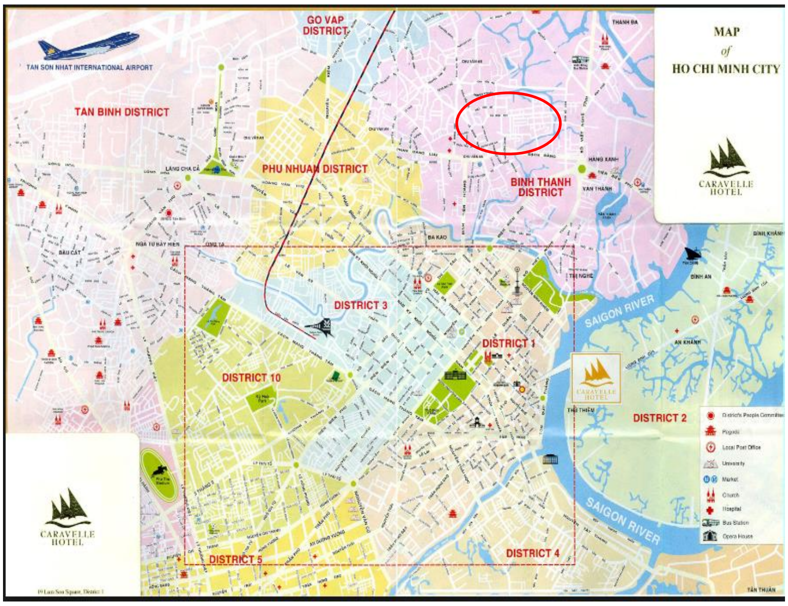


Figure 3.2. The map of Binh Thanh district

The target population of this study was HCMC riders who were injured in a motorcycle crash. For this study, the population sampled was patients who were admitted to Gia Dinh Hospital, HCMC in Vietnam. Eligible participants, aged 18 years and older, were identified through the hospital emergency department (ED). The researcher identified prospective participants daily from the ED admission list, which provided detailed information of all patients who were admitted to the hospital in the last 24 hours due to a motorcycle crash. The information on the admission list included the participants name, age, sex, address, telephone number, time of admission and the department they were admitted to.

The Gia Dinh Hospital is located in Binh Thanh district of HCMC and is one of the largest trauma and orthopaedic hospitals in southern Vietnam. This tertiary hospital belongs to the Health Service of HCMC. This large-scale hospital has 1,500 beds, serves about 1,500 inpatients daily, with more than 4,000 patients visiting the hospital on a daily basis and more than 300 emergency patients of which nearly one-third are traffic related injuries (245).

The hospital treats people living in other districts of HCMC, including Go Vap, Phu Nhuan districts, part of District I and the outlying districts of Thu Duc district, District 2, 9, 12. In addition, the hospital also treats patients from neighbouring provinces such as Dong Nai. Binh Duong, Vung Tau and some central provinces (see Figure 3.2).

3.3.3 Recruitment criteria

Inclusion criteria stipulated that potential participants were:

- A commuter motorcyclist involved in a motorcycle crash.
- Aged 18 years and over.
- A resident of HCMC.

Exclusion criteria for potential participants were:

- Cognitive impairment due to the crash (determined by a physician).
- Severe physical condition (e.g., stroke, paralysis).
- Not able to provide informed consent.
- Unable to remember the events of the crash.
- Referral to another hospital.
- Does not speak Vietnamese.
- The researcher unable to approach the patient at the hospital and at home (asleep when visited at the hospital and telephone calls not answered after discharge).

3.3.4 Sample size

A sample of 350 participants was recruited into the study at baseline. This provided the necessary power to detect significant changes/differences over the three assessments and allowed for an attrition rate of approximately 50%. The sample size was based on the study by Roset et al. (1999) (246) who observed that a sample size of 176 was sufficient to detect a 5.2 point change in the visual analogue scale (VAS) component of EQ-5D and a 0.05 point change in the EQ-5D index, with 80% power at alpha 0.05. The larger sample size of 350 in this new study ensured that even smaller changes in EQ-5D could be detected with the 80% power, allowing for attrition.

These calculations were also based on information provided by clinicians at Gia Dinh hospital. Records showed that approximately 2,500 patients were admitted to the ED due to a motorcycle crash annually. It was anticipated that 50% of patients would satisfy the inclusion criteria, with an anticipated response rate of 60% and an anticipated loss to follow-up of 52%. These assumptions were based on communication with physicians from Gia Dinh hospital and previous studies (55, 60). It was estimated that it would take approximately one year to recruit the final sample of 350 participants.

In order to complete the recruitment of 350 participants within one year, recruitment was undertaken five days a week (Monday to Friday from 7am to 5:30pm) by the researcher. However, during the weekend (Friday night to Sunday night) the names and contact details of eligible participants were collected by the hospital nursing staff. On Monday, the researcher called all discharged patients and followed up on those who remained in hospital.

3.3.5 Data collection:

Information was collected at baseline while the participants were in the hospital or within one-week post-discharge, at 6 months post-discharge and 12 months post-discharge.

Eligible participants were consecutively recruited from 1st June 2017 to 31th January 2018 at the Gia Dinh Hospital. Recruitment occurred over an 8 month period so that collected data represented the wet and dry seasons of HCMC. HCMC has two seasons: dry (November to April) and over wet (May to October) (243).

After obtaining the patients' basic information that included name, age, sex and the hospital department where they were admitted from the admissions list at the ED, the researcher would visit the patient, after obtaining permission from medical staff. The patients were approached and asked to confirm whether they had been involved in a motorcycle crash. If the patients were injured by motorcycle crash, the researcher explained the study procedures and invited them to participate. The researcher interviewed the participant in-hospital or within one-week post-discharge and at 6 months and 12 months post-discharge.

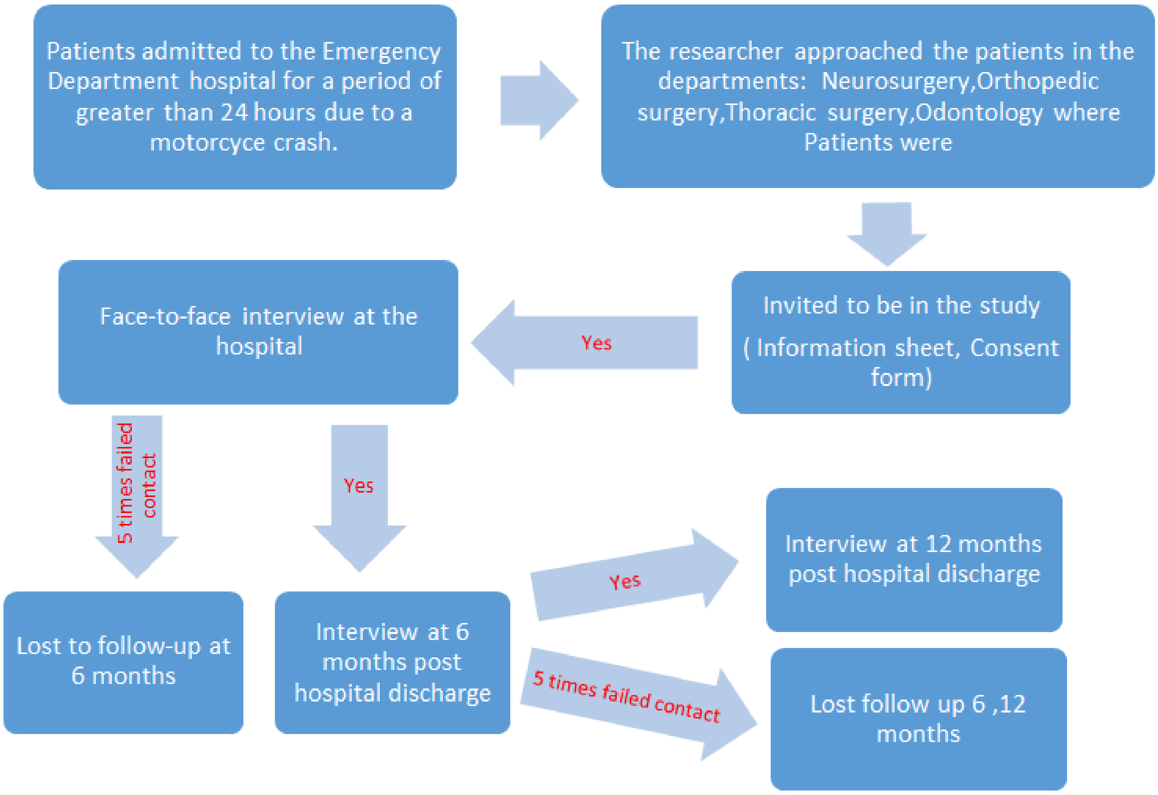


Figure 3.3. Flowchart of data collection

Baseline data collection

The baseline data collection included a review of each participant's medical records and participant interview. The review of medical records and interview were only conducted when the physicians considered the patient medically fit to provide informed consent (see Appendix H). Once approved by the physician, potential participants were provided with a Participant Information sheet (see Appendix G) which included the purpose of the study, what the study would involve, that participation in the study was voluntary, they could withdraw at any time and all information would remain confidential. Potential participants were also informed that they needed to provide informed consent so that the researcher could review their medical records and collect information. All participants were asked to provide their contact details (mailing address, mobile-phone number) and their next of kin's telephone number (who living with participants) to enable follow-up at 6 months and 12 months post-discharge.

Patients who agreed to participate in the study were provided with a study identification number (ID). This number was recorded in a participant identification coding sheet together with patient participant identification number (admission number from medical record) assigned by the researcher. The study participant ID and patient ID were printed on the top of the questionnaire but there was no identifiable information, such as name, telephone number, and email or house address on the questionnaire. The participant identification coding list with participant ID and patient ID were stored separately from the name and telephone number of participants. This list was stored on a secure server at the University of Medicine and Pharmacy at HCMC. Only the main researcher had access to the identifying information.

The researcher-administered baseline questionnaire took approximately 25 minutes to complete. Reviewing medical record took approximately 30 minutes for each participant (see Appendix D).

Six months and twelve months follow-up data collection

The follow-up data collection occurred at 6 and12 months post-discharge either by a telephone or a face-to-face interview, depending on the participant's preference. The researcher contacted the participants or their relatives by telephone to remind and re-explain the study and the purpose of the interview. If the patients or their relatives could not be contacted after five attempts over two weeks they were considered to be lost to follow up (see Figure 3.3).

3.3.6 Questionnaires and instruments:

Baseline assessment

The following information was collected at the baseline by the researcher.

Socio-demographic characteristics: age, sex, education, occupation and marital status.

Information obtained from medical records consisted of injury details, blood alcohol concentration, height and weight.

Crash details: included crash time, date, admission status (direct, transfer, unclear), place of crash, type of crash, and behavioural factors (the blood alcohol concentration (BAC), mobile phone use, helmet type, helmet use, how often wear helmet, the speed at crash, speed limit, motorcycle licence), and nature of the crash (weather, riding experience, type of motorcycle, familiar with route)

Injury details: included type of injury; injury severity (ISS); length of stay in the hospital (LoS); and co-morbidities.

The injury severity was determined based on the **Injury Severity Score** (**ISS**). The ISS was calculated based upon summing the square of three most severe Abbreviated Injury Scale (AIS) scores from six body regions. Each injury region is assigned a score from 1 (minor), 2 (moderate), 3 (serious), 4 (severe), 5 (critical) and 6 (un-survivable) (247). The areas of body considered in scoring included: head and neck, face, chest, abdomen, extremities, and external structure (wound, burn, integumentary system). ISS ranges from 0 to 75 with the higher score indicating more severe injury (191)

Health outcomes: health-related quality of life using the EQ-5D-5L and the Short Form 12 health Survey version 2 (SF12V2), pain intensity (Numeric Pain Rating Scale), depression and anxiety (CES-D), and functional status (Lawton Instrumental Activities of Daily Living scale).

Health-related quality of life (HRQoL) with the EQ-5D-5L:

The EQ-5D-5L was used to measure participants' HRQoL of day before injury. The EQ-5D-5L provides a description of participants problems by five dimensions namely mobility, self-care, usual activities, pain/comfort and anxiety/distress, and a score for overall self-rated health (Visual Analogue Scale) (25, 248). Each dimension is categorised in five levels of severity (no problems, slight problems, moderate problems, severe problem and extreme problem) which are coded from 0 to 5. The EQ Visual Analogue Scale (EQ-VAS) is used to assess self-rated health by using a 100mm scale with the score ranged from 0 (the worst health you can image) to 100 (the best health you can image). The EQ-5D-5L has been used in various studies measuring HRQoL of trauma patients (25). It has been translated into the Vietnamese language and has been validated and is culturally adapted for use with a Vietnamese population (249, 250). The Cronbach alpha for the EQ-5D-5L has been reported previous studies on Vietnamese population (251, 252).

Health-related quality of life with the Short Form 12 health Survey version 2 (SF-12 v2 referred to as the SF-12 hereafter):

The SF-12 was used to assess the HRQoL of injury participants at four week before injury. The SF-12 is a subset of the Medical Outcome Study 36-item (SF-36) that comprises 12 questions which is reported in two psychometrically based physical component scores (PCS) and mental component scores (MCS). It is used to measure eight dimensions of physical and mental health including general health perceptions (GH), physical functioning (PF), role limitations due to physical health problems (RP), role limitations due to emotional problems (RE), bodily pain (BP), social functioning (SF), mental health (MH) and vitality (VT). Scale scores are transformed into the range from 0 to 100 following the scoring manual. Higher PCS and MCS scores reflect better health status. It has been widely used to measure health status in injured patients and quick to perform over the phone (25, 26, 55). The validity and reliability of this instrument in Vietnamese population were reported from previous studies (253-255).

Pain intensity was assessed by Numeric Pain Rating Scale (NPR). Participants were asked to self-report the level of pain over the past 24 hours from no pain (score=0) to worst pain imaginable (score=10) (256). Inter-rater reliability has been reported to be excellent, with 100% of agreement between two raters scoring the 0 to 10 point (218). Test-retest reliability has also been demonstrated to be accepted in different populations (257, 258) (256, 259). The construct validity was examined by Young (258).The NPR was used to measure pain outcomes of Vietnamese adult patients with orthopaedic surgery and cancer diseases (219, 260). Participants were also asked if they have used any pain medications in the four hours before the interview.

Depression was measured using the Centre for Epidemiological Studies-Depression Scale (CES-D) which has been validated and adapted for use with a Vietnamese population (261, 262). It is a 20-item measure in which participant's rate how often over the past week they have any symptoms associated with depression, such as poor appetite, loneliness, restless sleep and unhappiness. Each item is scored from 0 (rarely/less than 1 day) to 3 (all of the time/ 5-7 days). All items are summed to create the total score ranging from 0 (no symptoms of depression) to 60 (have almost all symptoms of depression), with higher score indicating more severe depression. The cut-off point to determine whether a participant has depression or not is 16, according to Radloff (263). This scale was previously validated by Vietnamese researchers, with Cronbach alpha from 0.85 to 0.9 and factorial and concurrent validity was confirmed. Now the Vietnamese version is also available (262, 264).

Functional status was assessed using the Lawton Instrumental Activities of Daily Living scale (LADL). This instrument is used to measure the functional status of a person at the present time and also changes over time. It includes 8 domains of daily activities such as telephone use, shopping, food preparation, housekeeping, laundry, transportation, responsibility for own medications, and handle finances ability. Scores range from 0 (low function, dependent) to 8 (high function, independent). The validity and reliability of this instrument have been reported by Graf (2008). This scale has been used in Vietnamese population previously (265).

Six months and twelve months follow-up questionnaire

The questionnaires took approximately 20 minutes to complete either by phone or face to face interview. The follow-up questionnaire was the same as that used to collect the data on health outcomes at baseline but information about returning to work was also collected (see Appendix E).

Return to work was assessed by following questions (26) (46):

1. Are you working at the moment?
2. When did you return to work?
3. Do you do have the same role as prior to the crash?
4. What is your occupation at the moment?

3.3.7 Translation and pilot testing of the questionnaires:

The translation process was conducted systematically by performing forward-translation, back-translation, and comparison. First, the questionnaires were translated from English to Vietnamese (forward-translation) by two independent bilingual translators with Vietnamese as their first language. Discrepancies between the two Vietnamese versions were then resolved. The Vietnamese version of the questionnaires was then back-translated into English, without any reference to the original instrument's wording. Subsequently, the original and translated versions of the questionnaires were compared by a bilingual expert and the study investigators. Finally, the questionnaires were revised according to the expert panel's comments and investigators' knowledge and experience.

Pilot testing of the questionnaire was performed on a random sample of 20 injured motorcyclists to test the appropriateness of the questions for a Vietnamese population. Modifications were made accordingly by the researcher.

3.3.8 Statistical analysis

Data were cleaned, checked, entered and analysed using Epidata (266) and Stata version 15.

Descriptive statistics were undertaken to describe the profile of the characteristics of the cohort and risk factors for a motorcycle crash. Means and standard deviation (SD) were used to describe continuous variables such as age, Body Mass Index (BMI), length of stay and the Injury Severity Score (ISS). If such variables had skewed distributions, median and interquartile range (IQR) were used instead of mean values while category variables were presented as percentages.

Inferential statistics were used for:

Assessing differences in key demographic variables between (1) participants who joined the study versus non-participants at baseline; and (2) participants who continued to participate and those lost to follow-up in the study at each time point. Student's (independent) t-tests or Mann-Whitney U-tests, Paired t-test or Wilcoxon tests were undertaken for continuous variables. Chi-square tests (with a Fisher's exact test conducted for counts of less than five) or Mc-Nemar's tests were used for categorical variables.

Examining the changes over the study period in all outcomes of interest. There were two ways to examining such changes of outcomes:

1. Within-group analysis of comparison in the mean difference of HRQoL scores, pain intensity score, functional status score, and depression score with previous time (pre-injury to 6 months; pre-injury to 12 months; 6 months to 12 months)
2. Multilevel analysis comparing changes between groups with unadjusted and adjusted for covariates.

Within-group analysis

Paired t-tests were undertaken to compare changes in depression scores, pain intensity scores, and Lawton ADL (LADL) scores with previous times (baseline vs 6 months; baseline vs 12 months; 6 vs 12 months). Non-parametric testes were used where appropriate. If the MCS and PCS data were skewed, Wilcoxon tests were used. McNemar's tests were used to compare the differences in categorical variables such as EQ dimensions, and depression with previous time periods.

Logistic regression analyses were used to determine the factors that predict injury severity, RTW/study. Details of model development for these outcomes are described below.

Covariates for inclusion in the multiple regression models were identified through the process of univariate testing with the relevant dependent outcomes. If p-value <0.25 in the univariate analysis, the covariates were included in the multiple regression models. These tests were conducted with an alpha of 0.05. All covariates were considered as potential predictors of dependent outcomes at 6 and 12 months based on previous studies (26, 35, 42, 46).

The pre-injury/ baseline covariates that were considered as predictors of changes in outcomes of interest at 6 and 12 months were age, sex, education, marital status, pre-injury health status (yes/no), ISS, LoS (days) and pre-injury HRQoL.

Association between independent variables and injury severity

Predictors of injury severity included in the model were: age, sex, education, marital status, previous history of a crash (yes, no), helmet use at time of crash (yes, no), motorcycle licence at time of crash (yes, no), crash type (multi-vehicle, single vehicle), speeding at time of crash (above limit, at or below limit), time of day (6:00am – 5:59pm, 6:00pm-5:59am) and weather (dry, wet) and have been used in previous road crash studies. (26, 35, 42, 46). Simple logistic regression was used to explore the association between each independent variable and crash severity. Initially, the crude odds ratio (COR) for each independent variable was calculated at 95% confidence interval (CI). All variables with p-value of < 0.25 were used when constructing the multiple logistic regression model. A p-value of < 0.05 was considered to demonstrate a statistically significant association.

Association between independent variables and return to work

Predictors for return to work at 6 and 12 months post-injury included sex, age, education, ISS, LoS, and physical and mental health using SF-12 at 6 and 12 months were derived from previous literature (26, 238, 267). Firstly, a separate simple logistic regression was used to explore the association between each predictor variable and return to work at 6 and 12 months. Potential association variables (p-value of < 0.25) with return to work on simple logistic regression were selected when constructing the multiple logistic regression models. The crude odds ratio (COR) for each independent variable was also calculated at 95% confidence interval (CI). Lastly, only independent variables significant at 5% were retained in the final model.

Multilevel models

Multilevel modeling (MLM) is well described in the literature (268, 269). MLM are also known as hierarchical linear models (270), random coefficient models (271) and variance component models (272). ANOVA are not appropriate due to the data structure not meeting the assumption of independence of observations from different clusters (269). MLM is suitable for analysing hierarchical and longitudinal study data. It has also recently been used in the field of injury to analyse repeated-measures designs, which are considered to be clustered within individuals (273) (46, 268). MLM techniques also allow the simultaneous examination of the effect of group-level (measure occasion) and individual level variables on individual level outcomes (268).

The MLM treats time measurements observed within an individual as a level one unit and individual as a level two unit. Covariates included age, sex, education, ISS, and LoS were included in the model at level one.

The two-level model can be written as follows:

$Y_{it} = \beta_{0t} + \beta_{1t}X_{it} + r_{it}$

Level 2:

$\beta_{0t} = \beta_0 + u_{0t}$ with $u_{0t} \sim (0, \sigma u0\ 2)$ and $r_{it} \sim N(0, \sigma e\ 2)$

$\beta_{1t} = \beta_{10} + u_{1t}$

Where:

Y_{it} is the outcome of interest

X_{j} = independent variables (sex, age, education, ISS, LoS)

i is each individual respondent in the sample (i=1,2,3 …..352)

t is occasion of follow-up (t=1,2,3)

β_{0t} is the unit intercept, or value of the outcome variable Y_{it} when X_{it} equals zero in the contextual unit t adjusted for differences among these units in X_{it}

β_{1t} is the slope of independent variables in contextual unit t

r_{it} is residual for the individual level model in contextual unit t

Applying multilevel analysis to evaluate changes in PCS, MCS of SF12, EQVAS score, functional score, pain score and depression score over time

A statistical model is briefly summarised below for the multilevel model with two levels, time measurements observed within an individual is treated as level one unit and individual as a level two unit. MLM analyses were used to examine the variation in these outcomes over time and between people, and to examine variables contributing to the variations. Building a MLM is similar to constructing regression equation at each level of the hierarchy. Therefore, MLM analysis requires dataset has a hierarchical structure; it must consist of individual and contextual level measurements.

3.3.9 Ethical considerations

Ethics approval was obtained from Human Research Ethics Committee of Curtin University under number HRE2017-0010, the University of Medicine and Pharmacy of HCMC under number 36/DHYD-HD, Vietnam and the Gia Dinh hospital, Vietnam.

Participants' welfare was considered at all stages of the study. Firstly, all participants were interviewed face-to-face prior to discharge from the hospital and two telephone interviews at 6 and 12 months post-hospitalisation by the trained researcher. Before approaching potential participants in the hospital, the researcher checked with physicians that participants were physically and emotionally well enough to participate. Each participant received a participant information sheet describing the purpose of research, the participant's role and rights, and how confidentiality would be protected. Participation in this study was entirely voluntary and participants were told that they had the right to withdraw at any time without consequences to their medical treatment. Each participant was identified by a study ID number (SID) and a patient ID number (PID). On each questionnaire, only the SID and PID number were used. The name was kept in a separate, password-controlled file in the different folder to the medical record data. Only the student and her supervisors have access to the file linking the name and ID number. All data were stored in an R drive at Curtin University for seven years.

Chapter 4. Results

Overview

This chapter describes the results of the study. First, recruitment and response rates are reported (Section 4.1). Secondly, demographic, crash characteristic, injury outcomes are described (Section 4.2). Section 4.3 presents a comparison of participants studied and those to lost follow-up or who declined to participate, as well as the development of statistical models. Section 4.4 presents the relationship between risk factors and injury severity among injured motorcyclists. Results of changes in HRQoL, functional status, pain intensity, and return to work/study over time (pre-injury, 6 and 12 months post-injury) are presented in Section 4.5, 4.6, 4.7 and 4.8, respectively. Finally, Section 4.9 presents change in depression over time (pre-injury, 6 and 12 months post-injury).

4.1. Recruitment and response rate

Between 1st June 2017 and 31th January 2018, a total of 441 participants who presented at the ED of the Gia Dinh hospital following a road traffic crash were reviewed, with 378 (85.7%) meeting the study's inclusion criteria. All eligible injured motorcycle riders were approached, and 352 agreed to participate in the study, giving a response rate of 93.1% (Figure 4.3). The researcher-administered questionnaire was completed by 330 participants (93.8%) while in hospital, and by the remaining 22 participants (6%) by telephone after discharge.

At the 6 month follow-up, 301 participants could be contacted (response rate: 85.5%) and 51 (14.5%) participants were lost to attrition: two participants died for reasons unrelated to the crash; 36 (10.2%) did not respond to five consecutive telephone calls; five (1.4%) refused to continue with the study; and eight (2.3%) had moved. At the 12 months follow-up, a total of 286 participants were followed up, giving a response rate of 81.3%; 15 (4.3%) participants were lost to attrition because the researcher was unable to make contact with them. Therefore, data were analysed for 352 participants at baseline, 301 at 6 months and 286 at 12 months post-injury. A comparison of demographic characteristics (age and sex) between those who participated in the study and those who declined to participate is presented in Table 4.1. There were no significant differences between those who completed and rejected the baseline interview in terms of age (p=0.665) and sex (p=0.723).

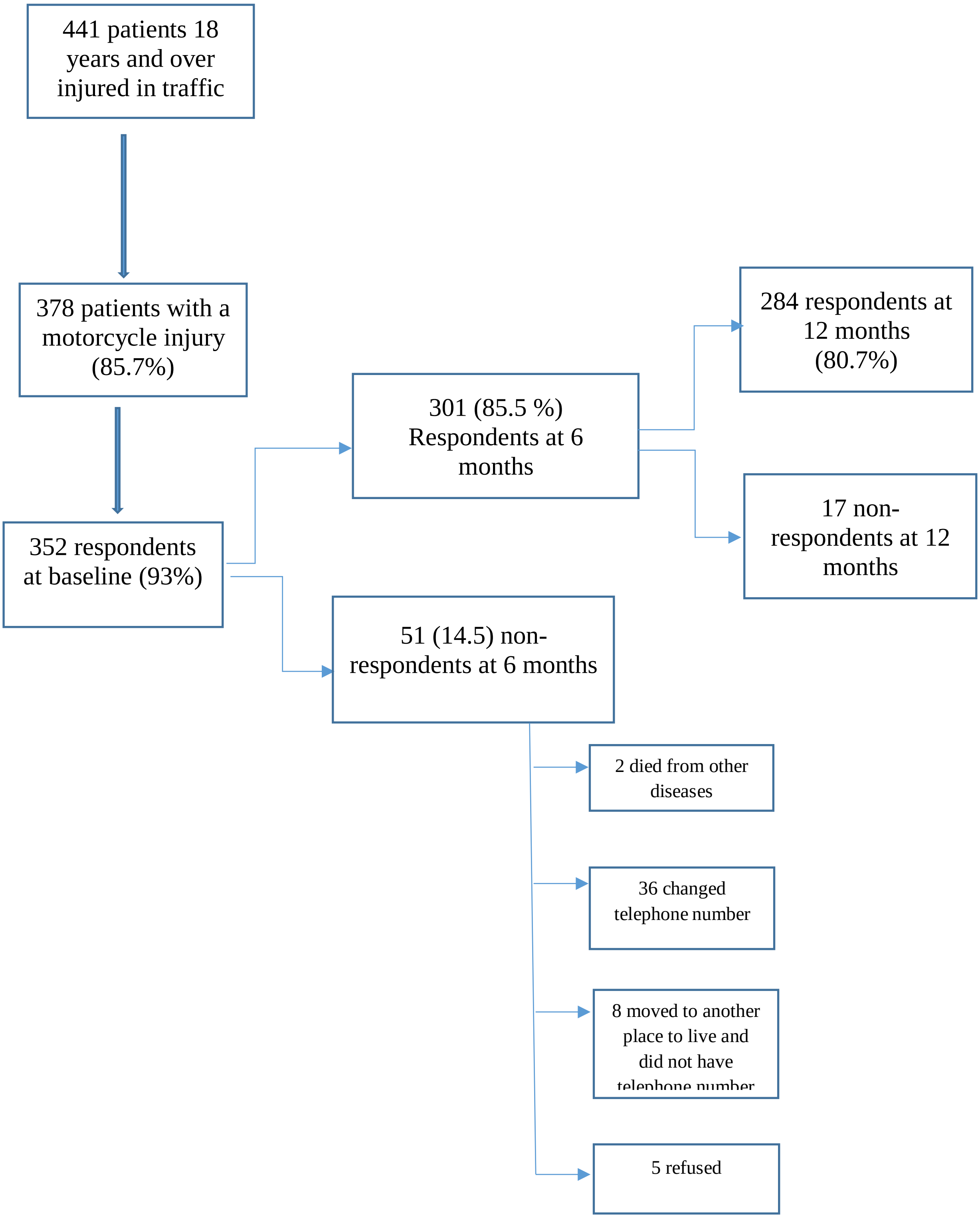


Figure 4.3. Flowchart of participant recruitment

Table 4.1. Comparison of baseline characteristics of motorcyclists hospitalised as a result of a crash in Ho Chi Minh City, Vietnam between those who participated in the study and those who declined (non-participants)

Characteristics	**Participants (n=352)**	**Non-participants (n=26)**	**p-value**
Sex (%)	n (%)	n (%)	
Male	235 (66.8)	19 (73.1)	0.665
Female	117 (33.2)	7 (26.9)	
Age (years)			
Mean (SD)	40.9 (15.3)	39.8 (14.8)	0.723

4.2 Descriptive statistics of study participants, the motorcycle crashes and participant injuries

4.2.1 Characteristics of study participants

Table 4.2 presents the demographic and socioeconomic characteristics of the study participants. Of the 352 participants, 235 (66.8%) were male and 117 (33.2%) were female. The ages ranged from 18 to 76 years with a mean of 40.9 (SD=15.3) years. The largest number of injured motorcyclists were in the 18-25 year age group (n= 89, 25.3%), followed by the 45-54 year old age group (n=82, 23.3%) and those aged 55+ years (n=77, 21.9%). One-third of participants had vocational training or a university degree (n=116, 33%). Most participants were free labourers (e.g., had their own business, taxi drivers, or were unskilled labourers without a permanent employer; n=160, 45.5%), followed by office workers (n=68, 19.3%) and students (n=61, 17.3%). Two-thirds of the cohort were married or in a de facto relationship (n=235, 66.8%). Approximately 76% (n=268) of participants were admitted directly to the hospital from the scene of the crash while 84 (23.9%) were transferred from other hospitals. Thirty-two (9.1%) participants self-reported a history of a previous motorcycle crash (of any severity) in the past year. In terms of riding exposure, motorcyclists self-reported that they travelled a median of 85.4 kilometres per week, with minimum of 4km and maximum of 980 km.

Table 4.2. Characteristics of motorcyclists hospitalised as a result of a crash in Ho Chi Minh City, Vietnam (n=352)

Motorcyclist characteristics	**n**	**%**
Sex		
Male	235	66.8
Female	117	33.2
Age group (years)		
18-25	89	25.3
26-34	47	13.3
35-44	57	16.2
45-54	82	23.3
55+	77	21.9
Education		
No formal/ Elementary school	57	16.2
Middle school	105	29.8
High school	74	21.0
Vocational/ university	116	33.0
Occupation		
Free labourer	160	45.5
Office worker	68	19.3
Student	61	17.3
Housewife	35	9.9
Unemployed/retired	28	8.0
Marital status		
De facto/ married	235	66.8
Single/separated/divorced/ widowed	117	33.2
Hospital admission status		
Direct	268	76.1
Transfer	84	23.9
Previous crash (in last year)		
Yes	32	9.1
No	320	90.9
Kilometre travelling per week	85.4 (4-980) a	

[a] *Median (range)*

4.2.2 Characteristic of the motorcycle crashes

Characteristics of the motorcycle crashes are presented in Table 4.3. Nearly three-quarters of crashes were multi-vehicle crashes (n=258, 73.3%). A breakdown by type of crash found that 52.3% (n=184) of crashes involved two motorcycles and 21.0% (n=74) involved a motorcycle and car or truck. Single-vehicle crashes accounted for 26.7% (n=94) of crashes, of which 13.1% (n=46) occurred due to the motorcyclist losing control and 13.6% (n=48) due to hitting an object, animal or pedestrian.

More than half of crashes occurred between 6:00 pm and 11:59 pm (n=211, 59.9%) followed by noon to 5:59 pm (n=73, 20.7%). More than three-quarters of the crashes occurred in dry weather (n=273, 77.6 %).

Approximately 13% (n=44) of motorcyclists were not wearing a helmet at the time of the crash. Of the 142 participants who had their blood alcohol concentration (BAC) tested at the hospital, 46.5% (n=66) had a BAC above the legal limit (0.05 g/dL). Overall, 18.8% of the total sample (including tested and untested, n=352) had a confirmed BAC above the legal limit. Forty one percent of participants (n=145) did not have a motorcycle licence at the time of the crash. Nine percent of participants (n= 33) self-reported that they were on their mobile phone at time of the crash. One in four participants (n=93) reported that their speed at the time of the crash was over the posted speed limit.

Table 4.3. Characteristics of motorcycle crashes resulting in hospitalisation in Ho Chi Minh City, Vietnam (n=352)

Crash characteristics	n	%
Crash type		
Multi-vehicle	258	73.3
Hit another motorcyclist	184	52.3
Hit a motor vehicle	74	21.0
Single- vehicle	94	26.7
Hit an object/pedestrian/ animal	48	13.6
Loss of control	46	13.1
Time of day		
12:00am-5:59am	6	1.7
6:00am -11:59am	62	17.6
12:00pm- 5:59pm	73	20.7
6:00pm-11:59pm	211	59.9
Weather		
Wet	79	22.4
Dry	273	77.6
BAC level (g/dl) a		
≥0.05	66	46.5
<0.05	76	53.5
Helmet use at time of the crash		
Yes	308	87.5
No	44	12.5
Mobile phone use at time of the crash		
Yes	33	9.4
No	319	90.6
Motorcycle licence at time of the crash		
Yes	207	58.8
No	145	41.2
Speeding at time of crash		
At limit or below	259	73.6
Above limit	93	26.4

[a] *Missing data: n= 210 participants who did not have their BAC tested*

Participants' responses to questions about their familiarity with the area where the crash occurred are described in Table 4.4. More than eighty percent of motorcyclists (n=282, 80.1%) had frequently used the same route where the crash occurred. Most of participants were familiar with the road where the crash occurred (n=262, 74.4%). Approximately 30% (n=107) of crashes occurred when motorcyclists travelled at a different time to their usual travel time.

Table 4.4. Familiarity with area of crash happened of motorcyclists resulting in hospitalisation in Ho Chi Minh City, Vietnam (n=352)

Familiarity with area	**n**	**%**
Same trip		
Yes	282	80.1
No	70	19.9
Same route		
Yes	262	74.4
No	90	25.6
Crash at same time as usually travel		
Yes	245	69.6
No	107	30.4

4.2.3 Description of the motorcyclists' injuries

Table 4.5 presents the injury characteristics of participants. The most common site of injury was the extremities (n=205, 58.2%), followed by the head (n=113, 32.1%) and external (surface - n=45, 12.8%) injuries. Approximately one in four motorcyclists (n=83, 24.6%) were injured in at least two body regions.

The mean length of hospital stay was 8.1 days (SD=6.3), ranging from 1 to 51 days (median=7; Inter quartile range (IQR) = 4-36). The mean ISS was 7.3 (SD=4.1), ranging from 1 to 26 (median = 8.5; IQR = 1-22). Half of participants experienced mild injury (n=176, 50.0%), and nearly 7% of hospitalised motorcyclists suffering severe injury (n=24, 6.8%).

Table 4.5. Injury characteristics of motorcyclists hospitalised as a result of a crash in Ho Chi Minh City, Vietnam (n=352)

Injury characteristics	n	%
Body region injured		
Head	113	32.1
Face and/or Neck	27	7.7
Chest	17	4.8
Abdomen	32	9.1
Extremities (upper and lower)	205	58.2
External (wound)	45	12.8
Injured in more than one area		
Yes	83	24.6
No	269	76.4
Injury severity [a]		
Mild	176	50
Moderate	152	43.2
Severe	24	6.8

[a] *Injury Severity Score (mild =ISS<9, moderate= 9≤ISS <16, severe =ISS≥16)*

4.3 Characteristic of study participants over time and statistical model development

4.3.1 Comparison of participants who completed the study and those to lost follow-up

A comparison of the baseline characteristics of participants who completed the study and those lost to follow-up at 12 months after injury are presented in Table 4.6. Overall, there were no significant differences in age (p=0.771), sex (p=0.239), education (p=0.797), Injury Severity Score (ISS) (p=0.112) and length of stay in hospital (LoS) (p=0.183) between participants who completed the study and those lost to follow-up. There was, however, a higher proportion of males in the group who completed follow-up compared to those were lost to follow-up (68.2% vs 60.6%), and participants lost to follow-up were less severely injured (based on their ISS and LoS than those who completed the study according to the ISS and LoS. However, these differences were not significant.

