UNIVERSITY OF CALIFORNIA SAN DIEGO
SAN DIEGO STATE UNIVERSITY

Epidemiology of crashes and injuries among commercial motorcyclists in Bamenda, Cameroon: A cross-sectional study

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Philosophy

in

Public Health (Epidemiology)

by

Che Wankie

Committee in charge:

University of California San Diego
- Professor Wael Al-Delaimy, Co-chair
- Professor Linda Hill, Co-chair
- Professor Jamila Stockman

San Diego State University
- Professor John Alcaraz
- Professor Richard Shaffer

2019

The Dissertation of Che Wankie is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Co-chair

Co-chair

University of California San Diego

San Diego State University

2019

DEDICATION

To my wonderful and loving family

EPIGRAPH

Knowledge is power.
Information is liberating.
Education is the premise of progress, in every society, in every family.

Kofi Annan
UN Secretary-General
1997-2006

TABLE OF CONTENTS

Signature Page iii
Dedication iv
Epigraph v
Table of Contents vi
List of Abbreviations viii
List of Symbols ix
List of Figures x
List of Tables xi
Acknowledgments xii
Vita xv
Abstract of the Dissertation xix
Chapter 1: Introduction 1
Commercial Motorcycles in Cameroon 2
Motorcycle Mortality and Morbidity in sub-Saharan Africa 3
Statement of the Problem 5
Objectives of the Current Study 6
Conceptual Framework 6
Study Design and Setting 9
Study Participants 9
Questionnaire Content 9
Interview Process 10
Injury Severity Score Measurements 11
Definitions 12
Ethical Consideration 14
References 16
Chapter 2: Prevalence of Motorcycle Crashes and Associated Factors among Commercial Motorcycle Riders and Passengers in Bamenda, Cameroon 19
Abstract 20
Introduction 22
Methods 24
Results 27
Discussion 31

References 45
Chapter 3: Epidemiology of Injury among Commercial Motorcycle Riders in Bamenda, Cameroon 48
Abstract 49
Introduction 51
Methods 53
Results 58
Discussion 61
References 72
Chapter 4: Patterns, Severity, and Post-Crash Management of Injuries among Commercial Motorcycle Riders in Bamenda, Cameroon 77
Abstract 78
Introduction 80
Methods 83
Results 85
Discussion 89
References 99
Chapter 5: Recommended Strategies for Prevention of Crash and Injury and Delivery of Prehospital Care to Commercial Motorcycle Users 104
Recommendations for prevention of crashes and injuries 108
Recommendations for delivery of post-crash care to the injured 116
Conclusion 120
References 121
Chapter 6: Discussion and Conclusion 123
Discussion 124
Conclusion 129
Appendixes 131
Appendix A: Institutional Review Board (IRB) Study Approval Letters 132
Appendix B: Survey (English Version) 137
Appendix C: Survey (Pidgin Version) 166

LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
AIS	Abbreviated Injury Score
AOR	Adjusted Odds Ratio
CAPI	Computer Assisted Personal Interview
cc	Cubic Centiliters
CI	Confidence Interval
DALYs	Disability-Adjusted Life Years
EMS	Emergency Medical Services
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
IL	Illinois
ISS	Injury Severity Score
LMIC	Low and Middle-Income Countries
NC	North Carolina
NHTSA	National Highway Traffic Safety Administration
OR	Odds Ratio
RTIs	Road Traffic Injuries
SAS	Statistical Analysis Software
SD	Standard Deviation
SPSS	Statistical Package for the Social Science
SDSU	San Diego State University
UCSD	University of California San Diego
US	United States of America
WHO	World Health Organization

LIST OF SYMBOLS

χ^2	Chi-square
n	sample
p	probability
p-value	probability value

LIST OF FIGURES

Figure 1.1: Conceptual Framework 8

Figure 1.2: Flowchart of Survey Design 15

Figure 2.1: Prevalence of ever had a crash (lifetime) 29

Figure 2.2: Number of crashes among ever crashers 29

Figure 2.3: Prevalence of crash within past 12 months (period) 29

Figure 2.4: Number of crashes among motorcyclists within the past 12 months 29

Figure 3.1: Most severe crash in lifetime and most recent crash within the past 12 months 56

Figure 4.1: Crash and injury events of commercial motorcycle riders in Bamenda, Cameroon 86

Figure 4.2: Anatomic distribution of minor and severe injuries among riders 90

LIST OF TABLES

Table 1.1: Haddon matrix applied for crash and injury among commercial motorcycle users 8

Table 2.1: Sociodemographic characteristics of riders and passengers by crash involvement; Bamenda, Cameroon 39

Table 2.2: Ridership characteristics of riders by crash involvement; Bamenda, Cameroon 40

Table 2.3: Ridership characteristics of passengers by crash involvement; Bamenda, Cameroon 41

Table 2.4: Adjusted odds ratio of crash involvement for motorcyclists; Bamenda, Cameroon 42

Table 2.5: Associated factors of vehicle collision for most severe crash among riders; Bamenda, Cameroon 43

Table 2.6: Adjusted odds ratio of single-vehicle collision for most severe crash among riders; Bamenda, Cameroon 44

Table 3.1: Example of crash classification of motorcyclists 57

Table 3.2: Demographic and motorcycle ridership characteristics, by injury status; Bamenda, Cameroon 69

Table 3.3: Crash- and environmental-related characteristics of motorcycle riders, by injury status; Bamenda, Cameroon 70

Table 3.4: Unadjusted and adjusted odds ratio of motorcycle injury sustained at most severe crash; Bamenda, Cameroon 71

Table 4.1: Post-crash indicators of commercial motorcycle riders, by injury severity; Bamenda, Cameroon 98

Table 5.1: Haddon matrix of recommended strategies for crash and injury prevention and post-crash care among commercial motorcycle users 107

ACKNOWLEDGMENTS

The fact that I am penning this acknowledgment is testament to the people who have believed in me and have been extremely generous and supportive these past years. This undertaking has been life-changing and my heartfelt thanks go to you all, to only some of whom it is possible to give particular mention here.

First and foremost, I would like to express my heart-felt gratitude and appreciation to my dissertation committee. Throughout this dissertation work you have been patient with me, always provided valuable feedback on my manuscripts, and words of encouragement. I would like to extend my deepest gratitude to Dr. Linda Hill, my committee co-chair, for her unstinting advice, continuous support, and guidance throughout this project. You have gone out of your way ensure that I succeed in this undertaking and I will be forever glad to have had this opportunity to work with you. I am also very grateful and extend a special word of thanks to Dr. Wael Al-Delaimy who without hesitation accepted to mentor me and co-chair my committee. I am truly appreciative of your invested time in me. Your ability to provide a clear epidemiologic perspective of several of the project concepts while being motivational has instilled in me the drive to be a better researcher. Thank you. I would like to acknowledge Dr. Richard Shaffer who despite his many obligations was willing to serve on my committee. You have been an inspirational mentor ever since I joined the program and have encouraged me to keep my head up high especially during tough times. You have been a blessing to me. I am extremely thankful to Dr. John Alcaraz for his statistical support. You have been valuable in explaining in a clear and concise way my statistical questions. Finally but not the least, I will like to thank Dr. Jamila Stockman for her guidance, support, and encouragement.

I would like to particularly thank all the commercial motorcycle riders and passengers for their dedication to participate in this study. Even in a very sensitive political climate you were willing to participate and offer information without hesitation. Many thanks go to the interviewers who worked extremely hard even in the rain.

This work was supported by funding from the Inamori Foundation, the University of California San Diego (UCSD) International Institute, and the UC San Diego Global Health Institute. Your financial help was invaluable to the success of this project.

I am greatly indebted to my parents Dr. Moses Wankie and Helen Atia, who instilled in me the love of learning and zeal to always do better than they did. A special thanks goes to my loving sister, Dr. Mankaa Wankie, who from our childhood has been my educational inspiration. There are truly no words enough to express my appreciation for everything you have done for me. To my cousin, Dr. Nche Zama, who provided the platform and the initial impetus of my higher education journey. Thank you very much for your unlimited kindness, motivation, and financial support. You have always been my inspiration. I owe a special gratitude to the Brownell family who welcomed me into their family upon arrival into the United States and have always ensured all is well with me. Thank you, mommy Christiana Fonkwa, for your prayers and weekly phone calls.

I would like to thank my cohort, Dr. John Bellettiere, Dr. Alyson Cavanaugh, and Toni Rush for their support and friendship. I will forever cherish our camaraderie.

Although I did not mention your name, from the bottom of my heart, I would like to thank my extended family, colleagues, and close friends for your encouragement and support.

Chapter 2, in full, is currently being prepared for submission for publication of the material. Wankie, Che; Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael*; Hill, Linda*. The dissertation author was the primary investigator and author of this material.

Chapter 3, in full, is currently being prepared for submission for publication of the material. Wankie, Che; Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael*; Hill, Linda*. The dissertation author was the primary investigator and author of this material.

Chapter 4, in full, is currently being prepared for submission for publication of the material. Wankie, Che; Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael*; Hill, Linda*. The dissertation author was the primary investigator and author of this material.

* Co-chairs

VITA

EDUCATION

2019	**Doctor of Philosophy, Epidemiology** University of California San Diego School of Medicine and San Diego State University Graduate School of Public Health San Diego, CA
2013	**Master of Science, Applied Statistics** College of Natural Sciences and Mathematics California State University Long Beach Long Beach, CA
2008	**Master of Public Health, Community Health Education** Health Science Department California State University Long Beach Long Beach, CA
2004	**Bachelor of Science, Computer Science** **Bachelor of Science, Computer Information Systems** Department of Mathematics and Computer Information Science Mansfield University of Pennsylvania Mansfield, PA

PROFESSIONAL EXPERIENCE

Jan 2014 – present	Epidemiologist Defense Health Agency (DHA)/Department of Defense (DoD) HIV/AIDS Prevention Program (DHAPP) San Diego, CA
Aug 2015 – May 2016	Teaching Assistant Graduate School of Public Health San Diego State University San Diego, CA
Aug 2008 – Aug 2013	Lecturer Departments of Health Science and Health Care Administration California State University Long Beach Long Beach, CA
May 2011 – Aug 2011	Bridge Student Assistant Instruction College of Education California State University Long Beach Long Beach, CA
Jan 2008 – Jun 2010	Research Assistant Department of Health Science California State University Long Beach Long Beach, CA
Jan 2006 – May 2008	Instructional Student Assistant Learning Assistance Center California State University Long Beach Long Beach, CA
Jan 2002 – Dec 2004	Mathematics Tutor, Learning Center; Mansfield University Mansfield, PA

PEER-REVIEWED PUBLICATIONS

Michael Grillo M., Sloan M., **Wankie C.**, Woodland K., Reader E.; Porter B., Macera C., Bulterys M., Shaffer R. (2017). Global HIV Prevention, Testing, and Counseling in Military Populations. *Current HIV research*. 15(2):95-101. doi: 10.2174/1570162X15666170516170412

Michael Grillo M., Sloan M., **Wankie C.**, Woodland K., Reader E.; Porter B., Macera C., Bulterys M., Shaffer R. (2017). Prevention Interventions for People Living with HIV in Military Settings. *Current HIV research*. 15(2):90-94. doi: 10.2174/1570162X15666170516165331

Wankie C., Kritz-Silverstein D., Barrett-Connor E., Kado D.M. (2015). Kyphosis and Sleep Characteristics in Older Persons: The Rancho Bernardo Study. *Journal of Sleep Disorder Management*, 1(1)

Friis, R. H., Garrido-Ortega, C., Safer, A. M., **Wankie, C.**, Griego, P. A., Forouzesh, M., Trefflich K., and Kuoch, K. (2012). Socioepidemiology of Cigarette Smoking among Cambodian Americans in Long Beach, California. *Journal of Immigrant and Minority Health*, *14*(2), 272-280. doi: 10.1007/s10903-011-9478-1

BOOK CHAPTER / CONTRIBUTION

Friis RH, Kugler J, Pallasigui J, Garrido-Ortega C, **Wankie C**. Global diffusion of smoke-free bars laws that prevent exposure to secondhand tobacco smoke. In: Friis RH, ed. *The Praeger Handbook of Environmental Health*. (pp. 319-334). Westport, Connecticut: Praeger Publishers; 2012. ISBN: 978-0-313-38600-8

Friis RH. 2013. Epidemiology for Public Health Practice. Sudbury, Massachusetts: Jones & Bartlett Learning; 5th edition. ISBN: 978-1449665494

Friis RH. 2012. Epidemiology 101. Sudbury, Massachusetts: Jones and Bartlett Publishers. ISBN: 978-1284107852

SELECTED PEER-REVIEWED PRESENTATIONS

Wankie C., Kritz-Silverstein D., Barrett-Connor E., Kado D. *Kyphosis and Sleep Characteristics in Older Persons: The Rancho Bernardo Study*. Epidemiology Research Exchange, San Diego, CA. May 2015

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Spatial Analysis of Cigarette Smoking among Cambodian Americans in Long Beach, CA.* 140th Annual Meeting of the American Public Health Association, San Francisco, CA. October, 2012

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Preferences for Smoking Cessation Methods among Cambodian Americans.* 139th Annual Meeting of the American Public Health Association, Washington, DC. Oct., 2011

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Socioepidemiology of smoking among Cambodian Americans in Long Beach, California.* 43rd Annual Society for Epidemiologic Research Meeting, Seattle, WA. June 23-26, 2010.

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Protecting minors from secondhand smoke in automobiles.* 138th Annual Meeting of the American Public Health Association, Denver, CO. November, 2010.

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Rules about smoking in Cambodian American households.* 138th Annual Meeting of the American Public Health Association, Denver, CO.

November, 2010.

Robert Friis, Claire Garrido-Ortega, Alan Safer, **Che Wankie**, Mohammed R. Forouzesh, Dexter Dizon, Kirsten Trefflich, Kimthai Kuoch. *Do Cambodian Americans perceive smoking as risky?* 138th Annual Meeting of the American Public Health Association, Denver, CO. November, 2010.

Robert Friis, Alan Safer, Claire Garrido-Ortega, **Che Wankie**, Mohammed R. Forouzesh, Paula Griego, Kirsten Trefflich, Kimthai Kuoch. *Epidemiology of cigarette smoking among Cambodian Americans.* 137th Annual Meeting of the American Public Health Association, Philadelphia. PA, Nov., 2009.

Sylvia Janich, Susanne Wiesmeth, Dinesh Devkota, Babu Ram Giri, **Che Wankie**, Sabine Twork, Robert Friis, Joachim Kugler. *Breaking the vicious circle of malnutrition and seeking medical aid in rural Nepal by adequate provision of food during sickness: A cross-sectional study in Amppipal hospital, Gorkha, Nepal.* 12th World Congress on Public Health, İstanbul, Turkey. April 27 - May 1, 2009.

Friis R, Lopez-Zetina J, **Wankie C**, Wechsler S, Lee S. *Health effects associated with goods movement in the Los Angeles basin.* 136th Annual Meeting of the American Public Health Association, San Diego, CA, October, 2008 and 20th VA Hospital/CSULB Annual Research Symposium, Long Beach, CA.

Janich S, Wiesmeth S, Devkota D, **Wankie C**, Giri BR, Twork S, Friis R, Kugler J. *Children in rural Nepal: Reasons for seeking medical aid and parental supportive behavior at last attendance.* 136th Annual Meeting of the American Public Health Association, San Diego, CA. October, 2008.

TECHNICAL REPORTS

Seroprevalence and Behavioral Epidemiology Risk Survey among the Cameroon Defense Force. Defense Health Agency Technical Report, 2019. (In progress)

Seroprevalence and Behavioral Epidemiology Risk Survey among the Gabonese Armed Forces. Defense Health Agency Technical Report, 2019. (In progress)

Seroprevalence and Behavioral Epidemiology Risk Survey among the Nigerien Armed Forces. Defense Health Agency Technical Report, 2019. (In progress)

Seroprevalence and Behavioral Epidemiology Risk Survey among the National Armed Forces - Burkina Faso. Naval Health Research Center Technical Report, 2019. (In progress)

Seroprevalence and Behavioral Epidemiology Risk Survey among the Beninese Armed Forces. Naval Health Research Center Technical Report, 2017.

Seroprevalence and Behavioral Epidemiology Risk Survey among the Togolese Armed Forces. Naval Health Research Center Technical Report, 2014.