Table 4.6. Comparison of Participants follow-up and those lost to follow-up at 12 months post-injury

Variables	Follow-up (n=286)	Lost to follow-up (n=66)	p-value
	n (%)	n (%)	
Sex			
Male	195 (68.2)	30 (60.6)	0.24
Female	91 (31.8)	26 (39.4)	
Age			
18-34	108 (37.8)	28 (42.4)	0.77
35-54	115 (40.2)	24 (36.4)	
55+	63 (22)	14 (21.2)	
Education			
Middle school and under	128 (44.7)	34 (51.5)	0.32
High school and over	158 (55.3)	32 (48.5)	
	Median [IQR] [c]		
ISS [a]	9 [4-9]	4 [4-9]	0.11 [d]
LoS [b]	7 [4-10]	6 [4-8]	0.18 [d]

[a] ISS: Injury Severity Score [b] LoS: Length of Stay in hospital (days)
[c] IQR: Inter quartile range [d] **M**ann-Whitney test

4.3.2 Demographic characteristics of participants involving in the study at baseline, 6 and 12 months post-injury

Table 4.7 presents the characteristics of participants at baseline, 6 and 12 months after motorcycle injury in HCMC. The majority of participants over time were male (n=235, 66.8%) at baseline, n=206, 68.4% at 6 months, and n=195, 68.2% at 12 months). The largest number of injured motorcycle riders were in the 35-54 age group (n=139, 39.5% at baseline, n=124, 41.2% at 6 months, and n=115, 40.2% at 12 months), and one-third of participants had vocational training or a university degree. There were no significant differences in sex, age and education over time in participants involved in the study. Regarding to injury characteristics among time measurements, the mean (SD) ISS and LoS at 6 and 12 months post-injury were slightly higher at baseline but these differences were not significant.

Table 4.7. Demographic and injury characteristics of motorcycle riders involving a motorcycle crash at baseline, 6 months and 12 months post-injury at HMC, Vietnam

Variables	**Baseline (n=352)**	**6 months post-injury (n=301)**	**12 months post-injury (n=286)**
	n (%)	n (%)	n (%)
Sex			
Male	235 (66.8)	206 (68.4)	195 (68.2)
Female	117 (33.2)	95 (31.6)	91 (31.8)
Age			
18-34	136 (38.6)	112 (37.2)	108 (37.8)
35-54	139 (39.5)	124 (41.2)	115 (40.2)
55+	77 (21.9)	65 (21.6)	63 (22)
Education			
Middle school and under	162 (46.0)	140 (46.5)	128 (44.8)
High school and over	190 (54.0)	161 (53.5)	158 (55.2)
ISS [a]	7.3 (4.1) [c] 8.5 [4-9] [b]	7.4 (4.2) [a] 9 [4-9] [b]	7.4 (4.0) [a] 9 [4-9] [b]
LoS [b]	8.1 (6.3) [a] 7 [4-10] [b]	8.3 (6.6) [a] 7 [4-10] [b]	8.4 (6.6) [a] 7 [4-10] [b]

[a] ISS: Injury Severity Score [b] LoS: Length of Stay in hospital (days)
[c] mean (standard deviation) [d] median [inter quartile range]

4.3.3 Statistical model development

The two statistical models are presented in this section: multiple logistic regression models and multilevel models.

Multiple logistic regression models were done in two steps. Firstly, a separate simple logistic regression was used to explore the association between each predictor variable (potential risk factors) and binary outcomes. Potential risk factors having p-value of < 0.25 in simple logistic regression models were included as predictors in the multiple logistic regression models. Odds ratio (OR) with 95% confidence interval (CI) were reported.

The multilevel models were also done in two steps: 1) Model 1 with no predictors of outcomes included (unconditional model or empty model); and then 2) Model 2 with all level-1 explanatory variables (full model) were developed.

4.4 Risk factors of injury severity of injured motorcyclists

4.4.1 Simple logistic regression model of injury severity

Simple logistic regression analyses examining risk factors for injury severity (measured by injury severity score) due to a motorcycle crash resulting in hospitalisation at baseline are presented in Table 4.8. The results of simple logistic regression found that unlicensed motorcyclists had more than three times the odds of a severe injury than licenced motorcyclists (Crude OR (COR) =3.08; 95% CI: 1.28-7.41). Motorcyclists who were involved in crashes during the night (between 6:00pm and 5:59am) had 3.3 times higher odds of a severe injury than motorcyclists involved in crashes occurring during the day (between 6:00am and 5:59pm: COR=3.3; 95% CI: 1.312-9.94).

Motorcyclists who were wearing a helmet at the time of the crash had 2.5 times higher odds of a severe injury than those who were not wearing a helmet at the time of crash. However, this difference was not statistically significant (95% CI: 0.95-6.80). Injury severity was not significantly associated with age (COR=1.01; 95% CI: 0.99-1.04), being a female (COR=1.01; 95% CI: 0.42-2.42), previous history of a crash (COR=0.68; 95% CI: 0.19-2.41), crash type (COR=0.70; 95% CI: 0.26-1.94), speeding at time of the crash (COR=0.86; 95% CI: 0.35-2.15), or wet weather (COR=1.45; 95% CI: 0.58-3.65).

Table 4.8. Simple logistic regression results for factors influencing injury severity of motorcyclists hospitalised as a result of a crash in Ho Chi Minh City, Vietnam (n=352)

Risk factor	COR [a]	95% CI [b]
Age (in years)	1.01	0.99-1.04
Sex		
Male (reference)	1.00	
Female	1.01	0.42-2.42
Previous history of a crash		
Yes (reference)	1.00	
No	0.68	0.19-2.41
Helmet use at time of crash		
Yes (reference)	1.00	
No	2.54	0.95-6.80
Motorcycle licence at time of crash		
Yes (reference)	1.00	
No	3.08*	1.28-7.41
Crash type		
Multi-vehicle(reference)	1.00	
Single-vehicle	0.70	0.26-1.94
Speeding at time of the crash		
Above limit (reference)	1.00	
At limit or below	0.86	0.35-2.15
Time of day		
Time 6:00 am- 5:59pm (reference)	1.00	
Time 6 pm- 5:59am	3.32*	1.12-9.94
Weather		
Dry (reference)	1.00	
Wet	1.45	0.58-3.65

*[a] COR indicates Crude Odds Ratio, [b] 95% CI indicates 95% confidence interval *p-value<0.05*

4.4.2 Multiple logistic regression model of injury severity

Table 4.9 presents the results of the multiple logistic regression analysis examining the association between risk factors and injury severity (measuring by ISS) of motorcyclists hospitalised due to a motorcycle crash. After controlling for potential confounding factors (including age, sex, occupation, marital status and education), motorcyclists who were not licenced to drive a motorcycle had more than 3.3 times the odds of severe injury than licenced motorcyclists (adjusted odds ratio (AOR)=3.3; 95% CI: 1.2-9.3). Motorcyclists who were involved in crashes during the night (between 6:00pm and 5:59am) had a 4.3 times higher odds of a severe injury than motorcyclists involved in crashes during the day (between 6:00am and 5:59pm: AOR=4.3; 95% CI: 1.3-13.8). Neither having a previous history of a crash, nor wearing the helmet at the time of crash was significantly associated with injury severity.

Table 4.9. Multiple logistic regression results for factors influencing injury severity of motorcyclists hospitalised as a result of a crash in Ho Chi Minh City,Vietnam (n=352)

Risk factor	AOR [a]	95% CI [b]
Previous history of a crash		
Yes	Reference	
No	0.48	0.13-1.81
Helmet use at time of crash		
Yes	Reference	
No	2.15	0.74-6.30
Motorcycle licence at time of crash		
Yes	Reference	
No	3.32*	1.18-9.34
Time of day		
Time 6:00 am- 5:59pm	Reference	
Time 6 pm- 5:59am	4.28*	1.33-13.78

** p-value <0.05 after adjusting for age, sex, occupation, marital status and education*
[a] Adjusted Odds Ratio *[b] 95% CI indicates 95% confident interval*

4.5 Change in HRQoL pre-injury, 6 months and 12 months post-injury

HRQoL outcomes were measured by the SF-12 version 2 and the European Quality of Life-5 Dimensions (EQ-5D-5L). The SF-12 is reported as Physical Component Scores (PCS), and Mental Component Scores (MCS). The EQ-5D is reported as the EQ- visual analogue scale (EQ-VAS) scores, and EQ domains. PCS and MCS scores range from 0 to 100. Higher PCS, MCS scores indicate better HRQoL. The EQ-VAS score ranges from 0 to 100. Higher the EQ-VAS score reflects better HRQoL.

4.5.1 Change in HRQoL scores of the study population relative to previous time point

Changes in such HRQoL outcomes relative to previous time points (pre-injury vs 6 months; pre-injury vs 12 months; 6 vs 12 months) are summarised in Table 4.10. In term of two component of SF-12, Table 4.10 showed that mean (SD) PCS scores were 51.8 (9.7) at time of before injury, declining significantly to 45.2 (13.7) at 6 months and 46.6 (10.8) at 12 months post-injury indicating a reduction in physical functioning. Compared to pre-injury, mean follow-up PSC at 6 months ($p<0.001$) and 12 months ($p=0.03$) post-injury declined significantly. Between 6 months and 12 months post-injury, mean PCS increased significantly ($p=0.029$).

Mean (SD) MCS scores were 46.8 (11.2), 42.6 (13.9) and 48.1 (11.5) at pre-injury, 6 months and 12 months after post-injury, respectively. The mean MCS scores significantly decreased at 6 months post-injury compared with pre-injury ($p<0.001$) indicating reduction in mental well-being. Mean follow-up MCS scores increased between pre-injury and 12 months post-injury but this finding was not statistically significant ($p>0.05$).

In term of HRQoL indicating by EQ-5D, there was a significant decline in the mean EQ-VAS scores at 6 ($p<0.001$) and 12 months ($p<0.001$) post-injury compared to pre-injury (Table 4.10) indicating. Overall, all dimensions of the EQ-5D showed significant improvement between 6 and12 months post-injury, except for the pain/discomfort dimension. However, none returned to pre-injury status. Before injury, pain/discomfort (n=90, 25.6%) was the dimension reported as causing problems in the highest proportion of participants, followed by anxiety/depression (n=86, 24.4%). At 6 months post-injury, pain/discomfort was still the dimension reported as problematic by the highest proportion of participants, with 56.5% (n=170) of participants compared to 25.6% (n=90) at baseline. Although the pain/discomfort dimension improved between 6 and 12 months post-injury, this improvement was not significant ($p=0.19$). Anxiety/depression improved significantly by 7%

between 6 and 12 months post-injury (p=0.02). At 12 months post-injury, 50% reported pain/discomfort while 35.5% of participants indicated anxiety or depression.

Table 4.10. Change in Health-related Quality of Life of motorcycle riders involving a motorcycle crash relative to previous time point at HCMC, Vietnam in 2017 and 2018

Variables	**Pre-injury (n=352)**	**6 months post- injury (n=301)**	**12 months post- injury (n=286)**	**Pre-injury vs 6 months**	**Pre-injury vs 12 months**	**6 vs 12 months**
	Mean±SD	Mean±SD	Mean±SD	p-value	p-value	p-value
SF-12						
PCS[a]	51.78 ±9.71	45.19±13.73	46.62±10.78	<0.001	<0.001	0.03
MCS[b]	46.83±11.99	42.56±13.94	48.14±11.52	<0.001	0.05	<0.001
The EQ-5D						
EQ-VAS[c]	85.60±10.99	75.12±12.05	79.96±12.25	<0.001	<0.001	<0.001
EQ-5D domains	n (%)	n (%)	n (%)			
Mobility						
No problems	340 (96.6)	211 (70.1)	219 (76.6)	<0.001	<0.001	<0.001
Problems	12 (3.4)	90 (29.9)	67 (23.4)			
Self-care						
No problems	347 (98.6)	232 (77.1)	242 (84.6)	<0.001	<0.001	0.01
Problems	5 (1.4)	69 (22.9)	44 (15.4)			
Usual activities						
No problems	325 (92.3)	191 (63.5)	207 (73.4)	<0.001	<0.001	0.03
Problems	27 (7.7)	110 (36.5)	79 (27.6)			
Pain/discomfort						
No problems	262 (74.4)	131 (43.5)	143 (50.0)	<0.001	<0.001	0.19
Problems	90 (25.6)	170 (56.5)	143 (50.0)			
Anxiety/depression						
No problems	266 (75.6)	169 (56.2)	185 (64.7)	<0.001	<0.001	0.02
Problems	86 (24.4)	432 (43.8)	101 (35.5)			

[a] *PCS: Physical Component Summary Score* [b] *MCS: Mental Component Summary Score*
[c] *EQ-VAS: The European Visual Analogue Scale*

4.5.2 Multilevel models examining changes in HRQoL over time

The changes in PCS and MCS of SF-12 across time without predictors (model 1)

The results of the variation in HRQoL across time are presented in Table 4.11. The results indicated that compared to pre-injury, participants' PCS reduced significantly by 6.61 points (95% CI: -8.21, -5.03) at 6 months and by 5.12 points (95% CI: -6.74, -3.51) at 12 months post-injury. In addition, the MCS decreased significantly by 4.24 (CI: -6.00, - 2.48) at 6 months post-injury, compared to before the motorcycle crash.

The random effects component of PCS shows the intra-class correlation (ICC) of PCS was 0.18, indicating that 18% of the variability in PCS was due to differences between individuals. The remainder of the variance was due to the variability across time measurements within individuals. Similarly, the ICC of MCS was 0.17, indicating that 17% of the variability in MCS was due to differences between individuals.

Table 4.11. Health-related quality of life across time among hospitalised motorcycle riders involving a motorcycle crash in HCMC, Vietnam

Variables	SF-12			
	PCS [a] Coefficient (SE)	95% CI	MCS [b] Coefficient (SE)	95% CI
Time of assessment				
Pre-injury	Reference		Reference	
6 months post-injury	-6.61* (0.81)	(-8.21 -5.03)	-4.24* (0.89)	(-6.00 - 2.48)
12 months post-injury	-5.12* (0.82)	(-6.74 -3.51)	1.27 (0.91)	(-0.51 3.06)
Constant	51.80 (0.6)			
Random effect	Estimate	95% CI	Estimate	95% CI
Between-person effect	24.39* (5.28)	15.95- 37.30	26.85* (6.15)	17.13-42.07
Within-person effect	106.37* (6.13)	94.99-119.09	129.17* (7.41)	115.42 -144.56
ICC[c]	0.18*		0.17*	

[a] *PCS: Physical Component Summary Score* [b] *MCS: Mental Component Summary Score*
[c] ICC: intra-class correlation * p-value<0.05

Change in PCS, MCS of SF12 across time with including all predictors (full model)

The results of the full model examining the change in PCS and MCS indicating by SF12 over time are presented in Table 4.12. After adjusting for predictors, the model analysing changes in HRQoL over time revealed that, compared to pre-injury, participants' PCS reduced significantly by 6.61 points (95% CI: -8.21, -5.03) at 6 months and by 5.12 points (95% CI: -6.74, -3.51) at 12 months post-injury indicating improved physical functioning between 6 and 12 months post-injury. However, physical function was still below pre-injury levels. Females had significantly lower PCS (β=-3.61; 95% CI: -5.16, -2.06) compared to males. Being age over 55 years was associated with lower PCS (β=-9.38; 95% CI: -11.32, -7.44) compared to being aged between 18 and 34 years.

The MCS decreased significantly by 4.23 (CI: -5.99, - 2.47) at 6 months post-injury, compared to before the motorcycle crash indicating poorer psychological functioning. The MCS increased by 1.29 points at 12 months but this increase was not statistically significant. Being female (β=-3.61; 95% CI: -5.16, -2.06) compared to male and aged over 55 years (β=-9.38; 95% CI: -11.32, -7.44) compared to age group of 18-34 were associated with lower MCS.

The random effects component of the model indicated that the variance in both PCS and MCS became smaller after the variables age, sex, ISS and LoS were included (Table 4.12). Five percent of the variation in PCS was explained by predictors variables in the full model (ICC=0.05). However, this variability was not significant (p=0.07). A total of 15% of the variability in MCS was explained by predictor variables.

Table 4.12. Multilevel modelling assessing the changes in PCS, MCS indicating by SF-12 of a sample of hospitalised motorcycle riders involving a motorcycle crash in HCMC, Vietnam in 2017 and 2018

Variables	SF-12			
	PCS[a] Coefficient (SE)	95% CI	MCS[b] Coefficient (SE)	95% CI
Time of assessment				
Pre-injury	Reference		Reference	
6 months post-injury	-6.61* (0.81)	(-8.21 -5.03)	-4.23* (0.89)	(-5.99 - 2.47)
12 months post-injury	-5.12* (0.82)	(-6.74 -3.51)	1.29 (0.91)	(-0.49 3.08)
Sex				
Male	Reference		Reference	
Female	-3.61 (0.79)	(-5.16 -2.06)	-1.60* (0.99)	(-3.56 -0.35)
Age				
18-34	Reference		Reference	
35-54	-2.26* (0.84)	(-3.91 -0.61)	-1.94 (1.06)	(-3.56 0.35)
55+	-9.38* (0.99)	(-11.32 -7.44)	-2.92* (1.25)	(-5.37 -0.46)
ISS[c]	-0.11 (0.09)	(-0.29 0.71)	-0.11 (0.16)	(-0.34 0.12)
LoS[d]	-0.14* (0.06)	(-0.25 -0.03)	-0.05 (0.07)	(-0.19 0.93)
Constant	61.50 (1.35)		51.59	
Random effect	Estimate	95% CI	Estimate	95% CI
Between-person effect	5.64* (3.97)	1.41- 22.47	23.82* (5.95)	14.58-38.89
Within-person effect	106.14* (6.09)	94.84- 118.78	129.26* (7.42)	115.49 -144.65
ICC[e]	0.05*		0.15*	

[a] *PCS: Physical Component Summary Score*
[b] *MCS: Mental Component Summary Score*
[c] *ISS: Injury severity score*
[d] *LoS: Length of stay in hospital (days)*
[e] *ICC: Intra-class correlation*
**p-value<0.05*

The variation in EQ-VAS across times without predictors

Table 4.13 shows the empty model that explored the variation in the EQ-VAS between and within individuals. The model indicated that the EQ-VAS scores reduced significantly by 10.5 points at 6 months (95% CI: -11.6, -9.4) and 6.5 points at 12 months (95% CI: -7.6, -5.4) after injury, compared with pre-injury indicating an improvement in health-related quality of life. The random effects component of the model showed the variance component and the proportion of variability explained by the level (in this case the time measurements). Fifty-four percent of the variance of the EQ-VAS was explained by differences between individuals.

Table 4.13. The change of EQ-VAS among hospitalised motorcycle riders involving a motorcycle crash in HCMC, Vietnam in 2017 and 2018.

Variables	The EQ-VAS[a]	
	Coefficient (SE)	95% CI
Time of assessment		
Pre-injury	Reference	
6 months post-injury	-10.48* (0.55)	(-11.57 -9.39)
12 months post-injury	-6.52* (0.56)	(-7.63 -5.41)
Constant	85.5	
Random effect	Estimate	95% CI
Between-person effect	57.39* (5.86)	46.98-70.11
Within-person effect	48.59* (2.82)	43.35-54.46
ICC[b]	0.54*	

[a] EQ-VAS: The EQ-visual analogue scale *[b] ICC: Intra-class correlation* **p-value<0.05*

Change in EQ-VAS of study population over time with including all predictors (full model)

The results of the full model modelling changes in EQ-VAS over time are presented in Table 4.14. The results indicated that the EQ-VAS score reduced significantly by 10.41 (95% CI: -11.49, -9.33) at 6 months and 6.48 (95% CI: -7.58, -5.38) at 12 months post-injury, compared to pre-injury. After adjusting for predictors, females had significantly lower EQ-VAS scores (β=-2.87; 95% CI: -4.30, -4.15) compared to males. Being aged between 35 to 54 years (β=-6.7; 95% CI: -8.24, -5.18), and over 55 years (β=-14.10; 95% CI: -15.89, -12.31) were associated with lower EQ-VAS compared to the 18 to 34 year old age group. The random effects component indicated 29% of the variation in EQ-VAS was explained by the predictor variables.

Table 4.14. Multilevel modelling assessing the change of HRQoL indicating by EQ-VAS among hospitalised motorcycle riders involving a motorcycle crash in HCMC, Vietnam in 2017 and 2018.

Variables	The EQ-VAS[a]	
	Coefficient (SE)	95% CI
Time of assessment		
Pre-injury	Reference	Reference
6 months post-injury	-10.41* (0.55)	(-11.49 -9.33)
12 months post-injury	-6.48* (0.56)	(-7.58 -5.38)
Sex		
Male	Reference	Reference
Female	-2.87* (0.73)	(-4.30 -1.45)
Age		
18-34	Reference	Reference
35-54	-6.70* (0.78)	(-8.24 -5.18)
55+	-14.10* (0.91)	(-15.89 -12.31)
ISS[b]	-0.25* (0.09)	(-0.41 -0.078)
LoS[c]	-0.13* (0.05)	(-0.24 -0.021)
Constant		
Random effect	Estimate	95% CI
Between-person effect	20.34* (3.11)	15.07-17.46
Within-person effect	48.6* (2.82)	43.36-54.45
ICC[d]	0.29*	

[a]*EQ-VAS: The EQ- visual analogue scale* **p-value<0.05*
[b]*ISS: Injury severity score* [c]*LoS: Length of Stay in hospital (days)* [d]*ICC: Intra-class correlation*

4.6 Changes in pain over study periods

Pain intensity was measured by the Number Rating Score (NRS). The model assessing changes in pain without predictor variables (empty model) and with predictor variables (full model) are presented in this section.

4.6.1 Comparison in pain intensity score (NRS) to previous times

The mean (SD) NRS at baseline (immediately following injury), 6 months and 12 months post-injury were 5.6 (2.5), 2.5 (2.2) and 2.1 (1.9), respectively (Table 4.15). The results of comparison in mean NRS to previous time points indicated that mean NRS at baseline was 3.1 points higher than mean NRS at 6 months (p<0.001) and 3.5 points higher at 12 months post-injury (p<0.001). The mean NRS at 6 months was significantly higher than 12 months of 0.4 points (p<0.001).

Table 4.15. Pain intensity score among injured motorcyclists at the time of injury, 6 months and 12 months post-injury at HCMC, Vietnam in 2017 and 2018[a]

Time of assessment	At the time of injury (n=352)	6 months post-injury (n=301)	12 months post-injury (n=286)
Mean (SD)	5.6(2.5)	2.5(2.2)	2.1(1.9)
p-value (baseline vs 6 months)	<0.001[a]		
p-value (baseline vs 12 months)		<0.001[a]	
p-value (6 vs12 months)			0.001[a]

[a] *Wilcoxon matched-pairs signed-rank test*

4.6.2. Multilevel models examining changes in pain intensity by NRS over time

The variation in NRS across time without predictors (empty model)

Table 4.16 presents the empty model examining the variation in NRS across time and across individual. The coefficient for means in the empty model indicated mean NRS decreased significant by 3 points (95% CI: -3.32, -2.74) and 3.5 points (95% CI: -3.78, -3.19) at 6 months and 12 months post-injury respectively, compared to pre-injury. The ICC was 0.30, showing that 30% of variation in mean NRS was due to differences between individuals.

Table 4.16. Multilevel mixed model of pain among injured motorcyclists at 6 and 12 months post-injury in HCMC, Vietnam in 2017 and 2018

Variables	Pain intensity score (NRS)	
Time of assessment	Coefficient (SE) (95% CI)[a]	
At the time of injury	Reference	
6 months post-injury	-3.03* (0.15)	(-3.32, -2.74)
12 months post-injury	-3.48* (0.15)	(-3.78, -3.19)
Constant	5.57	
Random effect	Estimate	95% CI
Between-person effect	1.51* (0.22)	1.12-2.03
Within-person effect	3.47* (0.20)	3.09-3.89
ICC[b]	0.30*	

*[a] 95% CI: 95% Confidence Interval *p-value<0.05*
[b]ICC: Intra-class correlation

Changes in NRS over time with including all predictors (full model)

The results of the full model examining change in NRS are summarised in Table 4.17. Overall, pain improved at 6 and 12 months post-injury. After adjusting for predictors, the model showed that NRS decreased significantly by 3.31 points (95% CI: -3.61, -3.01) at 6 months and 3.62 points (95% CI: -3.92, -3.32) at 12 months post-injury, compared to immediately following the injury. Females (β=0.52, 95% CI: 0.18, 0.87) and those aged over 55 years (β=0.45, 95% CI: 0.38, 0.89) had significantly higher mean NRS over time. Participants with higher PCS (β =-0.03, 95% CI:-0.04, -0.02) and MCS (β=-0.02, 95% CI:-0.03, -0.01) had significantly lower pain scores. The random effects component indicated the predictor variables including age, sex, ISS, LoS, and HRQoL accounted for 22% of variation in pain over time (ICC=0.3).

Table 4.17. Multilevel mixed model of pain among injured motorcyclists at 6 and 12 months post-injury in HCMC, Vietnam in 2017 and 2018

Variables	Pain intensity score (NRS)	
Time of assessment	**Coefficient (95% CI)[a]**	
At the time of injury	Reference	
6 months post-injury	-3.31* (0.15)	(-3.61, -3.01)
12 months post-injury	-3.62* (0.15)	(-3.92, -3.32)
Sex		
Male	Reference	
Female	0.52* (0.17)	(0.18, 0.87)
Age		
18-34	Reference	
35-54	0.19 (0.19)	(-0.18, 0.56)
55+	0.46* (0.23)	(0.38, 0.89)
Education		
High education and over	Reference	
Secondary school and under	-0.20*	(-0.12, -0.52)
Injury Severity Score	0.02 (0.02)	(-0.02, 0.06)
Length of stay in hospital (days)	0.05* (0.01)	(0.03, 0.08)
SF-12		
Physical Component Score	-0.03* (0.00)	(-0.04, -0.02)
Mental Component Score	-0.02* (0.00)	(-0.03, -0.01)
Constant	6.73	
Random effect	**Estimate**	**95% CI**
Between-person effect	0.92* (0.19)	0.63-1.38
Within-person effect	3.41* (0.19)	3.02-3.80
ICC[b]	0.22*	

*[a] 95% CI: 95% Confidence Interval *p-value<0.05*
[b]ICC: Intra-class correlation

4.7. Changes in functional status over study periods

Functional status was measured by the Lawton Instrumental Activities of Daily Living (LADL). Higher LADL score reflects higher function.

4.7.1. Comparison in functional scores with previous times

Table 4.18 compares mean functional scores over time. Overall, function improved significantly between data collection points. At the baseline, mean (SD) LADL was 3.5 (1.3). This score increased significantly at mean (SD) of 6.2 (2.1) at 6 months post-injury ($p<0.001$). At 12 months post-injury, the mean (SD) score reached 6.9 (1.8).

Table 4.18. LADL score among injured motorcyclists at the time of injury, 6 months and 12 months post-injury at HCMC, Vietnam in 2017 and 2018[a]

Time of assessment	At the time of injury (n=352)	6 months post-injury (n=301)	12 months post-injury (n=286)
Mean (SD)	3.5 (1.3)	6.2 (2.1)	6.9 (1.8)
p-value (baseline *vs* 6 months)	0.000[a]		
p-value (baseline *vs* 12 months)		0.000[a]	
p-value (6 *vs* 12 months)			0.000[a]

[a] *Wilcoxon matched-pairs signed-rank test*

4.7.2. Multilevel assessing changes in functional scores over time

The variation in LADL across time without predictors (empty model)

Table 4.19 presents the results of the empty model assessing the change in LADL between time points across individuals. The coefficient for means in the model indicated that a positive score for LADL at 6 and 12 months. This showed that LADL improved significantly over time. The random effects component showed 22% of variability in LADL due to variability in between individual (ICC=0.22).

Table 4.19. Multilevel mixed model of functional score among injured motorcyclists over study period in HCMC, Vietnam in 2017 and 2018

Variables	LADL[a]	
Time of assessment	Coefficient	(95% CI)[b]
At the time of injury	Reference	
6 months post-injury	2.89*	(2.64, 3.13)
12 months post-injury	3.51*	(3.27, 3.75)
Constant	1.90	
Random effect	Estimate	95% CI
Between-person effect	0.47* (0.11)	0.30-0.75
Within-person effect	2.26* (0.13)	2.02-2.53
ICC[c]	0.22*	

[a]*LADL: Lawton Instrumental Activities of Daily Living* [b] *95% CI: 95% Confidence Interval*
[c]*ICC: Intra-class correlation* **p-value<0.05*

Changes in functional scores over time with including all predictors (full model)

Table 4.20 shows that, after adjusting for predictors, participants' functional scores increased by 2.89 points (95% CI: 2.64, 3.13) at 6 months and by 3.51 points (95% CI: 3.27, 3.75) at 12 months post-injury, indicating improved levels of function compared to immediately after the injury. Participants aged over 55 years (β=-0.59, 95% CI: -0.93, -0.24) and with higher ISS (β=-0.05, 95% CI: -0.08, -0.02) had significantly lower functional status scores. Participants with higher PCS (β=0.02, 95% CI: 0.01, 0.03) and MCS (β=0.02, 95% CI: 0.01, -0.03) had significantly higher functional status scores. The random effects component indicated the predictor variables accounted for 18% of variation in functional scores among injured motorcyclists (ICC=0.18).

Table 4.20. Multilevel mixed model of functional score among injured motorcyclists over study period in HCMC, Vietnam in 2017 and 2018

Variables	LADL[a]	
Time of assessment	**Coefficient**	**(95% CI)[b]**
At the time of injury	Reference	
6 months post-injury	2.89*	(2.64, 3.13)
12 months post-injury	3.51*	(3.27, 3.75)
Sex		
Male	Reference	
Female	-0.06*	(-0.20, - 0.33)
Age		
18-34	Reference	
35-54	-0.14	(-0.43, 0.15)
55+	-0.59*	(-0.93, -0.24)
Education		
High education and over	Reference	
Secondary school and under	-0.29	(-0.45, 0.05)
Injury Severity Score	-0.05*	(-0.08, -0.02)
Length of stay in hospital (days)	-0.02	(-0.04, 0.001)
SF-12		
Physical Component Score	0.02	(0.01, -0.03)
Mental Component Score	0.02	(0.01, -0.03)
Constant	1.90	
Random effect	**Estimate**	**95% CI**
Between-person effect	0.47* (0.11)	0.30-0.75
Within-person effect	2.26* (0.13)	2.02-2.53
ICC[c]	0.18*	

[a]LADL: Lawton Instrumental Activities of Daily Living [b]95% CI: 95% Confidence Interval
[c]ICC: Intra-class correlation **p-value<0.05*

4.8. Return to work/study (RTW/study) and predictors for RTW/study at 6 months and 12 months post-injury

4.8.1. Percentage of RTW/study at 6 months and 12 months post-injury

Table 4.21 shows the percentage of RTW/study among injured motorcyclists at three time points: pre-injury, 6 and 12 months post-injury. Those participants who had worked or studied prior to injury were included in the calculation.

Of the 352 participants in the study, 318 (90.3%) were working or studying at the time of their crash. The percentage of participants who were able to RTW/study was 59.6% (n=165) at 6 months, and 81.7% (n=210) at 12 months post-injury.

Table 4.21. Prevalence of RTW/study among injured motorcyclists at pre-injury, 6 months and 12 months post-injury at HCMC, Vietnam in 2017 and 2018

RTW/study	n	%
Pre-injury (n=352)	318	90.3
6 months post-injury (n=277)	165	59.6
12 months post-injury (n=257)	210	81.7

4.8.2. Simple logistic regression examining predictors for RTW/study at 6 months and 12 months post-injury

Table 4.22 presents simple logistic regression examining the relationship between socio-demographic, the injury severity score, length of stay in the hospital, and health-related quality of life measured by SF-12 and RTW/study at 6 and 12 months after motorcycle injuries.

Predictors of lower odds of RTW/study at 6 months post-injury included: being aged 35-54 years old (COR: 0.48; 95% CI: 0.28, 0.83) or over 55 year old (COR: 0.25; 95% CI: 0.12, 0.53); lower education (COR: 0.51; 95% CI: 0.31, 0.85); higher ISS (COR: 0.90; 95% CI: 0.85, 0.96); and greater LoS (COR: 0.93, 95% CI: 0.88, 0.97). Better physical functioning had significantly higher odd of RTW/study at 6 months (COR: 1.03; 95% CI: 1.01, 1.04).

The results of simple logistic regression examining predictors for RTW/study at 12 months indicated being female (COR: 0.37, 95% CI: 0.19, 0.69), aged between 35 and 54 and over 55 years old (COR: 0.12; 95% CI: 0.04, 0.32), higher ISS (COR: 0.84; 95% CI: 0.78, 0.91), and longer time in the hospital (COR: 0.92; 95% CI: 0.88, 0.96) were significantly associated with lower odd of RTW/study.

Table 4.22. Simple logistic regression for RTW/study among injured motorcyclists at 6 months and 12 months post-injury at HCMC, Vietnam in 2017 and 2018 [a]

Variables	RTW/study at 6 months post-injury (n=277)	RTW/study at 12 months post-injury (n=257)
	COR (95% CI)[b]	COR (95% CI)
Sex		
Male	Reference	Reference
Female	0.62 (0.37, 1.03)	0.37 (0.19, 0.69)
Age (years)		
18-34	Reference	Reference
35-54	0.48 (0.28, 0.83)	0.23 (0.10, 0.56)
55+	0.25 (0.12, 0.53)	0.12 (0.04, 0.32)
Education		
High education and over	Reference	Reference
Secondary school and under	0.51 (0.31, 0.85)	1.01 (0.45, 2.28)
Injury Severity Score	0.90 (0.85, 0.96)	0.84 (0.78, 0.91)
Length of stay in hospital (days)	0.93 (0.88, 0.97)	0.92 (0.88, 0.96)
SF-12		
Physical Component Score	1.03 (1.01,1.04)	1.16 (1.12, 1.22)
Mental Component Score	1.01(0.99, 1.03)	1.07 (1.04, 1.08)

[a] *Return to work if working/study prior to injury (n=318)*
[b] *COR: Crude Odds Ratio, 95% CI: 95% Confidence Interval*

4.8.3. Multiple logistic regression examining predictors for RTW/study at 6 months and 12 months post-injury

A multiple logistic regression model (Table 4.23) found that, at 6 months post-injury, there were significantly lower odds of RTW/study for participants with longer LoS in hospital (AOR=0.95, 95% CI: 0.91-0.98). Those with lower education levels had significantly lower odds of RTW/study (AOR=0.51; 95% CI: 0.31, 0.85). At 12 months post-injury there were significantly lower odds of participants RTW/study among those aged between 35 and 54 (AOR=0.21; 95% CI: 0.06, 0.72) and with a higher ISS (AOR=0.85; 95% CI: 0.77, 0.93). Participants with higher PCS and MCS had significantly higher odds of RTW/study (AOR=1.14; 95% CI: 1.09, 1.20 and AOR=1.04; 95% CI: 1.00, 1.09, respectively).

Table 4.23. Multiple logistic regression for RTW/study among injured motorcyclists at 6 and 12 months post-injury at HCMC, Vietnam in 2017 and 2018 [a]

Variables	RTW/study at 6 months post-injury (n=277)	RTW/study at 12 months post-injury (n=257)
	AOR (95% CI)[b]	AOR (95% CI)
Sex		
Male	Reference	Reference
Female	0.82 (0.47, 1.41)*	0.92 (0.37, 2.29)
Age (years)		
18-34	Reference	Reference
35-54	0.59 (0.32, 1.06)	0.21* (0.06, 0.72)
55+	0.36* (0.16, 0.85)	0.24* (0.06, 0.99)
Education		
Secondary school and under	Reference	Reference
High education and over	1.97* (1.16, 3.33)	1.01 (0.45, 2.28)
Injury Severity Score	0.94 (0.89, 1.00)	0.85 (0.77, 0.93)
Length of stay in hospital (days)	0.95* (0.91, 0.98)	0.96 (0.45, 1.20)
SF-12		
Physical Component Score	1.02 (0.99,-1.04)	1.15(1.09, 1.20)
Mental Component Score	1.01(0.99, 1.03)	1.04 (1.00, 1.09)

[a] *Return to work if working/study prior to injury (n=318)*
[b] *AOR indicates Adjusted Odds Ratio, 95% CI indicates 95% Confidence Interval *p<0.05*

4.9 Changes in depression over study periods

4.9.1. Prevalence and change in depression compare to previous time

Table 4.24 summarises the depression scores and percentage of participants who reported symptoms of depression pre-injury, 6 months and 12 months post-injury. The mean score of self-reported depression increased at 6 months post-injury but was similar to the scores pre-injury at 12 months post-injury. Of 352 participants at baseline, 100 (28.4%) participants reported depression before-injury and this number increased by 129 (42.9%) at 6 months after injury. Of the participants who completed the interview 12 months post-injury, 86 (30.1%) had symptoms of depression.

Comparison mean depression scores indicated that there were significant differences in mean (SD) depression scores between baseline [13.7 (9.6)] and 6 months post-injury [18 (11.4)], 6 and 12 months post-injury [13.9 (9.7)]. However, mean depression score at 12 months post-injury was not significantly higher than pre-injury (p=0.275).

Table 4.24. Depression among injured motorcyclists at baseline, 6 months and 12months post-injury at HCMC, Vietnam in 2017 and 2018[a]

Time of assessment	Pre-injury (n=352)	6 months post-injury (n=301)	12 months post-injury (n=286)
Mean (SD)	13.7 (9.6)	18.0 (11.4)	13.9 (9.7)
Normal (n, %)	252(71.6)	172(57.1)	200(69.9)
Problem	100(28.4)	129(42.9)	86(30.1)
p-value **(**baseline vs 6 months)	0.000[a]		
p-value (baseline vs 12 months)		0.275[a]	
p-value (6 vs12 months)			0.000 [a]

[a] *Wilcoxon matched-pairs signed-rank test*

4.9.2. Multilevel models assessing change in depression over time study period

The results of the multilevel mixed model examining changes in the depression scores are presented in Table 4.25. Overall, depression scores increased significantly by 4.65 points (95% CI: 3.29, 60.2) at 6 months post-injury, compared to pre-injury. Females reported higher depression scores over time (β=3.10, 95% CI: 1.48, 4.72) and those aged over 55 years had significantly higher pain scores of 2.74 points over time (95% CI: 0.38, 0.89) compared to those aged between 18 and 34. Participants with longer LoS in the hospital had significantly higher depression scores (β =0.16, 95% CI: 0.04, 0.29).