SCHOLARSHIPS / FELLOWSHIPS / HONORS

May 2017	UC San Diego International Institute Graduate Fellowship
April 2017	UC San Diego Global Health Institute Fellowship
Dec 2016	Inamori Fellowship
May 2012	California State University Chancellor's Doctoral Incentive Program
Jul 2008 – Jul 2010	Cornelius Hopper Diversity Award from the University of California's Tobacco-Related Disease Research Program (TRDRP)
Spring 2003/2004	Outstanding Computer Science Student Award
Aug 2002/Dec 2004	Slabey Award - Exceptional student in Computer Science Department
Jan 2001 – Dec 2004	President's /Dean's List; Mansfield University, Pennsylvania

FUNDED FELLOWSHIPS/GRANTS

May 2017	UCSD International Institute Research Travel Grant; $1, 500
April 2017	UCSD Global Health Institute Student Field Experience Travel Funds; $2,000
Dec 2016	Inamori Fellowship; $5,000
Dec 2016	California State University CDIP Winter Travel Grant; $1,500
Nov 2014/ 2015	California State University CDIP mini-grant award; $2,500
May 2012	California State University Chancellor's Doctoral Incentive Program (CDIP);$30,000
June 2009	Enhancing Educational Effectiveness through Technology; $1,500 (Role: Mentor)
Jul 2008 – Jul 2010	Determinants of Smoking Prevalence among Cambodian Americans: University of California's Tobacco-Related Disease Research Program (TRDRP); $30,000 (Role: Trainee)

GUEST LECTURER

Fall 2011	HSC 422: Environmental Health; Dept. of Health Science, CSULB
Fall 2010	HSC 401: Community Health Education; Dept. of Health Science, CSULB
Spring 2009	HCA 422: Global Health Issues; Dept. of Health Care Admin., CSULB
Spring 2009	HSC 420: International Health; Dept. of Health Science, CSULB

MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS

June 2014 – present	Advisory Board for the Master of Public Health Program, Department of Health Science at California State University Long Beach
2009 – present	Society for Epidemiologic Research (SER)
2008 – present	American Public Health Association (APHA)
2008 – 2013	Southern California Public Health Association (SCPHA); Secretary 2009-11
2007 – 2008	Southern California Society for Public Health Education (SCSOPHE)

STATISTICAL/COMPUTER PROGRAMMING SKILLS

SAS, SPSS, Minitab, EpiInfo, Qualtrics, ArcGIS, SQL, HTML, CSS, Photoshop, Macromedia Flash, VBA, Perl, PHP, JavaScript, C++, Microsoft Office (PowerPoint, Access, Excel, Word, Publisher, Outlook)

LANGUAGES

Speaking, reading, and writing proficiency in English, French, German, and Pidgin English

ABSTRACT OF THE DISSERTATION

Epidemiology of crashes and injuries among commercial motorcyclists in Bamenda, Cameroon: A cross-sectional study

by

Che Wankie

Doctor of Philosophy in Public Health (Epidemiology)

University of California San Diego, 2019
San Diego State University, 2019

Professor Wael Al-Delaimy, Co-chair
Professor Linda Hill, Co-chair

Background: The facts are not in dispute. Globally, road traffic injuries (RTIs) are one of the three leading causes of death among people aged 5 to 44 years and responsible for 1.35 million annual deaths and 20-50 million non-fatal injuries. In sub-Saharan Africa, the burden of RTIs is disproportionately high among commercial motorcycle users. However, region-specific associated factors that predispose crash and injury among commercial

motorcycle users are not fully understood. The objectives of this dissertation were to: 1) Estimate the prevalence of crashes and examine associated factors among commercial motorcycle riders and passengers; 2) Estimate injury prevalence and identify associated factors among commercial motorcycle riders; and 3) Provide an overview of patterns, severity, and post-crash management of injuries among commercial motorcycle riders.

Methods: From July 12 to 26, 2017, a cross-sectional study collected data from 829 consented commercial motorcycle riders and passengers in Bamenda, Cameroon. Participants aged 18 years or older were administered a questionnaire about demographics, crash, and injury characteristics. In addition, participants involved in a crash reported information related to the most severe crash and the most recent crash within the past 12 months, when applicable.

Results: A total of 67.2% commercial motorcycle users (77.4% riders, 46.3% passengers) were ever involved in a crash. The prevalence of crash involvement among commercial motorcycle users within the past 12 months was 17.9% (21.5% riders, 5.7% passengers). Among riders ever involved in a crash, 80.8% sustained one or more anatomic injuries amounting to 685 injuries. In addition, 80.2% of riders sustained one or more anatomic injuries at the most recent crash within the past 12 months for a total of 112 injuries. Findings from this dissertation showed that speeding riders who currently smoked, carried more than two passengers, and had three or more years of riding experience were at increased odds of crash involvement. Furthermore, most injuries sustained were to the extremities and head and neck anatomic regions with abrasions, swellings, and lacerations as the most common types of injuries.

Conclusion: This study offers insight to the elevated crash and injury burden among commercial motorcycle users and associated factors. Findings suggest the importance of additional research efforts focused on strategies to prevent crash and mitigate injury.

CHAPTER 1: INTRODUCTION

Commercial Motorcycles in Cameroon

Over the past three decades, Cameroon has witnessed an unprecedented growth in the number of motorcycles on its urban and rural roads. Motorcycles now form an integral part of its transportation network serving unmet private and public transportation needs. In Cameroon, most motorcycles are operated for commercial purposes while a few are used for private transportation, courier services, and the delivery of healthcare services to the hard to reach areas. Commercial motorcycles commonly known in Cameroon as "*Bend Skin*" or "*Nanfang*" are a prominent mode of intra-city transportation and also serve rural communities.[1,2]

Several reasons can be attributed to the dominance of commercial motorcycles on Cameroon's roads. First, commercial motorcycles were an indigenous response to the growing unmet demand for public transportation after the failure of the monopolized state-owned bus company, the Cameroonian Urban Transport Company.[3] Second, the economic crisis from the mid-1980s to early 2000s resulted in under-employment of many young educated people who saw commercial motorcycling as a source of revenue.[1] Third, commercial motorcycles are a response to economic and population growth and the increasing demand for intra-city transportation. Fourth, commercial motorcycles are able to navigate the poor road network marred with potholes or gullies. Fifth, commercial motorcycles have become increasingly popular due to the door-to-door service, negotiable fare opportunity, and effectiveness to eschew perpetually congested roads. Sixth, the availability and affordability of cheaper Chinese motorcycles has permitted

---

Cameroon is a Central African nation of about 24.5 million inhabitants spread across ten administrative regions.[31] Approximately, 50.4% of the total population is urban dwellers with an estimated 3.6% annual urbanization rate change. [32] The two main cities are Douala and Yaoundé with a combined estimated population of 7 million.[31] In 2017, it was estimated that the country had 51350km of road network of which only 8% was paved.[33]

some entrepreneurs to own fleets of motorcycles and rent them out to riders who cannot afford a motorcycle.[4]

Commercial motorcyclists are vulnerable road users often impacted by significant health, psychological, social, and financial burden. Commercial motorcycle riders often have to work extended hours on poor road conditions which contributes to fatigue, overall poor health, and increased risk of crash, injury, and fatality.[5] Moreover, most commercial motorcycle riders precariously manoeuver through traffic, ride on sidewalks or on lanes of incoming traffic, go through intersections without fully halting, or overtake on the wrong side. Furthermore, commercial motorcycle riders are often unlicensed, not adequately trained to ride motorcycles, disobey general traffic rules, often do not wear a safety helmet, and usually carry more than one passenger per trip.[6,7] The increasing number of commercial motorcycles has added to noise and air pollution through unnecessary honking, loud engine sound, use of low quality fuel, and lack of regular motorcycle maintenance. Commercial motorcycles can be perceived as a fascinating mode of transportation in that it provides mobility solutions to millions of urban dwellers yet compromises these benefits with challenges that cities are unable to cope with.

Motorcycle Mortality and Morbidity in sub-Saharan Africa

Mortality: Worldwide, road traffic injuries (RTIs) are reported as the leading cause of mortality among persons aged 5-29 years and among the three leading causes of mortality among persons aged 5-44 years.[8,9] The death toll from road traffic crashes in 2016 was 1.35 million persons. It is estimated that RTIs will be the fifth leading cause of global disease burden by 2030 with most of the projected increase to occur in low- and

middle-income countries (LMICs).[10,11] Globally, the 2016 rate of road traffic fatality per 100,000 population was 18.2 with Africa (26.6 per 100,000 population) having the highest regional rate and Europe (9.3 per 100,000 population) the lowest. Road traffic death rates in sub-Saharan Africa are among the highest in the world.[12] Interestingly, Africa has the lowest motorization yet the highest road traffic fatality; the contrary is true for Europe.[13] Regrettably, more than half of road traffic fatalities are among vulnerable road users: pedestrians, cyclists, and motorcyclists. The World Health Organization (WHO) regional distribution of mortality by road user type in 2016 showed Africa having the lowest motorcycle-related mortality rate (9%) in comparison to South-East Asia (43%).[9] It is plausible that this low mortality rate is due to lack of accurate data and not the effective implementation of road safety measures. Of African countries that provided fatality rates in 2016, Benin (57%) and Togo (72%) had the highest motorcycle fatality rates as a proportion of road user types. Information about death rates by type of road user are not available for Cameroon.[9]

Morbidity: Globally, RTIs accounted for about 76 million disability-adjusted life years (DALYs) in 2010.[14] In sub-Saharan Africa, motorcycle riders contributed 12% of RTI-related DALYs in 2010.[12] In 2016, RTIs in Cameroon accounted for 441 DALYs per 100,000 population with 127.6 attributed to persons aged 15-29 years.[15] RTIs continue to be a leading cause of morbidity and loss of productivity.[16] Overall, injured commercial motorcycle riders, their families, and caregivers may suffer financial, physical, psychological, and social burdens that could significantly reduce their quality of life.

Statement of the Problem

Cameroon, like many African counties struggles to prioritize RTIs alongside HIV/AIDS even though more people die from road traffic injuries (RTIs).[9,17] The current state of knowledge about the incidence, prevalence, and burden of crashes, injuries, and fatalities among road users in Cameroon is unsatisfactory. The 2018 World Health Organization Global Status Report on Road Safety estimated 7066 road traffic fatalities (30.1 per 100,000 population) in Cameroon.[9] Fatality estimates stratified by type of road user are unavailable. These fatality estimates do not use surveillance data; rather have relied on a prediction from statistical models which use covariates such as population, national income, or vehicle stock information.[12] This makes fatality estimates speculative and underestimates the severity of RTIs. The lack of a comprehensive national or regional surveillance system capable of collecting, cataloging, and reporting crash and injury data severely limits the effectiveness of concrete estimates or any preventive and intervention strategies to mitigate road traffic morbidity and mortality. Furthermore, underlying factors contributing to the increased crash and injury severity need to be identified and examined in order to develop tailored prevention and intervention programs. Finally, post-crash management in Cameroon remains a theoretical concept for medical professionals and requires the incorporation of a basic level of emergency medical care.[18] Twice as many crash victims in LMICs die before reaching the hospital when compared to high-income countries.[19] The lack of all aspects of prehospital care and the underdeveloped hospital care in Cameroon emphasizes the increased likelihood of severe post-crash injury, permanent disability, and fatality.[20]

Objectives of the Current Study

The overall purpose of this study is to provide an overview of the determinants and distribution of crashes and injuries among commercial motorcycle users in Bamenda, Cameroon.

The objectives of the current study are to:

1) Estimate the prevalence of crashes (lifetime and period) and examine associated factors among commercial motorcycle riders and passengers
2) Estimate injury prevalence and identify associated factors among commercial motorcycle riders
3) Provide an overview of patterns, severity, and post-crash management of injuries among commercial motorcycle riders

Conceptual Framework

The proposed conceptual framework for this research is an adaptation of the Haddon Matrix; one of the most widely used paradigms for injury prevention as shown in Figure 1.1.[21] In injury epidemiology, the Haddon Matrix provides a framework to identify and understand the etiology of crash and injury and to design and prioritize effective prevention and intervention programs.[21,22] The Haddon Matrix, a conceptual model developed by William Haddon Jr, combines the epidemiologic triad (host, agent/vehicle, and environment) with a time sequence of three crash phases (pre-crash, crash, and post-crash).[21,23] Haddon suggested that injuries behave like infectious diseases. For example, yellow fever (the agent) is transmitted to humans (the host) through the bite of a mosquito (the vector) in a certain geographic location (the environment). Similarly, injuries result from an interaction of host, vehicle, and

environmental factors. As an applicable example in this study, the host is the commercial motorcycle user (rider or passenger), the agent is collision, vehicle is the motorcycle (usually a 125cc model), and the environment (a road in Bamenda). Haddon crash phases are a continuum of time events: pre-event, event, and post-event. The interaction of human-agent-environment predisposing factors in the pre-crash phase determines whether a crash will occur. The pre-event phase considers factors that influence a crash. Interestingly not every crash occurrence involves injury. However, an interaction of human-agent-environment factors at the event phase builds on the determinants of the pre-event phase to determine injury involvement. The event phase describes potential of injury sustainment. The post-crash phase describes the factors that influence the severity of the crash and injury as well as care and treatment. Although some of the underlying factors examined are not modifiable and may not be directly associated to crash and injury, obtaining such vital information will contribute to a better understanding of the effects of predisposing factors specific to LMIC settings and provide baseline data for future research. Such information can be employed to develop tailored prevention strategies and intervention initiatives that are effective to improve road safety. Table 1.1 illustrates an application of the Haddon matrix for crash and injury among commercial motorcycle users.

Table 1.1: Haddon matrix applied for crash and injury among commercial motorcycle users[24]

	Human	Vehicle	Environment
Pre-crash	Sex, age, educational level, smoking status, alcohol use, sleep duration, motorcycle ownership, overload of passengers, speeding, conspicuity	Condition of motorcycle, motorcycle conspicuity, passenger, load on motorcycle, helmets	Road condition, weather, time of operation, traffic laws, safety policies, *urban/rural*, speed limits, *traffic lights and signs*, lane makings, licensing laws, impaired riding laws, helmet use laws, law enforcement
Crash / Injury	Helmet wear, rider reaction time, passenger reaction, protective gear	Vehicle collision type, impact collision, speed, *GPS*	Roadside objects, Inroad objects, road intersection, Road-side protection
Post-crash / Injury Severity	Preexisting conditions, Loss of personal possession, self-first aid, treatment expenses, rehabilitation, financial cost, social cost, Loss of productivity	Fire risk, damage, *pollution*	*Emergency call number*, bystander assistance, *Good Samaritan laws*, police involvement, trauma care staff, *distance to health facility, traffic congestion, ambulance services*, trauma care equipment and facility, treatment cost, insurance compensation,

Variables in italics were not examined in the dissertation research

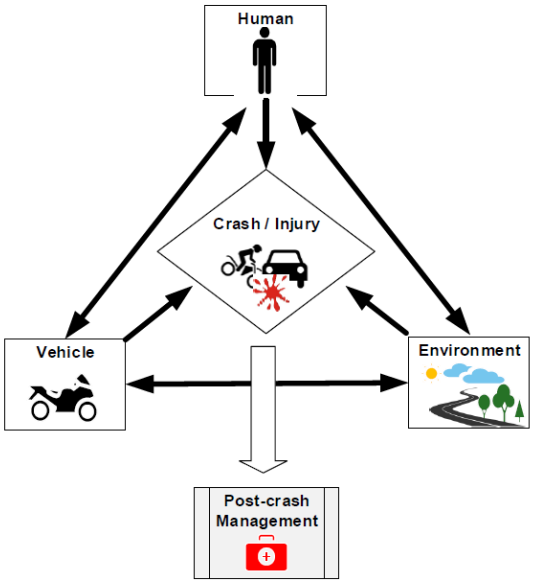


Figure 1.1: Conceptual Framework

Study Design and Setting

A cross-sectional study design was used to collect data from commercial motorcycle riders and passengers in Bamenda, Cameroon. Bamenda, a city located in the North-Western region of Cameroon has an estimated population of 322,889 and an estimated surface area of 47 km².[25] Bamenda is divided into three councils; Bamenda I, Bamenda II, and Bamenda III. Data were collected from July 12 through 26, 2017. Participants were interviewed Tuesdays through Saturdays during non-business rush hours of 10am and 4pm.

Study Participants

Participants comprised commercial motorcycle riders and passengers. Participants were eligibility to participate if they were, 1) a commercial motorcycle rider or passenger, 2) 18 years of age or older; 3) spoke either pidgin or English; 4) operated or used motorcycles within the city of Bamenda, and 5) provided informed consent. Commercial motorcycle riders were recruited from 15 major road intersections across the city and from two market places within the city, where there are often stationed. Passengers were recruited from inner city streets, street intersections, and market places.

Questionnaire Content

The "*Motorcycle Ridership Questionnaire*" for motorcycle riders and passengers was developed with some items adopted from a previously validated instrument obtained from the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation.[26] Some questionnaire items were adapted to improve comprehension. The questionnaire included questions on sociodemographic,

motorcycle ridership, protection and safety, crash, injury, and post-crash management. Figure 1.2 illustrates the survey design process in which the questionnaire modules were administered.

Sociodemographic variables included gender, age, marital status, education level, income status, alcohol use, and sleep. Motorcycle ridership included variables on ownership, ridership, registration status, and trip factors. Protection and safety included variables on use of protective equipment (e.g., helmets), and motorcycle maintenance. Crash and injury characteristics included variables on crash occurrence, collision type, road condition, day and time of crash/operation, number of passengers on motorcycle at time of crash, use of protective equipment, weather condition, type of injury, and anatomic location of the injury. Additional information was collected on post-crash management which included medical care, medical facility admission, treatment cost, payment mechanism, and property damage and associated costs.

All questions were developed in English. The Principal Investigator prepared a pidgin questionnaire version by translating the English questionnaire (Pidgin, is a widely spoken *lingua franca*, among people in the region). Questionnaire context was verified by back translation and pilot testing. Back translation was performed by a linguist local to Bamenda. Nomenclature used by motorcycle riders was considered. A full version of the questionnaire is presented in Appendix B and C.

Interview Process

Five university graduate students were recruited to perform interviews. All interviewers received a one-week comprehensive training to provide them with knowledge, skills, and abilities to administer a survey and an overview of the study

protocol. Data collection from riders at each selected location began with a project information session to the intersection syndicate president by the Principal Investigator. Following each information session, interviewers approached each motorcycle rider to inquire on their interest in study participation. After provision of eligibility and consent information, riders who met study participation criteria conducted a face-to-face interview using a questionnaire that was preloaded into a computer assisted personal interview (CAPI) program on an electronic tablet. Passengers were approached by interviewers at the selected location and briefly informed about the study objective. Passengers who consented were interviewed. In general, participants were interviewed in either pidgin or English, depending on the language of preference. Each participant who consented to the study was offered an incentive of 500frs CFA as compensation for their time. All interviews were conducted in the privacy of the participant and each participant was reminded that their participation was completely voluntary and they could stop at any time. Each interview was estimated to be completed within 30 minutes.

Injury Severity Score Measurements

Injury Severity Scoring is a worldwide recognized process that standardizes the combined effects of the magnitude and distribution of multiple traumatic anatomic injuries.[27,28] The injury severity score (ISS) is an assigned value intended to represent the degree of injury severity in a single value. The ISS is used in trauma and injury management to evaluate priority and quality of care needed by each patient.[27] The ISS was developed to address the limitations of the abbreviated injury scale (AIS), thus the AIS serves as a foundation of the ISS. The ISS is an assessment of overall injury

severity while the AIS is an assessment of injury severity for each anatomic region. The AIS classifies an individual's injury by anatomic region (head and neck, face, chest, abdomen, extremities, and external) according to its relative severity on a 6 point scale (1 = minor, 2 = moderate, 3 = serious, 4 = severe, 5 = critical, and 6 = survivable).[29] The ISS is computed as a sum of the squares of the highest AIS code in each of the three most severely injured AIS anatomic regions. The ISS takes a range of values from 1 to 75.

For the current study, all injury information was self-reported. Participants were asked about the types of injuries sustained and the anatomic locations of the injuries. The types of injuries asked were abrasion, laceration, sprain, fracture, dislocation, swelling, blunt, and burn. Each self-reported injury type was carefully assigned an ordinal AIS score from the AIS-90 coding dictionary.[30] In this study, the ISS was categorized and dichotomized into: minor = 1-3 and severe = 4-75. An injury was considered minor if it required little or no treatment and no hospitalization or bed rest (e.g. abrasions and sprains). An injury was considered severe if it required medical treatment, hospitalization, and bed rest (e.g. lacerations, fractures, and concussions). Internal injuries and fatalities were not included in this study.

Definitions

The following definitions apply to terms used throughout this study:

Motorcycle: A two-wheeled vehicle. Motorcycles used in Cameroon vary by type and brand. Typically, motorcycles have a 125 cubic centimeter capacity single-cylinder engine.

Commercial motorcycle rider: A person who operates a motorcycle and transports passengers for a fare. Most motorcycle riders in Cameroon are male.

Passenger: A person seated on, but not operating the motorcycle. In this study all passengers used a motorcycle for commercial public transportation.

Motorcyclist: A general term referring to a commercial motorcycle user (rider or passenger).

Crash: Any physical contact between a motorcycle and another vehicle, person, or roadside object; falls included.

Ever had a crash: This applied to whether a motorcyclist was ever involved in a crash or not. Motorcyclists were asked the number of involved crash events as a commercial motorcycle user. Motorcyclists with a crash event were asked to provide information about the most severe crash in their lifetime as a commercial motorcycle user and the most recent crash within the past 12 months.

Most severe crash in lifetime: Defined as the worst crash that the commercial motorcyclist ever had during their lifetime as a commercial motorcycle user. Motorcyclists with single or multiple crash events were asked to provide information about their perceived most severe crash. By default, if a motorcyclist reported a single crash event that crash was considered the most severe. Furthermore, motorcyclists with a crash event were asked to provide injury information related to the most severe crash. All motorcyclists who reported a crash event were asked if any of the crash events occurred within the past 12 months (see Figure 1.2).

Most recent crash within the past 12 months: Defined as the most recent (last) crash that a motorcyclist had within the past 12 months. A single crash that occurred within

the past 12 months was classified as the most severe crash and the most recent crash within the past 12 months. If a motorcyclist had multiple crashes of which some happened prior to the past 12 months and some within the past 12 months, the motorcyclist was asked to provide information for their most severe crash and most recent crash within the past 12 months. If the most severe crash was the same as the most recent crash within the past 12 months, information was provided once. If a motorcyclist had multiple crashes within the past 12 months, information was provided for the most recent event (Figure 1.2).

Single-vehicle collision: Defined as a type of road traffic collision in which only one the motorcycle was involved and included ejections and collision with fixed objects.

Ethical Consideration

The current study was reviewed and approved by three institutional review boards; the University of California San Diego Human Research Protections Program in the United States (Project # 161701SW), the Bamenda Regional Hospital Institutional Review Board and the Provincial Delegate's Office for Ministry of Health (No. 382/NWR/RDPH) in Bamenda Cameroon.

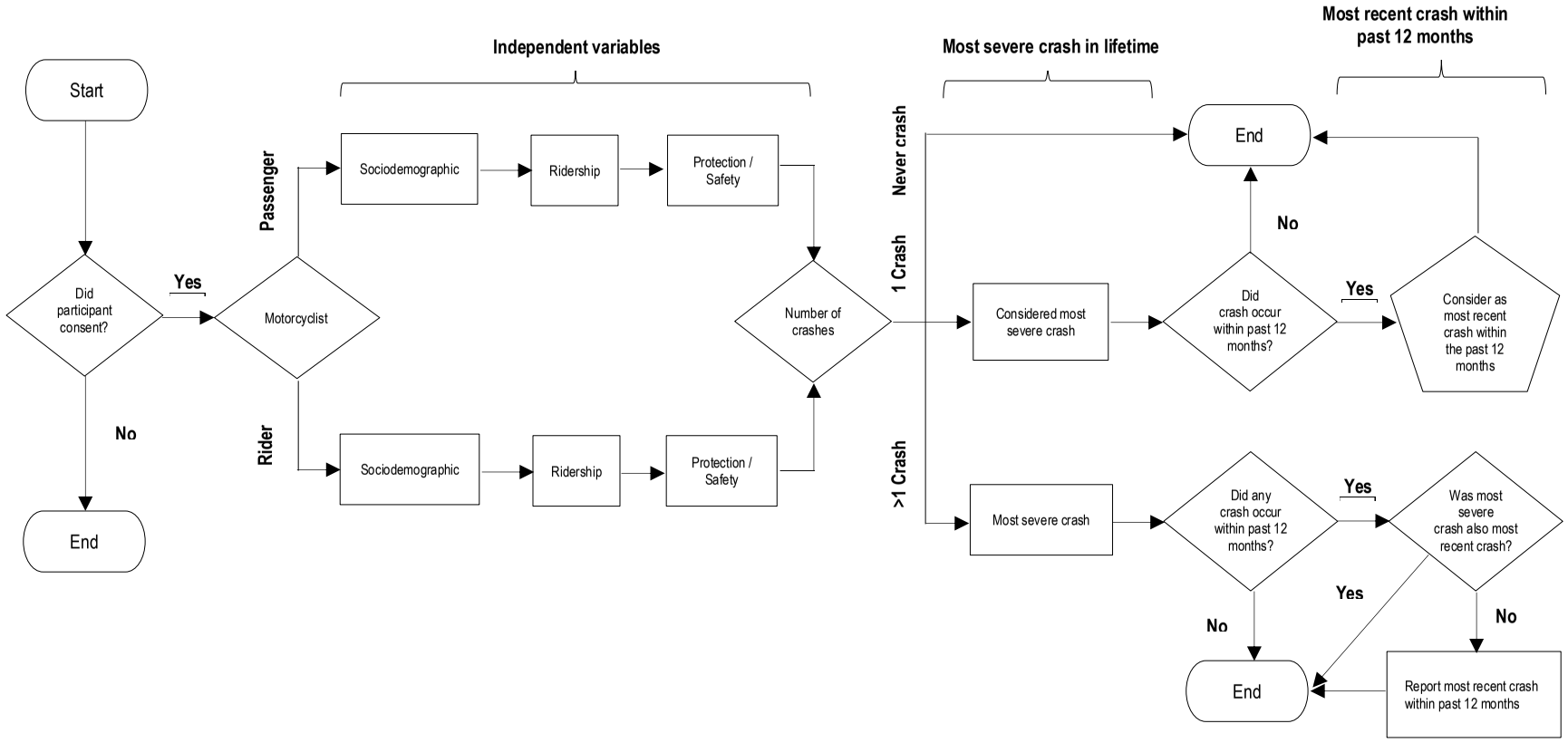


Figure 1.2: Flowchart of Survey Design

REFERENCES

1. Konings P. Solving Transportation Problems in African Cities : Innovative Responses by the Youth in Douala , Cameroon. *Afr Today*. 2006;53(1):35-50.

2. Atekmangoh C. *Les Mbengis" - Migration, Gender, and Family: The Moral Economy of Transnational Cameroonian Migrants' Remittances*. Mankon, Bamenda: Langaa Research & Publishing CIG; 2017.

3. Kumar A. Understanding the emerging role of motorcycles in African cities: A political economy perspective. *Sub-Saharan Africa Transp Policy Progr Discuss Pap*. 2011;13(1).

4. Yakubu AT. Determinants of Earnings among Commercial Motorcycle Operators in Kwara State , Nigeria. *Int J Econ Manag Sci*. 2012;2(2):11-17.

5. S Kisaalita W, Sentongo-Kibalama J. Delivery of urban transport in developing countries: the case for the motorcycle taxi service (boda-boda) operators of Kampala. *Dev South Afr*. 2007;24(2):345-357. doi:10.1080/03768350701327319.

6. Chichom-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C, Ngowe-Ngowe M. 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(1):915. doi:10.1186/s12889-015-2290-4.

7. Lin MR, Kraus JF. A review of risk factors and patterns of motorcycle injuries. *Accid Anal Prev*. 2009;41(4):710-722. doi:10.1016/j.aap.2009.03.010.

8. Adeloye D, Thompson J, Akanbi MA, et al. The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis. *WHO Bull*. 2016;(April):1-23. doi:10.2471/BLT.15.163121.

9. World Health Organization (WHO). *Global Status Report on Road Safety 2018*. Geneva, World Health Organization; 2018.

10. Naci H, Chisholm D, Baker TD. Distribution of road traffic deaths by road user group: A global comparison. *Inj Prev*. 2009;15(1):55-59. doi:10.1136/ip.2008.018721.

11. Chisholm D, Naci H, Hyder a. a., Tran NT, Peden M. Cost effectiveness of strategies to combat road traffic injuries in sub-Saharan Africa and South East Asia: mathematical modelling study. *Bmj*. 2012;344(mar02 1):e612-e612. doi:10.1136/bmj.e612.

12. Bhalla K, Harrison J, Shahraz S, et al. *Burden of Road Injuries in Sub Saharan Africa*. Boston, MA; 2013. africa.globalburdenofinjuries.org.

13. World Health Organization 2016. *Road Safety in the African Region 2015*.; 2016. doi:10.2832/404614.

14. Murray CJL, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2197-2223. doi:10.1016/S0140-6736(12)61689-4.

15. World Health Organization (WHO). *Global Health Estimates 2016: Deaths by Cause, Age, and Sex 2000-2016*. Geneva, Switzerland; 2018. http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html. Accessed December 19, 2016.

16. WHO. Road traffic injuries. WHO Publishing. http://www.who.int/en/news-room/fact-sheets/detail/road-traffic-injuries. Published 2018. Accessed October 19, 2018.

17. Mathers CD, Boerma T, Ma Fat D. Global and regional causes of death. *Br Med Bull*. 2009;92(1):7-32. doi:10.1093/bmb/ldp028.

18. Ro YS, Shin SD, Jeong J, et al. Evaluation of demands, usage and unmet needs for emergency care in Yaoundé, Cameroon: A cross-sectional study. *BMJ Open*. 2017;7(2):1-10. doi:10.1136/bmjopen-2016-014573.

19. Heng Y Van, Husum H, Murad MK, et al. *Strengthening Care for the Injured : Success Stories and Lessons Learned from around the World*. 1st ed. (Mock C, Juillard C, Joshipura M, Goosen J, eds.). Geneva, Switzerland; 2010.

20. Nkemtendong Tolefac P, Njamen Nana T, Mefire Chichom A, et al. Challenges in Emergency Medical Services in a ResourceLimited Setting in Sub-Sahara Africa; Perspectives from Cameroon: a Review Article. *Int Ann Med*. 2017;1(10). doi:10.24087/IAM.2017.1.10.308.

21. Haddon W. Advances in the epidemiology of injuries as a basis for public policy. *Public Health Rep*. 1980;95(5):411-421. doi:10.2307/4596353.

22. Barnett DJ, Balicer RD, Blodgett D, Fews AL, Parker CL, Links JM. The application of the Haddon matrix to public health readiness and response planning. *Environ Health Perspect*. 2005;113(5):561-566. doi:10.1289/ehp.7491.

23. Runyan CW. Using the haddon matrix: Introducing the third dimension. *Inj Prev*. 2015;21(2):126-130. doi:10.1136/ip.4.4.302rep.

24. Fowler CJ. Injury Prevention. In: McQuillan KA, Makic MBF, Whalen E, eds. *Trauma Nursing: From Resuscitation Through Rehabilitation*. 4th ed. St. Louis, MO: Saunders, an imprint of Elsevier Inc.; 2009:992.

25. Institut National de la Statistique. *Annuaire Statistique Du Cameroun*. Yaoundé, Cameroun; 2013. www.statistics-cameroon.org.

26. Westat and Dynamic Science I. Motorcycle crash causes and outcomes: Pilot study. 2010;(June):233. http://www.nhtsa.gov/staticfiles/nti/pdf/811280.pdf.

27. Stevenson M. An overview of the injury severity score and the new injury severity score. *Inj Prev*. 2001;7(1):10-13. doi:10.1136/ip.7.1.10.

28. Association for the Advancement of Automotive Medicine. Overview: Abbreviated Injury Scale. https://www.aaam.org/abbreviated-injury-scale-ais/. Published 2016. Accessed June 1, 2018.

29. Copes WS, Champion HR, Sacco WJ, Lawnick MM, Keast SL BL. The injury severity score revisited. *J Trauma-Injury Infect Crit Care*. 1988;28(1):69-77.

30. The Medical Algorithms Company Limited. Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS). https://www.medicalalgorithms.com/abbreviated-injury-scale-ais-and-the-injury-severity-score-iss. Published 2018. Accessed September 10, 2017.

31. United Nations, Department of Economic and Social Affairs PD. World Population Prospects: The 2017 Revision.

32. Central Intelligence Agency. The World Factbook 2018-19: Cameroon. The World Factbook 2018-19. https://www.cia.gov/library/publications/the-world-factbook/geos/cm.html. Published 2018. Accessed December 12, 2018.