Table 4.25. Multilevel mixed model of depression score among injured motorcyclists over study period in HCMC, Vietnam in 2017 and 2018

Variables	Depression score	
Time of assessment	Coefficient	(95% CI)[b]
Pre-injury	Reference	
6 months post-injury	4.65	**(3.29, 6.02)**
12 months post-injury	0.59	(-0.79, 1.98)
Sex		
Male	Reference	
Female	3.10	**(1.48, 4.72)**
Age		
18-34	Reference	
35-54	1.74	(0.08, 3.48)
55+	2.74	(0.69, 4.79)
Education		
High education and over	Reference	
Secondary school and under	1.52	(0.02, 3.03)
Injury Severity Score	0.03	(-1.62, 0.26)
Length of stay in hospital (days)	0.16	(0.04, 0.29)
Constant	9.80	(5.92,13.70)
Random effect	**Estimate**	**95% CI**
Between-person effect	19.52 (4.07)	(12.98, 29.38)
Within-person effect	77.93 (4.53)	(69.54, 87.33)

4.10.Summary

This chapter presented the results of the study and the steps in the development of models for assessing the changes in long-term outcomes following motorcycle injuries in Vietnam. The results showed that health outcomes improved over 12 months post-injury despite the ongoing disability. Females, participants aged over 55 years and those with a higher injury severity score were more likely to have poorer health outcomes over the time of the study.

Chapter 5. Discussion, recommendations and conclusion

Overview of the chapter

The research aimed to gain a better understanding of the characteristics of, and risk factors for, motorcycle injuries, and the long-term health outcomes following motorcycle crashes in Ho Chi Minh City (HCMC), Vietnam, using a prospective longitudinal design. To date, there is limited published research examining health-related quality of life (HRQoL), pain, functional status and depression among injured adult motorcyclists in Vietnam, and more broadly in low-and middle-income countries (LMICs) where motorcycle injuries and fatalities account for highest burden globally (1). Previous research conducted in high income countries (HICs) has measured some health outcomes (42), at a shorter time point (61) or at one time point after injury (60). This research examined HRQoL, pain, functional status and depression at three time points: before or at the time of injury; at 6 months post-injury; and 12 months post-injury. Measuring the changes in health outcomes before, and at 12 months after sustaining a motorcycle injury has the potential to provide insights into how motorcycle injuries affect long-term wellbeing in adult motorcyclists in HCMC, Vietnam. The findings make a unique contribution to the literature and have the potential to guide health professionals and policy makers regarding rehabilitation programs to improve health outcomes for injured motorcyclists in HCMC, and Vietnam.

This thesis comprises three published papers presented in Appendix B (B1, B2, B3) and a full results chapter that expanded the results of each published paper. This chapter will provide a general discussion of the key findings and how the findings contribute to motorcycle injury prevention in HCMC, Vietnam and, more broadly, LMICs. Briefly, the first paper entitled '*Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam*' describes the characteristics and severity of motorcycle crashes resulting in hospitalisation of motorcyclists. Paper 2, '*Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam*', reports the long-term health outcomes in terms of health-related quality of life over 12 months post-injury. Paper 3 entitled '*Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam*', reports on changes in pain, functional status and return to work/study over 12 months post-injury in motorcyclists admitted to hospital in HCMC, Vietnam. Finally, a discussion on the changes in levels of depression 12 months post-injury is presented as part of the discussion ; these are an unpublished set of results contributing to the overall body of work undertaken in this research. The limitations and strengths of this doctoral study will also be presented in this chapter. Finally, the chapter will conclude with recommendations, implications for future research and practice, and a conclusion.

5.1 Crash characteristics, injury outcomes and risk factors associated with injury severity for motorcycle crashes resulting in hospitalisation in Ho Chi Minh City (HCMC).

Demographic and crash characteristics

This study highlighted the demographic characteristics of riders injured in motorcycle crashes in Vietnam and potentially other LMICs. These characteristics included being young, male, and an office worker/student. Young males were over-represented (67%) among hospitalised motorcyclists in Vietnam. This is consistent with previous research, which found risk-taking characteristics of male motorcyclists including drinking while riding (3, 133), speeding (170) and aggression (163, 274) may contribute to an increased risk of motorcycle injury. However, the proportion of males involved in motorcycle crashes in this study was lower compared with studies in HICs (200, 275). The difference in type of motorcycle and purpose of motorcycle use in HICs may explain the higher proportion of males than females in crashes in these countries. Motorcycles in HICs such as the United States, Australia, and Europe have an engine capacity greater than 250cc, and are used to travel longer distances and as part of leisure activities. In contrast, the majority of motorcycles in LMICs are ‘scooters’ with engine capacities ranging from 50cc to 250cc and are used to carry out daily functions such as commuting to work and school (3, 90, 276).

The study found that one in five hospitalised motorcyclists in Vietnam were students and office workers. The result contrasts with studies in Australia (277) where students are rarely involved in crashes. The differences in these findings may in part be due to differences in road use patterns and road infrastructure between the two countries. Irrespective of road-related factors, young people often take risks related to road safety including distractive behaviours such as using a mobile phone, or disobeying traffic rules (157). The findings demonstrate the need for targeted prevention strategies that highlight the potential serious consequences of risk-taking whilst riding a motorcycle among this group of people. A sustained, well-funded multi-strategy approach that embraces awareness raising, education advocacy and legislation is essential to ensure the road safety laws are understood and adhered to by all road users in Vietnam.

The study also found that one in four hospitalisations were related to speeding (26%). Despite the introduction of legislation to prevent speeding by the Vietnamese Government (10), enforcement remains a challenge. The use of automated enforcement methods to detect speeding vehicles has proven somewhat effective (1). However, motorcycles have a rear number plate only, making the issuing of fines difficult. Accordingly, the introduction of rear facing cameras needs to be considered as one potential solution. Together with visible enforcement (e.g., on the spot roadside checks by police), automated enforcement may bring about a reduction in speeding which may translate to a reduction in crashes and subsequent hospitalisations. There must be more investment in technology and modern equipment.

Interestingly, this study found that four out of ten of hospitalised motorcyclists did not have a valid motorcycle licence at the time of the crash. The reasons for holding an invalid motorcycle licence may include: licence suspension; cancellation; disqualification; riding a motorcycle on a car licence; and/or not obtaining a motorcycle licence. Reviewing the enforcement of licensing laws and penalties for lack of a licence must be implemented regularly. Moreover, the probationary licence should be considered as a mean of regulating riding licence for new riders while offering additional training for commercial riders (e.g motorcycle taxi) (168).

A crash between two motorcycles was the most common mechanism of injury, followed by a motorcycle crashing with a car or truck. Previous research has found that crashes between a motorcycle and motor vehicles (278); and between motorcycle and pedestrians were the most common (141, 279). As expected, a crash involving two motorcycles is the most frequent crash type, as 95% of transportation is by motorcycle in Vietnam. Furthermore, due to the lack of designated lanes for motorcycles on Vietnam roads, motorcycles generally use the same lanes as heavy vehicles for example cars or trucks placing them at increased risk (10). Single vehicle crashes due to hitting an object, animal and pedestrian or the motorcyclist losing control accounted for more than one in four motorcycle crashes. The reasons for this may include: motorcycle riders travelling under the influence of alcohol (129) and/or drugs (130, 133), poor road surface quality (168) and/or lack of lighting for a motorcyclist to be seen on the road (129). In addition, the lack of pedestrian walkways on most roads has been cited as a reason for crash involvement of pedestrians and motorcyclists in Vietnam and other LMICs (279, 280). These findings highlight road infrastructure, road design and maintenance as priority areas for improvement in HCMC, Vietnam. A call to action would include removing environmental hazards, installing pedestrian paths, enhancing street lighting, constructing motorcycle lanes, and ensuring that roads are well maintained to improve safety for motorcyclists and pedestrians alike (10, 168).

Injury severity and outcomes

The study found motorcycle injuries represented a substantial public health issue in Vietnam with nearly one in fifteen participants sustaining a severe injury in a motorcycle crash. In this study, motorcyclists who suffered serious injuries were excluded; notably, the proportion of severe injury was relatively high compared to other HICs such as Alabama (6.8%) (281). This was a similar proportion to other LMICs such as Taiwan (163) or Tanzania (279), further highlighting the burden of motorcycle injuries in LMICs.

Previous research has found that injuries to the extremities and traumatic brain injuries were the most common motorcycle-related injuries (3, 163, 275, 280). Similarly, this study found injuries to the extremities accounted for more than half of injured motorcyclists. These injuries occur in body regions less protected by clothing (282). Whilst the use of protective clothing may reduce the impact and the severity of the injury, they can be uncomfortable in a hot climate making compliance poor (280). Traumatic brain injuries were the second common motorcycle-related injuries in this study, accounting for more than one-third of injured motorcyclists. Although 87% of respondents reported wearing a helmet at the time of their crash, improper motorcycle helmet use (e.g., helmet came off or did not have their helmet fastened) may partly explain why 13% of traumatic brain injuries occurred among the motorcyclists. In addition, the quality of the helmets available in LMICs such as Vietnam is often questionable (120, 122). The findings indicate the need for continued public health strategies that include a combination of awareness raising, education on how recognise and purchase a good quality helmet that meets international safety standards, and legislation measures to ensure that the use of protective clothing, specifically helmets, becomes accepted practice. Increasing awareness via media campaigns coupled with regular and visible enforcement activities is one of the most effective ways to improve behavioral risk factors for road traffic injury (112).

The findings on length of stay in the hospital (LoS) following a motorcycle crash in Vietnam are consistent with a study conducted in Taiwan, a neighboring country of Vietnam, where motorcycles are mainly used for transportation (163). However, LoS are shorter than those reported in HICs such as Australia (283). This may be explained in part by the difference in motorcycle types and road infrastructure in these regions. Australia is a geographically vast country with wide roads. Australian motorcyclists are more likely to ride a motorcycle at high speed which can lead to serious injury and longer LoS in the hospital (165, 167, 284). In contrast, LMICs, such as Vietnam or Taiwan, often use light motorcycles and have narrow streets and congested road network that can lead to high risk of crash but less severe injuries (165). In addition, hospital facilities and specialist injury units, accommodation, access to rehabilitation services and fees for service vary between HICs and LMICs (238) which may have impacted on the length of time an injured motorcyclist remained in the hospital. The combination of these factors may explain a shorter LoS in the HCMC context.

Risk factors for motorcycle injuries

The results found unlicensed riders were significantly more likely to having higher injury severity among hospitalised motorcyclists. This is consistent with previous research that reported that when involved in a crash, unlicensed riders are more likely to be more seriously injured than licenced riders (285). Licencing programs provide theoretical knowledge and practical skills for novice riders. During the programs, riding experience and skills can be developed gradually over time in low-risk environments (90), leading to riders who have better control of their motorcycle. In addition, unlicensed motorcyclists may be more likely to engage in risky riding behaviour such as speeding and non-use of helmets (166, 286).

Crashing at night-time was significantly associated with increased injury severity among hospitalised motorcyclists in this study, which is consistent with most reports (110, 286-288). Reasons may include the influence of speed and alcohol at night both of which have been found to be associated with higher injury severity (3, 110, 117). This finding supports the important role of legislation and enforcement strategies to target key risk factors such as managing speed and drink-driving to reduce motorcycle injuries and deaths. From 1 January 2020 (after the data for this study was collected), the Vietnamese government changed national drinking laws with the aim to reduce the harmful effects of alcoholic beverages. The legal BAC limit has been changed from 0.05 g/dl to 0.00 g/dl (289). Currently, data on the effectiveness of this new law is not available, however the effectiveness of changing legal BAC limits has been found in Brazil (290) and Taiwan (291). The effects of lowering the legal BAC limit in Vietnam will depend on the level of enforcement, fines, public acceptance and willingness to comply all of which will be an important component of future research.

5.2 Change in Health-related Quality of Life after (HRQoL) over one year motorcycle injury and predictors

To date there is a dearth of information about the HRQoL among injured motorcyclists in LMICs. This study contributes to a small body of literature about the change in HRQoL for motorcyclists involved in crashes in LIMCs. Although the results cannot be directly compared to the results of previous studies, it is interesting that the trend of change over time in this study are similar to the findings of previous studies in HICs, e.g., United States and Europe (20, 292). This study found that HRQoL scores increased overall between 6 and 12 months post-injury and they did not return to the baseline scores at the 12 month follow-up. This reflects the impact of motorcycle injuries on the health of the populations. However, the size of the reduction in the Physical Component Scores (PCS) of the SF12 in our study was more pronounced than in the study conducted in the United States (292). The difference in the results is probably due to injured patients in HICs having earlier and better access to treatment and rehabilitation services leading to better recovery post-injury. This study highlights the importance of screening and treating physical comorbidities as part of a holistic approach to injury management, and in a timely manner.

This study found that the Mental Component Scores (MCS) of the SF12 changed very little over time. Compared to pre-injury, the MCS reduced significantly by 4.3 points at 6 months post-injury, however the MCS increased by 1.27 points at 12 months which was not significant. This finding is consistent with previously published research (292, 293). The reasons for the small changes in mental well-being may be because the majority of participants in this study suffering mild and moderate injuries. To further the understanding of the effect of injury in a motorcycle crash on mental health, future research should also include all levels of injury severity.

This study also found that females reported being less satisfied with their quality of life than males post injury. Notably, previous studies reported females were more vulnerable to loss of HRQoL at 12 months post-injury (22, 54, 294). Differences in social roles and family responsibilities between males and females may play an important part in recovery and impact on females' quality of life following a traffic injury. For example, it can be posited that females in Vietnam are predominantly responsible for household tasks and provide the majority of child-care in the family unit (249, 295). Therefore, there is an expectation that they will continue to contribute to the household chores and child-care despite their injuries. As these are part of the measurement of quality of life, females may be disproportionately affected (220, 296).

Age is also an important predictor of HRQoL among injured motorcycle riders. Increasing age was significantly associated with a reduction in both physical and mental health scores, which is consistent with previous studies (297-299). It has been suggested older adults may be more likely to have a longer recovery time than younger adults, and this may cause disruption to their occupation, and/or social contact resulting in a poorer HRQoL (9, 14). Moreover, the literature has indicated that older people with a higher level of physical activity were more likely to have an increased HRQoL before injury (297, 300). This finding may reflect the importance of rehabilitation programs and social support in the recovery period post-injury, especially among older adults. This is of particular importance for future health system planning, given the aging population and the need to anticipate rehabilitation service demand and minimise the burden on the public health system.

5.3 The proportion of return to work/ study (RTW/study), functional status, pain after one year motorcycle injury and predictors

Return to work/study and predictors

At 6 months post-injury, 60% of motorcyclists returned to work/study; at 12 months, eight out of ten (82%) motorcyclists returned to work/study. These proportions are considerably lower than those previously reported in HICs such as Australia (61) (87% at 6 months post-crash) and the United States (60) (86% at 12 months post-injury). The reason for lower proportions of RTW/study in the current study may be due to late access to treatment and rehabilitation services, which is related to the financial capacity of LMICs compared to HICs (238, 301). Although the study demonstrated the proportion of RTW/study among motorcyclists involved in a motorcycle crash in Vietnam increased over the 12 months period, a substantial proportion of injured motorcycle riders were yet to RTW /study at 12 months post-injury, highlighting the ongoing burden of motorcycle injuries in Vietnam and LMICs. Delayed return to work results in adverse social and economic consequences for the individual, family and society in term of care provision, sick leave, presenteeism, absenteeism, and disability (1, 267, 302).

When examining risk factors for delayed RTW/study among motorcycle injury population, this study found that lower education levels and older age were significantly associated with delayed RTW/study. The results are consistent with previous studies in both HICs and LMICs (46, 87, 294, 303). This may be explained by a low education level is more likely to be associated with a lower income. That may increase the difficulty in accessing expensive treatment or rehabilitation services, and ultimately increase time to recovery and RTW (232). In addition, those people with a low income are more likely to receive low quality emergency and in-hospital care, being less likely to RTWand more likely to become dependent on others (87). The longer length of stay in the hospital has been cited as a predictor of delayed RTW/study among motorcycle injury population (236). This can be explained by a need for more time in rehabilitation, or the type of work previously undertaken by the injured motorcyclist prevents or delays the RTW/study. Therefore, there is a requirement for timely in-patient access to rehabilitation services and easy access to low or no cost out-patient access immediately following discharge to ensure the timeframe to RTW/study is minimized albeit consistent with the injuries sustained. Going forward, RTW/study post-injury is a complex issue and requires careful planning of the allocation of resources by government, health care providers and those injured.

Change in functional status and predictors

The results of this study highlight the impact of motorcycle crashes on functional status of injured motorcyclist over 12 months post-injury. This study found that functional status of injured motorcyclists improves over time but the mean functional score, measured by the Lawton Instrumental Activities of Daily Living scale (LADL), at 12 months post-injury was 6.9, out of a perfect (no limitation) score of 8, reflecting residual functional limitations. Our findings confirmed the result of a study by Forman (2012) (200) conducted in eight European countries which reported that approximately 46% of motorcycle users had functional limitations at 12 months post-injury (200). This suggests that motorcyclists who are injured, even when they are riding a motorcycle with a lower engine capacity, exhibit functional limitations up to 12 months post-injury This reflects importance of measuring functional outcomes in motorcycle injuries in quantifying the burden of road injuries.

The results of improvement in physical function over 12 months follow-up in this study contrasts to a study of two-wheel road users in three European countries. This study reported no change in physical function between 6 and 12 months post-injury but physical function was reported to be better than at baseline (42). The difference in results may be due to the exclusion criteria of this study, which excluded very seriously injured motorcyclists. Future research should investigate all level of injuries (209).

When examining predictors of change in functional status, the findings demonstrated that lower functional status among those aged over 55 years and female, was consistent with previous studies (46, 48, 211). These findings have identified the recovery of injured motorcyclist's subgroups. This work played an important role for targeting group interventions to improve outcomes, and provided information about likely prognosis and demand for services.

Change in pain intensity scores and predictors

Although pain is a common symptom following traumatic injury, pain intensity following a motorcycle crash has received little attention in the literature. To date, there has been no investigation on changes in pain using rating scales (e.g., Numeric Rating Scale (NRS)) for injured motorcycle riders over a 12 month period. There were some studies that assessed pain at 6 months (61) and 12 months using different tools (60). As a result, the results of this study make a timely contribution to the literature but cannot be directly compared to previous studies on motorcycle injuries.

This study found that the reported pain of hospitalised motorcyclists reduced over the 12 months follow-up period. This is consistent with findings from previous studies on RTIs (35, 37). It is striking that, at 12 months post-injury, the pain intensity score indicated residual prolonged pain. This may indicate a lack of recovery, suggesting the injuries sustained from the motorcycle crash resulted in long-term morbidity. As previously outlined, this could be addressed using in-patient and/or out-patient targeted early intervention, such as pain management and mobility training to improve long-term outcomes.

As with previous research on RTIs, this study found that older age, lower education and being male were associated with higher pain levels over time (33, 35, 304). This study found an association between better physical health (indicated by higher the SF-12 PCS scores) and improvements in pain intensity over time. Injured people who were more sedentary due to difficulties with mobility, reported increased pain related to their injury. The finding supports research showing that an inability to exercise can exacerbate pain (305). Poorer mental well-being (indicated by lower SF-12 MCS scores) was significantly associated with higher pain intensity over the 12 months follow-up, consistent with the published literature showing the influence of psychological distress in chronic pain. This highlights the needs for appropriate rehabilitation programs for both mental well-being and physical health in post-injury care.

Education status has previously been found to be associated with chronic pain in RTIs survivors at 12 months post-injury (35, 214). The current study confirms this relationship among hospitalised motorcyclists. A higher education level can be a marker for higher income which in turn may affect treatment compliance and access to rehabilitation programs (214, 306). Furthermore, educational status may reflect some underlying cognitive process that influences the perception of pain (229, 307).

One unexpected finding in this study was that injury severity measured by ISS was not significantly associated with pain intensity scores. It would be expected that more severe injuries would have a higher pain intensity score. There are a few possible explanations. Firstly, severely injured patients were excluded from this study due to their capacity to respond to questionnaire at the time of data collection. Furthermore, the association between injury severity and pain is still controversial (34, 306). This is an area for further research.

5.4. Change in depression and predictors

Finally, the detailed findings of change in depression were presented in Section 4.9 of results chapter. This study found depression among hospitalised motorcyclists increased significantly at 6 months after the motorcycle injury compared with pre-injury and it dropped by 12 months post-injury. However, levels at 12 months were still higher than the level of depression before the motorcycle injury. These findings contrast with previous studies in HICs that found that depression reduced over time following injury (40) or that there were no significant changes in depression between at the time of admission and 6 or 12 months follow-up period (42). This may be explained by the effectiveness of early intervention programs to prevent depression after injury in HICs (231, 308). Depression among hospitalised motorcyclists in Vietnam may also arise partly due to the difficulty of coping with the immediate consequences of the event (41, 309). This highlights the need for coordinated responses by health professionals that includes appropriate referrals for physical and psychological counselling and ongoing mental health support and services, rather than focusing exclusively on the presenting physical injury.

A longer stay in hospital was found to be associated with a higher depression score. Patients who are hospitalised for longer may have difficulty RTW/study and that may lead to poor mental health (310). This result was consistent with previous research (49). Furthermore, financial problems related to a longer length of stay in hospital have also been cited as leading to depression (231). Future research between LoS and depression is required to gain a better understanding of the relationships and inform the implementation of appropriate depression management programs for injured patients both whilst in hospital, and upon discharge.

5.5. Strengths and Limitations

There were several strengths of the study. Most importantly, this was the first longitudinal study to examine a range of health outcomes following motorcycle injuries in HCMC, Vietnam and other parts of LMICs. The thesis contributes to the small body of literature on motorcycle injury over a 12-month period, providing better estimates of the burden of motorcycle injuries in Vietnam and other LMICs. The study also achieved a high response rate over time (85.5% at 6 months and 81.3% at 12 months follow-up), a large sample size, and used objective injury data obtained from the medical record review. Another important strength of this study was the use of a longitudinal design, that was able to change in long-term outcomes by using multilevel analysis method. Multilevel modelling was used to explain variation in outcomes by participant baseline characteristics, taking into account the use of three time points.

There were a number of limitations to this study. This was a cohort study in the Gia Dinh hospital, one of the largest trauma and orthopaedic hospitals in southern Vietnam, located in Binh Thanh district of HCMC, Vietnam. However, as participants were selected from one hospital, it is not a population-based study, limiting the generalisability of the findings. The recruitment method relied on a single researcher identifying, recruiting, enrolling, and interviewing participants. It is also noted that the same questions were asked on three occasions and this may have affected the quality of the responses from some participants.

The measures collected in this thesis were limited to self-report measures and were susceptible to recall or social desirability bias. This study included an objective measure of alcohol use, BAC; however, BAC was excluded as a predictor of injury severity due to a high proportion of missing data for this variable. Another limitation of this study was that the study excluded very seriously injured motorcyclists because participants needed the cognitive capacity to answer the questions at baseline data collection. This could have led to an underestimation of the adverse health outcomes in motorcycle crash injured riders. This could also have led to not finding an association between helmet wearing and injury severity.

5.6 Recommendations for Future Research

The findings of this study highlight areas for future consideration for the reduction of motorcycle injuries as well as improvement the long-term outcomes following motorcycle injuries in HCMC and potentially other LMICs. A number of recommendations that should be included in future research into motorcycle crashes in Vietnam and other LMICs are discussed below:

Further investigation is needed to evaluate the multiple factors leading to motorcycle injuries. This work should focus on evaluating behavioural, environmental and vehicle-related factors. This would provide a comprehensive picture about motorcycle injuries, allowing development of priority areas for action.

Future studies should ideally include all levels of injury severity (mild, moderate and severe) to ensure that the findings can be generalised to the whole injured population. This may involve using Emergency Department presentations so that less serious injured motorcyclists are included. Alternate forms of data collection (such as audit police reports and reports by family members) so that data on more seriously injured motorcyclists, who cannot be interviewed, can be included.

In term of evaluating the long-term health outcomes of motorcycle crashes, future studies should follow-up participants for a longer period than one year to confirm our study findings before developing intervention programs for (physical) rehabilitation and the mental health consequences of injury, including dealing with chronic pain, loss of normal roles due to reduced function and depression.

The barriers to accessing mental health care among injured motorcyclists should also be investigated. This would generate data to inform program and policy interventions to enable the early identification, and in turn earlier intervention, of mental health problems resulting from injuries relating to motorcycle crashes.

Future consideration needs to be given to the financial burden of motorcycle injuries together with the health insurance schemes that exist in Vietnam and the level of reimbursement. In 2000, a financial autonomy policy was rolled out in Vietnamese government hospitals to generate additional resources. The policy has helped hospitals improve their financial sustainability however there may be some evidence of the over use of tests and expensive medications (311). Therefore, an exploration of the medical care costs paid out-of-pocket by injury patients in a low-income setting would be worthwhile. Evidence of the high total costs of medical and rehabilitation services would highlight the need for comprehensive injury prevention programs, not only to protect the Vietnamese community from the financial burden but also the losses in mental health and quality of life that result from a motorcycle crash and the injuries sustained.

5.7 Implications for Future Policy and Practice

The findings of this research have the potential to have a positive impact on policy and road safety practice in Vietnam. While the Vietnamese Government have introduced legislation related to the wearing of motorcycle helmets and alcohol limits for motorcycle riders and implemented infrastructure changes to improve road and pedestrian safety, these are only part of a multi-strategy and multi- agency injury prevention approach. It is key to adopt a comprehensive conceptual framework to guide the development of road safety strategies to ensure they are complete, effective and efficient in a LMIC setting.

The Safe Systems approach is an internationally recognised framework that originated in Sweden in 1995 as "Vision Zero" (312). The framework has been widely adopted in countries including Australia, recognises that road deaths are unacceptable and should be avoided, and that humans make errors, therefore a safe road system must be designed to prevent fatal crashes. The framework includes five 'pillars': safe roads; safe speeds; safe vehicles; safe people; and post-crash care (168). Notably, 'safe people' is only one of the five pillars.

Safe roads

Safe roads includes road infrastructure and transport networks (1, 10, 312). This study has identified the majority of motorcycle crashes occurred 6pm to midnight and motorcycle injuries were more serious at these times. Improvements in street lighting (10, 313), especially in high-risk areas such as intersections, and road design including roadway curvature is a priority to mitigate the severity of motorcycle injuries in Vietnam. In addition, motorcycle lanes should be separated from the general traffic with a physical barrier or structure (313).

Safe speeds

Speed is an important factor in influencing motorcycle crashes and motorcycle injury severity (142, 143). While, Vietnam has speed legislation for motorcycles, motorcyclists do not monitor their speed when riding (10). The use of traffic calming devices such as roundabouts and speed bumps (168) to moderate the speed of motorcycle is needed. Furthermore, the use of guideposts and line marking to provide visual cues to riders to moderate their speed are recommended. Modern equipment combined with technology such as a camera with a Global Positioning System (GPS) attached to a motorcycle to monitor speed is another option. This must be linked to traffic control centers (168).

Safe vehicles

The technical safety of a motorcycle is an important factor for reducing motorcycle crashes (1), thus technical safety standards for motorcycles (e.g., wired head and tail lights; anti-lock braking systems) must be maintained. There are more than 261 technical checking centers in Vietnam, however these are only available for the inspection of cars (10). Currently, motorcycles and mopeds are not subject to periodic testing (10). Going forward, dedicated motorcycles and mopeds centers for technical testing and quality inspection are needed to reduce motorcycle crashes related to technical failure.

Safe people

Safe people represents rider behaviours targeting key risk factors including drink-driving, motorcycle helmet use, motorcycle mobile phone use, motorcycle rider training and licensing (1). This study found drinking, using a mobile phone, not having a licence and not wearing a helmet played a direct role in motorcycle injuries and severity. Encouraging riders to take responsibility for their personal safety via public awareness campaigns, education and skills training, and public service announcements regarding road safety legislation (10), along with enforcement remains vital (1).

Post-crash care

The WHO has mentioned emergency care as a core component of post-crash care (1). In HCMC, Vietnam, emergency medical activities ("115" emergency aid centres and 24 hour satellite stations) have been established for timely intervention after traffic crashes. This could save lives, restore functional living, limit long-term repercussions and reduce the cost and burden on families and society. However, limited resources (e.g., a shortage of personnel and ambulances) have seriously affected the quality of service and nine out of ten people involved in road crashes in Vietnam are collected by other road users or are transported by taxi, motorcycles or bicycles to a medical facility or hospital (10, 314). To mitigate the short- and long-term adverse health outcomes following road crashes, establishment of emergency stations every 15km is recommended to ensure those involved in crashes are reached within 10 to 15 minutes of the incident (10).

The long-term outcomes following motorcycle injuries, the role of, and access to rehabilitation programs for injured motorcyclists should be given careful consideration. There is a requirement for the injured motorcyclist irrespective of the severity to be able to access rehabilitation programs immediately upon discharge, and for a prescribed follow-up period. This may include access to services such as pain control, physiotherapy and occupational therapy services with the ultimate goal of returning the injured person back to their previous level of function and return to work, study or employment and home duties as soon as possible.

5.8 Conclusion

This prospective longitudinal study has provided insights into the burden of motorcycle injuries in HCMC, Vietnam. This was the first study to identify characteristics and risk factors for hospitalised motorcyclists involved in motorcycle crashes. The motorcycle behaviours that contributed to those involved in motorcycle crashes included unlicenced motorcycle riders, speeding, not wearing a helmet, and using a mobile phone. Awareness raising and education on road safety laws should be implemented on a regular basis to make road users aware of the importance and benefits of abiding by road safety laws. Unlicenced motorcycle riders and crashes at night were associated with increased injury severity among hospitalised motorcyclists. The study highlights how motorcycle injuries affect the long-term health outcome of hospitalised motorcyclists. Injury interventions and safety strategies targeting risky behaviours, safe speeds, safe motorcycles, and post-crash care have the potential to reduce motorcycle injuries and improve the long-term health outcomes among hospitalised motorcyclists. Finally, recommendations from this research has the potential to reduce the risk of motorcycle injuries and improve the long-term health outcomes following motorcycle injuries in Vietnam and other LMICs.

References

1. World Health Organization. Global status report on road safety 2018. France; 2018. Report No.: Licence: CC BYNC-SA 3.0 IGO.

2. Gabbe BJ, Cameron PA. Importance of functional and quality of life outcomes in trauma. The Surgeon. 2013;11(2):114.

3. Lin M-R, Kraus JF. A review of risk factors and patterns of motorcycle injuries. Accident Analysis & Prevention. 2009;41(4):710-22.

4. Rahman N, Baharuddin K, Mohamad S. Burden of motorcycle-related injury in Malaysia. International Journal of Emergency Medicine. 2015;8(1):1-6.

5. Le LC, Blum RW. Road traffic injury among young people in Vietnam: evidence from two rounds of national adolescent health surveys, 2004-2009. Glob Health Action. 2013;6:1-9.

6. Ngo AD, Rao C, Phuong Hoa N, Hoy DG, Thi Quynh Trang K, Hill PS. Road traffic related mortality in Vietnam: Evidence for policy from a national sample mortality surveillance system. BMC Public Health. 2012;12:561-.

7. Haworth N. Powered two wheelers in a changing world-challenges and opportunities. Accident; analysis and prevention. 2012;44(1):12-8.

8. Shinar D. Safety and mobility of vulnerable road users: pedestrians, bicyclists, and motorcyclists. 2012. p. 1-2.

9. Alexiou KI, Roushias A, Varitimidis SE, Malizos KN. Quality of life and psychological consequences in elderly patients after a hip fracture: a review. Clinical interventions in aging. 2018;13:143-50.

10. Economic and Social Commission for Asia and the Pacific. Road Safety Performance Review Viet Nam. Bangkok, Thai Lan: United Nations; 2018.

11. Mai PX, editor The road safety situation in Vietnam. Southeast Asia Safer Mobility Symposium 2013; 2013; Melaka, Malaysia.

12. Hung DV, Stevenson MR, Ivers RQ. Barriers to, and factors associated, with observed motorcycle helmet use in Vietnam. Accid Anal Prev. 2008;40(4):1627-33.

13. MacKenzie EJ, Rivara FP, Jurkovich GJ, Nathens ABMD, Frey KP, Egleston BL, et al. A National Evaluation of the Effect of Trauma-Center Care on Mortality. The New England Journal of Medicine. 2006;354(4):366-78.

14. de Jongh MAC, Kruithof N, Gosens T, van de Ree CLP, de Munter L, Brouwers L, et al. Prevalence, recovery patterns and predictors of quality of life and costs after non-fatal

injury: the Brabant Injury Outcome Surveillance (BIOS) study. Injury Prevention. 2017;23(1):59.

15. Gabbe BJ, Simpson PM, Sutherland AM, Wolfe R, Fitzgerald MC, Judson R, et al. Improved functional outcomes for major trauma patients in a regionalized, inclusive trauma system. Annals of surgery. 2012;255(6):1009-15.

16. Hoffman K, Cole E, Playford ED, Grill E, Soberg HL, Brohi K. Health Outcome after Major Trauma: What Are We Measuring? PLoS One. 2014;9(7).

17. Ardolino A, Sleat G, Willett K. Outcome measurements in major trauma--results of a consensus meeting. Injury. 2012;43(10):1662-6.

18. Sleat GKJ, Ardolino AM, Willett KM. Outcome measures in major trauma care: a review of current international trauma registry practice. Emergency Medicine Journal : EMJ. 2011;28(12):1008.

19. Yin S, Njai R, Barker L, Siegel PZ, Liao Y. Summarizing health-related quality of life (HRQOL): development and testing of a one-factor model. Population health metrics. 2016;14:22.

20. Gabbe BJ, Sutherland AM, Hart MJ, Cameron PA. Population-based capture of long-term functional and quality of life outcomes after major trauma: the experiences of the Victorian State Trauma Registry. The Journal of trauma. 2010;69(3):532-6.

21. Rainer TH, Yeung HH, Gabbe BJ, Yuen KY, Ho HF, Kam CW, et al. A Comparison of Functional Outcome in Patients Sustaining Major Trauma: A Multicentre, Prospective, International Study. PLoS One. 2014;9(8):e103396.

22. Rissanen R, Berg H-Y, Hasselberg M. Quality of life following road traffic injury: A systematic literature review. Accident Analysis & Prevention. 2017;108:308-20.

23. Heura Llaquet B, Montmany S, Rebasa P, Secanella M, Alberich M, Navarro S. Analysis of quality of life after major trauma: a spanish follow-up cohort study. European Journal of Trauma and Emergency Surgery. 2018:1-9.

24. Kenardy J, Heron-Delaney M, Hendrikz J, Warren J, Edmed SL, Brown E. Recovery trajectories for long-term health-related quality of life following a road traffic crash injury: Results from the UQ SuPPORT study. Journal of Affective Disorders. 2017;214:8-14.

25. Polinder S, Haagsma JA, Belt E, Lyons RA, Erasmus V, Lund J, et al. A systematic review of studies measuring health-related quality of life of general injury populations. BMC Public Health. 2010;10:783.

26. Dinh MM, Cornwall K, Bein KJ, Gabbe BJ, Tomes BA, Ivers R. Health status and return to work in trauma patients at 3 and 6 months post-discharge: an Australian major

trauma centre study. European Journal of Trauma and Emergency Surgery. 2016;42(4):483-90.

27. Fu Xy, Chen M, Yu T, Liu Xk. Health-related quality of life of trauma patients after intensive care: a 2-year follow-up study. European Journal of Trauma and Emergency Surgery. 2011;37(6):629-33.

28. Gabbe BJ, Simpson PM, Sutherland AM, Wolfe R, Lyons RA, Cameron PA. Evaluating time points for measuring recovery after major trauma in adults. Annals Surgery. 2013;257(1):166-72.

29. Meerding WJ, Looman CW, Essink-Bot ML, Toet H, Mulder S, van Beeck EF. Distribution and determinants of health and work status in a comprehensive population of injury patients. The journal of trauma. 2004;56(1):150-61.

30. Littleton SM, Cameron ID, Poustie SJ, Hughes DC, Robinson BJ, Neeman T, et al. The association of compensation on longer term health status for people with musculoskeletal injuries following road traffic crashes: emergency department inception cohort study. Injury. 2011;42(9):927-33.

31. Hirabayashi K, Takayama S. [Persistent chronic pain following traffic accident]. Masui The Japanese journal of anesthesiology. 2010;59(11):1350-6.

32. Rosenbloom BN, Khan S, McCartney C, Katz J. Systematic review of persistent pain and psychological outcomes following traumatic musculoskeletal injury. Journal of Pain Research. 2013;6:39-51.

33. Tecic T, Lefering R, Althaus A, Rangger C, Neugebauer E. Pain and quality of life 1 year after admission to the emergency department: factors associated with pain. European Journal of Trauma and Emergency Surgery. 2013;39(4):353-61.

34. Velmahos CS, Herrera-Escobar JP, Al Rafai SS, Chun Fat S, Kaafarani H, Nehra D, et al. It still hurts! Persistent pain and use of pain medication one year after injury. American journal of surgery. 2019.

35. Gopinath B, Jagnoor J, Kifley A, Nicholas M, Blyth F, Kenardy J, et al. Differential Predictors of Pain Severity Over 12 Months Following Noncatastrophic Injury Sustained in a Road Traffic Crash. J Pain. 2018;20(6):676-84.

36. Berben SAA, Meijs THJM, van Dongen RTM, van Vugt AB, Vloet LCM, Mintjes-de Groot JJ, et al. Pain prevalence and pain relief in trauma patients in the Accident & Emergency department. Injury. 2008;39(5):578-85.

37. Gopinath B, Jagnoor J, Nicholas M, Blyth F, Harris IA, Casey P, et al. Presence and predictors of persistent pain among persons who sustained an injury in a road traffic crash. Eur J Pain. 2015;19(8):1111-8.

38. Rainey EE, Petrey LB, Reynolds M, Agtarap S, Warren AM. Psychological factors predicting outcome after traumatic injury: the role of resilience. The American Journal of Surgery. 2014;208(4):517-23.

39. Wiseman T, Foster K, Curtis K. Mental health following traumatic physical injury: An integrative literature review. Injury. 2013;44(11):1383-90.

40. Wiseman TA, Curtis K, Lam M, Foster K. Incidence of depression, anxiety and stress following traumatic injury: a longitudinal study. Scandinavian journal of trauma, resuscitation and emergency medicine. 2015;23:29.

41. Bryant RA, O'Donnell ML, Creamer M, McFarlane AC, Clark CR, Silove D. The Psychiatric Sequelae of Traumatic Injury. The American Journal of Psychiatry. 2010;167(3):312-20.

42. Papadakaki M, Tsalkanis A, Sarris M, Pierrakos G, Eleonora Ferraro O, Stamouli M-A, et al. Physical, psychological and economic burden of two-wheel users after a road traffic injury: Evidence from intensive care units of three EU countries. Journal of Safety Research. 2018;67:155-63.

43. Van Huy N, Dunne MP, Debattista J. Factors Associated with Depression Among Male Casual Laborers in Urban Vietnam. Community Mental Health Journal. 2015;51(5):575-84.

44. Thao Thi Thu N, Ngoc Thi Minh N, Manh Van P, Han Van P, Nakamura H. The four-domain structure model of a depression scale for medical students: A cross-sectional study in Haiphong, Vietnam. PLoS One. 2018;13(3).

45. Dat LV. Vietnam National Road Safety Goals and Action plan Oppotunities and Challenges. 2015.

46. Gabbe BJ, Simpson PM, Harrison JE, Lyons RA, Ameratunga S, Ponsford J, et al. Return to Work and Functional Outcomes After Major Trauma: Who Recovers, When, and How Well? Ann Surg. 2016;263(4):623-32.

47. Fitzharris M, Fildes B, Charlton J, Kossmann T. General Health Status and Functional Disability Following Injury in Traffic Crashes. Traffic Injury Prevention. 2007;8(3):309-20.

48. Holtslag HR, van Beeck EF, Lindeman E, Leenen LP. Determinants of long-term functional consequences after major trauma. J Trauma. 2007;62(4):919-27.

49. Silva-Nash J. Depression, Functional Dependence, Quality of Life and Return to Work Among Hospitalized Burn Patients in Wuhan, China [M.S.]. Ann Arbor: Duke University; 2019.

50. Soberg HL, Finset A, Bautz-Holter E, Sandvik L, Roise O. Return to work after severe multiple injuries: a multidimensional approach on status 1 and 2 years postinjury. The Journal of trauma. 2007;62(2):471-81.

51. Wang V, Fort E, Beaudoin-Gobert M, Ndiaye A, Fischer C, Bergeret A, et al. Indicators of long-term return to work after severe traumatic brain injury: A cohort study. Annals of physical and rehabilitation medicine. 2019;62(1):28-34.

52. Clay FJ, Newstead SV, McClure RJ. A systematic review of early prognostic factors for return to work following acute orthopaedic trauma. Injury. 2010;41(8):787-803.

53. Pélissier C, Fort E, Fontana L, Charbotel B, Hours M. Factors associated with non-return to work in the severely injured victims 3 years after a road accident: A prospective study. Accident; analysis and prevention. 2017;106:411-9.

54. Polinder S, Haagsma JA, Steyerberg EW, van Beeck EF. Health-related quality of life in persons after traumatic brain injury: a systematic review of the literature. The Lancet. 2013;381(S2).

55. Lewis JA, Vint H, Pallister I. Pilot study assessing functional outcome of tibial pilon fractures using the VSTORM method. Injury. 2013;44(8):1112-6.

56. Ha NT, Ederer D, Vo VAH, Pham AV, Mounts A, Nolen LD, et al. Changes in motorcycle-related injuries and deaths after mandatory motorcycle helmet law in a district of Vietnam. Traffic Inj Prev. 2015;19(1):75-80.

57. Olson Z, Staples JA, Mock C, Nguyen NP, Bachani AM, Nugent R, et al. Helmet regulation in Vietnam: impact on health, equity and medical impoverishment. Inj Prev. 2016;22(4):233-8.

58. Nguyen H, Ivers RQ, Jan S, Martiniuk ALC, Li Q, Pham C. The economic burden of road traffic injuries: evidence from a provincial general hospital in Vietnam. Injury Prevention. 2013;19(2):79.

59. Hoang HTM, Pham TL, Vo TTN, Nguyen PK, Doran CM, Hill PS. The costs of traumatic brain injury due to motorcycle accidents in Hanoi, Vietnam. Cost Effectiveness and Resource Allocation : C/E. 2008;6:17-.

60. Hotz GA, Cohn SM, Mishkin D, Castelblanco A, Li P, Popkin C, et al. Outcome of motorcycle riders at one year post-injury. Traffic injury prevention. 2004;5(1):87-9.

61. de Rome L, Ivers R, Fitzharris M, Haworth N, Heritier S, Richardson D. Effectiveness of motorcycle protective clothing: Riders' health outcomes in the six months following a crash. Injury. 2012;43(12):2035-45.
62. Keall MD, Newstead S. Analysis of factors that increase motorcycle rider risk compared to car driver risk. Accident Analysis & Prevention. 2012;49:23-9.
63. NHTSA. Traffic Safety Facts 2015 Data : Motorcycles 2017 [Available from: https://crashstats.nhtsa.dot.gov/#/DocumentTypeList/11.
64. World Bank and Institute for Health Metrics and Evaluation. Transport for health: The Global Burden of Disease from Motorised Road Transport. Seatle, WA: IHME; 2014.
65. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. lancet. 2013;380(9859):2095-128.
66. Alam K, Mahal A. The Economic Burden of Road Traffic Injuries on Households in South Asia. PLoS One. 2016;11(10).
67. Cui MJ, Chen Y, Li Y, Hu J, Zhang XJ. [Risk factors for road traffic injury in agricultural vehicle drivers]. Zhonghua lao dong wei sheng zhi ye bing za zhi = Zhonghua laodong weisheng zhiyebing zazhi = Chinese journal of industrial hygiene and occupational diseases. 2017;35(8):574-7.
68. Peden MM, diPietro G, Hyder AA. Two years into the road safety in 10 countries project: how are countries doing? Injury Prevention. 2012;18(4):279.
69. Hyder AA, Bishai D. Road Safety in 10 Countries: a global opportunity. Traffic injury prevention. 2012;13 Suppl 1:1-2.
70. Hyder AA, Allen KA, Peters DH, Chandran A, Bishai D. Large-scale road safety programmes in low- and middle-income countries: an opportunity to generate evidence. Global public health. 2013;8(5):504-18.
71. Bachani AM, Peden M, Gururaj G, Norton R, Hyder AA. Road Traffic Injuries. In: rd, Mock CN, Nugent R, Kobusingye O, Smith KR, editors. Injury Prevention and Environmental Health. Washington (DC): The International Bank for Reconstruction and Development / The World Bank

(c) 2017 International Bank for Reconstruction and Development / The World Bank.; 2017.
72. World Health Organization. Global status report all road safety 2015. Switzerland; 2015. Contract No.: 16/10.

73. Bachani AM, Zhang XJ, Allen KA, Hyder AA. Injuries and violence in the Eastern Mediterranean Region: a review of the health, economic and social burden. Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit. 2014;20(10):643-52.

74. Wijnen W, Stipdonk H. Social costs of road crashes: An international analysis. Accident; analysis and prevention. 2016;94:97-106.

75. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Inj Prev. 2016;22(1):3-18.

76. Alemany R, Ayuso M, Guillén M. Impact of road traffic injuries on disability rates and long-term care costs in Spain. Accident Analysis & Prevention. 2013;60:95-102.

77. Zakeri R, Nosratnejad S. 172: Economic burden of road traffic injuries in low and middle income countries versus high income countries: a systematic review BMJ Open. 2017;7.

78. Blincoe L, Miller TR, Zaloshnja E, Lawrence AB. New NHTSA Study Shows Motor Vehicle Crashes Have $871 Billion Economic and Societal Impact on U.S. Citizens. Targeted News Service. 2014 05/28/

2014 May 28.

79. Wesson HKH, Boikhutso N, Bachani AM, Hofman KJ, Hyder AA. The cost of injury and trauma care in low- and middle-income countries: a review of economic evidence. Health policy and planning. 2014;29(6):795-808.

80. Silcok B. Guidelines for estimating the costs of road crashes in developing countries. London: Department for International Development; 2003.

81. European Commission. Statistics—Accidents Data 2014 [Available from: http://ec.europa.eu/transport/road_safety/specialist/statistics/index_en.htm.

82. Sullivan R, Edwards P, Sloggett A, Marshall CE. Families bereaved by road traffic crashes: linkage of mortality records with 1971-2001 censuses. Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention. 2009;15(6):364-8.

83. Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al. World Report on Road Traffic Injury Prevention. Geneva: World Health Organization; 2004.

84. Arango-Lasprilla JC, Nicholls E, Villasenor Cabrera T, Drew A, Jimenez-Maldonado M, Martinez-Cortes ML. Health-Related Quality Of Life In Caregivers Of

Individuals With Traumatic Brain Injury From Guadalajara, Mexico. Journal of Rehabilitation Medicine. 2011;43(11):983-386.

85. Foster AM, Armstrong J, Buckley A, Sherry J, Young T, Foliaki S, et al. Encouraging family engagement in the rehabilitation process: a rehabilitation provider's development of support strategies for family members of people with traumatic brain injury. Disability and rehabilitation. 2012;34(22):1855-62.

86. Gillen R, Tennen H, Affleck G, Steinpreis R. Distress, depressive symptoms, and depressive disorder among caregivers of patients with brain injury. The Journal of Head Trauma Rehabilitation. 1998;13(3):31.

87. Sann S. Developing efffective policies to reduce disability from road crashes in Cambodia. Center for Accident Research and Road Safety-Queensland (CARRS-Q): Queensland University of Technology; 2017.

88. Mock C, Quansah R, Krishnan R, Arreola-Risa C, Rivara F. Strengthening the prevention and care of injuries worldwide. Lancet (London, England). 2004;363(9427):2172-9.

89. Jeremy Torr. How many bikes on the planet? 2020 [Available from: https://www.bikesales.com.au/editorial/details/how-many-bikes-on-the-planet-122295/.

90. OECD/ ITF. Improving Safety for Motorcycle, Scooter and Moped Riders Paris: Paris : OECD Publishing; 2015.

91. Association of European Motorcycle Manufactures (ACEM). The MAIDS Report Version 2.0: In-depth investigation of accidents involving powered two wheelers. Brussels: ACEM; 2009.

92. Tahunan L. Royal Malaysia Police Annual Report. Kuala Lumpur: Royal Malaysia Police; 2009.

93. Xiong L, Zhu Y, Li L. Risk Factors for Motorcycle-related Severe Injuries in a Medium-sized City in China. AIMS public health. 2016;3(4):907-22.

94. Pai C-W, Saleh W. An analysis of motorcyclist injury severity under various traffic control measures at three-legged junctions in the UK. Safety Science. 2007;45(8):832-47.

95. Abdul Manan MM, Várhelyi A. Motorcycle fatalities in Malaysia. IATSS Research. 2012;36(1):30-9.

96. General Statistics Office of Vietnam. Area, population and population density by province by Cities, provincies, Year and Items 2019 [Available from: https://www.gso.gov.vn/default_en.aspx?tabid=774.

97. World Bank. GDP (current US$)-Vietnam 2020 [Available from: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=VN.

98. Hung DV, Stevenson MR, Ivers RQ. Motorcycle helmets in Vietnam: ownership, quality, purchase price, and affordability. Traffic Inj Prev. 2008;9(2):135-43.

99. The World Bank. Life expectancy at birth 2017 [cited 2019 05 June]. Available from: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=VN.

100. (CDC-Vietnam) CfDCaPV. Global health-Vietnam 2017 [Available from: https://www.cdc.gov/globalhealth/countries/vietnam/default.htm.

101. Bui LN, Nguyen NTT, Tran LK, Vos T, Norman R, Nguyen HT. Risk factors of burden of disease: a comparative assessment study for evidence-based health policy making in Vietnam. The Lancet. 2013;381:S23.

102. Takashima K, Wada K, Tra TT, Smith DR. A review of Vietnam's healthcare reform through the Direction of Healthcare Activities (DOHA). Environ Health Prev Med. 2017;22(1):74-.

103. World Health Organization. Hospitals in Vietnam 2020 [Available from: https://www.who.int/vietnam/health-topics/hospitals#:~:text=Public%20hospitals%20in%20Viet%20Nam%20are%20divided%20into%20three%20levels,mostly%20located%20in%20urban%20areas.

104. Ivers RQ, Nguyen HT, La QN. Status of road safety and injury burden: Vietnam. Journal of orthopaedic trauma. 2014;28 Suppl 1:S50-S1.

105. Resolution on a number of urgent countermeasures to curb traffic safety and alleviate traffic congestion., Resolution number 32/2007/NQ-CP (2007).

106. Enserink M. Hats off to Vietnam's helmet law. Science. 2014;345(6202):1261.

107. Phong NT. National Road Traffic Safety Strategies: Midterm Report to 2020 and Vision for 2030. Hanoi, Vietnam: Institute of Strategy and Development for Transportation; 2010.

108. Thanh NX, Hang HM, Chuc NT, Lindholm L. The economic burden of unintentional injuries: a community-based cost analysis in Bavi, Vietnam. Scandinavian journal of public health Supplement. 2003;62:45-51.

109. Nguyen H. Injury, a Significant Cause of Poverty: Evidence From a Prospective Cohort Study of Adult Injuries in Thai Binh Province, Vietnam. Sydney: University of Sydney; 2012.

110. Lin M-R, Chang S-H, Huang W, Hwang H-F, Pai L. Factors associated with severity of motorcycle injuries among young adult riders. Annals of emergency medicine. 2003;41(6):783-91.

111. Mayrose J. The effects of a mandatory motorcycle helmet law on helmet use and injury patterns among motorcyclist fatalities. J Safety Res. 2008;39(4):429-32.

112. Bao J, Bachani AM, Viet CP, Quang N, Nguyen N, Hyder AA. Trends in motorcycle helmet use in Vietnam: results from a four-year study. Public Health. 2017;144S:S39-S44.

113. Mertz KJ, Weiss HB. Changes in Motorcycle-Related Head Injury Deaths, Hospitalizations, and Hospital Charges Following Repeal of Pennsylvania's Mandatory Motorcycle Helmet Law. American Journal of Public Health. 2008;98(8):1464-7.

114. Khor D, Inaba K, Aiolfi A, Delapena S, Benjamin E, Matsushima K, et al. The impact of helmet use on outcomes after a motorcycle crash. Injury. 2017;48(5):1093-7.

115. Gabella B, Reiner KL, Hoffman RE, Cook M, Stallones L. Relationship of helmet use and head injuries among motorcycle crash victims in El Paso County, Colorado, 1989-1990. Accident; analysis and prevention. 1995;27(3):363-9.

116. Rowland J, Rivara F, Salzberg P, Soderberg R, Maier R, Koepsell T. Motorcycle helmet use and injury outcome and hospitalization costs from crashes in Washington State. American journal of public health. 1996;86(1):41-5.

117. Baru A, Azazh A, Beza L. Injury severity levels and associated factors among road traffic collision victims referred to emergency departments of selected public hospitals in Addis Ababa, Ethiopia: the study based on the Haddon matrix. BMC emergency medicine. 2019;19(1):2-.

118. MacLeod JBA, Digiacomo JC, Tinkoff G. An evidence-based review: helmet efficacy to reduce head injury and mortality in motorcycle crashes: EAST practice management guidelines. The Journal of trauma. 2010;69(5):1101-11.

119. Passmore J, Tu NT, Luong MA, Chinh ND, Nam NP. Impact of mandatory motorcycle helmet wearing legislation on head injuries in Viet Nam: results of a preliminary analysis. Traffic Inj Prev. 2010;11(2):202-6.

120. Ackaah W, Afukaar F, Agyemang W, Thuy Anh T, Hejar AR, Abdul G, et al. The use of non-standard motorcycle helmets in low- and middle-income countries: a multicentre study. Injury Prevention. 2013;19(3):158.

121. Ramli R, Che Man Z, Nordin R, Abdul Karim F, Rashdi MF, Oxley J, et al. Photo-oxidative degradation of motorcycle helmets in Hanoi, Vietnam: A prospective preliminary study. Traffic Inj Prev. 2016;17 Suppl 1:79-85.

122. Li L-P, Li G-L, Cai Q-E, Zhang AL, Lo SK. Improper motorcycle helmet use in provincial areas of a developing country. Accident; analysis and prevention. 2008;40(6):1937-42.

123. Ouellet JV, Kasantikul V. Motorcycle helmet effect on a per-crash basis in Thailand and the United States. Traffic injury prevention. 2006;7(1):49-54.

124. Sanyang E. Risk factors and injury characteristics among trauma patients in The Gambia [Ph.D.]. Ann Arbor: The University of Iowa; 2016.

125. Chang F, Li M, Xu P, Zhou H, Haque MM, Huang H. Injury Severity of Motorcycle Riders Involved in Traffic Crashes in Hunan, China: A Mixed Ordered Logit Approach. International journal of environmental research and public health. 2016;13(7).

126. Kasantikul V, Ouellet JV, Smith T, Sirathranont J, Panichabhongse V. The role of alcohol in Thailand motorcycle crashes. Accid Anal Prev. 2005;37(2):357-66.

127. Liu H-T, Liang C-C, Rau C-S, Hsu S-Y, Hsieh C-H. Alcohol-related hospitalizations of adult motorcycle riders. World Journal of Emergency Surgery. 2015;10(1):2.

128. Mascarenhas MDM, Souto RMCV, Malta DC, Silva MMAd, Lima CMd, Montenegro MdMS. Characteristics of motorcyclists involved in road traffic accidents attended at public urgent and emergency services. Ciencia & saude coletiva. 2016;21(12):3661-71.

129. Nguyen N, Passmore J, Tran L, Luong A. Role of Alcohol in Hospitalized Road Trauma in Viet Nam. Traffic Injury Prevention. 2013;14(4):329-34.

130. Drummer OH, Gerostamoulos J, Batziris H, Chu M, Caplehorn J, Robertson MD, et al. The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. Accident Analysis & Prevention. 2004;36(2):239-48.

131. Lester L, Baker R, Coupland C, Orton E. Alcohol Misuse and Injury Outcomes in Young People Aged 10–24. Journal of Adolescent Health. 2018;62(4):450-6.

132. Penning R, Veldstra JL, Daamen AP, Olivier B, Verster JC. Drugs of abuse, driving and traffic safety. Current drug abuse reviews. 2010;3(1):23-32.

133. Christophersen AS, Gjerde H. Prevalence of alcohol and drugs among motorcycle riders killed in road crashes in Norway during 2001-2010. Accident; analysis and prevention. 2015;80:236-42.

134. Poulsen H, Moar R, Pirie R. The culpability of drivers killed in New Zealand road crashes and their use of alcohol and other drugs. Accident Analysis & Prevention. 2014;67:119-28.

135. Elliott S, Woolacott H, Braithwaite R. The prevalence of drugs and alcohol found in road traffic fatalities: a comparative study of victims. Science & justice : journal of the Forensic Science Society. 2009;49(1):19-23.

136. NHTSA NHTSA. Traffic safety facts 2005:Motorcycles. Washington, DC : NHTSA; 2007.

137. Gjerde H, Christophersen AS, Normann PT, Assum T, Øiestad EL, Mørland J. Norwegian Roadside Survey of Alcohol and Drug Use by Drivers (2008–2009). Traffic Injury Prevention. 2013;14(5):443-52.

138. Bothwell PW. The problem of motor-cycle accidents. The Practitioner. 1962;188:474-88.

139. Wells S, Mullin B, Norton R, Langley J, Connor J, Lay-Yee R, et al. Motorcycle rider conspicuity and crash related injury: case-control study. BMJ: British Medical Journal. 2004;328(7444):857-60.

140. Jou R-C, Yeh T-H, Chen R-S. Risk Factors in Motorcyclist Fatalities in Taiwan. Traffic Injury Prevention. 2012;13(2):155.

141. Hurt HH, Ouellet JV, Thom DR. Motorcycle accident cause factors and identification of countermeasures. Volume 1 : technical report. 1981.

142. Ding C, Rizzi M, Strandroth J, Sander U, Lubbe N. Motorcyclist injury risk as a function of real-life crash speed and other contributing factors. Accid Anal Prev. 2019;123:374-86.

143. European Commission. Speed and the injury risk for different speed levels 2019 [Available from: https://ec.europa.eu/transport/road_safety/specialist/knowledge/speed/speed_is_a_central_issue_in_road_safety/speed_and_the_injury_risk_for_different_speed_levels_en.

144. Nilsson G. Traffic safety dimensions and the power model to describe the effect of speed on safety [Doctoral thesis]. Lund, Sweden: Lund Institute of Technology and Society; 2004.

145. Finch DJ, Kompfner P, Lockwood CR, G. M. Speed, speed limits and accidents. Crowthorne, United Kingdom; 1994. Contract No.: 00665273.

146. Association of European Motorcycle Manufactures (ACEM). Final report 1.3: In-Depth Investigation of Accidents Involving PTW. Brussels, Belgium 2004.

147. Lipovac K, Đeric M, Tešic M, Andric Z, Maric B. Mobile phone use while driving-literary review. Transportation Research Part F, Traffic Psychology and Behaviour. 2017;47F:132.

148. Caird JK, Willness CR, Steel P, Scialfa C. A meta-analysis of the effects of cell phones on driver performance. Accident; analysis and prevention. 2008;40(4):1282-93.

149. Mohan VR, Sarkar R, Abraham VJ, Balraj V, Naumova EN. Differential patterns, trends and hotspots of road traffic injuries on different road networks in Vellore district, southern India. Tropical medicine & international health : TM & IH. 2015;20(3):293-303.

150. Korpinen L, Pääkkönen R. Accidents and close call situations connected to the use of mobile phones. Accident Analysis & Prevention. 2012;45:75-82.

151. Bener A, Lajunen T, Özkan T, Haigney D. The effect of mobile phone use on driving style and driving skills. International Journal of Crashworthiness. 2006;11(5):459-65.

152. Hallett C, Lambert A, Regan MA. Cell phone conversing while driving in New Zealand: Prevalence, risk perception and legislation. Accident Analysis & Prevention. 2011;43(3):862-9.

153. Perez-Nunez R, Hidalgo-Solorzano E, Vera-Lopez JD, Lunnen JC, Chandran A, Hijar M, et al. The prevalence of mobile phone use among motorcyclists in three Mexican cities. Traffic Inj Prev. 2014;15(2):148-50.

154. Lamble D, Kauranen T, Laakso M, Summala H. Cognitive load and detection thresholds in car following situations: safety implications for using mobile (cellular) telephones while driving. Accident Analysis & Prevention. 1999;31(6):617-23.

155. Truong LT, Nguyen HTT. Mobile phone related crashes among motorcycle taxi drivers. Accident Analysis & Prevention. 2019;132:105288.

156. Truong LT, Nguyen HTT, De Gruyter C. Mobile phone use among motorcyclists and electric bike riders: A case study of Hanoi, Vietnam. Accident Analysis & Prevention. 2016;91:208-15.

157. Truong LT, Nguyen HTT, De Gruyter C. Mobile phone use while riding a motorcycle and crashes among university students. Traffic Injury Prevention. 2019;20(2):204-10.

158. Truong LT, Nguyen HTT, De Gruyter C. Correlations between mobile phone use and other risky behaviours while riding a motorcycle. Accid Anal Prev. 2018;118:125-30.

159. Shaker RH, Eldesouky RS, Hasan OM, Bayomy H. Motorcycle Crashes: Attitudes of the Motorcyclists Regarding Riders' Experience and Safety Measures. Journal of Community Health. 2014;39(6):1222-30.

160. Cheng W, Gill GS, Sakrani T, Dasu M, Zhou J. Predicting motorcycle crash injury severity using weather data and alternative Bayesian multivariate crash frequency models. Accident; analysis and prevention. 2017;108:172-80.

161. SafetyNet. Powered Two-Wheelers 2010 [Available from: https://ec.europa.eu/transport/road_safety/specialist/knowledge/pdf/powered_two_wheelers.pdf.
162. Chaudhuri U, Ratnapradipa KL, Shen S, Rice TM, Smith GA, Zhu M. Trends and patterns in fatal US motorcycle crashes, 2000-2016. Traffic Inj Prev. 2019;20(6):641-7.
163. Lam C, Pai CW, Chuang CC, Yen YC, Wu CC, Yu SH, et al. Rider factors associated with severe injury after a light motorcycle crash: A multicentre study in an emerging economy setting. PLoS One. 2019;14(6):e0219132.
164. Eden L, Kuhn A, Gilbert F, Meffert RH, Lefering R. Increased Mortality Among Critically Injured Motorcyclists Over 65 Years of Age. Dtsch Arztebl Int. 2019;116(27-28):479-85.
165. Vlahogianni EI, Yannis G, Golias JC. Overview of critical risk factors in Power-Two-Wheeler safety. Accident; analysis and prevention. 2012;49:12-22.
166. Ferreira S, Amorim M, Couto A. Risk factors affecting injury severity determined by the MAIS score. Traffic Injury Prevention. 2017;18(5):515-20.
167. Cunningham G, Chenik D, Zellweger R. Factors influencing motorcycle crash victim outcomes: a prospective study. ANZ Journal of Surgery. 2012;82(7-8):551-4.
168. Motorcycle Safety Review Group. Western Australian Strategic Direction for Improving the Safety of Motorcyclists and Moped Riders 2016 - 2020, Towards Zero,

. Western Australia: The Road Safety Commission; 2015.
169. Vecino-Ortiz AI, Jafri A, Hyder AA. Effective interventions for unintentional injuries: a systematic review and mortality impact assessment among the poorest billion. The Lancet Global health. 2018;6(5):e523-e34.
170. Andreuccetti G, Leyton V, Heráclito Barbosa C, Sinagawa DM, Bombana HS, Ponce JC, et al. Drink driving and speeding in Sao Paulo, Brazil: empirical cross-sectional study (2015–2018). BMJ Open. 2019;9(8).
171. Vadeby A, Forsman Å. Traffic safety effects of new speed limits in Sweden. Accident; analysis and prevention. 2018;114:34-9.
172. Jou R-C, Wang P-L. The intention and willingness to pay moving violation citations among Taiwan motorcyclists. Accident Analysis & Prevention. 2012;49:177-85.
173. Wali B, Ahmed A, Iqbal S, Hussain A. Effectiveness of enforcement levels of speed limit and drink driving laws and associated factors – Exploratory empirical analysis using a

bivariate ordered probit model. Journal of Traffic and Transportation Engineering (English Edition). 2017;4(3):272-9.

174. Rahim SASM, Jamil HM, Musa M, Isah N, WS V. Impact studies of automated enforcement system implementation: Kajang, Malaysia; 2014 [Available from: https://www.miros.gov.my/1/dl.php?filename=MRR_AES Evaluation Report.pdf.

175. Speed limits and safe driving distance for motor vehicles and heavy-duty vehicles on public roads CIRCULAR NO. 91/2015/TT-BGTVT DATED DECEMBER 31, 2015 (2015).

176. Fell JC, Voas RB. The effectiveness of reducing illegal blood alcohol concentration (BAC) limits for driving: Evidence for lowering the limit to .05 BAC. Journal of Safety Research. 2006;37(3):233-43.

177. Fell JC, Voas RB. The effectiveness of a 0.05 blood alcohol concentration (BAC) limit for driving in the United States. Addiction. 2014;109(6):869-74.

178. Sun SW, Kahn DM, Swan KG. Lowering the legal blood alcohol level for motorcyclists. Accident; analysis and prevention. 1998;30(1):133-6.

179. Decree No. 46/2016/ND-CP dated May 26, 2016 of the Government on administrative penalties for road traffic offences and rail transport offences, No. 46/2016/ND (2016).

180. World Health Organization. The Global status report in road safety 2013 2013 [Available from: https://www.who.int/violence_injury_prevention/road_traffic/countrywork/vietnam/en/.

181. Guiding the compulsory wearing of helmets, circular no. 312/2000/TTBGTV (2000).

182. Guiding the compulsory wearing of helmets circular no. 08/2001/TT-BGTVT (2001).

183. Guiding the Compulsory Wearing of Helmet. Circular Number 312/2000/TT-BGTVT, Circular Number 312/2000/TT-BGTVT (2007).

184. United Nations. Global Plan for the Decade of Action for Road Safety 2011-2020 2011 [Available from: https://www.who.int/roadsafety/decade_of_action/plan/plan_english.pdf?ua=1.

185. Hutchinson TP, Wundersitz LN. Road safety mass media campaigns: why are results inconclusive, and what can be done? International journal of injury control and safety promotion. 2011;18(3):235-41.

186. Zampetti R, Messina G, Quercioli C, Vencia F, Genco L, Di Bartolomeo L, et al. Nonfatal road traffic injuries: can road safety campaigns prevent hazardous behavior? An Italian experience. Traffic injury prevention. 2013;14(3):261-6.

187. Bonnet E, Lucie L, Ridde V. What interventions are required to reduce road traffic injuries in Africa? A scoping review of the literature. PLoS One. 2018;13(11).
188. AMA launches Mass Media Campaign on Road Safety. Ghana News Agency (GNA). 2019 11/13/

2019 Nov 13.
189. Tran TNL, Nguyen TL, Luong MA, Khieu TQT. Can blood alcohol concentration of road traffic injury patients decrease after information education communication campaign in Vietnam. Injury Prevention. 2012;18(Suppl 1):A188.
190. Elder RW, Shults RA, Sleet DA, Nichols JL, Thompson RS, Rajab W. Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: A systematic review. American Journal of Preventive Medicine. 2004;27(1):57-65.
191. Baker SP, O'Neill B, Haddon W, Jr., Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. 1974;14(3):187-96.
192. Fouda EY, Youssef M, Emile SH, Elfeki H, Thabet W, Abdallah E, et al. Pattern of major injuries after motorcycle accidents in Egypt: The Mansoura Emergency Hospital experience. Trauma. 2017;19(1):39-45.
193. Elachi IC, Okunola BB, Yongu WT, Onyemaechi NO, Odatuwa-Omagbemi OD, Ahachi CN, et al. Motorcycle-related injuries at a university teaching hospital in north central Nigeria. Nigerian medical journal : journal of the Nigeria Medical Association. 2014;55(6):452-5.
194. Ankarath S, Giannoudis PV, Barlow I, Bellamy MC, Matthews SJ, Smith RM. Injury patterns associated with mortality following motorcycle crashes. Injury. 2002;33(6):473-7.
195. Saidi H, Mutisto BK. Motorcycle injuries at a tertiary referral hospital in Kenya: injury patterns and outcome. European Journal of Trauma and Emergency Surgery. 2013;39(5):481-5.
196. Wyatt JP, O'Donnell J, Beard D, Busuttil A. Injury analyses of fatal motorcycle collisions in south-east Scotland. Forensic Science International. 1999;104(2–3):127-32.
197. Sosin DM, Sacks JJ, Holmgreen P. Head injury--associated deaths from motorcycle crashes. Relationship to helmet-use laws. JAMA. 1990;264(18):2395-9.
198. European Commission. Motorcycle safety helmets. COST 327. 2001.
199. Chichom-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C, Marcelin N-N. A prospective pilot cohort analysis of crash characteristics and pattern of injuries in riders and

pillion passengers involved in motorcycle crashes in an urban area in Cameroon: lessons for prevention. BMC Public Health. 2015;15:915.

200. Forman JL, Lopez-Valdes FJ, Pollack K, Heredero-Ordoyo R, Molinero A, Mansilla A, et al. Injuries among powered two-wheeler users in eight European countries: a descriptive analysis of hospital discharge data. Accident; analysis and prevention. 2012;49:229-36.

201. Van HT, Singhasivanon P, Kaewkungwal J, Suriyawongpaisal P, Khai LH. Estimation of non-fatal road traffic injuries in Thai Nguyen, Vietnam using capture-recapture method. The Southeast Asian journal of tropical medicine and public health. 2006;37(2):405-11.

202. Mayou R, Bryant B. Outcome in consecutive emergency department attenders following a road traffic accident. British Journal of Psychiatry. 2001;179(6):528-34.

203. Bazargan-Hejazi S, Ahmadi A, Shirazi A, Ainy E, Djalalinia S, Fereshtehnejad SM, et al. The Burden of Road Traffic Injuries in Iran and 15 Surrounding Countries: 1990-2016. Archives of Iranian medicine. 2018;21(12):556-65.

204. Hays R, Reeve BB. Measurement and modeling of health-related quality of life. In: Killewo J, Heggenhougen HK, Quah SR, editors. Epidemiology and demography in public health. San Diego: Academic Press; 2010. p. p. 195-205.

205. Kyrkou MR. Health-related quality of life. International Public Health Journal. 2014;6(4):355-70.

206. Gabbe BJ, Cameron PA, Williamson OD, et al. The relationship between compensable status and long-term patient outcomes following orthopaedic trauma. Medical Journal of Australia. 2007;187(1):14-7.

207. Tamura N, Kuriyama A, Kaihara T. Health-related quality of life in trauma patients at 12months after injury: a prospective cohort study. European Journal of Trauma and Emergency Surgery. 2018:1-7.

208. Watson WL, Ozanne-Smith J, Richardson J. Retrospective baseline measurement of self-reported health status and health-related quality of life versus population norms in the evaluation of post-injury losses. Injury Prevention. 2007;13(1):45.

209. Polinder S, van Beeck EF, Essink-Bot ML, Toet H, Looman CWN, Mulder S, et al. Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands. The Journal of trauma. 2007;62(1):133-41.

210. Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt DB. Outcome after major trauma: 12-month and 18-month follow-up results from the Trauma Recovery Project. The Journal of trauma. 1999;46(5):765-71.
211. Tan AL, Chiong Y, Nadkarni N, Jolene Yu Xuan C, Ming Terk C, Wong TH. Predictors of Change in Functional Outcome at six months and twelve months after Severe Injury: A Retrospective Cohort Study. World Journal of Emergency Surgery. 2018;13(1):1-8.
212. Gofin R, Adler B. A seven item scale for the assessment of disabilities after child and adolescent injuries. Inj Prev. 1997;3(2):120-3.
213. Yiengprugsawan V, Berecki-Gisolf J, McClure R, Kelly M, Sam-ang S, Sleigh AC, et al. The Effect of Injuries on Health Measured by Short Form 8 among a Large Cohort of Thai Adults. PLoS One. 2014;9(2).
214. Herrera-Escobar JP, Seshadri AJ, Rivero R, Toppo A, Al Rafai SS, Scott JW, et al. Lower education and income predict worse long-term outcomes after injury. J Trauma Acute Care Surg. 2019;87(1):104-10.
215. Dinakar P, Stillman AM. Pathogenesis of Pain. Seminars in Pediatric Neurology. 2016;23(3):201-8.
216. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. Journal of clinical nursing. 2005;14(7):798-804.
217. Lara-Munoz C, De Leon SP, Feinstein AR, Puente A, Wells CK. Comparison of three rating scales for measuring subjective phenomena in clinical research. I. Use of experimentally controlled auditory stimuli. Arch Med Res. 2004;35(1):43-8.
218. Herr KA, Spratt K, Mobily PR, Richardson G. Pain intensity assessment in older adults: Use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults. Clinical Journal of Pain. 2004;20(4):207-19.
219. Thinh DHQ, Sriraj W, Mansor M, Tan KH, Irawan C, Kurnianda J, et al. Analgesic Prescription Patterns and Pain Outcomes in Southeast Asia: Findings From the Analgesic Treatment of Cancer Pain in Southeast Asia Study. Journal of Global Oncology. 2018(4):1-10.
220. Hours M, Chossegros L, Charnay P, Tardy H, Nhac-Vu H-T, Boisson D, et al. Outcomes one year after a road accident: Results from the ESPARR cohort. Accident Analysis & Prevention. 2013;50:92-102.

221. Daoust R, Paquet J, Moore L, Émond M, Gosselin S, Lavigne G, et al. Early Factors Associated with the Development of Chronic Pain in Trauma Patients. Pain Research & Management : The Journal of the Canadian Pain Society. 2018;2018:8.

222. Jenewein J, Moergeli H, Wittmann L, Büchi S, Kraemer B, Schnyder U. Development of chronic pain following severe accidental injury. Results of a 3-year follow-up study. Journal of psychosomatic research. 2009;66(2):119-26.

223. Mkandawire NC, Boot DA, Braithwaite IJ, Patterson M. Musculoskeletal recovery 5 years after severe injury: long term problems are common. Injury. 2002;33(2):111-5.

224. Wynne-Jones G, Jones GT, Wiles NJ, Silman AJ, Macfarlane GJ. Predicting new onset of widespread pain following a motor vehicle collision. Journal of Rheumatology. 2006;33(5):968-74.

225. Islam S, Ahmed M, Walton GM, Dinan TG, Hoffman GR. The association between depression and anxiety disorders following facial trauma - A comparative study. Injury. 2010;41(1):92-6.

226. O'Donnell ML, Varker T, Holmes AC, Ellen S, Wade D, Creamer M, et al. Disability after injury: the cumulative burden of physical and mental health. The Journal of clinical psychiatry. 2013;74(2):e137-e43.

227. Varela A. The Relationship Between Psychosocial Factors and Rerported Disability: The Role of Pain Self-efficacy [Ph.D.]. Ann Arbor: Capella University; 2019.

228. Zatzick D, Jurkovich GJ, Rivara FP, Wang J, Fan M-Y, Joesch J, et al. A national US study of posttraumatic stress disorder, depression, and work and functional outcomes after hospitalization for traumatic injury. Annals of surgery. 2008;248(3):429-37.