33. Commonwealth Secretariat 2019. Cameroon. The Commonwealth. http://thecommonwealth.org/our-member-countries/cameroon.

CHAPTER 2: PREVALENCE OF MOTORCYCLE CRASHES AND ASSOCIATED FACTORS AMONG COMMERCIAL MOTORCYCLE RIDERS AND PASSENGERS IN BAMENDA, CAMEROON

ABSTRACT

Background: Motorcycle riders and passengers are at higher risk of injury or fatality from a crash compared to other types of motor vehicle users due to the absence of the external vehicle structure of other vehicles that serves to protect individuals when crashes occur. The current study estimated the prevalence (lifetime and 12 month period) of commercial motorcycle crashes and examined factors associated with crash.

Methods: From July 12 to 26, 2017, a population-based cross-sectional study among commercial motorcycle riders and passengers was conducted in Bamenda, Cameroon. Consenting motorcycle riders and passengers aged 18 years or older were administered a questionnaire to obtain information on sociodemographic and applicable pre-crash factors. This study measured lifetime and 12 month period prevalence of crash involvement among motorcycle riders and passengers.

Results: Among the commercial motorcycle riders (n = 552) and passengers (n = 268), a total of 67.2% (77.4% riders, 46.3% passengers) reported one or more lifetime crashes. The prevalence of crash involvement among commercial motorcyclists within the past 12 months was 17.9% (21.5% riders, 5.7% passengers). Among all participants, riders (AOR = 2.88, 95% CI = 2.00, 4.13), who were male (AOR = 2.25, 95% CI = 1.32, 3.85), currently smoked (AOR = 1.99, 95% CI = 1.06, 3.72), and used alcohol (AOR = 1.49, 95% CI = 1.08, 2.07) were at increased odds of crash involvement. Among riders, those who currently smoked (AOR = 2.23, 95% CI = 1.00, 4.94), had 3 years (AOR = 2.14, 95% CI = 1.14, 4.01) or 5 years (AOR = 3.15, 95% CI = 1.73, 5.73) of riding experience and sometimes carried more than two passengers (AOR = 3.57, 95% CI = 1.18, 10.84) were at increased odds of crash involvement.

Among passengers, males (AOR = 2.22, 95% CI = 1.27, 3.87) who used alcohol (AOR = 2.80, 95% CI = 1.62, 4.89) were at increased odds of crash involvement. Finally, riders who reported single-vehicle collision had increased odds for severe crash if they used alcohol (AOR = 2.11, 95% CI = 1.21, 3.69), rode on roads that were unpaved (AOR = 4.34, 95% CI = 2.50, 7.52), muddy (AOR = 5.91, 95% CI=1.60, 21.78) or pothole-ridden (AOR = 2.39, 95% CI = 1.17, 4.89), and at speeds of 45km/h or more (AOR = 2.55, 95%CI = 1.28, 5.08).

Conclusion: Occurrence of road traffic crashes tends to be frequent among motorcyclists of male gender, alcohol users, riders carrying multiple passengers, speeders, and riders spending more riding time on poor road conditions. Research efforts should focus on strategies to reduce motorcycle crashes, including injuries and fatality by improving rider safety through the practice of safe rider behaviors, improved road infrastructure, and implementation and enforcement of effective road traffic policies.

INTRODUCTION

Cameroon, like several sub-Saharan Africa countries, has in recent years seen the use of motorcycles as a primary mode of transportation due to the lack of an organized public transportation system, a rapidly growing urban population, motorcycle affordability, and a dilapidating road network.[1–5] Due to the high density of automobiles on the narrow, pothole ridden urban streets, residents have resorted to the use of motorcycles to navigate perpetually congested roads. Commercial motorcycle riders commonly known in Cameroon as "*Bend Skin*" or "*Nanfang*" provide motorcycle taxi services in both urban and rural areas.[6,7] A commercial motorcycle rider is a person who operates a motorcycle and transport passengers for a fare; a passenger is a person seated on, but not operating, the motorcycle; and a motorcyclist is a general term referring to either the rider or passenger.[8] Commercial motorcycle riders are often unlicensed, not adequately trained to ride motorcycles, disobey traffic rules, and/or do not wear a safety helmet.[9,10] Moreover, safety of these riders is compromised by the few rarely enforced traffic laws and policies. It is common to observe overloaded motorcycles with two or more adult passengers or as many children as possible based on their body size; all without helmets.

The National Highway Traffic Safety Administration reported in 2015 that motorcyclists in the United States were 29 times more likely to die from a crash compared to other types of motor vehicle users and 5 times more likely to be injured.[8] Because motorcycle riders represent a vulnerable group of road users due to the small size of the vehicle they operate and their frequent disregard of safety measures, it is important to identify and examine factors associated with motorcycle ridership and to

establish guidelines for evidence-based public policies to significantly improve motorcycle safety. While there has been an abundance of motor vehicle crash research in general, few studies have focused on commercial motorcycle crashes in sub-Saharan Africa and examined regional specific risk factors. A majority of motorcycle crashes are preventable; therefore it is essential to identify contributing risk factors and crash patterns in order to establish tailored prevention strategies.

In Bamenda specifically, and in Cameroon generally, no population-based study has estimated the prevalence of motorcycle crashes or examined associated factors. Bamenda is the fifth largest city in Cameroon with an estimated geographic area of 47km^2, an estimated population of 322,889 persons, and is challenged by similar urban transportation problems as other major cities.[11] Although the number of motorcycle taxis operating in Bamenda is unknown, a large number of its residents use these services as a preferred mode of urban transportation. For example, it was estimated that 25000 motorcycle taxis operated in Douala, the most populated city in Cameroon with an estimated population of 1.9 million in 2008.[12] The increasing number of commercial motorcycle riders is evidence of the profound demand of public transportation. Even though an economic incentive, commercial motorcycle transportation may come with a hefty health burden. There is a paucity of motorcycle crash data due to lack of an effective health surveillance system for road traffic crashes and injuries. The purpose of the current study was to estimate the prevalence (lifetime and 12 month period) of commercial motorcycle crashes and identify associated factors among motorcycle riders and passengers.

METHODS

Study Design and Setting

We conducted a population-based cross-sectional study among commercial motorcycle riders and passengers in Bamenda, Cameroon. Data were collected from July 12 to 26, 2017. Motorcyclists were interviewed Tuesdays through Saturdays during non-business rush hours of 10am and 4pm. Commercial motorcycle riders were recruited from 15 randomly selected major road intersections across the city and from two market places within the city where there are often stationed. Data collection at each selected site began with a project information session to the intersection syndicate president by the Principal Investigator. Following each information session, interviewers approached each motorcycle rider to inquire on their interest in study participation. Passengers were recruited from inner city streets, street intersections, and market places. Participants were eligible for study inclusion if they were aged 18 years or older, operated within the city, spoke either pidgin or English, identified as a commercial motorcycle rider or passenger, and consented to participate in the study. Consenting participants were administered a questionnaire via computer assisted personal interview which included items on sociodemographic and applicable pre-crash factors adapted from the Haddon matrix. The Haddon matrix is a conceptual model used in injury epidemiology to understand the causes of crash and injury and to identify countermeasures to address these problems. Haddon's matrix combines three crash phases (pre-crash, crash, and post-crash) and the epidemiological triad that influence crash phases (host, vehicle, and environment).[13–15] All interviews were conducted by five recruited university graduate students. All interviewers received a one-week

comprehensive training which provided knowledge, skills, and abilities to administer a survey and an overview of the study protocol.

Outcome measures: The outcomes of interest were: (1) Ever been involved in a motorcycle crash, defined as “How many crashes have you been involved in as a commercial motorcyclist?” This variable was dichotomized as whether the motorcyclist ever had a crash or never had a crash. In addition, participants reported if any of the crashes occurred within the past 12 months. In consideration that some motorcyclists had multiple crash events when examining predisposing factors of crash, information about road condition, type of road traffic collision (single-vehicle vs. multi-vehicle), and estimated riding speed were asked for the most severe crash. A single-vehicle collision was defined as a type of road traffic collision in which only the motorcycle was involved which included ejections and/or collision with fixed objects.

Covariates: Covariates were identified from the Haddon’s matrix and a comprehensive literature review. Demographic characteristics included sex, age, education level, marital status, smoking status, alcohol use, sleep duration per day, and daytime napping. Ridership characteristics included motorcycle ownership status, rider licensure, motorcycle training time, riding experience, ridership frequency, time of operation, number of passengers carried, and estimated speed. Passenger characteristics included number of trips per day, average daily expenditure, motorcycle usage frequency, multiple passengers allowed, and number of years of motorcycle use. Environment characteristics included whether road was paved and road condition (i.e., dusty, potholes, muddy).

All collected data were self-reported. Sleep duration measured the total number

of hours slept per day. Education level was defined as the highest level of schooling. Marital status was defined as single or not single. Smoking status measured whether the participant smoked at the time of the interview. Alcohol use measured whether the participant consumed alcoholic drinks. Daytime napping measured if participant takes a nap during the day. Motorcycle ownership defined who owned the motorcycle operated by the participant. Motorcycle registration measured whether motorcycle was registered or not. Rider licensure measured if participant had a rider license or not. Motorcycle training time measure the length of time rider used towards hands-on training. Riding experience measured the length of time a rider had operated a motorcycle for commercial purposes. Ridership frequency measured how often the rider operated a motorcycle. Time of operation measured the period of the day that rider operated. Estimated speed was captured as rider's self-reported speed at the time of the crash. Motorcycle usage frequency measured how often a passenger used a motorcycle. Allowed multiple passengers measured if passenger allowed rider to carry another passenger. A paved road was defined as a road covered with asphalt. Road condition indicated the condition of the road at the time of the crash (e.g., dusty, potholes, muddy). The most severe crash was defined as the worst crash the participant ever had on a commercial motorcycle.

The current study was reviewed and approved by three institutional review boards; the University of California San Diego Human Research Protections Program in the United States (Project # 161701SW), the Bamenda Regional Hospital Institutional Review Board, and the Provincial Delegate's Office for Ministry of Health (No. 382/NWR/RDPH) in Bamenda Cameroon.

Statistical analyses

Variables were analyzed as either continuous or categorical based on an *a priori* decision and adapted cutoff points established from previous epidemiologic studies. Sociodemographic and modifiable factors were described as measures of center or proportions and tested for significance using the independent t-test and Chi-square/Fishers Exact test, respectively. Logistic regression models were used to assess whether selected identified factors were associated with motorcycle crash involvement among motorcycle riders and passengers. Model adequacy was assessed with the Hosmer-Lemeshow goodness-of-fit statistic. Covariates considered as potential confounders were added into a logistic regression model by use of a statistical backward elimination technique. Covariates were considered confounders and retained in the final model if the association between motorcycle crash involvement and type of motorcycle user was significant at $p < 0.10$ or if their removal changed the parameter estimate by 15% or more. Variables identified via literature review as potential confounders but not significantly associated with crash were included in the final model. Unadjusted and adjusted odds ratio (AOR) with 95% confidence intervals (CI) were presented. For all analyses besides confounder verification, significance was considered at $p \leq 0.05$. All analyses were conducted using Statistical Package for the Social Science (SPSS) version 21 (Chicago, IL: SPSS Inc.) and Statistical Analysis Software (SAS), version 9.3 (SAS Institute, Inc., Cary, NC).

RESULTS

Motorcyclists Characteristics

A total of 829 motorcyclists who met study eligibility were enrolled. Nine

participants were eliminated due to incomplete data for almost all variables. Of the 820 study participants used in analysis, 552 (67.3%) were riders. All commercial motorcycle riders where male and among passengers, 176 (65.7%) were male. The mean age of study participants was 28.9 years (SD = 7.6, range = 18–75). A total of 464 (56.6%) motorcyclists reported single marital status. In addition, 33.5% (n = 275) reported education status of primary or lower. Only 10.1% (n = 83) of participants currently smoked and 66.0% (n = 541) reported alcohol use. Participants reported sleeping 7.7 hours (SD = 1.6) on average while 45.4% (n = 372) took a nap during the day.

Crash Characteristics

Figure 2.1 to Figure 2.4 show the prevalence and distribution of ever crash involvement and crash involvement within the past 12 months. A considerable number of motorcyclists had been ever involved in a crash (67.2%; n = 551). Lifetime crash prevalence was 77.4% among riders and 46.3% among passengers. On average, motorcyclists were involved in 3.1 crashes (SD = 3.4, range = 1–25). The average number of crashes among riders and passengers were 3.3 (SD = 3.6, range = 1–25) and 2.4 (SD = 2.4, range = 1–20), respectively. When applicable, participants reported if any of the crashes occurred within the past 12 months. The prevalence of any crash involvement within the past 12 months was 17.9% among motorcyclists (21.5% riders, 5.7% passengers). Within the past 12 months, motorcyclists were involved in 1.3 crashes on average (SD = 0.7, range = 1–5). On average, riders were involved in 1.3 crashes within the past 12 months (SD = 0.7, range = 1–5) and passengers 1.4 crashes (SD = 0.8, range = 1–3).

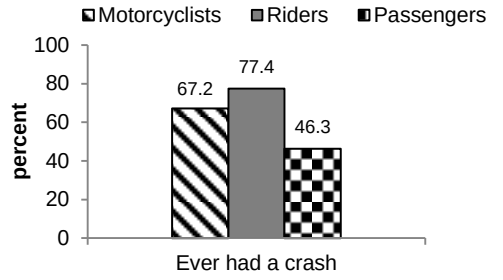


Figure 2.1: Prevalence of ever had a crash (lifetime)

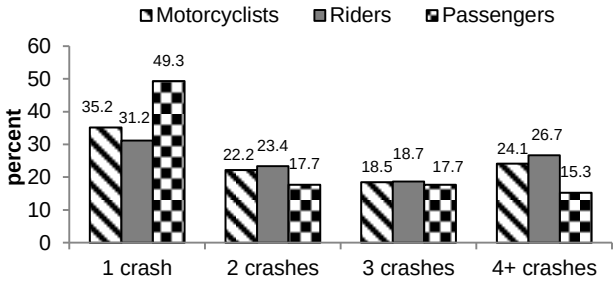


Figure 2.2: Number of crashes among ever crashers

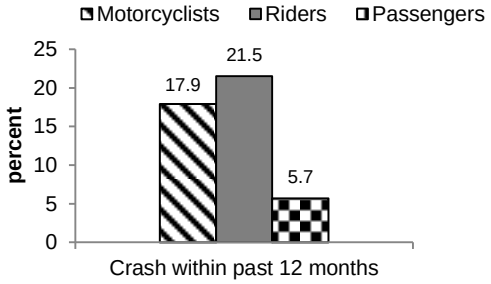


Figure 2.3: Prevalence of crash within past 12 months (period)

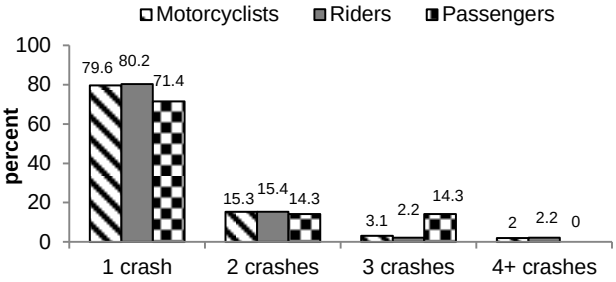


Figure 2.4: Number of crashes among motorcyclists within the past 12 months

Ever involved in a crash: Bivariate analysis of motorcyclists (Table 2.1) who reported ever involved in a crash tended to be riders ($p < 0.001$), male ($p < 0.001$), had a primary education or lower ($p = 0.024$), were not single ($p = 0.029$), currently smoked ($p < 0.001$), used alcohol ($p < 0.001$), slept slightly longer ($p = 0.048$), and took daytime naps ($p < 0.001$).

A distribution of ridership characteristics is shown in Table 2.2. Riders who reported ever involved in a crash were more likely to have at least a year of commercial ridership experience ($p = 0.001$) and carried two or more passengers on average per trip ($p = 0.007$). A distribution of passenger characteristics is shown in Table 2.3. There

were no statistically significant differences between passengers who reported ever involved in a crash and those who did not.