229. Craig A, Tran Y, Guest R, Gopinath B, Jagnoor J, Bryant RA, et al. Psychological impact of injuries sustained in motor vehicle crashes: systematic review and meta-analysis. BMJ open. 2016;6(9):1.

230. Mayou R, Bryant B. Outcome 3 years after a road traffic accident. Psychological Medicine. 2002;32(4):671-5.

231. Giummarra MJ, Lennox A, Dali G, Costa B, Gabbe BJ. Early psychological interventions for posttraumatic stress, depression and anxiety after traumatic injury: A systematic review and meta-analysis. Clinical Psychology Review. 2018;62:11-36.

232. World Health Organization & World Bank. World Report on Disability Geneva; 2011.

233. Young A, Roessler R, Wasiak R, McPherson K, Poppel M, Anema J. A Developmental Conceptualization of Return to Work. Journal of Occupational Rehabilitation. 2005;15(4):557-68.
234. Schultz IZe, Gatchel RJe. Handbook of Return to Work : From Research to Practice / edited by Izabela Z. Schultz, Robert J. Gatchel. 1st ed. 2016.. ed: New York, NY : Springer US : Imprint: Springer; 2016.
235. Franche R-L, Krause N. Readiness for Return to Work Following Injury or Illness: Conceptualizing the Interpersonal Impact of Health Care, Workplace, and Insurance Factors. Journal of Occupational Rehabilitation. 2002;12(4):233-56.
236. Toien K, Skogstad L, Ekeberg O, Myhren H, Schou Bredal I. Prevalence and predictors of return to work in hospitalised trauma patients during the first year after discharge: a prospective cohort study. Injury. 2012;43(9):1606-13.
237. Sigurdardottir S, Andelic N, Wehling E, Anke A, Skandsen T, Holthe OO, et al. Return to work after severe traumatic brain injury: a national study with a one-year follow-up of neurocognitive and behavioural outcomes. Neuropsychological rehabilitation. 2018:1-17.
238. MacKenzie EJ, Morris JA, Jurkovich GJ, Yasui Y, Cushing BM, Burgess AR, et al. Return to work following injury: the role of economic, social, and job-related factors. American Journal of Public Health. 1998;88(11):1630-7.
239. Silva AR, Sime MM. Barriers and facilitators to return to work post-acute orthopedic trauma in upper limbs: an integrative literature review. Cad Bras Ter Ocup. 2019;27(2):426-37.
240. Chien D-K, Hwang H-F, Lin M-R. Injury severity measures for predicting return-to-work after a traumatic brain injury. Accident; analysis and prevention. 2017;98:101-7.
241. Haider AH, Herrera-Escobar JP, Al Rafai SS, Harlow AF, Apoj M, Nehra D, et al. Factors Associated With Long-Term Outcomes After Injury: Results of the Functional Outcomes and Recovery After Trauma Emergencies (FORTE) Multicenter Cohort Study. Ann Surg. 2018;268(4):574-83.
242. Oxley J, Yuen J, Ravi MD, Hoareau E, Mohammed MAA, Bakar H, et al. Commuter motorcycle crashes in Malaysia: An understanding of contributing factors. Annals of advances in automotive medicine Association for the Advancement of Automotive Medicine Annual Scientific Conference. 2013;57:45-54.
243. Vietnam weather Travel and Local Information Guide 2021 [cited 2021. Available from: http://www.vietnam-guide.com/ho-chi-minh-city/weather.htm.

244. Regulations on driver training, driving tests and insurance of driving licences for road motor vehicles (2017).

245. GiaDinh Hospital. General about about Gia Dinh hospital 2018 [Available from: http://www.bvndgiadinh.org.vn/home/about/.

246. Roset M, Badia X, Mayo NE. Sample size calculations in studies using the EuroQol 5D. Quality of Life Research. 1999;8(6):539-49.

247. Stanford P, Booth N, Suckley J, Twelvetree T, Thomas D. Assessment of injury severity in patients with major trauma. Nursing Standard (2014). 2016;30(49):54.

248. Shearer D, Morshed S. Common generic measures of health related quality of life in injured patients. Injury. 2011;42(3):241-7.

249. Quality of life profile of general Vietnamese population using EQ-5D-5L [Internet]. BioMed Central. 2017 [cited 2017

2017-11-29]. Available from: https://search.proquest.com/docview/1959859538?accountid=10382

250. Nguyen HTT, Moir MP, Nguyen TX, Vu AP, Luong LH, Nguyen TN, et al. Health-related quality of life in elderly diabetic outpatients in Vietnam. Patient Prefer Adherence. 2018;12:1347-54.

251. Tran BX, Hwang J, Nguyen LH, Nguyen AT, Latkin NRK, Tran NK, et al. Impact of Socioeconomic Inequality on Access, Adherence, and Outcomes of Antiretroviral Treatment Services for People Living with HIV/AIDS in Vietnam. PLOS ONE. 2016;11(12):e0168687.

252. Tran BX, Ohinmaa A, Nguyen LT, Nguyen TA, Nguyen TH. Determinants of health-related quality of life in adults living with HIV in Vietnam. AIDS Care. 2011;23(10):1236-45.

253. Dao-Tran T-H, Anderson D, Seib C. How life stressors influence modifiable lifestyle factors, depressive symptoms, and physical and mental health among Vietnamese older women? BMC Psychiatry. 2017;17.

254. Dao-Tran T-H, Seib C, Jones L, Anderson D. A cross-cultural comparison of health-related quality of life and its associated factors among older women in Vietnam and Australia. BMC Research Notes. 2018;11(1):174.

255. Sorkin D, Tan AL, Hays RD, Mangione CM, Ngo-Metzger Q. Self-Reported Health Status of Vietnamese and Non-Hispanic White Older Adults in California. Journal of the American Geriatrics Society. 2008;56(8):1543-8.

256. McCaffery M, Beebe A. Pain: clinical manual for nursing practice Pain: clinical manual for nursing practice Nursing standard (Royal College of Nursing (Great Britain) : 1987). 1994;9(11):55.

257. Taylor LJ, Herr K. Pain intensity assessment: a comparison of selected pain intensity scales for use in cognitively intact and cognitively impaired African American older adults. Pain management nursing : official journal of the American Society of Pain Management Nurses. 2003;4(2):87-95.

258. Young IA, Cleland JA, Michener LA, Brown C. Reliability, construct validity, and responsiveness of the neck disability index, patient-specific functional scale, and numeric pain rating scale in patients with cervical radiculopathy. American journal of physical medicine & rehabilitation. 2010;89(10):831-9.

259. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies Comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for Assessment of Pain Intensity in Adults: A Systematic Literature Review. Journal of Pain and Symptom Management. 2011;41(6):1073-93.

260. Van Giang N, Chiu H-Y, Thai DH, Kuo S-Y, Tsai P-S. Validity, Sensitivity, and Responsiveness of the 11-Face Faces Pain Scale to Postoperative Pain in Adult Orthopedic Surgery Patients. Pain Management Nursing. 2015;16(5):678-84.

261. To KG, Meuleners LB, Fraser ML, Van Duong D, Van Do D, Huynh VA, et al. The impact of cataract surgery on depressive symptoms for bilateral cataract patients in Ho Chi Minh City, Vietnam. Int Psychogeriatr. 2014;26(2):307-13.

262. Thai TT, Jones MK, Harris LM, Heard RC. Screening value of the Center for epidemiologic studies – depression scale among people living with HIV/AIDS in Ho Chi Minh City, Vietnam: a validation study. BMC Psychiatry. 2016;16(1):145.

263. Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. Applied Psychological Measurement. 1977;1(3):385-401.

264. Bui Tu Q, Truong Quang T, Nguyen Duc T. Validation of a Brief CES-D Scale for Measuring Depression and Its Associated Predictors among Adolescents in Chi Linh, Hai Duong, Vietnam. AIMS Public Health. 2016;3(3):448-59.

265. Nguyen DT, Nguyen ND. A Comprehensive Study on Home Care Needs Among Elderly in an Urban Area of Ho Chi Minh City, Vietnam Research on Humanities and Social Sciences. 2017;7(14).

266. Epidata Software 2017 [Available from: https://www.epidata.dk/.

267. Fort E, Bouffard E, Charnay P, Bernard M, Boisson D, Laumon B, et al. Return To Work Following Road Accidents: Factors Associated With Late Work Resumption. Journal of Rehabilitation Medicine. 2011;43(4):283-91.

268. Cornelius AE, Brewer BW, Van Raalte JL. Applications of multilevel modeling in sport injury rehabilitation research. International Journal of Sport and Exercise Psychology. 2007;5(4):387-405.

269. Detry MA, Ma Y. Analyzing Repeated Measurements Using Mixed Models. JAMA. 2016;315(4):407-8.

270. Raudenbush SW. Hierarchical linear models : applications and data analysis methods / Stephen W. Raudenbush, Anthony S. Bryk. 2nd ed.. ed. Bryk AS, editor. Thousand Oaks: Thousand Oaks : Sage Publications; 2002.

271. De Leeuw J, Kreft I. Random Coefficient Models for Multilevel Analysis. Journal of Educational Statistics. 1986;11(1):57-85.

272. Longford NT, Snijders TAB. Random coefficient models. Sociologische gids. 1995;XLII(4-5):369-71.

273. Newsom JT. Longitudinal Data Analysis : A Practical Guide for Researchers in Aging, Health, and Social Sciences. Jones RN, Hofer SM, editors. Hoboken: Hoboken : Taylor & Francis; 2011.

274. Cheng ASK, Lee HC. Risk-taking behavior and response inhibition of commuter motorcyclists with different levels of impulsivity. Transportation Research Part F: Traffic Psychology and Behaviour. 2012;15(5):535-43.

275. Alghnam S, Alsulaim HA, BinMuneif YA, Al-Zamil A, Alahmari A, Alshafi A, et al. Injuries following motorcycle crashes at a level-1 trauma center in Riyadh. Annals of Saudi Medicine. 2019;39(3):185-91.

276. Moskal A, Martin J-L, Laumon B. Risk factors for injury accidents among moped and motorcycle riders. Accident Analysis & Prevention. 2012;49:5-11.

277. Mitchell RJ, Bambach MR, Foster K, Curtis K. Risk factors associated with the severity of injury outcome for paediatric road trauma. Injury. 2015;46(5):874-82.

278. Alshatti F. Analysis of motorcycle crashes and fatalities including the impact of distracted drivers in Texas. In: Dessouky S, Sharif H, Weissmann J, editors.: ProQuest Dissertations Publishing; 2016.

279. Chalya PL, Mabula JB, Ngayomela IH, Kanumba ES, Chandika AB, Giiti G, et al. Motorcycle injuries as an emerging public health problem in Mwanza City, north-western Tanzania. Tanzania journal of health research. 2010;12(4):214-21.

280. Solagberu BA, Ofoegbu CKP, Nasir AA, Ogundipe OK, Adekanye AO, Abdur-Rahman LO. Motorcycle injuries in a developing country and the vulnerability of riders, passengers, and pedestrians. Injury Prevention. 2006;12(4):266.

281. Islam S, Brown J. A comparative injury severity analysis of motorcycle at-fault crashes on rural and urban roadways in Alabama. Accident; analysis and prevention. 2017;108:163-71.

282. Otte D, Schroeder G, Richter M. Possibilities for load reductions using garment leg protectors for motorcyclists -- a technical, medical and biomechanical approach. Annual proceedings / Association for the Advancement of Automotive Medicine Association for the Advancement of Automotive Medicine. 2002;46:367-85.

283. White D, Lang J, Russell G, Tetsworth K, Harvey K, Bellamy N. A comparison of injuries to moped/scooter and motorcycle riders in Queensland, Australia. Injury. 2013;44(6):855-62.

284. Rifaat SM, Tay R, de Barros A. Severity of motorcycle crashes in Calgary. Accident; analysis & prevention. 2012;49:44-9.

285. Blows S, Ivers RQ, Connor J, Ameratunga S, Woodward M, Norton R. Unlicensed Drivers and Car Crash Injury. Traffic Injury Prevention. 2005;6(3):230-4.

286. Mohd Hafzi Md Isa ZMJ, Sarani RSVW. Injury Severity Analysis of Accidents Involving Young Motorcycle Riders in Malaysia. Journal of the Eastern Asia Society for Transportation Studies. 2011;9(0):1997-2010.

287. Yuen CW, Mohamed Rehan K, Saifizul A. Analysis of Motorcyclist Riding Behaviour on Speed Table. The Scientific World Journal. 2014;2014.

288. Savolainen P, Mannering F. Probabilistic models of motorcyclists' injury severities in single- and multi-vehicle crashes. Accident; analysis and prevention. 2007;39(5):955-63.

289. Law No. 44/2019/QH14 dated June 14, 2019 of the National Assembly on Prevention and Control of Harms of Liquor and Beer Abuse, (2020).

290. Andreuccetti G, Carvalho HB, Cherpitel CJ, Ye Y, Ponce JC, Kahn T, et al. Reducing the legal blood alcohol concentration limit for driving in developing countries: a time for change? Results and implications derived from a time-series analysis (2001-10) conducted in Brazil. Addiction. 2011;106(12):2124-31.

291. Huang CY, Chou SE, Su WT, Liu HT, Hsieh TM, Hsu SY, et al. Effect of Lowering the Blood Alcohol Concentration Limit to 0.03 Among Hospitalized Trauma Patients in Southern Taiwan: A Cross-Sectional Analysis. Risk management and healthcare policy. 2020;13:571-81.

292. Alghnam S, Palta M, L Remington P, Mullahy J, S Durkin M. The association between motor vehicle injuries and health-related quality of life: a longitudinal study of a population-based sample in the United States. Quality of Life Research. 2014;23(1):119-27.

293. Pons-Villanueva J, Rodríguez de Armenta MJ, Martínez-González MA, Seguí-Gómez M. Longitudinal assessment of quality of life and its change in relation to motor vehicle crashes: the SUN (Seguimiento Universidad de Navarra) Cohort. The Journal of trauma. 2011;70(5):1072-7.

294. Fitzharris M, Bowman D, Ludlow K. Factors associated with return-to-work and health outcomes among survivors of road crashes in Victoria. Australian and New Zealand Journal of Public Health. 2010;34(2):153-9.

295. Knodel J, Loi VM, Jayakody R, Huy VT. Gender roles in the family. Asian Population Studies. 2005;1(1):69-92.

296. Holbrook TL, Hoyt DB. The impact of major trauma: quality-of-life outcomes are worse in women than in men, independent of mechanism and injury severity. The Journal of trauma. 2004;56(2):284-90.

297. Gopinath B, Jagnoor J, Kifley A, Dinh M, Craig A, Cameron ID. Predictors of health-related quality of life after non-catastrophic injury sustained in a road traffic crash. Ann Phys Rehabil Med. 2019;63(4):280-7.

298. Khati I, Hours M, Charnay P, Chossegros L, Tardy H, Nhac-Vu H-T, et al. Quality of life one year after a road accident: Results from the adult ESPARR cohort. Journal of Trauma and Acute Care Surgery. 2013;74(1):301-11.

299. Kenardy J, Heron-Delaney M, Warren J, Brown E. The effect of mental health on long-term health-related quality of life following a road traffic crash: Results from the UQ SuPPORT study. Injury. 2015;46(5):883-90.

300. Puciato D, Borysiuk Z, Rozpara M. Quality of life and physical activity in an older working-age population. Clin Interv Aging. 2017;12:1627-34.

301. The National Assembly. Law on medical examination and treatment (No.40/2009/QH12): Government of Vietnam; 2009 [Available from: http://www.moj.gov.vn/vbpq/en/lists/vn%20bn%20php%20lut/view_detail.aspx?itemid=10471

302. Gane EM, Smits EJ, Brakenridge CL, Gangathimmaiah V, Jagnoor J, Cameron ID, et al. Functional and employment outcomes following road traffic crashes in Queensland, Australia: Protocol for a prospective cohort study. Journal of Transport & Health. 2019;15:100678.

303. Accardi-Ravid MC, Dyer JR, Sharar SR, Wiechman S, Jensen MP, Hoffman HG, et al. The Nature of Trauma Pain and Its Association with Catastrophizing and Sleep. International Journal of Behavioral Medicine. 2018;25(6):698-705.

304. Hains JW. Geriatric Medicine: An Evidence-Based Approach. Anaesthesia and Intensive Care. 2015;43(3):428.

305. McLean SA, Clauw DJ, Abelson JL, Liberzon I. The development of persistent pain and psychological morbidity after motor vehicle collision: integrating the potential role of stress response systems into a biopsychosocial model. Psychosomatic medicine. 2005;67(5):783-90.

306. Williamson DO, Epi DCG, Gabbe JB, Physio AB, Cameron RP, Edwards DE, et al. Predictors of Moderate or Severe Pain 6 Months After Orthopaedic Injury: A Prospective Cohort Study. Journal of Orthopaedic Trauma. 2009;23(2):139-44.

307. Edmed SL, Moss KM, Warren J, Kenardy J. The effect of changes in pain expectations on persistent pain following a road traffic crash. Eur J Pain. 2018;22(2):426-36.

308. Guest R, Tran Y, Gopinath B, Cameron ID, Craig A. Psychological distress following a motor vehicle crash: A systematic review of preventative interventions. Injury. 2016;47(11):2415-23.

309. Niemi M, Målqvist M, Giang KB, Allebeck P, Falkenberg T. A narrative review of factors influencing detection and treatment of depression in Vietnam. International Journal of Mental Health Systems. 2013;7.

310. Carnide N, Franche RL, Hogg-Johnson S, Côté P, Breslin FC, Severin CN, et al. Course of Depressive Symptoms Following a Workplace Injury: A 12-Month Follow-Up Update. Journal of Occupation Rehabilitation. 2016;26(2):204-15.

311. Nguyen H, Ivers R, Jan S, Pham C. Analysis of out-of-pocket costs associated with hospitalised injuries in Vietnam. BMJ Glob Health. 2017;2(1):e000082-e.

312. Belin M-Å, Tillgren P, Vedung E. Vision Zero – a road safety policy innovation. International Journal of Injury Control and Safety Promotion. 2012;19(2):171-9.

313. Hobday M. Motorcycle safety in Western Australia: review of popular routes, crash risk factors and options to improve current state, based on Safe System approach. Western Australia: Curtin-Monash Accident Research Centre (C-MARC); 2019.

314. Nagata T, Takamori A, Kimura Y, Kimura A, Hashizume M, Nakahara S. Trauma center accessibility for road traffic injuries in Hanoi, Vietnam. J Trauma Manag Outcomes. 2011;5:11.

Appendices

Appendix A: Statement of contribution

April 2021

To Whom It May Concern

I, Han Thi Ngoc Doan, am the primary contributor for the study design, data collection, analysis, and interpretation of data, drafting, revising and approving the following manuscripts entitled:

- Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.
- Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.
- Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Han Thi Ngoc Doan, PhD candidate Signature: ---------------------- Date:

April 2021

To Whom It May Concern

I, Han Thi Ngoc Doan, am the primary contributor for the study design, data collection, analysis, and interpretation of data, drafting, revising and approving the following manuscripts entitled:

- Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.
- Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.
- Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Han Thi Ngoc Doan, PhD candidate Signature: ----------------------

I, Professor Jonine Jancey, as a Co-Author, endorse that this level contribution by the candidate indicated above is appropriate.

Professor Jonine Jancey Signature: ----------------------

April 2021

To Whom It May Concern

I, Han Thi Ngoc Doan, am the primary contributor for the study design, data collection, analysis, and interpretation of data, drafting, revising and approving the following manuscripts entitled:

- Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.
- Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.
- Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Han Thi Ngoc Doan, PhD candidate Signature: ----------------------

I, Dr Justine Leavy, as a Co-Author, endorse that this level contribution by the candidate indicated above is appropriate.

Dr Justine Leavy Signature: ----------------------

April 2021

To Whom It May Concern

I, Han Thi Ngoc Doan, am the primary contributor for the study design, data collection, analysis, and interpretation of data, drafting, revising and approving the following manuscripts entitled:

- Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.
- Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.
- Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Han Thi Ngoc Doan, PhD candidate Signature: ----------------------

I, Dr Michelle Hobday, as a Co-Author, endorse that this level contribution by the candidate indicated above is appropriate.

Dr Michelle Hobday Signature: ----------------------

By signing below, the co-authors give their permission to include the aforementioned publications in this thesis and endorse that level of the contribution by the candidate indicated above is appropriate.

Jonine Jancey Signature: Date:04/06/2021

Justine Leavy Signature Date:04/06/2021

Michelle Hobday Signature: Date: 04/06/2021

X

Han Doan

Mrs

Appendix B: Lists of publication

B1. Publication 1

This article has been published in the Journal of Traffic Injury Prevention: Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prev. 2019;20(7):732-737. doi: 10.1080/15389588.2019.1643460. Epub 2019 Aug 21. PMID: 31433684.

Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam

Han Thi Ngoc Doan & Michelle B. Hobday

TRAFFIC INJURY PREVENTION
2019, VOL. 20, NO. 7, 732–737
https://doi.org/10.1080/15389588.2019.1643460

Taylor & Francis
Taylor & Francis Group

Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam

Han Thi Ngoc Doan[a,b] and Michelle B. Hobday[a]

[a]Curtin–Monash Accident Research Centre, Curtin University, Perth, Western Australia, Australia; [b]Faculty of Public Health, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam

ABSTRACT

Objective: This study aims to describe the crash characteristics, injury outcomes, and risk factors associated with injury severity for motorcycle crashes resulting in hospitalization in Ho Chi Minh City (HCMC), Vietnam.

Methods: A cross-sectional study was undertaken of motorcyclists who were injured as the result of a crash and were admitted to hospital for more than 24 h. Information was collected using a researcher-administered questionnaire and a medical record review. Descriptive statistics and a multiple logistic regression model were undertaken. The outcome of interest was severity of the injury, measured using the Injury Severity Score (ISS).

Results: A total of 352 hospitalized motorcyclists were included in the study, of which 6.8% ($n = 24$) were classified as severe injuries (ISS > 15). At the time of the crash, 41% of participants were not licensed to drive a motorcycle, 26% were speeding, 13% were not wearing a helmet, and 9% were using their mobile phone. The results of the multiple logistic regression model found that not being licensed to drive a motorcycle (adjusted odds ratio [AOR] = 3.32; 95% confidence interval [CI], 1.18–9.34) and crashing at nighttime (AOR = 4.28; 95% CI, 1.33–13.78) were significantly associated with increased injury severity among hospitalized motorcyclists.

Conclusions: This study highlighted several high-risk behaviors among hospitalized motorcyclists in Vietnam. In addition, the study found that being unlicensed and crashing at night were associated with higher injury severity among hospitalized motorcyclists. The findings suggest that prevention and enforcement interventions targeting high-risk behaviors may reduce the significant morbidity and mortality associated with motorcycle crashes in Vietnam.

ARTICLE HISTORY
Received 16 January 2019
Accepted 10 July 2019

KEYWORDS
Motorcycle injuries; crash characteristics; injury patterns; motorcycle; Injury Severity Score; Vietnam

Introduction

Road traffic crashes (RTCs) are a major cause of death and permanent disability and are a significant cost to the community in both developing and developed countries. Each year, approximately 1.25 million people are killed and over 50 million are injured in road crashes, with 90% of fatalities occurring in developing countries (World Health Organization 2015). Road trauma is expected to rise to the fourth leading cause of death and disability globally by 2030 (Mathers and Loncar 2006). A large proportion of these deaths and injuries are attributed to motorcycle crashes in developing countries, including Vietnam (Ngo et al. 2012; WHO 2015). Motorcycle crashes constitute one-third of road fatalities in the Western Pacific and Southeast Asian countries (WHO 2015).

Vietnam is a developing country located in Southeast Asia. In recent years, Vietnam has experienced a rapidly growing number of motor vehicles on its roads. According to the Vietnamese National Transportation Safety Committee, the number of registered vehicles has increased from 5,000,000 in 2000 to 46,792,091 in 2015, of which motorcycles account for 94% (44,128,822) of vehicles (Dat 2015).

The increase in the number of motorcycles in Vietnam has been accompanied by an increase in motorcycle crashes. The WHO (2015) estimated that 14,000 people die due to crashes every year in Vietnam, of which 59% are motorcyclists. Recognizing the burden of RTCs among motorcycle users, the Vietnamese government has introduced interventions including a motorcycle helmet law, alcohol limits for motorcycle riders, and infrastructure changes to improve safety. Although the rate of road traffic deaths has been decreasing since 2012, Vietnam's rate of 24.5 deaths per 100,000 population remains high for Southeast Asia (WHO 2015).

Few studies have examined risk factors for motorcycle crashes resulting in hospitalization in Vietnam. Previous studies have focused on the cost and trends in head injury

CONTACT Han Thi Ngoc Doan han.doan@postgrad.curtin.edu.au Curtin–Monash Accident Research Centre, Curtin University, Perth, Western Australia 6845, Australia.
Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/gcpi.
Associate Editor Giovanni Savino oversaw the review of this article.
Supplemental data for this article can be accessed on the publisher's website.

following the introduction of motorcycle helmet laws (Hoang et al. 2008; Ha et al. 2015). Most research examining risk factors for motorcycle crashes has been undertaken in developed countries (Lin and Kraus 2009). However, the majority of motorcycles in Vietnam are scooters with engine capacities ranging from 50 to 250 cc. They are used for daily commuting in both urban and rural areas because of their suitability for traveling on narrow streets, as well as ease of parking (Lin and Kraus 2009). In contrast, motorcycles in developed countries such as the United States, Australia, and Europe have larger engine capacities and are primarily used for recreation or sports purposes (Organization for Economic Cooperation and Development, International Transport Forum 2015). Therefore, crash characteristics and risk factors for motorcycle crashes in Vietnam may differ from those in developed countries.

Due to the predominance of motorcycle crashes in Vietnam, the prevention and minimization of trauma resulting from motorcycle crashes is an urgent issue. Therefore, this study aims to describe the crash characteristics, injury outcomes, and risk factors associated with injury severity for motorcycle crashes resulting in hospitalization in Ho Chi Minh City (HCMC), Vietnam.

Methods

Study design and settings

A prospective cohort study of motorcyclists hospitalized due to involvement in a motorcycle crash was conducted between June 1, 2017, and January 30, 2018. This describes a cross-sectional analysis of the baseline data collected for the study.

Study participants

The study participants included adults aged 18 years and over hospitalized due to a motorcycle crash occurring on a public road who were admitted for at least 24 h to the Gia Dinh hospital between June 1, 2017, and January 30, 2018. Gia Dinh hospital is one of the largest trauma and orthopedic hospitals located in southern Vietnam.

Inclusion criteria stipulated that potential participants were aged 18 years or over on admission; the rider of the motorcycle; a resident of HCMC; and a commuter motorcyclist. (A commuter motorcyclist was defined as a person who regularly commutes to and from work [at least 3 days a week] using a motorcycle or uses a motorcycle for running daily errands.) For the purpose of this study, a motorcyclist refers any person riding a powered 2-wheeler with an engine capacity over 50 cc. Exclusion criteria were cognitive impairment; serious injuries due to the crash (as assessed by the physician); not able to provide informed consent; unable to remember the events of the crash; or did not speak Vietnamese.

A total of 378 potential participants were initially identified for inclusion in the study. Three hundred and fifty-two agreed to participate in the study, representing a response rate of 93.1%. Twenty-one (5.6%) participants refused and 5 (1.3%) could not be contacted post hospital discharge. There was no significant difference between those who participated in the study and those who did not in terms of age ($P = .723$) and gender ($P = .665$).

Data collection

Prospective participants were identified from the admission list of the emergency department at Gia Dinh hospital. This list provided detailed information including age, gender, hospital room, type of injuries, and admission status on those who were injured and then admitted to the hospital for a period of at least 24 h due to a motorcycle crash. The researcher approached potential participants in the hospital to explain the study objectives and invite them to participate in the study, after obtaining permission from the treating physician. If the potential participant agreed to participate, informed written consent was obtained. A medical record review was also undertaken by the researcher.

Questionnaire

Demographic, motorcycle riding exposure, and self-reported crash history information were collected by the researcher using a face-to-face questionnaire on the ward or via telephone within 1 week after discharge from the hospital, between June 1, 2017, and January 30, 2018.

Information about crash characteristics was also collected via the questionnaire, including type of crash, time of day of the crash, weather conditions, helmet usage at the time of the crash, mobile phone usage at the time of the crash, motorcycle license at the time of the crash, and speeding at the time of the crash. Objective information regarding blood alcohol concentration (BAC) was obtained from the medical record review where available.

Injury Severity Score

Information on injury patterns, length of stay in hospital, and injury severity was also collected from the medical record review. The Injury Severity Score (ISS) was then calculated for each participant by the researcher. The ISS is calculated using the summed squares of the Abbreviated Injury Score of 3 of the 6 most injured body regions (Baker et al. 1974). The 6 Abbreviated Injury Score body regions are head or neck, face, chest, abdominal or pelvic contents, extremities or pelvic girdle, and external. An ISS of 16 or greater is generally defined as a major trauma (severe injury; Stanford et al. 2016).

Ethical considerations

Ethics approval was obtained from Curtin University (HRE2017-0010), the University of Medicine and Pharmacy at HCMC (#UMP-40), and Gia Dinh Hospital (KHTH-QLTTSL-04).

Table 1. Characteristics of motorcyclists hospitalized as a result of a crash in Ho Chi Minh City, Vietnam ($n = 352$).

Motorcyclist characteristics	*N*	%
Gender (male)	235	66.8
Age group (years)		
18–34	136	38.6
35–54	139	39.5
55+	77	21.9
Direct hospital admission	268	76.1
Previous crash in the last year	52	9.1

Table 2. Characteristics of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam ($n = 352$).

Crash characteristics	*N*	%
Crash type (multivehicle)	258	73.3
Time of day		
Day (6:00 a.m.–5:59 p.m.)	135	38.4
Night (6:00 p.m.–5:59 a.m.)	217	61.6
BAC level (g/dL) ≥0.05[a]	66	46.5
Wearing helmet at time of the crash	308	87.5
Using mobile phone at time of the crash	33	9.4
Having motorcycle license at time of the crash	207	58.8
Speeding at time of crash (above limit)	93	26.4

aMissing data: $n = 142$ participants whose BAC level was tested.

Statistical analysis

Descriptive statistics were undertaken to describe the characteristics of the cohort as well as injury outcomes and crash characteristics.

The outcome of interest was the severity of the injury, which was grouped into 2 categories: mild (ISS < 9) and moderate injury (ISS 9–15) versus severe injury (ISS > 15; Stanford et al. 2016). Twenty-four (6.8%) of the 352 injured motorcyclists in the study were classified as having severe injuries (ISS > 15). Multiple logistic regression was performed to assess risk factors for increasing severity of injury. Independent variables included in the model were age, gender, education, marital status, previous history of a crash (yes, no), helmet use at the time of the crash (yes, no), motorcycle license at the time of the crash (yes, no), crash type (multivehicle, single vehicle), speeding at the time of the crash (above, at, or below the limit), time of day (6:00 a.m.–5:59 p.m., 6:00 p.m.–5:59 a.m.), and weather (dry, wet). Simple logistic regression was used to explore the association between each independent variable and crash severity. Initially, the crude odds ratio for each independent variable was calculated with a 95% confidence interval (CI). All variables with a *P* value <.25 were used when constructing the multiple logistic regression model. A *P* value <.05 was considered to demonstrate a statistically significant association. All statistical analyses were performed using Stata Ver. 15.

Results

Characteristics of injured motorcycle riders

Table 1 presents the characteristics of the study participants. Of the 352 participants, 235 (66.8%) were male and 117 (33.2%) were female. The ages ranged from 18 to 76 years with a mean of 40.9 (SD = 15.3) years. The largest number of injured motorcyclists were in the age group 18–25 years ($n = 89$, 25.3%), followed by the age group 45–54 years ($n = 82$, 23.3%) and those aged 55+ years ($n = 77$, 21.9%). One-third of participants had vocational training or a university degree ($n = 116$, 33%). Most participants were free laborers (e.g., had their own business, taxi drivers, unskilled laborers without a permanent employer; $n = 160$, 45.5%), followed by office workers ($n = 68$, 19.3%) and students ($n = 61$, 17.3%). The majority of the cohort were married/de facto ($n = 235$, 66.8%). Approximately 76% ($n = 268$) of participants were admitted directly to the hospital from the scene of the crash and 84 (23.9%) were transferred from other hospitals. Thirty-two (9.1%) participants self-reported a history of a previous motorcycle crash (of any severity) in the past year. In terms of riding exposure, motorcyclists self-reported that they traveled an average of 85.4 km per week, ranging from 4 to 980 km.

Crash characteristics

Characteristics of the motorcycle crashes are presented in Table 2. The majority of crashes were multivehicle crashes ($n = 258$, 73.3%). A breakdown by type of crash found that 52.3% ($n = 184$) of crashes involved 2 motorcycles and 21.0% ($n = 74$) involved a motorcycle and car or truck. Single-vehicle crashes accounted for 26.7% ($n = 94$) of crashes, of which 13.1% ($n = 46$) occurred due to the motorcyclist losing control and 13.6% ($n = 48$) due to hitting an object, animal, or pedestrian.

The majority of crashes occurred between 6:00 p.m. and 11:59 p.m. ($n = 211$, 59.9%), followed by 12:00 p.m. to 5:59 p.m. ($n = 73$, 20.7%). The majority of crashes also occurred in dry weather ($n = 273$, 77.6%).

Approximately 13% ($n = 44$) of motorcyclists were not wearing a helmet at time of the crash. Of the 142 participants who had their BAC tested at the hospital, 46.5% ($n = 66$) had a BAC above the legal limit (0.05 g/dL). Overall, 18.8% of the total sample (including tested and untested) had a confirmed BAC above the legal limit. Forty-one percent of participants ($n = 145$) did not have a motorcycle license at the time of the crash. Nine percent of participants ($n = 33$) self-reported that they were on their mobile phone at time of the crash. One in 4 participants ($n = 93$) reported that their speed at the time of the crash was over the posted speed limit.

Injury characteristics

Table 3 presents the injury characteristics for participants. The most common site of motorcyclists' injuries was the extremities ($n = 205$, 58.2%), followed by the head ($n = 113$, 32.1%) and external injuries (surface injuries; $n = 45$, 12.8%). Approximately 1 in 4 motorcyclists were injured in at least 2 body regions. The mean length of hospital stay was 8.1 days (SD = 6.3), ranging from 1 to 51 days (median = 7; interquartile range = 4–36). The mean ISS was 7.3 (SD = 4.1), ranging from 1 to 26 (median = 8.5; interquartile range = 1–22). Nearly 7% of hospitalized motorcyclists suffered severe injuries ($n = 24$, 6.8%).

Table 4 presents the results of the simple and multiple logistic regression analyses examining risk factors for injury severity due to a motorcycle crash resulting in hospitalization. Multiple logistic regression found that motorcyclists who were not licensed to drive a motorcycle were more likely to have a severe injury than licensed motorcyclists (adjusted odds ratio [AOR] = 3.3; 95% CI, 1.2–9.3). Motorcyclists who crashed during the night (between 6:00 p.m. and 5:59 a.m.) sustained 4.3 times higher odds of a severe injury than motorcyclists involved in crashes during the day (between 6:00 a.m. and 5:59 p.m.: AOR = 4.3; 95% CI, 1.3–13.8).

Discussion

To our knowledge, this is the first study to examine crash characteristics, injury outcomes, and risk factors for injury severity among motorcyclists hospitalized in a large district of HCMC, Vietnam. The study findings showed that motorcycle injuries represent a significant public health issue in Vietnam, with nearly 1 in 15 participants in this study sustaining a severe injury in a motorcycle crash. This is a higher proportion than a study conducted in Taiwan (Lin et al. 2003) but lower than the proportion reported in a study in Nigeria (Elachi et al. 2014). These differences could be due to the study design or definition of injury severity. This study was undertaken in-hospital and motorcyclists who suffered serious injuries were excluded from the study, whereas the study in Taiwan was population based and included only students from 2 junior colleges. The study in Nigeria was hospital based and included all motorcycle-related injuries.

The study also found that nearly half of the hospitalized motorcyclists were unlicensed. In addition, unlicensed motorcyclists had a 3 times higher odds of severe injury than licensed motorcyclists. This is consistent with previous research conducted in Malaysia that reported that riding without a license was associated with a higher probability of being killed or injured in a motorcycle crash (Isa et al. 2011). Possible explanations for this finding are that unlicensed motorcyclists may be older, with higher risk of serious injury due to age (Ferreira et al. 2017), or unlicensed motorcyclists may be more likely to engage in risky riding behaviors such as speeding, riding while intoxicated, and not using a helmet. It should be noted that the proportion of motorcyclists who were not licensed to drive a motorcycle was considerably higher in this study than in the Malaysian study (around a quarter). These findings highlight the need to improve the current motorcycle licensing system in Vietnam to ensure that all motorcyclists have the proper training before riding on the roads.

The study also found that the majority of motorcycle crashes occurred between 6 p.m. and 12:00 a.m., and these nighttime crashes had more than 4 times higher odds of more serious injuries than crashes that occurred during daytime hours. There could be several explanations for this finding. Firstly, rider speeds may be higher at night. Speed is associated with higher injury severity (Lin et al. 2003; Lin and Kraus 2009). Though self-reported speeding behavior at the time of the crash was not significantly associated with injury severity in our study, this may be due to participant underreporting of speeding.

It is widely acknowledged that road users, including motorcyclists, are more likely to be under the influence of alcohol at night (Lin and Kraus 2009) and that alcohol increases both crash risk and injury severity for motorcyclists (Lin and Kraus 2009). Having a BAC over the legal limit was common in our study (47% of tested participants and 19% of all participants); alcohol consumption may also have contributed to the more severe nighttime crashes. Unfortunately, there was a large amount of missing data for BAC levels in this study, so BAC could not be included in the model. In a busy emergency department in Vietnam, patients' BACs are not routinely tested. The test only is done when the physicians suspects that a patient may have consumed alcohol (usually male patients, those admitted during the late afternoon or at night, patients smelling of alcohol, patients with insurance) or where the police require testing. Further research is required to determine the association between BAC level and crash severity in Vietnam. However, the high prevalence of BACs over the legal limit in this study suggests that prevention of riding under the influence of alcohol through mass and social media campaigns, school and community education, as well as increased police enforcement may be important for reducing the severity of motorcycle crashes in Vietnam.

Table 3. Injury characteristics of motorcyclists hospitalized as a result of a crash in Ho Chi Minh City, Vietnam ($n = 352$).

Injury characteristics	N	Percent
Body region injured		
Head	113	32.1
Face and/or neck	27	7.7
Chest	17	4.8
Abdomen	32	9.1
Extremities (upper and lower)	205	58.2
External (wound)	45	12.8
Injury severity (severe injury)[a]	24	6.8
Mild/ moderate	328	92.2

[a]Injury severity (mild = ISS < 9, moderate = 9 ≤ ISS <16, severe = ISS ≥ 16).

Table 4. Multiple logistic regression results for factors influencing injury severity among motorcyclists hospitalized as a result of a crash in Ho Chi Minh City, Vietnam ($n = 352$).

Risk factor	Crude odds ratio	95% CI	AOR	95% CI
No previous history of a crash[a]	0.68	0.19–2.41	0.48	0.13–1.81
No helmet use at time of crash[a]	2.54	0.95–6.80	2.15	0.74–6.30
No motorcycle license at time of crash[a]	3.08	1.28–7.41	3.32*	1.18–9.34
Nighttime (6 p.m.–5:59 a.m.)	3.32	1.12–9.94	4.28*	1.33–13.78

[a]Reference = yes.
*Significant at $P < .05$ after adjusting for age, gender, occupation, marital status, and education.

It is also possible that poor visibility on unlit roads contributed to increased injury severity. Previous research has similarly reported increased severity for motorcycle crashes in dark conditions (Lin et al. 2003). Explanations for this include reduced conspicuity of motorcyclists to other road users at night as well as decreased visibility for motorcyclists in dark conditions, reducing their ability to take evasive action in response to a conflict or hazard (Pai and Saleh 2007). These findings suggest that improvements in street lighting may be important in reducing the severity of motorcycle crashes in Vietnam; however, further research is required to confirm this.

In addition to the high levels of unlicensed riding and riding with a BAC over the legal limit, other risky behaviors included not wearing a helmet, mobile phone use while driving, and speeding. In this study, 1 in 7 hospitalized motorcyclists were not wearing a helmet at the time of the crash. Motorcycle helmets are effective in protecting the head from serious injury. In Vietnam, a law mandating the use of helmets for all motorcycle riders on all roads was enacted in 2007 and has resulted in a substantial increase in helmet use among motorcyclists, from 30% prior to the legislation to between 72 and 95% after enactment (Bao et al. 2017). However, the high proportion of head injuries sustained by motorcyclists in this study emphasizes the importance of increasing the use of motorcycle helmets that comply with national government standards in Vietnam. Programs that raise awareness of the benefits of purchasing a good-quality helmet that will protect the head and face in the event of a crash should be investigated. These could be incorporated in the licensing procedure and training programs to better prepare motorcyclists for on-road riding.

Nine percent of hospitalized motorcyclists in this study reported that they were on their mobile phone at the time of the crash. Mobile phone use while driving or riding is illegal in Vietnam; however, a recent roadside study reported that 9% of motorcyclists were observed using their phones (Truong et al. 2016). In addition, 26% self-reported that they were speeding at the time of the crash. Previous research has also reported speed to be a risk factor for motorcycle crashes. For example, an Australian study reported that nearly half of fatal motorcycle crashes involved excessive speed on the part of the motorcyclist (Siskind et al. 2011). Because this was based on self-report, it is likely that these risky behaviors were underreported and therefore may present an even more significant issue for motorcyclist crashes in Vietnam. Again, advertising campaigns and police enforcement efforts may be effective in reducing these behaviors among motorcyclists in Vietnam.

The length of stay in the hospital following a motorcycle crash in this study was shorter than that reported in previous studies in, for example, Kenya (Saidi and Mutisto 2013) and Australia (White et al. 2013). This may be because motorcyclists with life-threatening injuries were not included in the study. Another reason may be that the hospital discharged injured motorcyclists earlier than is optimal due to lack of space.

The main limitation of this study was that it was not population based. It was conducted at one large tertiary hospital in a district of HCMC, preventing citywide or nationwide generalizability. However, many of the risk factors for motorcycle crash severity identified in this study are consistent with previous studies (Lin and Kraus 2009; Isa et al. 2011). Another limitation was that data regarding speeding behavior, helmet use, riding exposure, and licensure of the motorcyclists were self-reported and might be subject to recall or social desirability bias. The study also did not include very seriously injured motorcyclists, which also limits the generalizability of the study findings. This study also excluded BAC as a predictor of injury severity due to missing data. However, the relatively large sample size plus the objective injury information obtained from the medical record review strengthens the study results.

In conclusion, motorcycle injuries constitute a major public health problem in HCMC, Vietnam. This study found that riding unlicensed, riding under the influence of alcohol, speeding, and using mobile phones were high-risk behaviors among hospitalized motorcyclists in Vietnam. In addition, being unlicensed and crashing at night were significantly associated with higher injury severity. Findings suggest that prevention and enforcement interventions targeting high-risk behaviors may reduce the significant morbidity and mortality associated with motorcycle crashes in Vietnam.

Acknowledgments

The authors thank Associate Professor Jonine Jancey for her comments on the article and Professor Lynn Meuleners for her assistance with a previous version of the article. We also thank the staff of Gia Dinh hospital for their support during data collection. We grateful to Professor Do Van Dung and Dr. To Gia Kien, who assisted us in data collection.

ORCID

Michelle B. Hobday http://orcid.org/0000-0002-7001-2598

References

Baker SP, O'Neill B, Haddon W, Long WB. 1974. The injury severity score: a methof for descrbing patients with multiple injuries and evaluating emergency care. J Trauma. 14(3):187–96.

Bao J, Bachani AM, Viet CP, Quang N, Nguyen N, Hyder AA. 2017. Trends in motorcycle helmet use in Vietnam: results from a four-year study. Public Health. 144S:S39–S44. doi:10.1016/j.puhe.2017.01.010.

Dat LV. 2015. Vietnam national road safety goals and action plan oppotunities and challenges. [accessed 2016 Oct 16]. https://www.unescap.org/sites/default/files/VietnamNationalRoadSafetyGoalsandActionplanOppotunitiesandChallenges.pdf.

Elachi IC, Okunola BB, Yongu WT, Onyemaechi NO, Odatuwa-Omagbemi OD, Ahachi CN, Mue DD. 2014. Motorcycle-related injuries at a university teaching hospital in north central Nigeria. Niger Med J. 55(6):452–5.

Ferreira S, Amorim M, Couto A. 2017. Risk factors affecting injury severity determined by the MAIS score. Traffic Inj Prev. 18(5): 515–20. doi: 10.1080/15389588.2016.1246724.

Ha NT, Ederer D, Vo VAH, Pham AV, Mounts A, Nolen LD, Sugerman D. 2015. Changes in motorcycle-related injuries and

deaths after mandatory motorcycle helmet law in a district of Vietnam. Traffic Inj Prev. 19(1):75–80. doi:10.1080/15389588.2017.1322203.
Hoang HTM, Pham TL, Vo TTN, Nguyen PK, Doran CM, Hill PS. 2008. The costs of traumatic brain injury due to motorcycle accidents in Hanoi, Vietnam. Cost Eff Resour Alloc. 6(1):17. doi:10.1186/1478-7547-6-17.
Lin MR, Chang SH, Huang W, Hwang HF, Pai L. 2003. Factors associated with severity of motorcycle injuries among young adult riders. Ann Emerg Med. 41(6):783–91.
Lin MR, Kraus JF. 2009. A review of risk factors and patterns of motorcycle injuries. Accid Anal Prev. 41(4):710–22. http://dx.doi.org/10.1016/j.aap.2009.03.010.
Mathers CD, Loncar D. 2006. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 3(11):e442. http://dx.doi.org/10.1371/journal.pmed.0030442.
Isa MHM, Jawi ZM, Sarani R, Wong SV. 2011. Injury severity analysis of accidents involving young motorcycle riders in Malaysia. J East Asia Soc Transp Stud. 9:1997–2010. doi:10.11175/easts.9.1997.
Ngo AD, Rao C, Phuong Hoa N, Hoy DG, Thi Quynh Trang K, Hill PS. 2012. Road traffic related mortality in Vietnam: evidence for policy from a national sample mortality surveillance system. BMC Publ Health. 12(1):561. doi:10.1186/1471-2458-12-561.
Organization for Economic Cooperation and Development, International Transport Forum. 2015. Improving safety for motorcycle, scooter and moped riders. Paris (France): OECD Publishing. p. 155–73.
Pai CW, Saleh W. 2007. An analysis of motorcyclist injury severity under various traffic control measures at three-legged junctions in the UK. Saf Sci. 45(8):832–47. doi:https://doi.org/10.1016/j.ssci.2006.08.021.
Saidi H, Mutisto BK. 2013. Motorcycle injuries at a tertiary referral hospital in Kenya: injury patterns and outcome. Eur J Trauma Emerg Surg. 39(5):481–5. http://dx.doi.org/10.1007/s00068-013-0280-8.
Siskind V, Steinhardt D, Sheehan M, O'Connor T, Hanks H. 2011. Risk factors for fatal crashes in rural Australia. Accid Anal Prev. 43(3):1082–8. https://doi.org/10.1016/j.aap.2010.12.016.
Stanford P, Booth N, Suckley J, Twelvetree T, Thomas D. 2016. Assessment of injury severity in patients with major trauma. Nurs Stand. 30(49):54–63. http://dx.doi.org/10.7748/ns.2016.e10342.
Truong LT, Nguyen HTT, De Gruyter C. 2016. Mobile phone use among motorcyclists and electric bike riders: a case study of Hanoi, Vietnam. Accid Anal Prev. 91:208–215. http://dx.doi.org/10.1016/j.aap.2016.03.007.
White D, Lang J, Russell G, Tetsworth K, Harvey K, Bellamy N. 2013. A comparison of injuries to moped/scooter and motorcycle riders in Queensland, Australia. Injury. 44(6):855–62.
World Health Organization. 2015. Global status report all road safety 2015. Geneva (Switzerland): Author [accessed 2018 Oct 16]. http://www.who.int/violence_injury_prevention/road_safety_status/2015.

B2. Publication 2

This article has been published in the Journal of **Asia Pacific Journal of Public Health:** Doan HTN, Hobday MB, Leavy JE, Jancey J. Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam. Asia Pac J Public Health. 2020 Mar-Apr;32(2-3):118-125. doi: 10.1177/1010539520912120. Epub 2020 Mar 23. PMID: 32204606.

Article

Asia Pacific Journal of Public Health
2020, Vol. 32(2-3) 118–125
© 2020 APJPH
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/1010539520912120
journals.sagepub.com/home/aph
SAGE

Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam

Han Thi Ngoc Doan, BPH, MPH[1,2], Michelle B. Hobday, MPH, PhD[3], Justine E. Leavy, MPH, PhD[1], and Jonine Jancey, BSc, PhD[1]

Abstract

Despite the burden of injury associated with motorcycle crashes and injuries in Vietnam, there are no studies investigating health-related quality of life (HRQoL) following a nonfatal motorcycle crash in this country. Therefore, this study aimed to evaluate the change of HRQoL preinjury, and at 6 and 12 months postinjury motorcycle crash in Ho Chi Minh City, Vietnam. Outcome measures were Physical Component Scores (PCS) and Mental Component Scores (MCS) of the Short Form 12 Health Survey (SF-12) version 2 and the EQ-5D. Multilevel mixed models were undertaken. A total of 352 hospitalized motorcyclists were followed-up. Compared with preinjury, the SF-12 PCS reduced by 6.61 points (95% confidence interval [CI] = −8.21 to −5.03) and 5.12 points (95% CI = −6.74 to −3.51) at 12 months postinjury. MCS also reduced by 4.23 points (95% CI = −5.99 to −2.47) at 6 months but increased by 1.29 points (95% CI = −0.49 to 3.08) at 12 months postinjury. The EQ-5D Visual Analogue Scale score decreased by 10.41 points (95% CI = −11.49 to −9.33) at 6 months and 6.48 points (95% CI = −7.58 to −5.38) at 12 months postinjury. The HRQoL among injured motorcycle riders improved between 6 and 12 months after injury but had not returned to the levels before injury.

Keywords

long-term outcomes, motorcycle injuries, health-related quality of life, motorcycle crashes, recovery, Vietnam

What We Already Know

- The fatality rates from motorcycle crashes in Vietnam and low- and middle-income countries (LMICs) are high.
- There is a dearth of information about health-related quality of life for motorcyclists involved in crashes in Vietnam and LMICs.

What This Article Adds

- Health-related quality of life (HRQoL) of injured motorcyclists improved between 6 and 12 months postinjury.
- HRQoL of motorcyclists had not returned to the levels preinjury at 12 months postinjury.
- Gender, increasing age, and length of stay in hospital were significantly associated with HRQoL.
- These findings further the understanding of the long-term HRQoL outcomes of motorcycle crashes.
- Provides evidence to support better estimates of the burden of motorcycle injuries in Vietnam and low- and middle-income countries.

Introduction

Road traffic injuries (RTIs) are recognized as a major public health issue due to their substantial contribution to the burden of disease. Globally, RTIs are responsible for up to 78

[1]Curtin University, Perth, Western Australia, Australia
[2]University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam
[3]Department of Health, Western Australia, Perth, Western Australia, Australia

Corresponding Author:
Han Thi Ngoc Doan, University of Medicine and Pharmacy at Ho Chi Minh City, 217 Hong Bang Street, Ward 11, District 5, Ho Chi Minh City, 700000, Vietnam.
Email: doanngochan@ump.edu.vn

million injuries and 1.35 million fatalities per year.[1,2] RTIs in low- and middle-income countries (LMICs) also result in significant burden of disease, accounting for more than 90% of global road traffic deaths.[2] While advances in trauma care have led to an increased likelihood of survival, the literature indicates that nonfatal RTIs are more likely to lead to long-term disability than premature death, with the long-term physical and mental health consequences.[3]

Health-related quality of life (HRQoL) is an excellent indicator of physical and mental health capturing self-perceived physical and mental health functioning and their impact on the individual's quality of life.[4] HRQoL has been found to be an important self-reported health outcome measure among injured people,[5] with previous studies finding that those injured in nonfatal RTIs report a significant reduction in HRQoL, including long-term psychological disorders and physical disability.[6-8] However, most of these studies examined all road users, rather than motorcycle crashes specifically.

There is a dearth of information about the long-term health outcomes for motorcyclists involved in crashes, with a limited number of studies having been conducted in high-income countries. A study based in Greece, Italy, and Germany found that 2-wheel users (motorcycles, scooters, and bicycles) had residual physical deficits and psychological problems 12 months postinjury.[9] Studies conducted in the United States and Australia, focusing on the effects of protective equipment including clothing and wearing helmets on health outcomes,[10,11] reported that over half of injured motorcycle riders continued to experience physical deficits 1 year after injury.[10] However, there is no research determining the change in HRQoL before injury and 12 months postinjury in motorcycle crashes, particularly in LMICs where motorcycles are the primary mode of transport.[2]

In many LMICs, the majority of road traffic deaths and injuries are attributed to motorcycle crashes.[2,12] Notably, motorcycle riders are more vulnerable, suffering more severe injuries than other groups of road users due to the lack of protective equipment compared with passenger cars.[13] Motorcycle riders are 8 times more likely to be injured and 37 times more likely to die in a crash compared with vehicle occupants.

Vietnam is a LMIC located in Southeast Asia where motorcycles are the main mode of transport for commuting. The number of registered motorcycles has increased more than 20-fold in the past 2 decades, from 2.3 million in 2002 to more than 47 million in 2016.[14] The increase in the number of motorcycles in Vietnam has been accompanied by an increase in the number of motorcycle crashes and injuries, especially in Ho Chi Minh City (HCMC), which has the highest population density and highest number of motorcycles in Vietnam. According to the World Health Organization, there were 8417 road traffic fatalities and 19 280 RTIs in 2016 in Vietnam, of which 70% were motorcycle crashes.[2,14] HCMC accounted for the highest number of injuries as well as fatalities related to road traffic in Vietnam with 3302 cases of injuries and 703 fatalities in 2015.[14] Despite the burden of injury associated with motorcycle crashes and injuries in Vietnam, there are no studies investigating HRQoL following a nonfatal motorcycle crash in this country. Therefore, this study aimed to evaluate the change of HRQoL before injury and 6 and 12 months after injury in a motorcycle crash in HCMC, Vietnam.

Materials and Methods

Study Design

This is a prospective cohort study in the Gia Dinh Hospital, one of the largest trauma hospitals in southern Vietnam, located in Binh Thanh district of HCMC.

Participants

Eligible participants were motorcycle riders aged 18 years and older on admission, and admitted to hospital for a period of at least 24 hours due to a motorcycle crash between June 1, 2017, and January 31, 2018.

Participants were excluded if any of the following were present: cognitive impairment due to the crash (physician-assessed); severe physical condition (eg, serious traumatic brain injury or spinal cord injury); unable to provide informed consent; no memory of the crash; transferred to another hospital; did not speak Vietnamese; or the researcher was unable to make contact with the patient at the hospital or at home.

Data Collection

At Baseline. Eligible participants were identified through emergency department (ED) admission lists based on the aforementioned inclusion criteria. The researcher approached eligible participants during their hospital stay, provided a participant information sheet and consent form, and extended an invitation to participate in the study. If eligible participants were discharged from hospital before being approached, they were contacted by mail for a follow-up telephone interview within 1 week of discharge. All eligible participants were approached only when their physicians considered them fit to participate. Interviews did not proceed until written consent was obtained.

At 6 and 12 Months Postinjury. Two weeks prior to the interview, the participants or their relatives were contacted by telephone to remind them of the study and the purpose of the interview. Patients were considered unavailable for follow-up and excluded at 6 and 12 months when one of the following criteria applied:

- Participant confirmed no interest in participating in the study
- Participant did not respond to 5 consecutive telephone calls over 2 weeks

Recruitment

A total of 441 participants admitted to the ED of the Gia Dinh Hospital due to a motorcycle crash were reviewed, with 378 (85.7%) meeting the study's inclusion criteria. All of the eligible injured riders were approached, and 352 (93.1%) agreed to participate in the study. The researcher-administered questionnaire was completed by 330 participants (93.8%) while in hospital, and by the remaining 22 participants (6%) by telephone after discharge. At 6-month follow-up, 51 (14.5%) participants were lost to attrition. At 12-month follow-up, 15 (4.3%) participants were lost to attrition. Data were collected for 286 (81.3%) participants at 12-month postdischarge.

Outcome Measures

The collection of baseline data via the researcher-administered questionnaire took approximately 20 minutes to complete. Follow-up data collection occurred at 6 and 12 months postinjury either by telephone or face-to-face interview, depending on the participant's preference. The interview took approximately 10 to 15 minutes to complete.

Demographic data, including age, sex, and education, were collected during the baseline interviews. Length of stay (LOS) in the hospital and Injury Severity Score (ISS) were extracted from medical records at baseline.

The evaluation of the HRQoL was undertaken using the Short Form 12 Health Survey version 2 (SF-12 v2) and the 5-level EuroQoL (EQ-5D-5L). These instruments have been translated into Vietnamese and have been used with the Vietnamese population.[15,16] Participants were questioned about their HRQoL in the month prior to the crash and at 6 months and 12 months postinjury.

The SF-12 v2 (referred to as the SF-12 hereafter) comprises 12 questions. The SF-12 is reported as the Physical Component Scores (PCS) and the Mental Component Scores (MCS). Higher PCS and MCS indicate a better health status.[17]

The EQ-5D-5L describes participants' quality of life using 5 dimensions, namely, mobility, self-care, usual activities, pain/comfort, and anxiety/distress, and a score for overall self-rated health (Visual Analogue Scale [EQ-VAS]).[18] The EQ-VAS is used to assess self-rated health by using a 100-mm scale with the score ranged from 0 (the worst health you can imagine) to 100 (the best health you can imagine).[18] According to the EQ-5D-5L user guide, the EQ-5D-5L dimension can be categorized into either no problems (level 1) or problems (levels 2-5).[19]

Statistical Analysis

Descriptive statistics were undertaken on demographic factors and HRQoL scores at baseline and at 6 and 12 months postinjury. Chi-square tests and Mann-Whitney *U* tests were used to compare the age, gender, and education of participants who completed the study and those lost to follow-up. Wilcoxon pair tests were used to compare change in PCS, and MCS of the SF-12 and EQ-VAS scores relative to the previous time point.

Multilevel mixed-effects regression models were undertaken to analyze the change in outcomes over time and to explore predictors of these outcomes. We specified a 2-level random coefficients model to account for the repeated measures of outcome (level 1) nested within different individuals (level 2). Each variable was added to the base model as a fixed effect to explain HRQoL variance between individuals and the change in such variables within each person over time. Explanatory variables included in the model at level 2 were age group, gender, ISS, and LOS. Stata version 15 was used for the analyses.

Ethics Approval

This study was approved by the Curtin University (HRE2017-0010), the University of Medicine and Pharmacy at HCMC (UMP-40), and the Gia Dinh Hospital (KHTH-QLTTSL-04).

Results

Overview of the Participants

Table 1 presents the characteristics of participants at baseline and at 6 and 12 months after motorcycle injury in HCMC. At baseline, the majority of participants were male (n = 235, 66.8%). The largest number of injured motorcycle riders were aged 35 to 54 years (n = 139, 39.5%), and one third of the participants (n = 116, 33.0%) had vocational training or university degree. There were no statistically significant differences in gender, age group, and education over the 3 time points.

A total of 301 (85.5%) participants were followed-up at 6 months postinjury, and 286 (81.3%) at 12 months postinjury. There were no significant differences in age, gender, education, ISS, and LOS between participants studied and those lost to follow-up.

Change in HRQoL Scores of the Study Population Relative to Previous Time Point

Changes in the mean PCS, MCS, EQ-VAS scores, and EQ domains are summarized in Table 2. The results of SF-12 indicated a significant decline in the mean PCS at 6 months ($P < .001$) and at 12 months postinjury ($P = .03$) compared with preinjury. The mean MCS significantly decreased at 6 months postinjury compared with before injury ($P < .001$). There was a nonsignificant increase in the MCS between preinjury and 12 months postinjury ($P = .055$).

There was a significant decline in the mean EQ-VAS scores at 6 ($P < .001$) and 12 months ($P < .001$) postinjury compared with preinjury (Table 2). All dimensions of the EQ-5D showed significant improvement between 6 and 12

Table 1. Demographic and Injury Characteristics of Motorcycle Riders Involving a Motorcycle Crash at Baseline and at 6 Months and 12 Months Postinjury at HCMC, Vietnam, in 2017 and 2018.

Variables	Baseline (n = 352), n (%)	6 Months Postinjury (n = 301), n (%)	12 Months Postinjury (n = 286), n (%)
Gender			
Male	235 (66.8)	206 (68.4)	195 (68.2)
Female	117 (33.2)	95 (31.6)	91 (31.8)
Age			
18-34	136 (38.6)	112 (37.2)	108 (37.8)
35-54	139 (39.5)	124 (41.2)	115 (40.2)
55+	77 (21.9)	65 (21.6)	63 (22)
Education			
No formal/elementary school	57 (16.2)	49 (16.3)	45 (15.7)
Middle school	105 (29.8)	91 (30.2)	83 (29)
High school	74 (21)	66 (21.9)	62 (21.7)
Vocational/university	116 (33)	95 (31.6)	96 (33.6)
Injury Severity Score	7.3 (4.1)[a]	7.4 (4.2)[a]	7.4 (4.0)[a]
	8.5 (4-9)[b]	9 (4-9)[b]	9 (4-9)[b]
Length of stay in hospital	8.1 (6.3)[a]	8.3 (6.6)[a]	8.4 (6.6)[a]
	7 (4-10)[b]	7 (4-10)[b]	7 (4-10)[b]

Abbreviation: HCMC, Ho Chi Minh City.
[a]Mean (SD).
[b]Median (interquartile range).

Table 2. Change in Health-Related Quality of Life of Motorcycle Riders Involving a Motorcycle Crash Relative to Previous Time Point at HCMC, Vietnam, in 2017 and 2018.

Variables	Preinjury (n = 352), Mean ± SD	6 Months Postinjury (n = 301), Mean ± SD	12 Months Postinjury (n = 286), Mean ± SD	*P*, Preinjury vs 6 Months	*P*, Preinjury vs 12 Months	*P*, 6 vs 12 Months
SF-12						
PCS	51.78 ± 9.71	45.19 ± 13.73	46.62 ± 10.78	.000	.000	.029
MCS	46.83 ± 11.99	42.56 ± 13.94	48.14 ± 11.52	.000	.055	.000
The EQ-5D						
EQ-VAS	85.60 ± 10.99	75.12 ± 12.05	79.96 ± 12.25	.000	.000	.000
EQ-5D Domains	n (%)	n (%)	n (%)			
Mobility						
No problems	340 (96.6)	211 (70.1)	219 (76.6)	.000	.000	.000
Problems	12 (3.4)	90 (29.9)	67 (23.4)			
Self-care						
No problems	347 (98.6)	232 (77.1)	242 (84.6)	.000	.000	.015
Problems	5 (1.4)	69 (22.9)	44 (15.4)			
Usual activities						
No problems	325 (92.3)	191 (63.5)	207 (73.4)	.000	.000	.035
Problems	27 (7.7)	110 (36.5)	79 (27.6)			
Pain/discomfort						
No problems	262 (74.4)	131 (43.5)	143 (50.0)	.000	.000	.194
Problems	90 (25.6)	170 (56.5)	143 (50.0)			
Anxiety/depression						
No problems	266 (75.6)	169 (56.2)	185 (64.7)	.000	.000	.025
Problems	86 (24.4)	432 (43.8)	101 (35.5)			

Abbreviations: HCMC, Ho Chi Minh City; SF-12, Short Form 12 Health Survey; PCS, Physical Component Score; MCS, Mental Component Score; EQ-VAS, European Visual Analogue Scale.

Table 3. Multilevel Modeling Assessing the Change of HRQoL of a Sample of Hospitalized Motorcycle Riders Involving a Motorcycle Crash in HCMC, Vietnam, in 2017 and 2018.

	SF-12				The EQ-5D	
	PCS		MCS		EQ-VAS	
Variables	Coefficient (SE)	95% CI	Coefficient (SE)	95% CI	Coefficient (SE)	95% CI
Time assessment						
Preinjury	Ref					
6 months postinjury	−6.61 (0.81)	−8.21 to 5.03	−4.23 (0.89)	−5.99 to 2.47	−10.41 (0.55)	−11.49 to −9.33
12 months postinjury	−5.12 (0.82)	−6.74 to −3.51	1.29 (0.91)	−0.49 to 3.08	−6.48 (0.56)	−7.58 to −5.38
Gender						
Male	Ref					
Female	−3.61 (0.79)	−5.16 to −2.06	−1.60 (0.99)	−3.56 to −0.35	−2.87 (0.73)	−4.30 to −1.45
Age						
18-34	Ref					
35-54	−2.26 (0.84)	−3.91 to −0.61	−1.94 (1.06)	−3.56 to 0.35	−6.70 (0.78)	−8.24 to −5.18
55+	−9.38 (0.99)	−11.32 to −7.44	−2.92 (1.25)	−5.37 to −0.46	−14.10 (0.91)	−15.89 to −12.31
ISS	−0.11 (0.09)	−0.29 to 0.71	−0.11 (0.16)	−0.34 to 0.12	−0.25 (0.09)	−0.41 to −0.078
LOS	−0.14 (0.06)	−0.25 to −0.03	−0.05 (0.07)	−0.19 to 0.93	−0.13 (0.05)	−0.24 to −0.021
Constant	61.5 (1.35)					
Random Effect	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Between-person effect	5.64 (3.97)	1.41 to 22.47	23.82 (5.95)	14.58 to 38.89	20.34 (3.11)	15.07 to 17.46
Within-person effect	106.14 (6.09)	94.84 to 118.78	129.26 (7.42)	115.49 to 144.65	48.6 (2.82)	43.36 to 54.45

Abbreviations: HRQoL, health-related quality of life; HCMC, Ho Chi Minh City; SF-12, Short Form 12 Health Survey; PCS, Physical Component Score; SE, standard error; CI, confidence interval; MCS, Mental Component Score; EQ-VAS, European Visual Analogue Scale; ISS, Injury Severity Score; LOS, length of stay.

months postinjury, except for the pain/discomfort dimension. However, none returned to preinjury status. Before injury, pain/discomfort (n = 90, 25.6%) was the dimension reported as causing problems in the highest proportion of participants, followed by anxiety/depression (n = 86, 24.4%). At 6 months postinjury, pain/discomfort was still the dimension reported as problematic by the highest proportion of participants, increasing to 56.5% (n = 170) of participants. Although the pain/discomfort dimension improved between 6 and 12 months postinjury, this improvement was not significant (P = .194). Anxiety/depression improved significantly by 7% between 6 and 12 months postinjury (P = .025).

Change in HRQoL Scores of Study Population Over Time

The results of the multilevel modeling examining the change in HRQoL scores over time are presented in Table 3. After adjusting for covariates, the model analyzing changes in HRQoL over time using the SF-12 revealed that, compared with preinjury, participants' PCS reduced significantly by 6.61 points (95% confidence interval [CI] = −8.21 to −5.03) at 6 months and by 5.12 points (95% CI = −6.74 to −3.51) at 12 months postinjury. In addition, the MCS decreased significantly by 4.23 (CI = −5.99 to −2.47) at 6 months postinjury, compared with before the motorcycle crash. The MCS increased by 1.29 points at 12 months, but this increase was not statistically significant. Females had significantly lower PCS (β = −3.61; 95% CI = −5.16 to −2.06) and MCS (β = −1.60; 95% CI: −3.56 to −0.35) compared with males over time. Being aged older than 55 years was associated with lower PCS (β = −9.38; 95% CI = −11.32 to −7.44) and MCS (β = −2.92; 95% CI = −5.37 to −0.46) compared with being aged between 18 and 34 years.

The results of the mixed model modeling changes in the HRQoL using the EQ-5D indicated that the EQ-VAS score reduced significantly by 10.41 (95% CI = −11.49 to −9.33) at 6 months and 6.48 (95% CI = −7.58 to −5.38) at 12 months postinjury, compared with preinjury. After adjusting for covariates, females had significantly lower EQ-VAS scores (β = −2.87; 95% CI = −4.30 to −4.15) compared with males over time. Being aged between 35 and 54 years (β = −6.7; 95% CI = −8.24 to −5.18) and older than 55 years (β = −14.10; 95% CI = −15.89 to −12.31) were associated with lower the EQ-VAS compared with the 18- to 34-year-old age group.

Discussion

This is the first longitudinal study to assess the changes in HRQoL of injured motorcycle riders due to a motorcycle crash from preinjury to 12 months postinjury in Vietnam. The results found that HRQoL scores increased between 6 and 12 months postinjury, but they did not return to the baseline scores at the 12-month follow-up. Factors significantly associated with HRQoL were older age, gender, and LOS in the hospital. Although there are no studies investigating the change in HRQoL over 12 months after motorcycle injury, limiting comparisons of the findings to other studies, the findings of this study were consistent with other studies that have found a reduction in HRQoL following an RTI.[3,20]

This study found that motorcycle riders involved in a motorcycle crash experienced a significant decrease in the PCS at 6 months and 12 months postinjury compared with preinjury. In contrast, the MCS reduced significantly at 6 months postinjury but improved at 12 months postinjury compared with preinjury. This change over time was consistent with the findings of previous studies in the United States and European countries reporting changes in HRQoL over time after an RTI.[21-23] However, the size of the reduction in the PCS of HRQoL in our study was more pronounced than in the study by Alghnam and colleagues, which only showed a decline of 2.8 in the score.[21] However, the follow-up in the Alghnam et al study was longer, up to 18 months, which may have resulted in a larger improvement of HRQoL due to the additional recovery time.[3] Another possible explanation for this is that injured patients in high-income countries may have better recovery postinjury due to earlier and better access to treatment and rehabilitation services.[24,25] In addition, the results of this study suggest that motorcycle riders are likely to suffer more severe injuries than motor vehicle drivers due to the exposure to environmental conditions (such as wind, gravel, and road surface damage), and the absence of the physical protection provided by the external body of a motor vehicle.[13]

In contrast to our study, a recent study of 54 two-wheel users in 3 European countries of Greece, Italy, and Germany found that reported levels of physical disability did not change between 6 and 12 months postinjury, although they were significantly higher than at 1 month postinjury. This study also found that psychological functioning was not significantly different at 1, 6, and 12 months after injury.[9] These poor health outcomes may have been due to all participants in this study experiencing severe injury and being admitted to the intensive care unit while our participants only included those with mild and moderate injuries. Therefore, the recovery of our participants may have been less protracted.

The study found the mean EQ-VAS score reduced significantly within 12 months postinjury compared with preinjury, although there was an improvement between 6 and 12 months postinjury. This indicates that injuries from motorcycle crashes resulted in substantial long-term morbidity, consistent with the findings of previous research.[25] Furthermore, the changes in the mean EQ-VAS scores in our study support the hypothesis that crash-injured motorcycle riders regain some lost HRQoL but do not achieve the preinjury health status at 12 months postinjury.[3] Although there has been no previous research investigating changes in HRQoL using the EQ-5D-5L for injured motorcycle riders, our findings were consistent with previous studies conducted on populations with unintentional injuries that assessed the burden of injuries in high-income countries.[26,27] A recent cross-sectional study by Vu et al[28] measured HRQoL using the EQ-5D-5L among participants involved in road traffic crashes admitted to a hospital in Vietnam. This study found that the EQ-VAS score among participants was 66. Our scores were higher at both 6 months (75.12) and 12 months postinjury (79.96). The differences may be due to participants' HRQoL being assessed at different times. While the EQ-VAS score of this study was followed-up following 6 and 12 months after injury, Vu et al assessed the EQ-VAS score during hospital admission, which could have impact on the lower EQ-VAS score.

This study found that injured female motorcycle riders had lower scores for both physical and mental health measures, which is similar to previous studies that have reported that females experience more long-term impairment and disability following traffic injuries than males.[3,27] However, the reasons for this disparity are unclear. It should be also noted that the majority of injured motorcycle riders in this study were young males reporting better outcomes. This study found that physical disability and psychological distress increased substantially with increasing age and increasing LOS in the hospital, consistent with other studies on RTIs in high-income countries.[29,30] This may be attributed to an increase in the healing time of older people.[3,30] In addition, the LOS negatively affected interpersonal relationships, work status, and social function, resulting in a HRQoL reduction.[6] Previous studies have found an association between injury severity and HRQoL.[3,27,30] However, our study did not find the association between ISS and HRQoL. A possible explanation is that most participants in this study suffered mild and moderate injury. The strengths of the study include the use of a longitudinal design allowing long-term changes in outcomes and baseline predictors to be analyzed. Second, multilevel modeling enabled us to explain variation in outcomes by participant baseline characteristics, while taking into account the longitudinal data structure. However, the current study has a number of limitations that need to be acknowledged. First, only people with mild and moderate severity injuries were included in the study. This could lead to underestimation of the adverse physical and adverse psychological outcomes of those injured in motorcycle crashes. Future studies could include motorcyclists with more severe injuries and with longer follow-up, such as 24 months. Another limitation was that it was not a population-based study. It was conducted at a single large tertiary hospital in a district of HCMC, potentially limiting citywide or national generalizability. However, changes in HRQoL in this study are consistent with previous studies on RTIs.