Table 2.4 shows the adjusted odds of crash involvement among motorcyclists (Model 1), riders only (Model 2), and passengers only (Model 3). The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 1 (motorcyclists) was 4.68, with 5 degrees of freedom and a *p*-value of 0.46, indicating no evidence of poor fit. In model 1, participants were at significantly higher odds of crash involvement if they were a rider (AOR = 2.88, 95% CI = 2.00, 4.13), male (AOR = 2.25, 95% CI = 1.32, 3.85), currently smoked (AOR = 1.99, 95% CI = 1.06, 3.72), and used alcohol (AOR = 1.49, 95% CI = 1.08, 2.07). The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 2 (riders) was 7.10, with 7 degrees of freedom and a *p*-value of 0.42, indicating no evidence of poor fit. In model 2, an assessment of predisposing factors specific to riders indicated higher odds of crash involvement among current smokers (AOR = 2.23, 95% CI = 1.00, 4.94), riders with 3-4 years (AOR = 2.14, 95% CI = 1.14, 4.01) and 5 or more years (AOR = 3.15, 95% CI = 1.73, 5.73) of riding experience, and among riders who carried, on average, two or more passengers on the same trip (AOR = 3.57, 95% CI = 1.18, 10.84). The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression in model 3 (passengers) was 3.18, with 5 degrees of freedom and a *p*-value of 0.87, indicating no evidence of poor fit. Model 3 showed a similar assessment of the association of predisposing factors and crash involvement among passengers indicated higher odds among males (AOR = 2.22, 95% CI = 1.27, 3.87) and alcohol users (AOR = 2.80, 95% CI = 1.62, 4.89).

Most severe crash: In consideration that motorcyclists could have multiple crash events; underlying factors of road condition and estimated speed in addition to predisposing factors associated with ever being involved in a crash were examined among motorcycle riders who reported a most severe crash. The most severe crash was defined as the crash that the participant perceived as the worst crash incident in their lifetime as a commercial motorcycle user. Table 2.5 shows the associative distribution of riders who reported vehicle collision and associated factors; road condition and estimated speed. Riders who reported a single-vehicle collision at the most severe crash had significantly lower proportions of crash on a paved road ($p < 0.001$) and higher proportions of crash when the road conditions were dusty, muddy, or pothole-ridden ($p < 0.001$) or if the rider was speeding at 45km/h or more ($p = 0.014$). Table 2.5 shows the association between underlying factors and type of vehicle collision for the most severe crash reported by riders. The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression indicated no evidence of poor fit ($\chi^2 = 6.87$; $p = 0.55$).

As shown in Table 2.6, riders were at increased odds of single-vehicle collision at the most severe crash if they used alcohol (AOR = 2.11, 95% CI = 1.21, 3.69), rode on roads that were unpaved (AOR = 4.34, 95% CI = 2.50, 7.52), muddy (AOR = 5.91, 95% CI=1.60, 21.78) or pothole-ridden (AOR = 2.39, 95% CI = 1.17, 4.89), and at speeds of 45km/h or more (AOR = 2.55, 95%CI = 1.28, 5.08).

DISCUSSION

Results from the current study showed high crash involvement proportions thought to exist among motorcyclists in Bamenda, Cameroon. Findings from this study

indicated that among commercial motorcycle users, male riders who currently smoked and used alcohol were at higher odds of crash involvement. Among riders, those who currently smoked, had 3 or more years of riding experience, and carried two or more passengers per trip were more likely to be involved in a crash. Among passengers, the likelihood of crash involvement was higher among males who used alcohol. After adjusting for covariates in the regression model, the odds of single-vehicle collision were higher among riders who rode on unpaved, muddy or pothole-ridden roads and at estimated speeds of 45km/h or more. These identified factors are in agreement with those of other studies conducted in several LMICs.[2,9,16–21]

Crash involvement prevalence from the current study is comparable to regional prevalence estimates from other studies. A 2011 cross-sectional study of 250 consented commercial motorcycle riders in Tudun-Wada Zaria, Nigeria, reported 76.4% crash involvement prevalence with 32.5% occurring 3-6 months prior to the start of that study.[22] Another cross-sectional study of 120 motorcyclists conducted in 2012 in Minna, Nigeria showed a crash involvement prevalence of 55.4%.[23] In Cameroon and unlike other sub-Saharan African countries women rarely operate motorcycles, drive taxis, or trucks. Commercial motorcycle riders tend to be younger males who are often inexperienced and exhibit risk-taking behaviors such as speeding, carrying multiple passengers, disobeying traffic laws, maneuvering through traffic, and performance of stunts.

Findings from the current study associated alcohol use with crash involvement, with passengers liable for certain crashes. While impaired riders are more likely to lose control of the motorcycle and run off the road, passengers are more likely to cause a

crash by shifting their weight unexpectedly especially after consuming alcohol.[24,25] This study did not ascertain if alcohol was consumed by the rider or passenger shortly before the crash occurred but does highlight the apparent existence of this behavior. This study showed that current smokers were at higher odds of crash involvement. Although a few studies have associated smoking with crash involvement, we do postulate that current smoking status is a surrogate for cannabis and Tramadol use among some commercial motor cycle riders. However, a previous study did show smokers were 1.5 times more likely to be involved in a motor vehicle crash compared to non-smokers.[26] Holding a cigarette while riding interferes with the rider's ability to have a firm grip on the handle. Smoke blown towards the face might interfere with the rider's vision. Anecdotal evidence from health care providers in the Bamenda regional hospital and other healthcare facilities has suggested use of cannabis and/or tramadol by several of the injured commercial motorcycle riders who present at the hospital or healthcare facility. A study among commercial motorcycle riders in Garoua, a Northern Cameroonian city, showed a 63.8% prevalence use of tramadol with 77.6% reporting it was work related.[27] In addition, some articles have drawn attention to the increasing use of Tramadol in Cameroon especially among commercial motorcycle riders who believe it relieves body pain while riding on the bad roads for longer periods.[28–30] Additional concerns shared with the principal investigator by older commercial motorcycle riders during data collection were related to the negative perceptions by the general population towards commercial motorcycle riders due to tramadol and cannabis use among younger riders. There is no doubt that a combination of alcohol consumption, smoking, and probable illicit drug use can lead to high crash severity.

A variety of reasons might explain why commercial motorcycle riders carry multiple passengers on a single trip as shown in this study. First, riders can increase their daily income by carrying multiple passengers on shorter trips. Second, riders who lease a motorcycle seek to carry more passengers to make an extra income after paying the daily motorcycle leasing fee. Third, riders may carry multiple passengers such as school children due to their smaller body size and low passenger fare. At times, passengers may wish to travel together on the same motorcycle encouraging a passenger overload. It is also common to observe an entire family, as many as four people, on a motorcycle if all travelling to the same location. Unlike cargo, a passenger's weight on a motorcycle requires the rider to make adjustments in handling and balancing tasks. This adjustment might become a challenge if multiple passengers are carried given they will react differently to actions taken by the rider during accelerations, turns, and decelerations.

The current study showed that riders with more years of riding experience had an increased likelihood of ever been in a crash. Although some studies have associated less driving experience with higher risk of motorcycle crashes, other studies have shown that riding skills do not have a significant impact in crash reduction.[10,31–34] In this study, a majority of riders had five or more years of riding experience. Riding experience is a conglomeration of skills gained by riding a motorcycle on the road which helps in riders' safety. These skills range from motorcycle operation and handling which can be achieved in a short period of time to anticipation of potentially hazardous traffic circumstances which are acquired over time to risks exposure. Some commercial motorcycle riders acquire riding experience over time but do not acquire riding

expertise since adequate road safety motor and cognitive skills are not fully developed. In California, persons who wish to operate a motorcycle must first obtain a learner's permit to practice riding a motorcycle, followed by a motorcycle written and riding skills test.[35] Novice riders gain substantial experience with additional rides while applying traffic rules and avoiding on-road hazards. This is not the case in Bamenda where most riders are unlicensed and few or no traffic rules are enforced. Riders gain skills to maneuver in traffic and ride on different road conditions but these skills are not enough to avoid various crash risk factors. In this study, most experienced riders owned the motorcycle they operated and worked longer hours. On the contrary, several novice riders do not own a motorcycle and are less often on the roads. Given few or no traffic rules are enforced, these riders are at greater odds of crash involvement by virtue of being on poor conditioned roads more often and having to share these roads with other unskilled motor vehicle users. [6,36] In comparison to other regions, the African region has the lowest number of vehicles per thousand persons, the lowest annual distanced travelled on average, yet the highest estimated fatality rate per 100,000 population.[37] This study highlights safety problems faced by motorcycle riders irrespective of their riding experience.

A majority of neighborhood roads are unpaved, dusty or muddy, and inaccessible by four-wheeled vehicles enabling commercial motorcycles to provide the convenience of inner-city to home transportation services. Findings from the current study showed that single-vehicle crashes occurred on pothole-ridden or unpaved muddy roads. Although several of the inner city paved roads are filled with potholes, some riders tend to ride at high speeds on the few even paved stretches to make up for

time on the rough stretches thus increasing risk of crash. Speeding is often defined as driving above the posted speed limits, but can also be considered driving at speeds deemed too high for traffic congested roads, or roads in bad weather conditions.[38,39] Several research studies have agreed on the eminent association between vehicle speeding and increased levels of crash and injury severity.[40,41]

Considering the increased odds of crash among riders with higher years of riding experience, we performed sensitivity analysis to explore any potential interaction effect of age on the association between years of riding experience and frequency of crashes. Findings from sensitivity analysis did not indicate any interaction between age and years of riding experience. Additional sensitivity analysis assessed the association between predisposing factors and crash occurrence outcome categorized into four groups as an ordinal scale. Upon running the adjusted models, age was significant. The proportional odds of higher crash involvement increased with age. However there were no additional variables to be adjusted for in the model besides alcohol use and number of passengers on motorcycle. It is possible that some unmeasured factors could be influencing the association of certain underlying factors and crash outcome.

There are a few limitations to the current study. The use of a cross-sectional study design did not permit the assessment of causal associations. Because of the lack of comprehensive road traffic crash data sources such as hospital records, police reports, insurance records, and death records, the current study used self-reported information from motorcycle users, which could limit validity on number of crashes. Additionally, information from motorcycle users who suffered from life-threatening injuries or who are deceased were not captured. There is a possibility of residual

confounding arising from the misclassification of certain factors or the inability to measure certain factors such as crash speed, number of crashes, number of hours slept, and fatigue. There is also a potential for recall and social desirability bias by which participants may not accurately recall certain events or may provide interviewers with desirable responses given their knowledge of the effects. For example, although crash was defined to the participant, some participants may have reported only crashes that involved another vehicle. Riders may also hesitate to admit tramadol or alcohol use given the negative associated consequences. Data collection took place amid regional instability which restricted movement within the city. Schools were not in session which prevented access to students who constitute a major sector of motorcycle passengers thereby increasing the likelihood of underestimated measures.

Despite the study shortcomings, there are several strengths to the current study. To our knowledge, this is the first population-based cross-sectional study that aims to estimate the prevalence of motorcycle crashes among commercial motorcycle riders and passengers in a major Cameroon city. The current study used a wide range of potential underlying factors that have not been fully examined in such a setting. In addition, potential confounders (including sociodemographic variables, vehicle, and environment characteristics) were controlled in multivariable regression analysis models improving the validity of findings. Most importantly, the current study obtained information about crash-related factors which could not be obtained otherwise given the lack of police, insurance, and hospital records.

In conclusion, findings from the current study strongly support the effects certain underlying factors have on increased risk of motorcycle crash leading to potential injury

and fatality. Poor road conditions were identified as the leading cause of motorcycle crashes as reported by commercial motorcyclists. This study also highlighted riders with more road exposure were at increased odds of crash given the lack of adequate road safety measures. The current study provides impetus for additional targeted research to fully examine factors that influence motorcycle crashes and to develop effective programs to prevent motorcycle crashes. Finally, research efforts should focus on the strategies to reduce motorcycle crashes and injuries by improving rider safety, rider behavior, road infrastructure, and adopting effective policies.

Acknowledgments

Chapter 2, in full, is currently being prepared for publication of the material. Co-authors include Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael; Hill, Linda. The dissertation author is the primary author of this material. This work was supported by the Inamori Fellowship Program [2017]; the University of California San Diego (UCSD) International Institute [2017]; and the UCSD Global Health Institute [2017]. These organizations had no involvement in the study design; collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication.

Table 2.1: Sociodemographic characteristics of riders and passengers by crash involvement; Bamenda, Cameroon

Characteristic	Ever had a crash (n = 551) n (%)	Never had a crash (n = 269) n (%)	Unadjusted odds ratio	95% CI	*p*-value
Motorcyclist					<0.001
Passenger	124 (22.5)	144 (53.5)	1.00		
Rider	427 (77.5)	125 (46.5)	3.97	2.90-5.42	
Sex					<0.001
Female	29 (5.3)	63 (23.4)	1.00		
Male	522 (94.7)	206 (76.6)	5.51	3.45-8.79	
Age, [years]					0.115
mean ± SD	29.2 ± 7.3	28.3 ± 8.3	1.02	0.99-1.04	
median (range)	28 (18-67)	27 (18-75)			
					0.122
18–24	160 (29.1)	95 (35.3)	1.00		
25–34	279 (50.6)	131 (48.7)	1.27	0.91-1.76	
35 and older	112 (20.3)	43 (16.0)	1.55	1.00-2.39	
Sleep duration [hours/day] (n = 808)					0.048
mean ± SD	7.8 ± 1.6	7.5 ± 1.5	1.10	1.00-1.21	
median (range)	8 (1-12)	8 (3-11)			
Education level (n = 819)					0.024
Primary or lower	202 (36.7)	73 (27.1)	1.00		
Secondary	180 (32.7)	103 (38.3)	0.63	0.44-0.91	
High school or higher	168 (30.6)	93 (34.6)	0.65	0.45-0.94	
Marital status					0.027
Single	297 (53.9)	167 (62.1)	1.00		
Not single	254 (46.1)	102 (37.9)	1.40	1.04-1.89	
Smoking status (n = 818)					<0.001
Non smoker	479 (87.2)	256 (95.2)	1.00		
Current smoker	70 (12.8)	13 (4.8)	2.88	1.56-5.30	
Alcohol use (n = 818)					<0.001
No	164 (29.9)	113 (42.0)	1.00		
Yes	385 (70.1)	156 (58.0)	1.70	1.26-2.30	
Alcohol use in the last 24 hours (n = 541)					0.670
No	305 (79.2)	121 (77.6)	1.00		
Yes	80 (20.8)	35 (22.4)	0.91	0.58-1.42	
Daytime napping					<0.001
No	276 (50.1)	172 (63.9)	1.00		
Yes	275 (49.9)	97 (36.1)	1.77	1.31-2.38	

Covariate significant at $p \leq 0.05$

Table 2.2: Ridership characteristics of riders by crash involvement; Bamenda, Cameroon

Characteristic	Ever had a crash (n = 427) n (%)	Never had a crash (n = 125) n (%)	Unadjusted odds ratio	95% CI	*p*-value
Daily income [frs CFA] (n = 547)					0.290
mean ± SD	6191.5 ± 2097.6	6439.5 ± 2835.3	1.00	1.00-1.00	
Median (range)	6000 (2500-15000)	5000 (3000-27000)			
Motorcycle ownership					0.976
Myself	300 (70.3)	88 (70.4)	1.00		
Other (family, rental, etc)	127 (29.7)	37 (29.6)	1.01	0.65-1.56	
Motorcycle registration					0.675
No	261 (61.1)	79 (63.2)	1.00		
Yes	166 (38.9)	46 (36.8)	1.09	0.72-1.65	
Rider licensure					0.426
No	295 (69.1)	91 (72.8)	1.00		
Yes	132 (30.9)	34 (27.2)	1.20	0.77-1.87	
Motorcycle training time (n=551)					0.285
Less than a week	131 (30.8)	50 (40.0)	1.00		
1–2 weeks	71 (16.7)	18 (14.4)	1.51	0.82-2.78	
3–4 weeks	82 (19.2)	22 (17.6)	1.42	0.80-2.52	
More than 1 month	142 (33.3)	35 (28.0)	1.55	0.95-2.54	
Riding experience (n = 551)					0.001
Less than 1 year	44 (10.3)	29 (23.2)	1.00		
1–2 years	66 (15.5)	22 (17.6)	1.98	1.01-3.88	
3–4 years	117 (27.5)	34 (27.2)	2.27	1.24-4.15	
5 years or more	199 (46.7)	40 (32.0)	3.28	1.84-5.85	
Ridership frequency					0.491
At most 3 times a week	39 (9.1)	14 (11.2)	1.00		
Daily or almost daily	388 (90.9)	111 (88.8)	1.26	0.66-2.39	
Time of operation					0.178
Nighttime (7pm-10pm)	203 (47.5)	68 (54.4)	1.00		
Daytime/Dusk (6am-7pm)	224 (52.5)	57 (45.6)	1.32	0.88-1.96	
Number of passengers carried per trip on average (n = 550)					0.007
Only one	31 (7.3)	9 (7.3)	1.00		
One or two	319 (74.9)	108 (87.1)	0.86	0.40-1.87	
Sometimes more than two	76 (17.8)	7 (5.6)	3.15	1.08-9.21	