Conclusions

This is the first study to assess changes in HRQoL in mild and moderate motorcycle crash-injured riders following injury in Vietnam. Twelve months after motorcycle injuries, the HRQoL had not returned to the levels before the crash. This was particularly noticeable when physical HRQoL was measured. These findings are important for furthering our understanding of the long-term HRQoL outcomes of motorcycle crashes, providing evidence to support better estimates of the burden of motorcycle injuries in Vietnam and other LMICs, and highlights the importance of screening and treating physical and psychological comorbidities as part of injury management in a timely manner.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Han Thi Ngoc Doan https://orcid.org/0000-0001-6504-4344

References

1. World Bank; Institute for Health Metrics and Evaluation. *Transport for Health: The Global Burden of Disease From Motorised Road Transport*. Washington, DC/Seattle, WA: World Bank/Institute for Health Metrics and Evaluation; 2014.
2. World Health Organization. *Global Status Report on Road Safety 2018. France 2018. Licence: CC BYNC-SA 3.0 IGO*. Geneva, Switzerland: World Health Organization; 2018.
3. Rissanen R, Berg HY, Hasselberg M. Quality of life following road traffic injury: a systematic literature review. *Accid Anal Prev*. 2017;108:308-320.
4. Yin S, Njai R, Barker L, Siegel PZ, Liao Y. Summarizing health-related quality of life (HRQOL): development and testing of a one-factor model. *Popul Health Metr*. 2016;14:22.
5. Gabbe BJ, Cameron PA. Importance of functional and quality of life outcomes in trauma. *Surgeon*. 2013;11:114.
6. Richmond TS, Kauder D, Hinkle J, Shults J. Early predictors of long-term disability after injury. *Am J Crit Care*. 2003;12:197-205.
7. Attenberger C, Amsler F, Gross T. Clinical evaluation of the Trauma Outcome Profile (TOP) in the longer-term follow-up of polytrauma patients. *Injury*. 2012;43:1566-1574.
8. Fitzharris M, Fildes B, Charlton J, Kossmann T. General health status and functional disability following injury in traffic crashes. *Traffic Inj Prev*. 2007;8:309-320.
9. Papadakaki M, Tsalkanis A, Sarris M, et al. Physical, psychological and economic burden of two-wheel users after a road traffic injury: evidence from intensive care units of three EU countries. *J Safety Res*. 2018;67:155-163.
10. Hotz GA, Cohn SM, Mishkin D, et al. Outcome of motorcycle riders at one year post-injury. *Traffic Inj Prev*. 2004;5:87-89.
11. de Rome L, Ivers R, Fitzharris M, Haworth N, Heritier S, Richardson D. Effectiveness of motorcycle protective clothing: riders' health outcomes in the six months following a crash. *Injury*. 2012;43:2035-2045.
12. Hyder AA, Waters H, Phillips T, Rehwinkel J. Exploring the economics of motorcycle helmet laws—implications for low and middle-income countries. *Asia Pac J Public Health*. 2007;19:16-22.
13. Keall MD, Newstead S. Analysis of factors that increase motorcycle rider risk compared to car driver risk. *Accid Anal Prev*. 2012;49:23-29.
14. Economic and Social Commission for Asia and the Pacific. *Road Safety Performance Review Viet Nam*. Bangkok, Thailand: United Nations; 2018.
15. Nguyen HTT, Moir MP, Nguyen TX, et al. Health-related quality of life in elderly diabetic outpatients in Vietnam. *Patient Prefer Adherence*. 2018;12:1347-1354.
16. Nguyen LH, Tran BX, Le QNH, Tran TT, Latkin CA. Quality of life profile of general Vietnamese population using EQ-5D-5L. *Health Qual Life Outcomes*. 2017;15:199.
17. Ware JE, Kosinski MA, Keller DS. *SF-12: How to Score the SF-12 Physical and Mental Health Summary Scales*. Boston, MA: Health Institute, New England Medical Center; 1998.
18. EuroQol Group. EuroQol—a new facility for the measurement of health-related quality of life. *Health Policy*. 1990;16:199-208.
19. Mandy VR, Bas J. *EQ-5D-5L User Guide. Basic Information on How to Use the EQ-5D-5L instrument*. Rotterdam, Netherlands: EuroQol Research Foundation; 2015.
20. Rainer TH, Yeung HH, Gabbe BJ, et al. A comparison of functional outcome in patients sustaining major trauma: a multicentre, prospective, international study. *PLoS One*. 2014;9:e103396.
21. Alghnam S, Palta M, Remington LP, Mullahy J, Durkin SM. The association between motor vehicle injuries and health-related quality of life: a longitudinal study of a population-based sample in the United States. *Qual Life Res*. 2014;23:119-127.
22. Lewis JA, Vint H, Pallister I. Pilot study assessing functional outcome of tibial pilon fractures using the VSTORM method. *Injury*. 2013;44:1112-1116.
23. Gabbe BJ, Simpson PM, Sutherland AM, Wolfe R, Lyons RA, Cameron PA. Evaluating time points for measuring recovery after major trauma in adults. *Ann Surg*. 2013;257:166-172.
24. Zhang Y, Ou F, Gao S, Gao Q, Hu L, Liu Y. Effect of low income on health-related quality of life: a cross-sectional study in northeast China. *Asia Pac J Public Health*. 2013;27:1013-1025.
25. Paryavi E, Gilotra MN, Johnson AJ, Pensy RA, Eglseder WA, Abzug JM. Upper extremity injuries in motorcyclists: implications for mortality and need for rehabilitation services. *J Trauma Acute Care Surg*. 2015;78:1021-1025.
26. Kendrick D, Kelllezi B, Coupland C, et al. Psychological morbidity and health-related quality of life after injury: multicentre cohort study. *Qual Life Res*. 2017;26:1233-1250.

27. Polinder S, van Beeck EF, Essink-Bot ML, et al. Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands. *J Trauma*. 2007;62:133-141.
28. Vu HM, Dang AK, Tran TT, et al. Health-related quality of life profiles among patients with different road traffic injuries in an urban setting of Vietnam. *Int J Environ Res Public Health*. 2019;16:E1462.
29. Gopinath B, Harris IA, Nicholas M, et al. A Comparison of health outcomes in older versus younger adults following a road traffic crash injury: a cohort study. *PLoS One*. 2015;10:e0122732.
30. Polinder S, Haagsma JA, Belt E, et al. A systematic review of studies measuring health-related quality of life of general injury populations. *BMC Public Health*. 2010;10:783.

B3. Publication 3

This article has been published in the Journal of Injury: Doan HTN, Hobday MB, Leavy JE, Jancey J. Doan HTN, Hobday MB, Leavy J, Jancey J. Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam. Injury. 2020 Apr;51(4):924-929. doi: 10.1016/j.injury.2020.02.125. Epub 2020 Mar 5. PMID: 32178844.

Injury 51 (2020) 924–929

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam

Han Thi Ngoc Doan[a,b,*], Michelle B. Hobday[c], Justine Leavy[a], Jonine Jancey[a]

[a] Collaboration for Evidence, Research and Impact in Public Health, School of Public Health, Curtin University, Perth, WA 6845, Australia
[b] Faculty of Public Health, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Viet Nam
[c] Epidemiology Branch, Department of Health, WA, Australia

ARTICLE INFO

Article history:
Accepted 25 February 2020

Keywords:
Long-term outcomes
Motorcycle injuries
Functional status
Pain
Return to work
Motorcycle crashes
Vietnam

ABSTRACT

Objective: This study aimed to determine changes in functional status, pain, and return to work/study (RTW/study) over 12 months post-injury in motorcyclists admitted to a large hospital in Ho Chi Minh City (HCMC), Vietnam.

Methods: A prospective study was undertaken with adult motorcyclists who were injured due to a crash and were admitted to hospital for more than 24 h. Pain and functional status data were collected at baseline (time of injury), and follow-up at 6 and 12 months post-injury. RTW/study was collected at 6 and 12 months post-injury. Multilevel mixed models and multiple logistic regression models were used to determine the changes in outcomes and predictors of outcomes including age, sex, education, Injury Severity Score, length of stay in the hospital and health-related quality of life.

Results: A total of 352 hospitalised motorcyclists were followed-up. The proportion of motorcyclist RTW/study was 60% (n = 165) at 6 months and 82% (n = 210) at 12 months post-injury. After adjusting for covariates, pain scores improved significantly at 6 months (β = -3.31, 95% CI: -3.61, -3.01) and 12 months post-injury (β = -3.62, 95% CI: -3.92, -3.32) compared to baseline. Functional status increased significantly by 2.89 points (95% CI: 2.64, 3.13) at 6 months and by 3.51 points (95% CI: 3.27, 3.75) at 12 months compared to baseline.

Conclusions: The study found improvements in outcomes over the study period, although there was on-going disability at 12 months post-injury (18% had not RTW/study). This study provides further evidence on the burden of motorcycle injuries in Vietnam and priorities for research, and further informs treatment and rehabilitation service planning.

Introduction

Road injuries and fatalities are a global public health issue with more than 50 million injured persons and 1.35 million killed every year [1]. Improvements in trauma care have led to an increased likelihood of survival after road injuries [2]. As a result, a greater emphasis has been placed on investigating the disabilities associated with road crash injuries to improve quality of survival and reduce the burden of non-fatal injury [3,4]. Previous research assessing long-term outcomes post road traffic injury found that a high proportion of trauma survivors experience chronic pain and long-term reduction in work capacity and functional status [5-8]. Most of these studies have focused on the long-term outcomes (from 6 months to 3 years post-injury) of road crashes involving all road users in high-income countries (HICs), rather than focusing on motorcycle crashes in a low and middle income setting.

Motorcycle injuries are a major public health issue in many low-and middle-income countries (LMICs) as they comprise up to 70% of road traffic fatalities [9]. According to World Health Organization (WHO), for every person that dies in a road traffic crash, at least 20 others sustain non-fatal injuries, often resulting in long-term disability [9]. In Vietnam, motorcycles accounted for approximately 95% of the nearly 50 million motorised vehicles in 2017 and motorcycle injuries constituted two-thirds of road traffic injuries and fatalities [10].

* Corresponding author at: Faculty of Public Health, University of Medicine and Pharmacy at Ho Chi Minh City, 217 Hong Bang Street, District 5, Ho Chi Minh City, Viet Nam.
E-mail addresses: han.doan@postgrad.curtin.edu.au, doanngochan@ump.edu.vn (H.T.N. Doan), michelle.hobday@health.wa.gov.au (M.B. Hobday), j.leavy@curtin.edu.au (J. Leavy), Janceyaj.jancey@curtin.edu.au (J. Jancey).

https://doi.org/10.1016/j.injury.2020.02.125
0020-1383/

Currently, there is little evidence about long-term outcomes, such as chronic pain, reduced function and return to work for motorcyclists involved in a crash with available data mainly coming from HICs [11-13]. A prospective study that followed-up 45 injured motorcyclists in Florida, United States found that at 12 months post-injury, one in five motorcyclists were still experiencing pain, with 86% of the study participants able to return to work [11]. A prospective cohort of 212 motorcyclists in Australia found that more than half of the injured motorcyclists were still experiencing pain, and 13% had not returned to their pre-crash work role six months post-crash [13]. There has been no investigations into the long-term effects of motorcycle-related injuries in LMICs, including Vietnam.

Determining long-term outcomes of motorcycle injuries in Vietnam is important as it informs the burden of injury to society, the effectiveness of systems of care for the injured, and research priorities. Therefore, this study aimed to determine changes in pain, functional status, and return to work/study over 12 months post-injury for motorcyclists admitted to a large hospital in Ho Chi Minh City (HCMC), Vietnam following a motorcycle crash. This study was approved by the Human Research Ethics Committees at Curtin University, the University of Medicine and Pharmacy at HCMC and the Gia Dinh Hospital.

Methodology

Study design and setting

A prospective cohort study was undertaken with patients admitted to the Gia Dinh hospital, one of the largest trauma hospitals in southern Vietnam, located in Binh Thanh district of HCMC.

Participants

Eligible participants were: motorcyclists aged 18 years and over on admission; admitted to hospital for a period of at least 24 h due to a motorcycle crash between 1 June 2017 and 31 January 2018. Participants were excluded if they were transferred to other hospitals; diagnosed with cognitive impairment due to the crash (assessed by physicians); in a severe physical condition (e.g., serious traumatic brain injury or spinal cord injury); unable to provide informed consent; had no memory of the crash; could not speak Vietnamese; or the researcher was unable to make contact with the patient at the hospital and at home (e.g., telephone calls not answered after discharge, or not correct address), and asleep when visited at the hospital.

Data collection

The researcher identified eligible participants through Emergency Department (ED) admission lists. The researcher entered the potential participant's hospital room, explained the study procedures and invited them to participate. If the eligible participants consented to participate, written informed consent was obtained. Those discharged from hospital before being approached were contacted by telephone within one week of discharge. Collection of baseline data from researcher-administered questionnaires took approximately 20 min.

Six and 12 months post-injury, the participants were contacted by telephone. If participants indicated they preferred face-to-face interviews at the initial interview, the researcher visited their home. Participants were considered lost to follow-up at 6 and 12 months when one of the following criteria applied: participants stated that they did not wish to complete the study; or participants did not respond to five telephone calls over a two-week period.

Assessment and outcome measures

At the baseline interview, demographic characteristics, and health outcomes including health-related quality of life, pain and functional status were collected. The questionnaires on health outcomes were repeated at the two follow-up interviews. Length of stay in the hospital (LoS) and Injury Severity Score (ISS) were extracted from medical records. A comorbid condition was defined as a previous disease at the time of injury.

Pain intensity was assessed using the Numeric Rating Scale (NRS). Participants were asked to report their level of pain over the past 24 h from no pain (score=0) to the worst pain imaginable (score=10) [14]. This scale is a valid, reliable and appropriate measure of pain [15]. This scale has been previously used in Asian countries including Vietnam [16].

Functional status was assessed using the Lawton Instrumental Activities of Daily Living scale (LADL) [17], a scale used to measure the changing functional status of a person over time. It includes eight domains of daily activities such as the ability to use a telephone, undertake shopping, food preparation, housekeeping, laundry, manage finances and medications and mode of transportation. A summary score ranges from 0 (low function, dependent) to 8 (high function, independent). The validity and reliability of this instrument has been reported [18] and has been used in a Vietnamese population previously to study home care needs among the elderly [19].

Health-related quality of life was assessed using the 12-item Short Form Health Survey version 2 (SF-12 v2) [20]. It was used to measure physical and mental health across eight health domains: physical functioning, role limitations due to physical problems, bodily pain, general health perception, vitality, social functioning, role limitation due to mental problems and mental health. Each domain was scored from 0 to 100, totalled and reported as the Physical Component Score (PCS) and Mental Component Score (MCS). Higher PCS and MCS scores indicate a better health status.

Return to work or study (RTW/study) data was collected at 6 and 12 months post-injury when the participant reported working (for income) or studying before the injury.

Statistical analysis

Descriptive statistics described demographics, the ISS and LoS. Comparisons of participants' baseline characteristics such as sex, age group, and education between participants who completed the study and those lost to follow up were performed using Chi-square tests. The distribution of ISS and LoS in the hospital were skewed so Mann-Whitney tests were used to compare these variables among participants who completed the study and those lost to follow up.

Potential predictors including sex, age, education, ISS, LoS, comorbidity, previous history of injury, PCS and MCS were selected based on previous studies [11-13]. Univariate tests were conducted to identify variables for inclusion in the final models. If the p-value <0.25 in the univariate analysis, the potential predictors were included in the multivariate regression. Multilevel mixed effects modelling (MLM) was undertaken to analyse the changes in pain score, and functional score over time, and to explore predictors of these outcomes. MLM models are well suited to analysing clustered and longitudinal data. This modelling also allows for the use of unbalanced data [21]. Multiple logistic regression analyses were used to analyse predictors of RTW/study (yes/no) at 6 and 12 months post-injury. Variables were considered significant level if the p-value was <0.05. All statistical analyses were performed using Stata version 15.

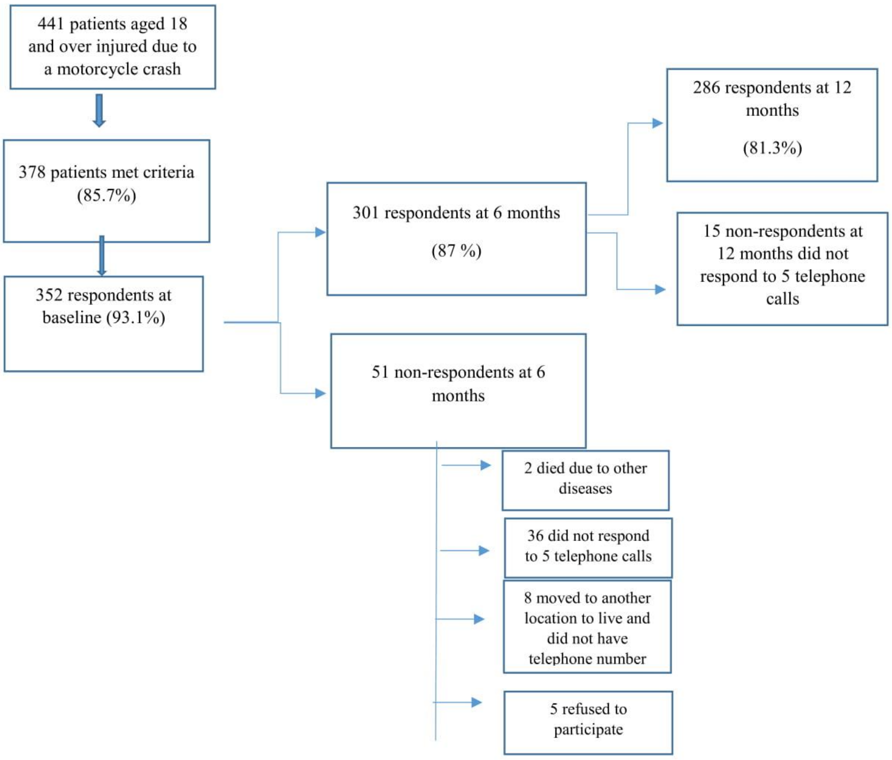


Fig. 1. Participant flow diagram.

Results

Overview of the participants

A total of 378 potential participants were initially identified for inclusion in the study. Twenty-one (5.6%) declined to participate and five (1.3%) could not be contacted following hospital discharge. Of the remaining 352 agreed to participate in the baseline study, representing a response rate of 93.1%. There were no significant differences in age ($p = 0.723$) and sex ($p = 0.665$) between those who participated in the study and those who declined. The mean [standard deviation (SD)] age of the participants was 40.9 (15.3) years and 66.8% ($n = 235$) were male. The median LoS was 7 days, Inter quartile range (IQR) = 4–36. The median ISS was 8.5, IQR = 1–22.

Follow-up and loss to follow-up

A total of 301 (85.5%) participants were followed-up at 6 months, and 286 (81.3%) at 12 months post-injury (Fig. 1). There was no significant differences in age, sex, education level, ISS and LoS between participants studied and those lost to follow-up (Table 1).

RTW/study

Of the 352 participants in the study, 318 (90.3%) were working or studying before they were injured. The proportion of participants who were able to RTW/study was 59.6% ($n = 165$) at 6 months, and 81.7% ($n = 210$) at 12 months post-injury.

A multiple logistic regression model found that at 6 months post-injury, there were significantly lower odds of RTW/study for greater length of stay in the hospital (OR=0.95, 95% CI: 0.91–0.98). Those with lower education levels had significantly lower odds of RTW/study (OR=0.51; 95% CI: 0.31, 0.85) after adjusting for covariates (Table 2). At 12 months post-injury there were significantly lower odds of participants RTW/study among those aged between 35 and 54 (OR=0.21; 95% CI: 0.06, 0.72) and with a higher ISS (OR=0.85; 95% CI: 0.77, 0.93). Participants with higher PCS and MCS had significantly higher odds of RTW/study (OR=1.14; 95% CI: 1.09, 1.20 and OR=1.04; 95% CI: 1.00, 1.09, respectively. Comorbidity, previous history of crash were not significantly associated with RTW/study both at 6 and 12 months post-injury.

Changes in pain and functional status over time

The results of the multilevel mixed model examining change in pain and functional status are summarised in Table 3. Overall, pain and functional status improved at 6 and 12 months post injury. After adjusting for covariates, the model showed that the pain score decreased significantly by 3.31 points (95% CI: −3.61, −3.01) at 6 months and 3.62 points (95% CI: −3.92, −3.32) at 12 months post-injury, indicating less pain compared to immediately following the injury. Compared to males, females experienced more pain (β=0.52, 95% CI: 0.18, 0.87) and participants aged

Table 1
Comparison of Participants follow-up and those lost to follow-up at 12 months post-injury.

Variables	Follow-up (n = 286)	Lost to follow-up (n = 66)	p-value
	n (%)	n (%)	
Sex			
Male	195 (68.2)	30 (60.6)	0.24
Female	91 (31.8)	26 (39.4)	
Age			
18–34	108 (37.8)	28 (42.4)	0.77
35–54	115 (40.2)	24 (36.4)	
55+	63 (22)	14 (21.2)	
Education			
Secondary school and under	128 (44.7)	34 (51.5)	0.32
High school and over	158 (55.3)	32 (48.5)	
	Median [IQR][c]		
ISS[a]	9 [4-9]	4 [4-9]	0.11[d]
LoS[b]	7 [4-10]	6 [4-8]	0.18[d]

[a] ISS: Injury severity score.
[b] LoS: Length of Stay in hospital (days).
[c] IQR: Inter quartile range.
[d] Mann–Whitney test.

Table 2
Multiple logistic regression for RTW/study among injured motorcyclists at 6 months and 12 months post-injury at HCMC, Vietnam in 2017 and 2018[a].

Variables	Return to work/study at 6 months post-injury (n = 277)	Return to work/study at 12 months post-injury (n = 257)
	OR (95% CI)[b]	**OR (95% CI)**
Sex		
Male	Reference	Reference
Female	0.82 (0.47, 1.41)	0.90 (0.41, 2.02)
Age (years)		
18–34	Reference	Reference
35–54	0.57 (0.32, 1.04)	0.21 (0.06, 0.72)
55+	0.52 (0.26, 1.04)	0.36 (0.12, 1.29)
Education		
Secondary school and under	Reference	Reference
High education and over	2.10 (1.23, 3.58)	1.01 (0.45, 2.28)
Injury Severity Score	0.95 (0.89, 1.00)	0.85 (0.77, 0.93)
Length of stay in hospital (days)	0.95 (0.91, 0.98)	0.96 (0.45, 1.20)
SF-12		
Physical Component Score	1.02 (0.99, 1.04)	1.14(1.09, 1.20)
Mental Component Score	1.01(0.99, 1.03)	1.04 (1.00, 1.09)

[a] Return to work if working/study prior to injury (n = 318).
[b] OR indicates Odds Ratio, 95% CI indicates 95% Confidence Interval.

Table 3
Multilevel mixed model of pain and functional status among injured motorcyclists at 6 and 12 months post injury in HCMC, Vietnam in 2017 and 2018.

Variables	Pain score	LADL[a]
Time assessment	β (95% CI)[b]	β (95% CI)[b]
Baseline	Reference	Reference
6 months post-injury	−3.31 (−3.61, −3.01)	2.89 (2.64, 3.13)
12 months post- injury	−3.62 (−3.92, −3.32)	3.51 (3.27, 3.75)
Sex		
Male	Reference	Reference
Female	0.52 (0.18, 0.87)	0.06 (−0.20, 0.33)
Age		
18–34	Reference	Reference
35–54	0.19 (−0.18, 0.56)	−0.14 (−0.43, 0.15)
55+	0.45 (0.38, 0.89)	−0.59 (−0.93, −0.24)
Education		
Secondary school and under	Reference	Reference
High school and over	−0.20 (−0.52, 0.12)	0.25 (0.21, 0.49)
Injury Severity Score	0.01 (−0.02, 0.06)	−0.05 (−0.08, −0.02)
Length of stay in hospital (days)	0.05 (0.03, 0.08)	−0.02 (−0.04, 0.01)
SF-12		
Physical Component Score	−0.03 (−0.04, −0.02)	0.02 (0.01, 0.03)
Mental Component Score	−0.02 (−0.03, −0.01)	0.02 (0.01, 0.03)

[a] LADL: Lawton Instrumental Activities of Daily Living.
[b] β indicates coefficient, 95% CI indicates 95% Confidence Interval.

over 55 years had significantly higher pain scores than those aged 18–34 years (β=0.45, 95% CI: 0.38, 0.89). Participants with higher PCS (β =−0.03, 95% CI:−0.04, −0.02) and MCS (β=−0.02, 95% CI:−0.03, −0.01) had significantly lower pain scores. Comorbidity and previous history of crash were not significantly associated with pain intensity and functional scores.

After adjusting for covariates, participants' functional scores increased by 2.89 points (95% CI: 2.64, 3.13) at 6 months and by 3.51 points (95% CI: 3.27, 3.75) at 12 months post-injury, indicating improved levels of function compared to immediately after the injury. Participants aged over 55 years (β=−0.59, 95% CI: −0.93, −0.24) and with higher ISS (β=−0.05, 95% CI: −0.08, −0.02) had significantly lower functional status scores. Participants with higher PCS (β=0.02, 95% CI: 0.01, 0.03) and MCS (β=0.02, 95% CI: 0.01, −0.03) had significantly higher functional status scores.

Discussion

This study is one of the few studies exploring changes in pain intensity, functional status and return to work/study of motorcyclists injured in a motorcycle crash. The study is particularly important as it was undertaken in a LMIC in Southeast Asia, a region with the highest number of motorcycle deaths and injuries worldwide [1]. The study revealed that pain and functional status of injured motorcycle riders due to a motorcycle crash improved significantly within 12 months of the injury. However, nearly one in five of those working or studying previously had not RTW/study 12 months post injury. These findings provide insight into the burden of motorcycle injury to the individual and society in Vietnam.

The proportion of participants who RTW/study post-injury was 60% at 6 months, and 82% at 12 months, which is considerably less at 6 months and somewhat less at 12 months compared to previous studies conducted in the HICs of Australia (87% at 6 months post-crash) [13] and the US (86% at 12 months post-injury) [11]. There could be several explanations for the differences, particularly at 6 months. Firstly, participants in HICs may have the financial capacity to access treatment and rehabilitation services [22]. In Vietnam, the health care system is under-resourced [23]. This lack of resources is likely to reduce access to post-injury care and rehabilitation services, potentially hindering recovery. While 77% of Vietnamese people have health insurance, this does not cover motor vehicle injuries when a positive blood alcohol concentration (BAC) is found [24]. The baseline data collection in this study revealed that 19% of those tested for BAC were over the legal limit but due to a large amount of missing data, this variable did not include in the models [25]. Secondly, the study in Australia included motorcycle riders who were not admitted to hospital, so were less seriously injured and were probably more likely to return to work sooner [13].

Few studies have assessed the changes in functional status outcomes of injured motorcycle riders up to 12 months post injury [12,26]. The findings of a study by Papadakaki et al. [12] reported no change in physical function between 6 and 12 months post-injury but better physical function compared to the time of injury. In contrast, in this study, physical function improved significantly up to 12 months post-injury. Notably, previous studies were conducted in HICs where motorcycles have larger engine capacities (>250cc) and are primarily used for recreation or sport while the majority of motorcycle in LMICs likes Vietnam are light motorcycles with cylinder capacities between 50cc to 250cc and are mainly used for the daily commute [27,28]. These differences could partly explain differences in injury severity and recovery after injury of motorcycle riders who are involved in a motorcycle crash between HICs and LMICs. Differences in tools assessing functional status across studies may lead to differences in the findings across studies. However, the finding of the present study is concur with previous study that measured physical functional status using the short form 12 among the injured motorclists in Vietnam (accepted but not yet published article).

In this study, participants with lower education levels and a longer length of stay in the hospital had lower odds of RTW/study 6 months post injury. This is consistent with other research reporting injured riders with lower educational levels, and those spending a longer time in hospital reporting a delayed RTW/study [29,30]. This may in part be explained by the less educated having lower incomes and being employed in physically demanding jobs, preventing an early RTW. In addition, a lower earning capacity may increase the difficulty in accessing comprehensive and/or expensive treatment, rehabilitation services, and ultimately increasing time to recovery and RTW/study [31]. In contrast, people with a higher education level may be employed in less physically demanding jobs and may have access to more flexible return to work options [32].

Participants aged 35 to 54 years had lower odds of RTW/study compared with younger participants (18–34 years) at 12 months post-injury. A middle-aged person may have more difficulty securing a job when they have recovered from their injury as either employers may have found alternative employees or the physically demanding nature of certain jobs may make finding employment more difficult for older people [33]. Consistent with other research [33-35] this study found lower functional status among those aged over 55 years, and those with a higher ISS. This could be due to natural physical decline related to advancing age, which impacts on recovery time [36]. However, this needs to be investigated further [33].

This study also found that better physical and mental well-being and lower ISS were important predictors of RTW/study at 12 months post injury. It seems plausible that more severe injuries require longer periods of treatment and rehabilitation, thus increasing time to RTW/study [37]. Furthermore, persisting disability due to injury severity has a direct effect on the likelihood of returning to work [32]. The *World Report on Disability* [32] indicated that only 44% of people of working age with disabilities had a job compared to 75% of people without disabilities. Of interest, our study also showed that better physical and mental well-being, measured by the SF-12 were associated with increased improvements in pain over time, which concurs with research showing that an inability to exercise and depressing can exacerbate pain [39]. Overall, better physical and mental well-being are associated with higher functioning over time [33,35]. This reinforces the need for easy access to cost-neutral or low cost rehabilitation programs as part of the comprehensive discharge plan to improve physical and mental health outcomes [38].

There are few studies examining changes in pain of injured motorcycle riders over a 12 month period [11,13]. This study found that, although pain improved significantly over study period time, there was residual pain due to motorcycle injuries at 12 months post-injury (about 23%). This suggests the injuries sustained from the motorcycle crash result in long-term morbidity. One suggestion to address this is targeted early interventions, such as pain management to improve long-term outcomes. In addition, as with previous research on road traffic injuries, this study found that older age was associated with higher pain levels compared to those of younger ages [8,39]. This could be due to a greater susceptibility to pain related to aging [36].

The strengths of this study are that it is a longitudinal study collecting outcomes data at three time points. To our knowledge, no similar studies have followed up injured motorcycle riders in Vietnam or other parts of Southeast Asia. Moreover, this study had a high follow-up rate of more than 80% at each time point. The current study has certain limitations, such as: only mild and moderately injured participants were included in the study because participants needed cognitive capacity to participate. This could lead to an underestimation of the adverse health outcomes related of motorcycle crash injured riders. In addition, the study was not population-based. It was conducted at one large tertiary hospital in a district of HCMC, preventing national generalisability. However, the study provides unique data in an under-reported area of road safety.

Conclusions

This is the first study to examine changes in pain, functional status and RTW/study outcomes of injured motorcycle riders due to a motorcycle crash up to 12 months post-injury in Vietnam or any LMICs. The study demonstrated that these outcomes improved over time but that a substantial proportion of injured motorcycle riders were yet to RTW /study at 12 months post- injury. In addition, being aged 55 years and over, a lower health-related quality of life, lower education level and increasing ISS were significantly associated with poorer health outcomes up to 12 months post motorcycle injury. Failures to RTW/study and poor health outcomes have adverse social and economic consequences for the individual and society. These findings highlight the need for planning and implementing of injury management programs that include early access, low cost rehabilitation services to support motorcycle crash patients after discharge in Vietnam.

Declaration of Competing Interest

The authors declare no conflicts of interest.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors thank the staff of the Gia Dinh hospital for their supporting during data collection. We grateful to Professor Do Van Dung, Dean of Faculty of Public Health, University of Medicine and Pharmacy at Ho Chi Minh City and Dr To Gia Kien, Vice-Dean of Faculty of Public Health, University of Medicine and Pharmacy at Ho Chi Minh City who assisted us in data collection.

References

[1] World Health Organization. Global status report on road safety 2018. France; 2018. Available from: https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/ .

[2] Gabbe BJ, Sutherland AM, Hart MJ, Cameron PA. Population-based capture of long-term functional and quality of life outcomes after major trauma: the experiences of the Victorian State Trauma Registry. J Trauma 2010;69(3):532–6 discussion 6.

[3] Polinder S, Haagsma JA, Belt E, Lyons RA, Erasmus V, Lund J, et al. A systematic review of studies measuring health-related quality of life of general injury populations. BMC Public Health 2010;10:783.

[4] Sleat GKJ, Ardolino AM, Willett KM. Outcome measures in major trauma care: a review of current international trauma registry practice. Emerg Med J 2011;28(12):1008.

[5] Fitzharris M, Fildes B, Charlton J, Kossmann T. General health status and functional disability following injury in traffic crashes. Traffic Inj Prev 2007;8(3):309–20.

[6] Pape H-C, Probst C, Lohse R, Zelle BA, Panzica M, Stalp M, et al. Predictors of late clinical outcome following orthopedic injuries after multiple trauma. J TRAUMA Inj Infect Crit Care 2010;69(5):1243–51.

[7] Haider AH, Herrera-Escobar JP, Al Rafai SS, Harlow AF, Apoj M, Nehra D, et al. Factors associated with long-term outcomes after injury: results of the functional outcomes and recovery after trauma emergencies (FORTE) multicenter cohort study. Ann Surg 2018;268(4):574–83.

[8] Gopinath B, Jagnoor J, Kifley A, Nicholas M, Blyth F, Kenardy J, et al. Differential predictors of pain severity over 12 months following noncatastrophic injury sustained in a road traffic crash. J Pain 2018;20(6):676–84.

[9] World Health Organization. Global status report all road safety 2015. Switzerland; 2015. Available from: https://www.who.int/violence_injury_prevention/road_safety_status/2015/en/ .

[10] . Economic and Social Commission for Asia and the Pacific. Road safety performance review Viet Nam. Bangkok: Thai Lan: United Nations; 2018.

[11] Hotz GA, Cohn SM, Mishkin D, Castelblanco A, Li P, Popkin C, et al. Outcome of motorcycle riders at one year post-injury. Traffic Inj Prev 2004;5(1):87–9.

[12] Papadakaki M, Tsalkanis A, Sarris M, Pierrakos G, Eleonora Ferraro O, Stamouli M-A, et al. Physical, psychological and economic burden of two-wheel users after a road traffic injury: evidence from intensive care units of three EU countries. J Safety Res 2018;67:155–63.

[13] de Rome L, Ivers R, Fitzharris M, Haworth N, Heritier S, Richardson D. Effectiveness of motorcycle protective clothing: riders' health outcomes in the six months following a crash. Injury 2012;43(12):2035–45.

[14] McCaffery M, Pain BA. clinical manual for nursing practice pain: clinical manual for nursing practice nursing standard.. R Coll Nurs. (Great Britain): 1987) 1994;9(11):55.

[15] Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs 2005;14(7):798–804.

[16] Thinh D.H.Q., Sriraj W., Mansor M., Tan K.H., Irawan C., Kurnianda J., et al. Analgesic prescription patterns and pain outcomes in Southeast Asia: findings from the analgesic treatment of cancer pain in Southeast Asia study. J Global Oncol 2018(4):1–10.

[17] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9(3):179–86.

[18] Graf C. The Lawton instrumental activities of daily living scale. Am J Nurs 2008;108(4):52–62 quiz -3.

[19] Nguyen DT, Nguyen ND. A comprehensive study on home care needs among elderly in an urban area of ho chi minh city. Viet Res Hum Soc Sci 2017;7(14):1–7.

[20] Ware JE, Kosinski M, Keller SD. SF-12: how to score the SF-12 physical and mental health summary scales 1998.

[21] Detry MA, Ma Y. Analyzing repeated measurements using mixed models. JAMA 2016;315(4):407–8.

[22] MacKenzie EJ, Morris JA, Jurkovich GJ, Yasui Y, Cushing BM, Burgess AR, et al. Return to work following injury: the role of economic, social, and job-related factors. Am J Public Health 1998;88(11):1630–7.

[23] Takashima K, Wada K, Tra TT, Smith DR. A review of Vietnam's healthcare reform through the Direction of Healthcare Activities (DOHA). Environ Health Prev Med 2017;22(1):74.

[24] The National Assembly. Law on medical examination and treatment (No. 40/2009/QH12). Government of Vietnam; 2009 http://www.moj.gov.vn/vbpq/en/Lists/Vn%20bn%20php%20lut/View_Detail.aspx?ItemID=10471.

[25] Doan HTN, Hobday MB. Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam. Traffic Inj Prevent 2019;20(7):732–7.

[26] Forman JL, Lopez-Valdes FJ, Pollack K, Heredero-Ordoyo R, Molinero A, Mansilla A, et al. Injuries among powered two-wheeler users in eight European countries: a descriptive analysis of hospital discharge data. Accid Anal Prevent 2012;49:229–36.

[27] Lin M-R, Kraus JF. A review of risk factors and patterns of motorcycle injuries. Accid Anal Prevent 2009;41(4):710–22.

[28] Tumwesigye NM, Atuyambe LM, Kobusingye OK. Factors associated with injuries among commercial motorcyclists: evidence from a matched case control study in Kampala City, Uganda. PLoS ONE 2016;11(2):e0148511. doi:10.1371/journal.pone.0148511.

[29] Toien K, Skogstad L, Ekeberg O, Myhren H, Schou Bredal I. Prevalence and predictors of return to work in hospitalised trauma patients during the first year after discharge: a prospective cohort study. Injury 2012;43(9):1606–13.

[30] Hours M, Chossegros L, Charnay P, Tardy H, Nhac-Vu H-T, Boisson D, et al. Outcomes one year after a road accident: results from the ESPARR cohort. Accid Anal Prevent 2013;50:92–102.

[31] Herrera-Escobar JP, Seshadri AJ, Rivero R, Toppo A, Al Rafai SS, Scott JW, et al. Lower education and income predict worse long-term outcomes after injury. J Trauma Acute Care Surg 2019;87(1):104–10.

[32] World Health Organization & World Bank. World report on disability Geneva; 2011.

[33] Gabbe BJ, Simpson PM, Harrison JE, Lyons RA, Ameratunga S, Ponsford J, et al. Return to work and functional outcomes after major trauma: who recovers, when, and how well. Ann Surg 2016;263(4):623–32.

[34] Holtslag HR, van Beeck EF, Lindeman E, Leenen LP. Determinants of long-term functional consequences after major trauma. J Trauma 2007;62(4):919–27.

[35] Tan AL, Chiong Y, Nadkarni N, Jolene Yu Xuan C, Ming Terk C, Wong TH. Predictors of change in functional outcome at six months and twelve months after severe injury: a retrospective cohort study. World J Emerg Surg 2018;13(1):1–8.

[36] Chapman S. Managing pain in the older person. Nurs Stand 2010;25(11):35–9.

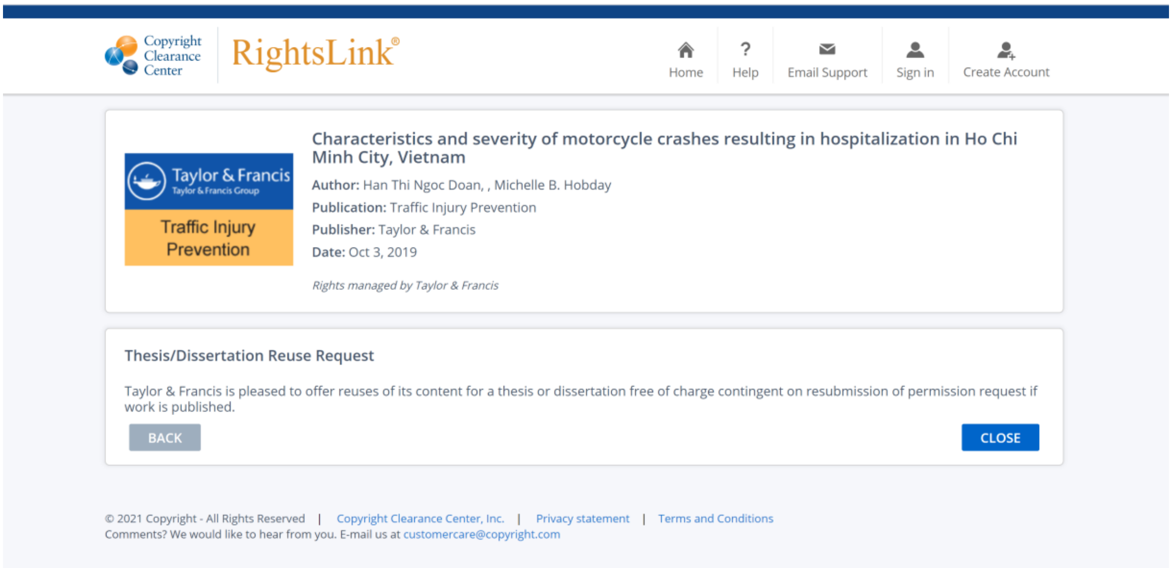
[37] Shi Q, Sinden K, MacDermid JC, Walton D, Grewal R. A systematic review of prognostic factors for return to work following work-related traumatic hand injury. J Hand Ther 2014;27(1):55–62 quiz.

[38] Silva AR, Sime MM. Barriers and facilitators to return to work post-acute orthopedic trauma in upper limbs: an integrative literature review. Cad Bras Ter Ocup 2019;27(2) 426-3.

[39] Tecic T, Lefering R, Althaus A, Rangger C, Neugebauer E. Pain and quality of life 1 year after admission to the emergency department: factors associated with pain. Eur J Trauma Emerg Surg 2013;39(4):353–61.

Appendix C: Copyright permissions

C1. Permission statement publication 1


Copyright Clearance Center | RightsLink®

Home | Help | Email Support | Sign in | Create Account

Taylor & Francis
Taylor & Francis Group
Traffic Injury Prevention

Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam

Author: Han Thi Ngoc Doan, , Michelle B. Hobday

Publication: Traffic Injury Prevention

Publisher: Taylor & Francis

Date: Oct 3, 2019

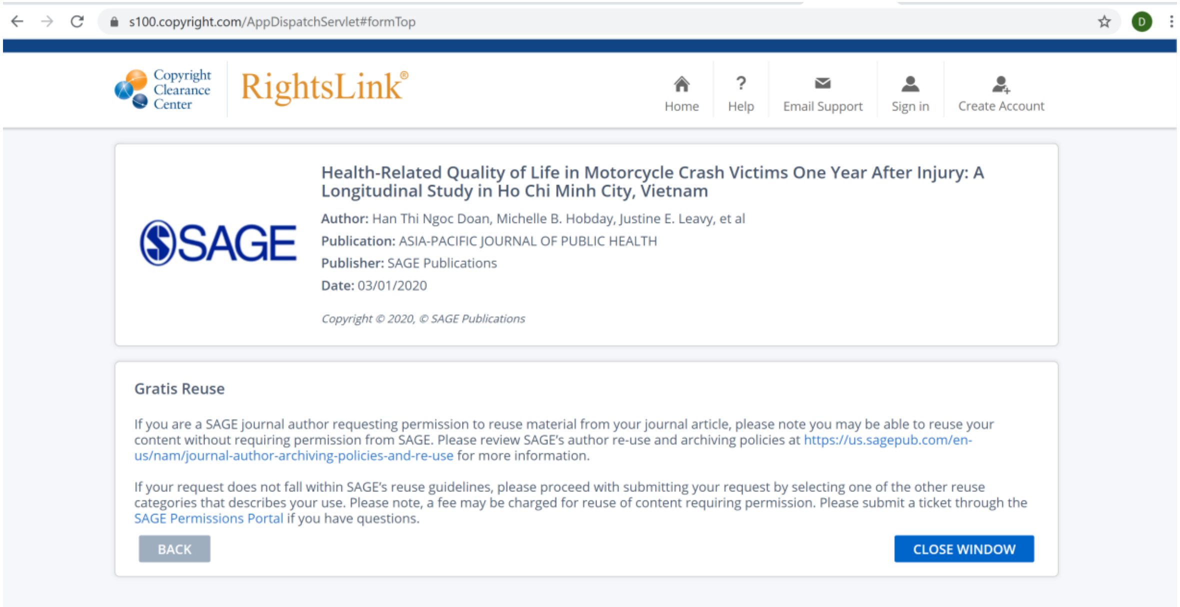
Rights managed by Taylor & Francis

Thesis/Dissertation Reuse Request

Taylor & Francis is pleased to offer reuses of its content for a thesis or dissertation free of charge contingent on resubmission of permission request if work is published.

BACK | CLOSE

C2. Permission statement publication 2



s100.copyright.com/AppDispatchServlet#formTop

Copyright Clearance Center RightsLink®

Home | Help | Email Support | Sign in | Create Account

SAGE

Health-Related Quality of Life in Motorcycle Crash Victims One Year After Injury: A Longitudinal Study in Ho Chi Minh City, Vietnam

Author: Han Thi Ngoc Doan, Michelle B. Hobday, Justine E. Leavy, et al

Publication: ASIA-PACIFIC JOURNAL OF PUBLIC HEALTH

Publisher: SAGE Publications

Date: 03/01/2020

Copyright © 2020, © SAGE Publications

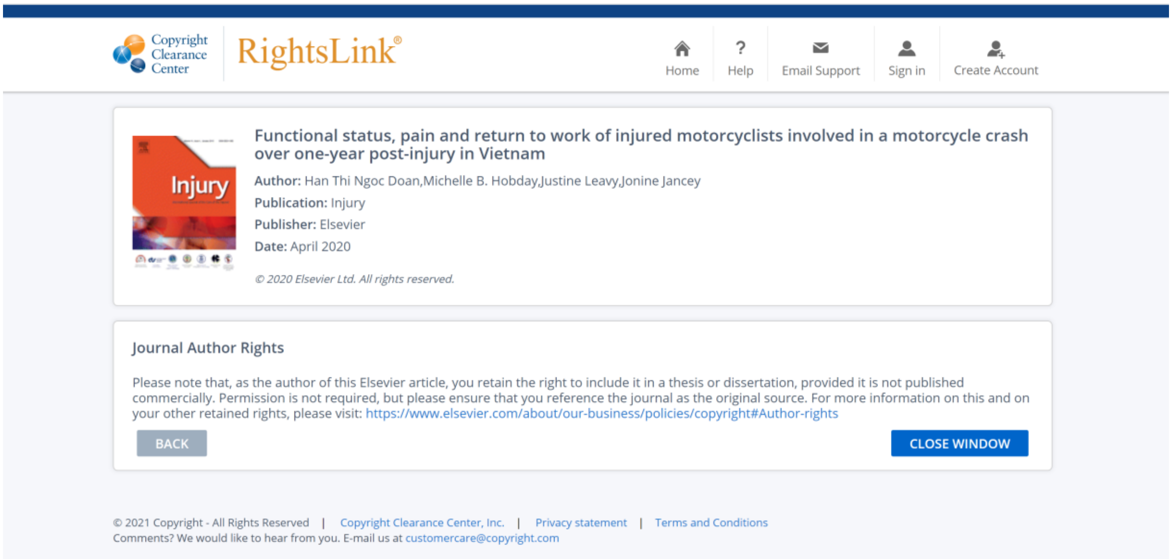
Gratis Reuse

If you are a SAGE journal author requesting permission to reuse material from your journal article, please note you may be able to reuse your content without requiring permission from SAGE. Please review SAGE's author re-use and archiving policies at https://us.sagepub.com/en-us/nam/journal-author-archiving-policies-and-re-use for more information.

If your request does not fall within SAGE's reuse guidelines, please proceed with submitting your request by selecting one of the other reuse categories that describes your use. Please note, a fee may be charged for reuse of content requiring permission. Please submit a ticket through the SAGE Permissions Portal if you have questions.

BACK | CLOSE WINDOW

C3: Permission statement publication 3



Copyright Clearance Center | RightsLink®

Home | Help | Email Support | Sign in | Create Account

Functional status, pain and return to work of injured motorcyclists involved in a motorcycle crash over one-year post-injury in Vietnam

Author: Han Thi Ngoc Doan,Michelle B. Hobday,Justine Leavy,Jonine Jancey

Publication: Injury

Publisher: Elsevier

Date: April 2020

© 2020 Elsevier Ltd. All rights reserved.

Journal Author Rights

Please note that, as the author of this Elsevier article, you retain the right to include it in a thesis or dissertation, provided it is not published commercially. Permission is not required, but please ensure that you reference the journal as the original source. For more information on this and on your other retained rights, please visit: https://www.elsevier.com/about/our-business/policies/copyright#Author-rights

BACK | CLOSE WINDOW

© 2021 Copyright - All Rights Reserved | Copyright Clearance Center, Inc. | Privacy statement | Terms and Conditions

Comments? We would like to hear from you. E-mail us at customercare@copyright.com

Appendix D: Baseline questionnaire

Baseline questionnaire

Code	Content	Answers	Code of answer	Note
Demographic information				
IS	Participant number	_ _ _ _		
ID	Medical record number			
A1	Interview day	---/-----/-------		
A2	Day of birth	---/-----/-------		
A3	Gender	Male	1	
		Female	2	
A4	Height	________________		
A5	Weight	________________		
A6	Education	No formal school/ cannot read and write	1	
		Primary school	2	
		Secondary school	3	
		High school	4	
		Degree and over	5	
A7	Marital status	Single	1	
		Married	2	
		In a relationship	3	
		Divorced/Separated	4	
		Widowed	5	
A8	Occupation	Free labor	1	
		Government	2	
		Non-Government	3	
		Jobless	4	
		Housewife	5	
		Other_____________________ _	6	

Information related injury				
B1	Place of crash	One way road	1	
		Two way roads	2	
		Multilane roads	3	
		Other________________	4	
B2	Crash types	Another motorcycle	1	
		Bicycle	2	
		Vehicle	3	
		Pedestrian	4	
		Obstacles	5	
		Other __________________	6	
B3	Helmet use	Yes	1	
		No		
			2	⇒go B9
B4	Helmet type using when accident happened	1/3 shell	1	
		1/2 shell	2	
		Full face	3	
		Do not know	4	
B5	Mobile phone use when operating motorcycle	Yes	1	
		No	2	
B6	Weather	Rain	1	
		Dry	2	
B7	Driver licenced	Yes	1	
		No	2	
B8	Speed at crash	Slow	1	
		Normal speed	2	
		Fast	3	
B9	How long have you had your licence? (year)	_________________________		
B10	How long have you been riding? (year)	_________________________ _		
B11	Weather	Rain	1	
		Dry	2	

B12	Have you been drinking alcohol at the accident?	Yes	1
		No	2

D. Depression

Please indicate how often you have felt this way before injury

D1	I was bothered by things that usally don't bother me	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D2	I did not feel like eating, my appetite was poor	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D3	I felt that I could not shake off the blues even with help from my family	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D4	I felt that I was just as good as other people	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D5	I has trouble keeping my mind on what i was doing	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D6	I fell depressed	< 1 ngày	1
		1-2 ngày	2
		3-4 ngày	3
		5-7 ngày	4
D7	I felt that everything i did be an effort	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D8	I felt hopeful about the future	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4

D9	I thought my life had been a failure	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D10	I felt fearful	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D11	My sleep was restless	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D12	I was happy	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D13	I talked less than usual	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D14	I felt lonely	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D15	People were friendly	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D16	I enjoued life	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D17	I had crying spells	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4

D18	I felt sad	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D19	I felt that people disliked me	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
D20	I could not get going	< 1 day	1
		1-2 days	2
		3-4 days	3
		5-7 days	4
The EQ-5D-5L Health related quality of life before injury			
E1	Mobility	No problems in walking about ☐	1
		Slight problems in walking about ☐	2
		Moderate problems in walking about ☐	3
		Severe problems in walking about ☐	4
		Unable to walk about ☐	5
E2	Self-care	No problems in washing or dress myself ☐	1
		Slight problems in washing or dress myself ☐	2
		Moderate problems in washing or dress myself ☐	3
		Severe problems in washing or dress myself ☐	4
		Unable to wash or dress myself ☐	5
E3	Usual activities (e.g. work, study, household, family or leisure activities)	No problems doing my usual activies ☐	1
		Slight problems doing my usual activies ☐	2
		Moderate problems doing my usual activies ☐	3
		Severe problems doing my usual activies ☐	4
		Unable to do my usual activies ☐	5

E4	Pain/Discomfort	No pain or discomfort ☐	1
		Slight pain or discomfort ☐	2
		Moderate pain or discomfort ☐	3
		Severe pain or discomfort ☐	4
		Extreme pain or discomfort ☐	5
E5	Anxiety/ Depression	Not anxious or depressed ☐	1
		Slight anxious or depressed ☐	2
		Moderate anxious or depressed ☐	3
		Severe anxious or depressed ☐	4
		Extreme anxious or depressed ☐	5

We would like to know how good or bad your health the day before injury.

This scale is numbered form 0 to 100.

100 means the best health you can imagine

0 means the worst health you can imagine

Your health score =

SF 12. Health status

Now I would like to ask you some items about your how you feel about your health. For each item, please rate your health status before injury

SF1	In general, would you say your health is?	Excellent	1
		Very good	2
		Good	3
		Fairly good	4
		Poor	5

The following items are about activities you might do during a typical day before injury. Did your health limit you in these activities? If so, how much

SF2	Moderate activities, such as moving a table, push a vacuum cleaner, bowling, or playing golf?	Yes, limited a lot	1
		Yes, limited a little	2
		No, not limited at all	3
SF3	Climbing several flights of stairs	Yes, limited a lot	1
		Yes, limited a little	2
		No, not limited at all	3

During the past 4 weeks before injury, have you have any of following problems with your work or other regular daily activities as a result of your physical health?

SF4	Accomplished less than you would like?	All of the time	1
		Most of the time	2
		Some of the time	3

		A little of the time	4
		None of the time	5
SF5	Were limited in the kind of work or other activities?	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
During the past 4 weeks before injury, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?			
SF6	Accomplished less than you would like	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
SF7	Did work or other activities as carefully as usual	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
SF8	During the past 4 weeks, how much did pain interfere with your normal work (including work outside the home and house work)?	Not at all	1
		Slight	2
		Moderately	3
		Quite a bit	4
		Extremely	5
These questions are about how you have been feeling during the past 4 weeks before injury. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks before injury.			
SF9	Have you felt calm and peaceful?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
SF10	Did you have a lot of energy?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4

		A little of the time	5
		None of the time	6
SF11	Have you felt downhearted and blue?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
SF12	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, ect,)?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
Activities daily living (IADL) Please indicate your ability to do these activities of daily living even you have never done.			
AD1	Ability to use telephone	Operates telephone on own initiative; looks up and dials numbers, etc. ☐	1
		Dials a few well-known numbers ☐	2
		Answers telephone but does not dial ☐	3
		Does not use telephone at all ☐	4
AD2	Shopping	Takes care of all shopping needs independently ☐	1
		Shops independently for small purchases ☐	2
		Needs to be accompanied on any shopping trip ☐	3
		Completely unable to shop ☐	4
AD3	Shopping	Takes care of all shopping needs independently ☐	1
		Shops independently for small purchases ☐	2
		Needs to be accompanied on any shopping trip ☐	3

		Completely unable to shop ☐	4
AD4	Housekeeping	Maintains house alone or with occasional assistance (e.g., "heavy work domestic help") ☐	1
		Performs light daily tasks such as dishwashing, bed making ☐	2
		Performs light daily tasks but cannot maintain acceptable level of cleanliness ☐	3
		Needs help with all home maintenance tasks ☐	4
		Does not participate in any housekeeping ☐	5
AD5	Laundry	Does personal laundry completely ☐	1
		Launders small items; rinses stockings, etc. ☐	2
		All laundry must be done by others ☐	3
AD6	Mode of transportation	Travels independently on public transportation or drives own car (motorbike) ☐	1
		Arranges own travel via taxi, but does not otherwise use public transportation ☐	2
		Travels on public transportation when assisted or accompanied by another ☐	3
		Travel limited to taxi or automobile with assistance of another ☐	4
		Does not travel at all ☐	5
AD7	Responsibility for own medications	Is responsible for taking medication in correct dosages at correct time ☐	1
		Takes responsibility if medication is prepared in advance in separate dosages ☐	2
		Is not capable of dispensing own medication ☐	3

AD8	Ability to handle finances	Manages financial matters independently (budgets, writes checks, pays rent and bills, goes to bank), collects and keeps track of income ☐	1
		Manages day-to-day purchases, but needs help with banking, major purchases, etc. ☐	2
		Incapable of handling money ☐	3

Pain intensity by NRP

Please rate your level of pain over the past 24 hours from best (score=0) to worst (score=10) with different injury regions

Region 1: ____________________

0 5 10

Region 2: ____________________

0 5 10

Region 3: ____________________

0 5 10

C. Injury details		
C1. Region of injury	Head	1
	Neck	2
	Spine	3
	Upper extremities	4
	Abdomen	5
	Thorax	6

	Lower extremities	7
	Pelvis	8
	Whole body	9
C2. Systolic Blood Pressure (SBP)	___________________	
C3. Respiratory Rate (RR)	___________________	
C4. AIS	Head & neck ____________ Face ____________ Chest ____________ Abdomen ____________ Extremity ____________ External ____________	
C5.Glasgow coma scale (GCS) on at arrival at hospital	______________________	
C6.Chronic disease comorbidity	Arthritis	1
	Asthma	2
	Back problems	3
	Cancer	4
	COPD	5
	CVD (cardiovascular disease)	6
	Diabetes	7
	Mental health conditions.	8
	Chronic stomach	9
C7.Blood alcohol concentration	_________________	

Appendix E: Following-up Questionnaire

Curtin University

Follow up questionnaire at 6 months/ 12 months

Code	**Content**	**Answers**	**Code of answer**	**Note**
Part 1:Demographic information				
IS	Participant number	_ _ _ _		
ID	Medical record number			
A1	Interview day	---/-----/-------		
A2	Day of birth	---/-----/-------		
A3	Gender	Male Female	1 2	
Part 2: Return to work				
B1	Do you return to your previous work?	Yes No	1 2	
B2	When do you return to work?			
B3	Do you do the same role as previous work?	Yes No	1 2	
B4	What is your current occupation?	Free labor Government Non-Government Jobless Housewife Other___________________	1 2 3 4 5 6	
Part 3: Health outcomes				
C. The Centre for Epidemiologic Studies Depression Scale (CES-D scale) Please indicate how often you have felt this way one week before injury				
C1	I was bothered by things that usually don’t bother me	< 1 day 1-2 days 3-4 days	1 2 3	☐

		5-7 days	4	
C2	I did not feel like eating, my appetite was poor	< 1 day	1	
		1-2 days	2	☐
		3-4 days	3	
		5-7 days	4	
C3	I felt that I could not shake off the blues even with help from my family	< 1 day	1	
		1-2 days	2	☐
		3-4 days	3	
		5-7 days	4	
C4	I felt that I was just as good as other people	< 1 day	1	
		1-2 days	2	
		3-4 days	3	☐
		5-7 days	4	
C5	I has trouble keeping my mind on what i was doing	< 1 day	1	
		1-2 days	2	
		3-4 days	3	☐
		5-7 days	4	
C6	I felt depressed	< 1 day	1	
		1-2 days	2	
		3-4 days	3	☐
		5-7 days	4	
C7	I felt that everything I did was an effort	< 1 day	1	
		1-2 days	2	
		3-4 days	3	☐
		5-7 days	4	
C8	I felt hopeful about the future	< 1 day	1	
		1-2 days	2	☐
		3-4 days	3	
		5-7 days	4	
C9	I thought my life had been a failure	< 1 day	1	
		1-2 days	2	
		3-4 days	3	☐
		5-7 days	4	
C10	I felt fearful	< 1 day	1	
		1-2 days	2	☐
		3-4 days	3	

		5-7 days	4	
C11	My sleep was restless	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C12	I was happy	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C13	I talked less than usual	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C14	I felt lonely	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C15	People were friendly	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C16	I enjoyed life	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C17	I had crying spells	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C18	I felt sad	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	
C19	I felt that people disliked me	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	

		5-7 days	4	
C20	I could not "get going"	< 1 day	1	☐
		1-2 days	2	
		3-4 days	3	
		5-7 days	4	

E. The EQ-5D-5L Health related quality of life before injury

E1	Mobility	No problems in walking about ☐	1
		Slight problems in walking about ☐	2
		Moderate problems in walking about ☐	3
		Severe problems in walking about ☐	4
		Unable to walk about ☐	5
E2	Self-care	No problems in washing or dress myself ☐	1
		Slight problems in washing or dress myself ☐	2
		Moderate problems in washing or dress myself ☐	3
		Severe problems in washing or dress myself ☐	4
		Unable to wash or dress myself ☐	5
E3	Usual activities (e.g. work, study, household, family or leisure activities)	No problems doing my usual activies ☐	1
		Slight problems doing my usual activies ☐	2
		Moderate problems doing my usual activies ☐	3
		Severe problems doing my usual activies ☐	4
		Unable to do my usual activies ☐	5
E4	Pain/Discomfort	No pain or discomfort ☐	1
		Slight pain or discomfort ☐	2
		Moderate pain or discomfort ☐	3
		Severe pain or discomfort ☐	4
		Extreme pain or discomfort ☐	5
E5	Anxiety/ Depression	Not anxious or depressed ☐	1
		Slight anxious or depressed ☐	2

		Moderate anxious or depressed ☐	3
		Severe anxious or depressed ☐	4
		Extreme anxious or depressed ☐	5

We would like to know how good or bad your health the day before injury.

This scale is numbered form 0 to 100.

100 means the best health you can imagine

0 means the worst health you can imagine

Your health score =

SF 12. Health status

Now I would like to ask you some items about your how you feel about your health. For each item, please rate your health status before injury

SF1	In general, would you say your health is?	Excellent	1
		Very good	2
		Good	3
		Fairly good	4
		Poor	5

The following items are about activities you might do during a typical day before injury. Did your health limit you in these activities? If so, how much

SF2	Moderate activities, such as moving a table, push a vacuum cleaner, bowling, or playing golf?	Yes, limited a lot	1
		Yes, limited a little	2
		No, not limited at all	3
SF3	Climbing several flights of stairs	Yes, limited a lot	1
		Yes, limited a little	2
		No, not limited at all	3

During the past 4 weeks before injury, have you have any of following problems with your work or other regular daily activities as a result of your physical health?

SF4	Accomplished less than you would like?	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
SF5	Were limited in the kind of work or other activities?	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5

During the past 4 weeks before injury, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?			
SF6	Accomplished less than you would like	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
SF7	Did work or other activities as carefully as usual	All of the time	1
		Most of the time	2
		Some of the time	3
		A little of the time	4
		None of the time	5
SF8	During the past 4 weeks, how much did pain interfere with your normal work (including work outside the home and house work)?	Not at all	1
		Slight	2
		Moderately	3
		Quite a bit	4
		Extremely	5
These questions are about how you have been feeling during the past 4 weeks before injury. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks before injury.			
SF9	Have you felt calm and peaceful?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
SF10	Did you have a lot of energy?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
SF11	Have you felt downhearted and blue?	All of the time	1
		Most of the time	2
		A good bit of the time	3

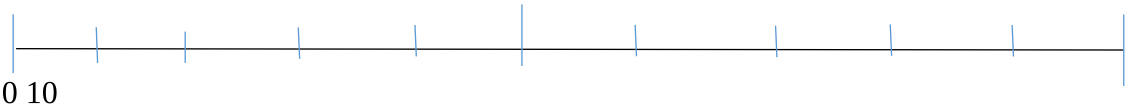
		Some of the time	4
		A little of the time	5
		None of the time	6
SF12	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, ect,)?	All of the time	1
		Most of the time	2
		A good bit of the time	3
		Some of the time	4
		A little of the time	5
		None of the time	6
Activities daily living (IADL) Please indicate your ability to do these activities of daily living even if you have never done it.			
AD1	Ability to use telephone	Operates telephone on own initiative; looks up and dials numbers, etc. ☐	1
		Dials a few well-known numbers ☐	2
		Answers telephone but does not dial ☐	3
		Does not use telephone at all ☐	4
AD2	Shopping	Takes care of all shopping needs independently ☐	1
		Shops independently for small purchases ☐	2
		Needs to be accompanied on any shopping trip ☐	3
		Completely unable to shop ☐	4
AD3	Food preparation	Plans, prepares, and serves adequate meals independently ☐	1
		Prepares adequate meals if supplied with ingredients ☐	2
		Heats and serves prepared meal, or prepare meal but doesn’t maintain adequate diet ☐	3
		Need to have meals prepared and served ☐	4

AD4	Housekeeping	Maintains house alone or with occasional assistance (e.g., "heavy work domestic help") ☐	1
		Performs light daily tasks such as dishwashing, bed making ☐	2
		Performs light daily tasks but cannot maintain acceptable level of cleanliness ☐	3
		Needs help with all home maintenance tasks ☐	4
		Does not participate in any housekeeping ☐	5
AD5	Laundry	Does personal laundry completely ☐	1
		Launders small items; rinses stockings, etc. ☐	2
		All laundry must be done by others ☐	3
AD6	Mode of transportation	Travels independently on public transportation or drives own car (motorbike) ☐	1
		Arranges own travel via taxi, but does not otherwise use public transportation ☐	2
		Travels on public transportation when assisted or accompanied by another ☐	3
		Travel limited to taxi or automobile with assistance of another ☐	4
		Does not travel at all ☐	5
AD7	Responsibility for own medications	Is responsible for taking medication in correct dosages at correct time ☐	1
		Takes responsibility if medication is prepared in advance in separate dosages ☐	2
		Is not capable of dispensing own medication ☐	3
AD8	Ability to handle finances	Manages financial matters independently (budgets,	1

	writes checks, pays rent and bills, goes to bank), collects and keeps track of income ☐	
	Manages day-to-day purchases, but needs help with banking, major purchases, etc. ☐	2
	Incapable of handling money ☐	3

Pain intensity by Numeric Pain Rating Scale

Please rate your overall level of pain over the past 24 hours from best (score=0) to worst (score=10)



0 10

Appendix F: Ethic Approval

F1. Ethic Approval

Curtin University

Office of Research and Development

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

12-Jan-2017

Name: Lynn Meuleners
Department/School: Curtin-Monash Accident Research Centre
Email: L.Meuleners@curtin.edu.au

Dear Lynn Meuleners

RE: Ethics approval
Approval number: HRE2017-0010

Thank you for submitting your application to the Human Research Ethics Office for the project **Motorcycle crashes in Ho Chi Minh City, Vietnam: An examination of crashes, long-term outcomes and behaviour**.

Your application was reviewed through the Curtin University low risk ethics review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007).*

Approval is granted for a period of one year from **12-Jan-2017** to **11-Jan-2018**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Meuleners, Lynn	Supervisor
Hobday, Michelle	Supervisor
Chow, Kyle	Supervisor
Doan, Han	Student

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
    - proposed changes to the approved proposal or conduct of the study

- unanticipated problems that might affect continued ethical acceptability of the project
- major deviations from the approved proposal and/or regulatory guidelines
- serious adverse events

3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval

None.

This letter constitutes ethical approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Dr Catherine Gangell
Manager, Research Integrity

F2. Ethic Approval 2

BỘ Y TẾ
ĐẠI HỌC Y DƯỢC TP HỒ CHÍ MINH

HỘI ĐỒNG ĐẠO ĐỨC TRONG NCYSH

Số: 136 /ĐHYD-HĐ

V/v chấp thuận các vấn đề đạo đức NCYSH

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM

Độc lập – Tự do – Hạnh phúc

TP Hồ Chí Minh, ngày 26 tháng 4 năm 2017

CHẤP THUẬN (CHO PHÉP) CỦA HỘI ĐỒNG ĐẠO ĐỨC TRONG NGHIÊN CỨU Y SINH HỌC ĐẠI HỌC Y DƯỢC TP HỒ CHÍ MINH

Căn cứ quyết định số 1863/QĐ-BYT ngày 27 tháng 5 năm 2009 của Bộ Y tế về việc ban hành Quy chế Tổ chức và hoạt động của Đại học Y Dược thành phố Hồ Chí Minh;

Căn cứ quyết định số 5129/QĐ-BYT ngày 19 tháng 12 năm 2002 của Bộ trưởng Bộ Y tế về việc ban hành Quy chế về tổ chức và hoạt động của Hội đồng đạo đức trong nghiên cứu y sinh học;

Căn cứ Quyết định số 1238/QĐ-ĐHYD-TC ngày 18 tháng 5 năm 2016 của Hiệu trưởng Đại học Y Dược TP Hồ Chí Minh về việc thành lập Hội đồng đạo đức trong nghiên cứu y sinh học;

Trên cơ sở xem xét của thường trực Hội đồng Đạo đức trong nghiên cứu y sinh học Đại học Y Dược ngày 26/4/2017,

Nay Hội đồng đạo đức **chấp thuận (cho phép)** về các khía cạnh đạo đức trong nghiên cứu đối với đề tài:

- Tên đề tài: *Tai nạn xe gắn máy tại Tp. Hồ Chí Minh, Việt Nam: Một khảo sát về tai nạn, kết cuộc dài hạn và yếu tố hành vi.*
- Mã số: 17119 - ĐHYD
- Chủ nhiệm đề tài: *Đoàn Thị Ngọc Hân - Nghiên cứu sinh*
- Đơn vị chủ trì: *Đại học Y Dược Tp. Hồ Chí Minh và Trung tâm Nghiên cứu Chấn thương Curtin-Monash*
- Địa điểm triển khai nghiên cứu: *Bệnh viện Chợ Rẫy và những người sử dụng xe gắn máy tại Tp. HCM).*
- Thời gian tiến hành nghiên cứu: từ *tháng 5/2017* đến *tháng 5/2018*
- Phương thức xét duyệt: *Qui trình rút gọn.*

Ngày chấp thuận (cho phép): *Ngày* **26/4/2017**.

Lưu ý: **HĐĐĐ có thể kiểm tra ngẫu nhiên trong thời gian tiến hành nghiên cứu**

TM. HỘI ĐỒNG
KT. Chủ tịch Hội đồng
Thường trực Hội đồng
PHÓ HIỆU TRƯỞNG

BỘ Y TẾ ĐẠI HỌC Y DƯỢC TP. HỒ CHÍ MINH

PGS.TS. Đỗ Văn Dũng

Appendix G: Information Letter

School of Public Health

GPO Box U 1987

Perth, WA 6845, Australia

PARTICIPANT INFORMATION STATEMENT

Research Title:	Motorcycle crashes in Ho Chi Minh City, Vietnam: An examination of crashes, long-term outcomes and behaviour
Principal Investigator:	Professor Lynn Meuleners Director, Curtin-Monash Accident Research Centre
Co- Investigators	Doan Thi Ngoc Han (PhD student) Dr Michelle Hobday Dr Kyle Chow
Version Number:	1
Version Date:	18/11/2016

What is the Project About?

- Motorcycle users in Vietnam are involved in more than 70% of road traffic crashes and make up more than a half of casualties and injuries.
- This study aims to examine the risk factors for a motorcycle crash and long-term health outcomes among injured commuter motorcyclists aged 18 and over in Ho Chi Minh City (HCMC), Vietnam.
- Injured motorcyclists who have been hospitalised will be interviewed about the circumstances of their crashes and the effect of the crashes on their health and well-being.
- The findings from this research will inform strategies to improve the long-term outcomes of motorcycle crash victims.

Who is doing the Research?

- The study is conducted by Doan Thi Ngoc Han under the supervision of Professor Lynn Meuleners, Curtin-Monash Accident Research Centre (C-MARC), Curtin University.
- There will be no costs to you for being involved and you will not be compensated for participating in this study.

Why am I being asked to take part and what will I have to do?

- You have been asked to take part because you are aged 18 and over, resident of HCMC and a commuter motorcyclist involved in a motorcycle crash.
- Your participation in this research is entirely voluntary

- Your participation involves researcher-administered questionnaire at hospital, 6 and 12 months post-hospitalisation. We estimate that the first questionnaire will take about 5 minutes to complete and no longer than 20 minutes each for the other two interviews.
- I will phone you or come your house at 6 and 12 months after your discharge from hospital to complete the questionnaire. Questions will explore your health status and quality of life, pain intensity, depression, and functional disability. I would appreciate if you could answer all the questions but you are free to refuse to answer some questions.

Are there any benefits' to being in the research project?

- There are no direct benefits to you for participating in this survey.
- However, this research will help to improve our understanding about the risk factors and the long-term effects of motorcycle crashes on health outcomes of injured motorcyclists.
- We hope that the results will help to inform and implement strategies to improve health outcomes of injured motorcyclists in Vietnam.

Are there any risks, side-effects, discomforts or inconveniences from being in the research project?

- It is unlikely that answering the questionnaire will cause psychological or emotional discomfort.
- You may choose to terminate involvement in the study at any time without giving any reason.

Who will have access to my information?

- No physicians or anyone who knows you personally will see your responses.
- The data gathered in this research will be treated as confidential.
- Your name will be stored separately from your questionnaires and linked using a password protected identifying number.
- Any data collected as part of this research will be stored securely as per Curtin University's Management of Research Data policy.
- Only my supervisors and I will be able access to the data.
- The results of this research may be presented at conferences or published in professional journals. You will not be identified in any results that are published or presented.

Will you tell me the results of the research?

If you are interested, we let you know the results of the research when the research is completed in 2020. Results will not be individualised but based on all the interviews which we have conducted and reviewed as part of the research.

Do I have to take part in the research project?

- Taking part in a research is entirely voluntary. It is your choice to take part or not. You do not have to agree if you do not want to.
- If you decide to take part and then change your mind, that is okay, you can withdraw from the project. You do not have to give us a reason; just tell us that you want to stop.
- If you chose not to take part or start and then stop the study, it will not affect your medical treatment.
- If you chose to leave the study, we will use any information already collected unless you tell us not to.

What happens next and who can I contact about the research?

If you would like further information or to ask questions about the project, please contact:

Professor Lynn Meuleners
Curtin-Monash Accident Research Centre
Curtin University
Phone: +61 8 9266 4636
Email: L.Meuleners@curtin.edu.au

Or Doan, Thi Ngoc Han, PhD student
Curtin University
Phone: +84 909 454 434
Email: han.doan@postgrad.curtin.edu.au

If you decide to take part in this research, we will ask you to sign the consent form. By signing it is telling us that you understand what you have read and what has been discussed. Signing the consent indicates that you agree to be in the research project and have your information used as described. Please take your time and ask any questions you have before you decide what to do. You will be given a copy of this information and the consent form to keep.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number 2017/0010). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au

Appendix H: Consent Form

CONSENT FORM

Project Title:	Motorcycle crashes in Ho Chi Minh City, Vietnam: An examination of crashes, long-term outcomes and behaviour
Investigator:	Doan Thi Ngoc Han PhD student
Version Number:	1
Version Date:	12/10/2016

- I have read the information statement version listed above and I understand its contents.
- I believe I understand the purpose, extent and possible risks of my involvement in this project.
- I voluntarily consent to take part in this research project.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007) – updated March 2014.
- I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	

Declaration by researcher: I have supplied an Information Letter and Consent Form to the participant who has signed above, and believe that they understand the purpose, extent and possible risks of their involvement in this project.

Researcher Name	
Researcher Signature	
Date	

Appendix I: Oral Presentations from PhD project

Oral Presentation certificate: the Mark Liveris Health Sciences Research Student Seminar, Faculty of Health Sciences, Curtin University, May 11, 2020

Seminar Program 2020

Welcome from the Dean of Research, Health Sciences
Professor Melinda Fitzgerald
12.00 pm (5 minutes)

Opening Remarks from the Pro Vice-Chancellor, Health Sciences
Professor Archie Clements
12.05 pm (5 minutes)

Presentation Session One
Chair – Professor Melinda Fitzgerald
12.10 pm – 12.50 pm (40 minutes)

1.1 James Clarke	1.7 Felicity Roux
1.2 Fiona Coll	1.8 Aileen Scully
1.3 Georgia Griffin	1.9 Laura Strachan
1.4 Rebecca Hood	1.10 Chimwemwe Tembo
1.5 Ayeisha Milligan Armstrong	1.11 Chanelle Wilson
1.6 Mareike Moormann	1.12 Adelaide Withers

Presentation Session Two
Chair – Professor Melinda Fitzgerald
12.50 pm – 1.50 pm (60 minutes)

2.1 Stephanie Bridgeman	2.7 Tess Fletcher	2.13 Marlene Kritz
2.2 Samuel Calder	2.8 Aleksandra Gozt	2.14 Chloe Maxwell-Smith
2.3 Annie Chappell	2.9 Danyelle Green	2.15 Kahlia McCausland
2.4 Maeve Coyle	2.10 Jodie Grigg	2.16 Kalyani Subbiah
2.5 Han Doan	2.11 Emily Jackson	2.17 Lily Toomey
2.6 Eleanor Dunlop	2.12 Nardia-Rose Klem	2.18 David Youens

Career Panel Discussion
PhD employability in changing times
1.50 pm – 2.35 pm (at least 45 minutes) & Panellists to be confirmed

Panel Moderator
- *Dr Kathleen Franklyn, Career Development Consultant, Curtin University*

Panellists to be confirmed.
- *Kellie Blyth, Director of Allied Health, Fiona Stanley Hospital*
- *Colin La Galia, Chief Executive Officer, Epichem Pty Ltd*
- *Bahareh Afsharnejad, PhD Candidate, School of Occupational Therapy, Social Work and Speech Pathology, Curtin University*

Presentation of Seminar Awards & Faculty Research Awards & Closing Remarks
2.35 pm – 2.45 pm (10 minutes)

Event concludes
2.50 pm