Covariate significant at $p \leq 0.05$

Table 2.3: Ridership characteristics of passengers by crash involvement; Bamenda, Cameroon

Characteristic	Ever had a crash (n = 124) n (%)	Never had a crash (n = 144) n (%)	Unadjusted odds ratio	95% CI	*p*-value
Number of trips/day					0.386
mean ± SD	2.7 ± 1.6	2.9 ± 2.5	0.95	0.84-1.07	
Median (range)	2.0 (1-10)	2.0 (1-20)			
Daily expenditure [frs CFA]					0.056
mean ± SD	445 ± 274	572 ± 650	1.00	0.99-1.00	
Median (range)	400 (100-2000)	400 (100-5000)			
Motorcycle ridership frequency					0.266
Not daily	36 (29.0)	51 (35.4)	1.00		
Daily	88 (71.0)	93 (64.6)	1.34	0.80-2.25	
Allowed multiple passengers					0.867
No	78 (62.9)	92 (63.9)	1.00		
Yes	46 (37.1)	52 (36.1)	1.04	0.63-1.72	
Most number of passengers with whom you ever shared ride					0.180
Two	40 (32.3)	58 (40.3)	1.00		
Three	66 (53.2)	74 (51.4)	1.29	0.77-2.18	
Four or more	18 (14.5)	12 (8.3)	2.18	0.94-5.01	
Number of years of motorcycle ridership					0.862
Less than 5 years	18 (14.5)	22 (15.3)	1.00		
Five years or more	106 (85.5)	122 (84.7)	1.06	0.54-2.09	

Covariate significant at $p \leq 0.05$

Table 2.4: Adjusted odds ratio of crash involvement for motorcyclists; Bamenda, Cameroon

Characteristic	Model 1 Motorcyclists (n=820) AOR (95%CI)	Model 2 Riders (n=552) AOR (95%CI)	Model 3 Passengers (n=268) AOR (95%CI)
Motorcyclist			
Passenger	1.00*		
Rider	**2.88 (2.00–4.13)**		
Sex			
Female	1.00*		1.00*
Male	**2.25 (1.32–3.85)**		**2.22 (1.27–3.87)**
Smoking status			
Non smoker	1.00*	1.00*	1.00
Current smoker	**1.99 (1.06–3.72)**	**2.23 (1.00–4.94)**	1.18 (0.37–3.77)
Alcohol use			
No	1.00*	1.00	1.00*
Yes	**1.49 (1.08–2.07)**	1.00 (0.64–1.57)	**2.80 (1.62–4.89)**
Number of trips/day			0.90 (0.80–1.03)
Ridership frequency			
At most 3 times a week		1.00	
Daily or almost daily		1.23 (0.62–2.45)	
Riding experience			
Less than 1 year		1.00*	
1–2 years		1.85 (0.92–3.71)	
3–4 years		**2.14 (1.14–4.01)**	
5 or more years		**3.15 (1.73–5.73)**	
Time of operation			
Nighttime (7pm–10pm)		1.00	
Daytime/Dusk (6am–7pm)		1.49 (0.97–2.27)	
Number of passengers carried			
One only		1.00*	
One or two		0.88 (0.39–1.96)	
Sometimes more than two		**3.57 (1.18–10.84)**	

Covariate significant at $p \leq 0.05$AOR: Adjusted Odds Ratio

Table 2.5: Associated factors of vehicle collision for most severe crash among riders; Bamenda, Cameroon

Characteristic	Single-vehicle (n = 162) n (%)	Multi-vehicle (n = 263) n (%)	Unadjusted Odds Ratio	95% CI	*p*-value
Road was paved (n = 424)					<0.001
No	94 (58.4)	63 (24.0)	1.00		
Yes	67 (41.6)	200 (76.0)	0.23	0.15-0.34	
Road condition at time of crash (n = 369)					<0.001
Other (bump, gutter, oil, garbage)	14 (10.1)	78 (33.9)	1.00		
Dust/Gravel	24 (17.3)	23 (10.0)	5.81	2.60-13.02	
Mud	16 (11.5)	7 (3.0)	12.73	4.44-36.56	
Pothole	85 (61.1)	122 (53.0)	3.88	2.06-7.31	
Estimated speed (n = 399)					0.014
5–20km/h	30 (19.7)	74 (30.0)	1.00		
25–40km/h	63 (41.5)	108 (43.7)	1.44	0.85-2.43	
45+ km/h	59 (38.8)	65 (26.3)	2.24	1.29-3.89	

Covariate significant at $p \leq 0.05$

Table 2.6: Adjusted odds ratio of single-vehicle collision for most severe crash among riders; Bamenda, Cameroon

Characteristic	Riders (n = 345) AOR (95%CI)
Education level	
Primary or lower	1.00
Secondary	1.16 (0.65–2.06)
High school or higher	1.03 (0.53–1.97)
Marital status	
Single	1.00
Not single	1.00 (0.60–1.66)
Smoking status	
Non smoker	1.00
Current smoker	0.63 (0.31–1.30)
Alcohol use	
No	1.00*
Yes	**2.11 (1.21–3.69)**
Road was paved	
Yes	1.00*
No	**4.34 (2.50–7.52)**
Road condition at time of crash	
Other (bump, gutter, oil, garbage)	1.00*
Dust/Gravel	2.11 (0.82–5.48)
Mud	**5.91 (1.60–21.78)**
Pothole	**2.39 (1.17–4.89)**
Estimated speed	
5–20km/h	1.00*
25–40km/h	1.34 (0.71–2.51)
45+ km/h	**2.55 (1.28–5.08)**

* Covariate significant at $p \leq 0.05$
AOR: Adjusted odds ratio

REFERENCES

1. Hazen A, Ehiri JE. Road traffic injuries: hidden epidemic in less developed countries. *J Natl Med Assoc*. 2006;98(1):73-82.

2. Odero W, Garner P, Zwi A. Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. *Trop Med Int Heal*. 1997;2(5):445-460. doi:10.1111/j.1365-3156.1997.tb00167.x.

3. Kumar A. Understanding the emerging role of motorcycles in African cities: A political economy perspective. *Sub-Saharan Africa Transp Policy Progr Discuss Pap*. 2011;13(1).

4. Aluko OO. Commercial Motorcycle Safety in Nigeria : The Past and Opportunity for Future Improvement. *Int J Eng Sci*. 2018;7(3):35-41. doi:10.9790/1813-0703013541.

5. S Kisaalita W, Sentongo-Kibalama J. Delivery of urban transport in developing countries: the case for the motorcycle taxi service (boda-boda) operators of Kampala. *Dev South Afr*. 2007;24(2):345-357. doi:10.1080/03768350701327319.

6. Konings P. Solving Transportation Problems in African Cities : Innovative Responses by the Youth in Douala , Cameroon. *Afr Today*. 2006;53(1):35-50.

7. Atekmangoh C. *Les Mbengis" - Migration, Gender, and Family: The Moral Economy of Transnational Cameroonian Migrants' Remittances*. Mankon, Bamenda: Langaa Research & Publishing CIG; 2017.

8. National Center for Statistics and Analysis. *Motorcycles: 2015 Data (Updated, Traffic Safety Facts. Report No. DOT HS 812 353)*. Washington, DC; National Highway Traffic Safety Administration; 2017.

9. Chichom-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C, Ngowe-Ngowe M. 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(1):915. doi:10.1186/s12889-015-2290-4.

10. Lin MR, Kraus JF. A review of risk factors and patterns of motorcycle injuries. *Accid Anal Prev*. 2009;41(4):710-722. doi:10.1016/j.aap.2009.03.010.

11. Institut National de la Statistique. *Annuaire Statistique Du Cameroun*. Yaoundé, Cameroun; 2013. www.statistics-cameroon.org.

12. Breit Consulting. *Analyse de l'impact de l'augmentation Du Parc de Motocyclettes Dans La Ville de Douala*. Yaoundé, Cameroun; 2008.

13. Haddon W. Advances in the epidemiology of injuries as a basis for public policy. *Public Health Rep*. 1980;95(5):411-421. doi:10.2307/4596353.

14. Mohan D, Tiwari G, Khayesi M, Nafukho FM. Road traffic injury prevention training manual. 2006:1-126.

15. Runyan CW. Using the haddon matrix: Introducing the third dimension. *Inj Prev*. 2015;21(2):126-130. doi:10.1136/ip.4.4.302rep.

16. Yankson IK, Browne ENL, Tagbor H, et al. Reporting on road traffic injury: content analysis of injuries and prevention opportunities in Ghanaian newspapers. *Inj Prev*. 2012;16(3):194-197. doi:10.1136/ip.2009.024174.Reporting.

17. Peden MM, Scurfield R, Sleet D, et al. *World Report on Road Traffic Injury Prevention*.; 2004. doi:10.1016/j.puhe.2005.09.003.

18. Zamani-Alavijeh F, Niknami S, Bazargan M, et al. Accident-related risk behaviors associated with motivations for motorcycle use in Iran: a country with very high traffic deaths. *Traffic Inj Prev*. 2009;10(3):237-242. doi:10.1080/15389580902822717.

19. Sagberg F, Bjørnskau T. Hazard perception and driving experience among novice drivers. *Accid Anal Prev*. 2006;38(2):407-414. doi:10.1016/j.aap.2005.10.014.

20. Karau P, Ogeng J, Okoro D, Muia M, Saumu M. Risk Factor Profile of Motorcycle Crash Victims in Risk Factor Profile of Motorcycle Crash Victims in Rural Kenya. *Ann African Surg*. 12(1):4-8.

21. Chalya PL, Ngayomela IH, Mabula JB, et al. Injury outcome among helmeted and non-helmeted motorcycle riders and passengers at a tertiary care hospital in north-western Tanzania. *Tanzan J Health Res*. 2014;16(4):1-10. doi:10.4314/thrb.v16i2.4.

22. Sufiyan M, Ahmad S. Knowledge, attitude and compliance with safety protective devices among commercial motorcyclists in Tudun-Wada Zaria, North-Western Nigeria. *Ann Niger Med*. 2012;6(2):80. doi:10.4103/0331-3131.108126.

23. Morenikeji W, Umaru E. Flying without navigational aids - The case of commercial motorcyclists in Minna, Nigeria. *Transp Res Part F Traffic Psychol Behav*. 2012;15(3):311-318. doi:10.1016/j.trf.2012.02.003.

24. Kasantikul V, Ouellet J V., Smith T, Sirathranont J, Panichabhongse V. The role of alcohol in Thailand motorcycle crashes. *Accid Anal Prev*. 2005;37(2):357-366. doi:10.1016/j.aap.2004.07.006.

25. Motorcycle Council of NSW INC. Safer People - Pillions. http://roadsafety.mccofnsw.org.au/a/34.html. Published 2016.

26. SacksJ.J., NelsonD.E. Smoking and injuries: an overview. *Prev Med (Baltim)*. 1994;23(4):515-520. doi:10.1006/pmed.1994.1070.

27. Amadou I. Usages du Tramadol à des fins non médicales par les moto-taxi de la ville de Garoua. 2014.

28. Tchaya Z, Bandolo GM, Bassompierre L. Tramadol: Cameroon's low-budget opioid crisis. http://www.france24.com/en/20180423-focus-cameroon-tramadol-drug-opiods-crisis-schools-education-rehab-addiction.

29. United Nations. *Report of the International Narcotics Control Board for 2016*. Vienna, Austria https://www.incb.org/documents/Publications/AnnualReports/AR2016/English/AR2016_E_ChapterIII-Africa.pdf.

30. Nofuru N. Abuse of Pain Medication Still Common In Cameroon, Despite Ban on Drug. *Global Press Journal*. https://globalpressjournal.com/africa/cameroon/abuse-pain-

medication-still-common-cameroon-despite-ban-drug/. Published April 27, 2016.

31. Mullin B, Jackson R, Langley J, Norton R. Increasing age and experience: are both protective against motorcycle injury? A case-control study. *Inj Prev*. 2000;6(1):32-35. doi:10.1136/ip.6.1.32.

32. Crundalla D, Loon E van, W. Stedmonb A, Crundall E. Motorcycling experience and hazard perception. *Accid Anal Prev*. 2013;50:456-464. doi:https://doi.org/10.1016/j.aap.2012.05.021.

33. Ivers RQ, Sakashita C, Senserrick T, et al. Does an on-road motorcycle coaching program reduce crashes in novice riders? A randomised control trial. *Accid Anal Prev*. 2016;86:40-46. doi:10.1016/j.aap.2015.10.015.

34. Sexton B, Baughan C, Elliott M, Maycock G, Trl TRLR. The accident risk of motorcyclists Prepared for Road Safety Division , Department for Transport. 2004:1-62.

35. DMV California. License Requirements for a Motorcycle M1 or M2. https://www.dmv.ca.gov/portal/dmv/detail/pubs/dl655/mcycle_htm/requirements. Published 2018. Accessed December 10, 2018.

36. Sexton B, Baughan C, Elliott M, Maycock G. *The Accident Risk of Motorcyclists*. Crowthorne, England; 2004. doi:TRL607.

37. World Health Organization (WHO). *Global Status Report on Road Safety 2015*. Geneva; 2015.

38. Gargoum SA, El-Basyouny K. Exploring the association between speed and safety: A path analysis approach. *Accid Anal Prev*. 2016;93:32-40. doi:10.1016/j.aap.2016.04.029.

39. Aarts L, Van Schagen I. Driving speed and the risk of road crashes: A review. *Accid Anal Prev*. 2006;38(2):215-224. doi:10.1016/j.aap.2005.07.004.

40. Garrison HG, Mckay MP, Gotschall CS, Newgard CD. *Recent Trends in Fatal Motorcycle Crashes: An Update*. Vol 50.; 2007. doi:10.1016/j.annemergmed.2007.06.010.

41. Deogratias E, Indupuru VK, Hovey P. Identification of Risk Factors Associated with Motorcycle-Related Fatalities in Ohio. *J Transp Eng*. 2011;137(7):474-480. doi:10.1061/(ASCE)TE.1943-5436.0000229.

CHAPTER 3: EPIDEMIOLOGY OF INJURY AMONG COMMERCIAL MOTORCYCLE RIDERS IN BAMENDA, CAMEROON

ABSTRACT

Background: Commercial motorcycle-related injuries compose a large proportion of road traffic injuries (RTIs) and constitute a major public health burden in Cameroon, yet data are sparse. This study estimated prevalence of injury among commercial motorcycle riders in Bamenda, Cameroon and examined associated factors.

Methods: Between July 12 and 26, 2017, a population-based cross-sectional study was conducted among consenting commercial motorcycle riders. Riders provided sociodemographic and injury information related to the most severe crash during lifetime as commercial motorcycle rider and to the most recent crash within the past 12 months. The outcome measured injury occurrence among motorcycle riders. Injury was defined as damage caused to the body by any external force at the time of crash.

Results: Among 427 motorcycle riders who reported a severe crash, 80.8% sustained an anatomic injury. Of the 91 motorcycle riders who reported the most recent crash within the past 12 months, 80.2% sustained an anatomic injury. Motorcycle riders who currently smoked (AOR = 4.81, 95% CI = 1.04, 22.20), had 3-4 years of riding experience (AOR = 4.68, 95% CI = 1.55, 14.12) or 5 or more years of riding experience (AOR = 3.09, 95% CI = 1.07, 8.93) compared to riders with less than a year of riding experience, had a side impact collision (AOR = 6.22, 95% CI = 1.18, 32.83), and rode at a speed of 45km/h or more (AOR = 4.67, 95% CI = 1.64, 13.25) compared to speeds less than 25km/h, were at significantly higher odds of sustaining an anatomic injury at the most severe crash, after adjusting for other covariates.

Conclusion: This study shows high RTI prevalence among commercial motorcycle riders in Cameroon. Current smoking status, more riding experience, side impact

collision, and high speeds were significant underlying factors associated with a sustained anatomic injury at the most severe crash. Findings from this study emphasize the need for development of novel and tailored interventions to significantly reduce motorcycle-related RTIs in Cameroon.

INTRODUCTION

Globally, road traffic injuries (RTIs) are a major public health problem claiming more than 1.35 million lives and causing approximately 50 million injuries yearly.[1–3] RTIs are the ninth leading cause of death worldwide and the leading cause of death among young people aged 5-29 years.[4,5] The Global Burden of Disease Study conducted in 2010 estimated that RTIs were responsible for over a third of the world's injury burden and resulted in the loss of 76 million disability-adjusted life years.[6] Moreover, low- and middle-income countries (LMICs) account for a majority of RTIs with sub-Saharan Africa countries bearing most of the burden.[1,2,7] RTIs are projected to be the fifth leading cause of global disease burden by 2030 with most cases occurring in LMICs.[8,9] Known risk factors that may contribute to this projected increase in RTI burden include inadequate traffic safety regulations, excessive speed, alcohol use, inadequate road infrastructure, and a lack of public health education.[8,10] In addition, the increase in the number of RTIs can be attributed to a combination of an increase in density of vehicles per road and competition for space on narrow roads.[11] Particularly, road traffic deaths are alarmingly high among pedestrians, cyclists, and motorcycle riders.[5,12] This paper applies the following definitions to motorcycle and commercial motorcycle rider: A motorcycle is a two-wheeled vehicle and a commercial motorcycle rider is a person who operates a motorcycle and transport passengers for a fare.[13]

Among all types of motor vehicle road users, motorcycle riders have the highest risk of fatal and nonfatal injuries.[14] In comparison to automobiles, motorcycle riders lack external protection provided by vehicle structure, have no internal protection from air bags and seat belts, have an increased likelihood to be ejected in a collision, and

are relatively unstable on different riding surfaces at high speeds.[15] Even though motorcycle injuries comprise a major proportion of RTIs globally, it is largely a neglected public health problem particularly in sub-Saharan Africa. Governments in Africa struggle to address RTIs as a top priority alongside malaria and HIV/AIDS.[16] Globally, approximately 25% of RTI fatalities are among motorcycle riders.[5]

Over the past decade, several urban regions in sub-Saharan Africa have seen economic growth which has fueled the increased demand for urban mobility services.[17] The introduction of inexpensive motorcycles has offered affordable commercial transportation services for poorer individuals who can now maneuver the unpaved, pothole ridden roads and get to areas inaccessible by four-wheeled vehicles.[18] Despite benefits and popularity of commercial motorcycling, anecdotal evidence suggest that the sudden rise in the number of users coupled with limited road safety has led to increasing road traffic crashes, injuries, and fatalities. Road traffic crashes involving motorcycles often result in severe injuries.

In spite of the high burden of RTIs, very few studies have examined the determinants and distribution of motorcycle-related RTIs. A recent systematic review found several studies focus on injury outcomes of hospitalized motorcycle riders.[19–25] Studies of hospitalized motorcycle riders are often of interest to injury researchers because of the availability of diagnosis and more severe injury. These studies tend to overestimate injury severity, underestimate injury prevalence, and cannot infer the magnitude of injury to the general population.[14] Furthermore, motorcycle riders in crashes that involve minor injuries often do not seek medical care and go unreported. In sub-Saharan Africa, motorcycle riders who cannot afford the often high medical care

expenses, prefer traditional African medicine or self-treatment, or are deceased at the crash scene are often unidentified.[26] Although studies of hospitalized cases provide significant information about the epidemiology of motorcycle injury, it omits most cases with minor injuries and the uninjured.[27] The purpose of this study was to estimate the prevalence of injury and identify associated factors among commercial motorcycle riders in Bamenda, Cameroon.

METHODS

Study Design and Population

A cross-sectional study was carried out among commercial motorcycle riders in Bamenda, Cameroon which has an estimated population of 322,889 persons.[28] Data were collected from July 12 through 26, 2017. Riders were interviewed Tuesdays through Saturdays during non-business rush hours of 10am and 4pm. Individuals were eligibility to participate if they were, 1) a commercial motorcycle rider, 2) 18 years of age or older; 3) spoke either pidgin or English; 4) operated within the city of Bamenda, and 5) provided informed consent. Commercial motorcycle riders were recruited from 15 major road intersections across the city and from two market places within the city.

Interview process

Five university graduate students were recruited to perform interviews. All interviewers received a one-week comprehensive training to provide them with knowledge, skills, and abilities to administer a survey and an overview of the study protocol. Data collection at each selected road intersection began with a project information session to the intersection syndicate president by the Principal Investigator. Following each information session, interviewers approached each motorcycle rider to

inquire on their interest in study participation. After provision of eligibility and consent information, riders who met study participation criteria conducted a face-to-face interview using a questionnaire via computer assisted personal interview. Participants were interviewed in either pidgin or English, depending on the language of preference. All questions were developed in English. The Principal Investigator prepared a pidgin questionnaire version by translating the English questionnaire. Questionnaire context was verified by back translation and pilot testing the questionnaire. Back translation was performed by a linguist local to Bamenda. Nomenclature used by motorcycle riders was considered. Participants were offered a monetary incentive of 500frs CFA for their participation and compensation for their time.

Measures

The questionnaire obtained information on sociodemographic, crash, and injury characteristics. Crash and injury characteristics for the most severe crash during lifetime as commercial motorcycle rider and for the most recent crash within the past 12 months were obtained. In this study, a motorcycle crash was defined as a fall-off or collision with a road object or another vehicle. Injury was defined as damage caused to the body by external force at time of crash.[29] Sociodemographic indicators included gender, age, education level (primary or lower, secondary, high school or higher), marital status (single or not single), smoking status (current smoker or nonsmoker), alcohol use (yes or no), number of alcoholic drinks consumed on a typical day, sleep duration per day (number of hours), and daytime napping (yes or no). Ridership characteristics included motorcycle ownership status (self or other), motorcycle registration status (yes or no), rider licensure (yes or no), and riding experience (less

than a year, 2-4 years, or 5 or more years). Riding experience was defined as the number of years of on-road motorcycle ridership including any motor and cognitive skills gained by exposure to traffic risks. Higher riding experience was not indicative of motorcycle riding expertise. Crash characteristics included time of operation (daytime or nighttime), vehicle collision type (single-vehicle or multi-vehicle), number of persons on motorcycle, whether load was carried (yes or no), impact collision (front, side, or rear), whether road was paved (yes or no), road condition (pothole, mud, or dust/gravel), helmet use (yes or no), and estimated speed (5-20km/h, 25-40km/h, or ≥45km/h). A single-vehicle collision was defined as a type of road traffic collision in which only the motorcycle was involved and included ejections and collision with fixed objects; including falls. A paved road was defined as a road covered with asphalt. Estimated speed was captured as rider's self-reported speed at the time of the crash. Participants were asked if a helmet was worn at the time of the crash. Participants provided information on injuries sustained at any of the six anatomical regions (head/neck, face, chest, abdomen, extremities, and external) at the time of the most severe crash and at the most recent crash within the past 12 months if one occurred. Injury status was the outcome and was dichotomized for analysis (injury or no injury).

Most severe crash in lifetime and most recent crash within the past 12 months: The most severe crash was defined as the worst crash the participant ever had in their lifetime as a commercial motorcyclist. Participants were asked the number of times ever involved in a motorcycle crash. Those who reported no crashes were classified as never involved in a crash. Those who reported a single crash were asked a follow up question if the crash occurred within the past 12 months. If a participant reported a

single crash which occurred prior to the past 12 months, that crash was classified as the most severe crash. If the single crash occurred within the past 12 months, that crash was classified as both the most severe crash and the most recent crash within the past 12 months. Participants who reported multiple crashes were asked to provide information about the crash they perceived as the most severe. If the perceived most severe crash occurred prior to the past 12 months, that crash was classified as the most severe crash. If the perceived most severe crash was the most recent crash that occurred within the past 12 months, that crash was classified as both the most severe crash and the most recent crash within the past 12 months. Furthermore, if the participant reported that the perceived most severe crash occurred prior to the past 12 months but another crash occurred within the past 12 months, both crashes were classified as the most severe crash and the most recent crash within the past 12 months, respectively. Reported injuries were with respect to the most severe crash or the most recent crash within the past 12 months. Figure 3.1 and Table 3.1 elucidate how crashes were classified.

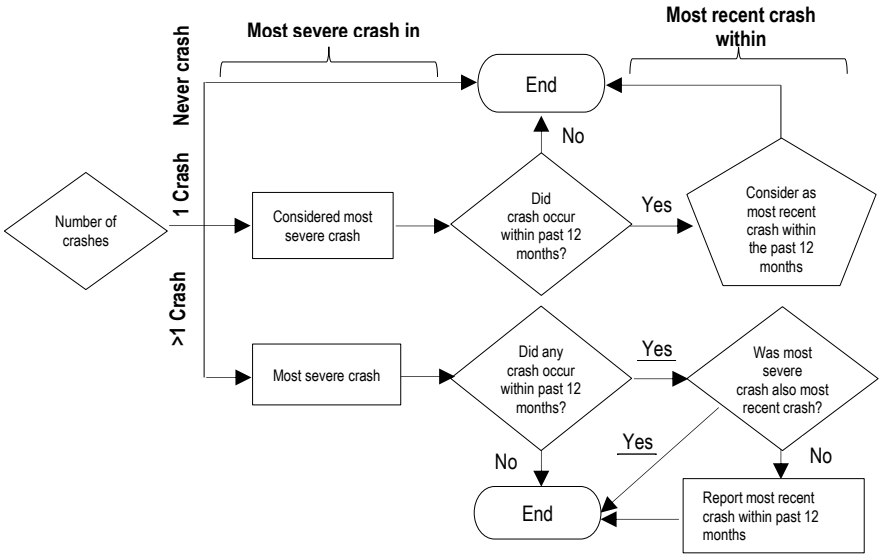


Figure 3.1: Most severe crash in lifetime and most recent crash within the past 12 months

Table 3.1: Example of crash classification of motorcyclists

Participant	Number of crashes	Crash occurred prior to past 12 months	Crash occurred within past 12 months	Crash classification
Participant 1	0			• Never crash
Participant 2	1	X		• Most severe crash (X)
Participant 3	1		Y	• Most severe crash (Y) • Most recent crash within past 12 months (Y)
Participant 4	2	X_1 X_2		• Most severe crash (X_2)
Participant 5	2	X	Y	• Most severe crash (X) • Most recent crash within past 12 months (Y)
Participant 6	2		Y_1Y_2	• Most severe crash (Y_1) • Most recent crash within past 12 months (Y_2)
Participant 7	3	X	Y_1Y_2	• Most severe crash (Y_2) • Most recent crash within past 12 months (Y_2)

The current study was reviewed and approved by three institutional review boards; the University of California San Diego Human Research Protections Program in the United States (Project # 161701SW), the Bamenda Regional Hospital Institutional Review Board and the Provincial Delegate's Office for Ministry of Health (No. 382/NWR/RDPH) in Bamenda Cameroon.

Statistical analyses

Differences in demographic and injury characteristics were assessed among motorcycle riders using the Pearson's Chi-square test, Fisher's Exact test, or independent t-test, where appropriate. Comparisons across groups by injury status were examined using the independent t-test for continuous variables and the Pearson's chi-square and Fisher's exact test for categorical variables. Multivariable logistic regression was used to examine associations of crash characteristics with injury status for the most severe crash and the most recent crash within the past 12 months. Logistic regression models were specified by using *a priori* knowledge of potential confounders

and if the *p*-value from the univariate analysis was less than 0.25.[30,31] Multicollinearity was assessed by examining tolerance. Model adequacy was assessed with the Hosmer-Lemeshow goodness-of-fit statistic.[32,33] Unadjusted and adjusted odds ratios with 95% confidence intervals (CI) were presented. All analyses were conducted using Statistical Package for the Social Science (SPSS) version 21 (Chicago, IL: SPSS Inc.) and Statistical Analysis Software (SAS), version 9.3 (SAS Institute, Inc., Cary, NC) with statistical significance defined as $p \leq 0.05$.

RESULTS

Information was collected from 557 consented commercial motorcycle riders. However, analyses were conducted on 552 riders with complete recorded data. All riders were male.

Population Characteristics

Most severe crash: A total of 427 (77.4%) commercial motorcycle riders reported a most severe crash. These riders were 28.9 years old (SD = 6.9, range = 18–55) on average with 50.8% (n = 217) of them between 25 and 34 years of age. A total of 42.0% (n = 179) reported an education status of primary or lower. A total of 52.5% (n = 224) of these riders reported single marital status. Only 14.4% (n = 41) of riders were current smokers. Over two-thirds of motorcycle riders (68.5%; n = 291) reported alcohol use with 37.0% (n = 157) consuming three or more drinks on a typical drinking day. When asked about sleeping, riders slept 7.8 hours per day (SD = 1.6; n = 422) on average while an additional 56.7% (n = 242) took a nap during the day.

Most recent crash within the past 12 months: Ninety-one (16.5%) commercial motorcycle riders reported a most recent crash within the past 12 months. Riders'

mean age was 27.6 years (SD = 7.3, range = 18–55) with 47.3% (n = 43) of them between 25 and 34 years of age. A total of 42.9% (n = 39) of these riders reported a primary education or lower. Of riders who reported a most recent crash within the past 12 months, 60.2% (n = 57) were of single marital status. A total of 15.4% (n = 14) riders reported current smoking status. Several motorcycle riders consumed alcohol (78.0%, n = 71) with 37.4% (n = 34) consuming three or more drinks on a typical drinking day. Motorcycle riders with a most recent crash within the past 12 months slept on average of 7.7 hours per day (SD = 1.8; n = 88) with 55.0% (n = 50) of them taking a daytime nap.

Injury Characteristics

A distribution of injuries sustained by commercial motorcycle riders who reported a most severe crash and those who reported a most recent crash within the past 12 months are presented in Table 3.2 and Table 3.3.

Most severe crash: Of the 427 riders who reported a most severe crash, 345 (80.8%) of them sustained one or more anatomic injuries. These injured motorcycle riders reported significantly higher smoking rates than uninjured motorcycle riders (16.0% vs 7.4%, $p = 0.047$). Most injured riders consumed alcohol with a significant proportion (39.6%) consuming 3 or more drinks on a typical drinking day ($p = 0.041$). Injured motorcycle riders had significantly more years of ridership experience than uninjured motorcycle riders with most reporting ridership experience of 3 or more years ($p = 0.012$). About 10% of injured motorcycle riders at the most severe crash were struck from the side or fell to the side compared to 4% of uninjured motorcycle riders ($p = 0.031$). Injured motorcycle riders reported significantly higher estimated riding speeds

at the time of the most severe crash than uninjured motorcycle riders ($p < 0.001$).

Most recent crash within past 12 months: Among 91 motorcycle riders who reported a most recent crash within the past 12 months, a majority (80.2%) sustained an anatomic injury. Although marginally significant, injured motorcycle riders were less likely to carry load at the time of the most recent crash in comparison to uninjured motorcycle riders ($p = 0.05$).

Determinants of Injury

The Hosmer-Lemeshow goodness-of-fit test statistic of the adjusted logistic regression model was 4.59, with 8 degrees of freedom and a *p*-value of 0.80, indicating no evidence of poor fit. Results of the logistic regression analysis for factors associated with injury are presented in Table 3.4. Findings, presented as adjusted odds ratio (AOR), from the logistics regression analysis indicated that being a current smoker, having more years of riding experience, side impact collision, and speeding were significantly associated with injury at the most severe crash. The odds of sustaining an injury for the most severe crash were higher among current smokers than nonsmokers (AOR = 4.81, 95% CI = 1.04, 22.20). Motorcycle riders with 3–4 years of riding experience (AOR = 4.68, 95% CI = 1.55, 14.12) and those with 5 or more years of riding experience (AOR = 3.09, 95% CI = 1.07, 8.93) were at significantly higher odds of injury for the most severe crash compared with motorcycle riders who had a year or less of riding experience. Motorcycle riders who were struck from the side (AOR = 6.22, 95% CI = 1.18, 32.83) were at significantly higher odds of injury for the most severe crash than those who had a rear impact collision. Motorcycle riders who travelled at estimated speeds of 45km/h or more were at increased odds of injury than riders who

were travelling at an estimated speed of 5-20km/h (AOR = 4.67, 95% CI = 1.64, 13.25).

Logistic regression modeling examined factors associated with injury at the most recent crash within the past 12 months. However, findings are not reported due to the small sample size and wide confidence intervals.

DISCUSSION

This study shows a high prevalence of injury among commercial motorcycle riders in Bamenda, Cameroon. In this study, 80.8% of commercial motorcycle riders who reported a most severe crash were injured and 80.2% of commercial motorcycle riders who reported a most recent crash within the past 12 months sustained one or more anatomic injuries. This study showed that current smoking status, more years of riding experience, side impact collision, and speeding were associated with motorcycle-related injury at the most severe crash.

The prevalence of injury shown in this study is higher than that of several previous cross-sectional studies conducted among commercial motorcycle riders in other sub-Saharan countries. A Tanzanian study, which examined injury outcome among helmeted and non-helmeted motorcycle riders who presented at a tertiary care hospital showed an injury prevalence of 71.6%.[34] Other studies in Nigerian cities have shown injury prevalence among commercial motorcycle riders ranging from approximately 65% to 90%.[35–37] A study conducted in 2012, which investigated prevalence and patterns of road traffic accidents in Southern Nigeria, showed that 72.8% of commercial motorcycle riders sustained an injury in the most recent accident.[38] Though valuable, several previous studies conducted in Africa have examined some factors associated with likelihood of crash and injury but only report

univariate results and rarely assessed confounding. In this study we showed that four factors were statistically associated with injury reported at the most severe crash; being a current smoker, more years of riding experience, side impact collision, and speeds at 45km/h or higher.

Interestingly, this study showed an association between current smoking status and higher odds of a sustained anatomic injury at the most severe crash. Although few studies have shown an association between current smoking and motor vehicle crash involvement, we postulate that in this study current smoking status is a surrogate to use of cannabis and tramadol, a synthetic opioid commonly used among some commercial motorcycle riders. A previous study indicated smokers were 1.5 times more likely to be involved in a motor vehicle crash compared to non-smokers.[39] Smoking while riding is a distraction which can lead to reduced reaction time.[40] Smoking can interfere with proper handling of the motorcycle handlebar; can cause smoke to blow towards the eyes, and hot ash to fly towards the face or clothes. Smokers are also more likely to consume alcohol.[41,42] Smokers have been shown to consume cannabis and Tramadol, putting them at risk.[43–45] Anecdotal evidence from newspaper and medical reports from the Bamenda regional hospital has suggested use of cannabis and/or tramadol by several of the injured motorcycle riders who present at the hospital. Relatively little is known about the combined effects of cannabis and tramadol use on motorcycle ridership despite the unique relationship with smoking.

Findings from this study showed that motorcycle riders with three or more years of riding experience were more likely to sustain an injury than motorcycle riders with less than a year of riding experience. Some previous studies have associated less

riding experience and younger age with higher risk of crashes and injuries.[46,47] This may vary regionally. In high-income countries, motorcycle riders are required to receive formal training on how to operate a motorcycle and understand traffic rules. Findings from a previous study indicated that irrespective of training, younger motorcycle riders often have fewer riding skills, are likely to be involved in risky or distracted riding, and less likely to respect traffic rules in comparison to older, experienced motorcycle riders.[48] Increasing age and experience may show protective factors against crash and injury.[47] While this study's finding may be contrary to previous studies conducted in high-income countries which portray increasing age and riding experience as a protective factor to risk of motorcycle crash and injury, we believe there are no significant advantages being an older motorcycle rider or having more years of riding experience in Bamenda and other urban regions in sub-Saharan Africa.[49] There are several plausible explanations for the lack of benefits from training, increasing age, and riding experience in reducing odds of crash and injury. First, commercial motorcycle riders in Bamenda are less likely to receive formal training on how to operate a motorcycle or learn any traffic rules irrespective of their age. Secondly, our study showed most commercial motorcycle riders to be older (29 years on average) and own their motorcycle (70.3%) indicating that younger motorcycle riders are less likely to operate regularly for commercial purposes. Thirdly, more years of riding experience may be associated with increased odds of crash and injury by virtue of increased exposure to road traffic risks.[50,51] The more time motorcycle riders spend on the road, the more likely they are to be involved in a crash and sustain an injury. Fourthly, even though this study defined riding experience as the number of years of riding as a

commercial motorcycle rider, riding experience could be interpreted differently by some motorcycle riders. Some may associate experience with skill level to operate a motorcycle or maneuver the poor roads, years of riding, years of license ownership, or the number of years since they first learned how to operate a motorcycle. Finally, acquired riding experience and skills of motorcycle riders may be nullified since they have to share the same narrow densely populated pothole-ridden, muddy or dusty roads with other reckless motorists. This study suggests that more years of riding experience increased the odds for crash and injury given the number of years of on-road motorcycle riding and exposure to road traffic risk.

In this study, a side impact collision at the most severe crash was associated with higher odds of injury. Motorcycle riders are likely to be in a side impact collision with a turning vehicle, another vehicle at an intersection, or upon fall-off on a muddy and slippery surfaced road.[52] In Bamenda, most intersections do not have traffic lights, stop signs, or police officers to direct and control the flow of traffic. A determination of who has the right of way to traverse an intersection or crossroad is not clearly defined. Illegal maneuver, distraction, inattention, turning in obstructed view, or aggressive riding or driving, are some of the reasons motorcycle riders could be injured from side impact collisions.[53,54] Finally, several roads are muddy and slippery after rainfall which puts motorcycle riders at greater risk of injury in a single-vehicle collision. Though not statistically different, it was observe in this study that a majority of motorcycle riders (83.3%) had a frontal impact at the most severe crash.

This study showed higher speed as an underlying factor of injury occurrence at the most severe crash. Many studies and reports have established association

between higher speeds and injury severity.[5,55–57] At higher speeds, motorcycle riders have a shorter time to stop but exert a higher impact force. A previous study showed that at speeds over 50km/h helmets are ineffective; an indication of the influence speed has on injury severity.[58] In developed countries, speed has often been associated with younger age, alcohol or drug use, road layout, and engine power.[59–61] In Bamenda, motorcycle riders tend to speed during rush hours as they scramble for passengers in order to maximize their income or on the few stretches of paved roads.

There are a few limitations to this research study that need to be highlighted. Information on crash and injury characteristics relied on self-reporting and could not be validated by other sources. The prevalence of injury should be interpreted with caution as the study obtained information related to the most severe crash and the most recent crash within the past 12 months. It is possible that some motorcycle riders were not able to recall details related to the most severe or recent crash or may have mixed up details if more than one crash self-evaluated as severe had occurred. Although motorcycle riding speed at the most severe and most recent crash within the past 12 months were estimated by the motorcycle rider, some may have underestimated the speed at the time of the crash given their *a priori* knowledge of speed and its association with risk of crash and injury. It is likely that behavioral factors such as alcohol consumption may be underestimated considering that some motorcycle riders are aware of impaired riding.

We also experienced certain nomenclature challenges in the study setting. Even though the study focused on crashes, we referred to “accidents” during the interview since the word crash is commonly associated with airplanes and not vehicles among

people of Cameroon. Furthermore, we had to define a crash event to each participant since most motorcycle riders consider a crash, “accident” to be a collision between two or more vehicles. The dynamic nature of the pidgin language required interviewers to explain unfamiliar words while maintaining the context. Another challenge involved the data collection period which took place amid regional instability due to the Anglophone crisis. Although many motorcycle riders participated in the study, it is likely that some motorcycle riders were skeptical about the study and did not want to participate. In consideration that crash and injury characteristics may vary between urban and rural roads, caution should be taken if these findings are to be generalized to rural regions in Cameroon. Human and environmental characteristics may have a different magnitude on injury between urban and rural settings. Finally, the use of a cross-sectional study design did not permit the assessment of causal associations.

This study had several strengths. This is the first population based cross-sectional study that examined the effects of known regional road traffic underlying factors and injury outcome. It is the first regional study that used a representative sample to estimate the prevalence of crash and injury among commercial motorcycle riders. Contrary to most studies which have examined factors associated with motorcycle-related injuries among hospitalized motorcycle riders; this study focused on motorcycle riders with varying crash and injury severity. It is likely that this study was inclusive of motorcycle riders who have been involved in one or multiple crashes and sustained injuries but never sought treatment at a medical facility, given the lack of post-crash care or high fee-for-service treatment expenses. Most importantly, this study obtained information about crash-related factors and injury which could not be obtained

otherwise given the lack of surveillance systems, police reports, insurance records, and hospital records.

Certain underlying factors have been evidently associated with burden of road traffic injuries. However, most of these factors have been identified in high-income countries with the ability to conduct more rigorous research. Using a blanket adaptation of underlying factors from high-income countries to the sub-Saharan Africa setting will not provide a reliable and valid assessment of road traffic crash and injury causalities. Crash and injury prevalence among motorcycle riders are soaring to new heights yet receive little or no attention compared to other regional malaise such as malaria and HIV/AIDS. Consideration must therefore be given to identify and investigate specific motorcycle-related factors associated with road traffic injuries in urban and rural sub-Saharan Africa countries. A detailed evaluation of specific regional motorcycle-related factors will inform tailored traffic policies and prevention strategies essential to crash, injury, and fatality reduction.[62] In addition, these evidence based results may be used to support transportation and public health institutions as well as policy makers with the capacity to promote public awareness on road safety, implement educational programs, and review, develop, and enforce road traffic policies.

This study showed some underlying determinants of motorcycle-related crashes and injuries in Bamenda, Cameroon where commercial motorcycling is the predominant mode of transportation. Furthermore, findings from this study emphasize the need for the development of novel and tailored intervention measures to significantly reduce the potential of motorcycle-related crashes and injuries in Cameroon.

Acknowledgments

Chapter 3, in full, is currently being prepared for publication of the material. Co-authors include Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael; Hill, Linda. The dissertation author is the primary author of this material. This work was supported by the Inamori Fellowship Program [2017]; the UCSD International Institute [2017]; and the UCSD Global Health Institute [2017]. These organizations had no involvement in the study design; collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication.

Table 3.2: Demographic and motorcycle ridership characteristics, by injury status; Bamenda, Cameroon

	Most severe crash (n = 427)		Most recent crash within past 12 months (n = 91)	
Characteristics	**No Injury (n = 82) n (%)**	**Injury (n = 345) n (%)**	**No Injury (n = 18) n (%)**	**Injury (n = 73) n (%)**
Age, [years] [a]				
mean ± SD	28.5 ± 6.9	29.0 ± 6.9	25.3 ± 5.2	28.2 ± 7.7
median (range)	27 (18-49)	28 (18-55)	24 (18-37)	27 (18-55)
18–24	26 (31.7)	100 (29.2)	9 (50.0)	26 (35.6)
25–34	41 (50.0)	176 (50.9)	8 (44.4)	35 (48.0)
35 and older	15 (18.3)	69 (19.9)	1 (5.6)	12 (16.4)
Sleep duration [hours/day] (n = 422; n = 88) [a]				
mean ± SD	7.9 ± 1.6	7.8 ± 1.6	8.3 ± 1.2	7.5 ± 1.9
median (range)	8 (4-12)	8 (1-12)	8 (6-10)	8 (1-11)
Education level (n = 426)				
Primary or lower	33 (40.2)	146 (42.4)	7 (40.2)	32 (43.8)
Secondary	25 (30.5)	118 (34.3)	2 (30.5)	21 (28.8)
High school or higher	24 (29.3)	80 (23.3)	9 (29.3)	20 (27.4)
Marital status				
Single	41 (50.0)	183 (53.0)	13 (72.2)	44 (60.3)
Not single	41 (50.0)	162 (47.0)	5 (27.8)	29 (39.7)
Smoking status (n = 425) [b]				
Non smoker	75 (92.6)	289 (84.0)	17 (94.4)	60 (82.2)
Current smoker	6 (7.4)	55 (16.0)	1 (5.6)	13 (17.8)
Alcohol use (n = 425)				
No	25 (30.9)	109 (31.7)	5 (27.8)	15 (20.5)
Yes	56 (69.1)	235 (68.3)	13 (72.2)	58 (79.5)
Number of drinks / typical drinking day (n = 424) [b]				
No drinks	25 (30.9)	109 (31.8)	5 (27.8)	15 (20.6)
1–2 drinks	35 (43.2)	98 (28.6)	9 (50.0)	28 (38.4)
3–4 drinks	18 (22.2)	107 (31.2)	4 (22.2)	22 (30.1)
5 or more drinks	3 (3.7)	29 (8.4)	0 (0.0)	8 (10.9)
Daytime napping				
No	38 (46.3)	147 (42.6)	11 (61.1)	30 (41.1)
Yes	44 (53.7)	198 (57.4)	7 (38.9)	43 (58.9)
Motorcycle ownership				
Myself	60 (73.2)	240 (69.6)	13 (72.2)	51 (69.9)
Other (family, rental, etc.)	22 (26.8)	105 (30.4)	5 (27.8)	22 (30.1)
Motorcycle registration				
No	56 (68.3)	205 (59.4)	13 (72.2)	37 (50.7)
Yes	26 (31.7)	140 (40.6)	5 (27.8)	36 (49.3)
Rider licensure				
No	67 (81.7)	287 (83.2)	17 (27.8)	66 (30.1)
Yes	15 (18.3)	58 (16.8)	1 (72.2)	7 (69.9)
Riding experience (n = 426; n = 90) [b,c]				
Less than 1 year	13 (30.9)	31 (9.0)	5 (27.8)	13 (18.1)
1–2 years	19 (43.2)	47 (13.7)	8 (44.4)	15 (20.8)
3–4 years	14 (22.2)	103 (29.9)	1 (5.6)	19 (26.4)
5 years or more	36 (3.7)	163 (47.4)	4 (22.2)	25 (34.7)

[a] Independent t-test
[b] Significant at $p \leq 0.05$ for most severe crash
[c] Significant at $p \leq 0.05$ for most recent crash within past 12 months

Table 3.3: Crash- and environmental-related characteristics of motorcycle riders, by injury status; Bamenda, Cameroon

Characteristics	Most severe crash (n = 427)		Most recent crash within past 12 months (n = 91)	
	No Injury (n = 82) n (%)	Injury (n = 345) n (%)	No Injury (n = 18) n (%)	Injury (n = 73) n (%)
Time of operation (n = 426; n = 89)				
Nighttime (7pm–10pm)	13 (16.0)	60 (17.4)	17 (16.0)	60 (83.3)
Daytime/Dusk only (6am–7pm)	68 (84.0)	285 (82.6)	0 (0.0)	12 (16.7)
Vehicle collision type (n = 425; n = 89)				
Multi-vehicle collision	53 (65.4)	210 (61.0)	12 (70.6)	42 (83.3)
Single vehicle collision	28 (34.6)	134 (39.0)	5 (29.4)	12 (16.7)
Impact collision (n = 419; n = 89) [b]				
Rear	11 (14.1)	23 (6.7)	14 (82.4)	61 (84.7)
Front	64 (82.0)	284 (83.3)	1 (5.9)	7 (9.7)
Side	3 (3.9)	34 (10.0)	2 (11.7)	4 (5.6)
Number of people on motorcycle (n = 427; n = 89)				
Driver only	42 (51.2)	160 (46.4)	11 (64.7)	38 (52.8)
1 passenger	33 (40.2)	132 (38.3)	4 (23.5)	25 (34.7)
2 or more passengers	7 (8.6)	53 (15.3)	2 (11.8)	9 (12.5)
Load was carried (n = 423; n = 89) [c]				
No	72 (87.8)	303 (88.9)	14 (82.4)	69 (95.8)
Yes	10 (12.2)	38 (11.1)	3 (17.6)	3 (4.2)
Road was paved (n = 426; n = 89)				
No	35 (42.7)	123 (35.8)	7 (0.0)	24 (16.7)
Yes	47 (57.3)	221 (64.2)	10 (16.0)	48 (83.3)
Road condition at time of crash (n = 371; n = 78)				
Other (bump, dip, oil spill, garbage)	21 (29.2)	71 (23.8)	4 (25.0)	9 (14.5)
Dust/Gravel	7 (9.7)	40 (13.4)	2 (12.5)	10 (16.2)
Mud	7 (9.7)	16 (5.3)	1 (6.2)	3 (4.8)
Pothole	37 (51.4)	172 (57.5)	9 (56.3)	40 (64.5)
Wore helmet at time of crash				
No	50 (61.0)	222 (64.4)	10 (58.8)	54 (75.0)
Yes	32 (39.0)	123 (35.6)	7 (41.2)	18 (25.0)
Estimated speed (n = 401; n = 84) [b]				
5–20km/h	24 (32.4)	80 (24.5)	6 (40.0)	23 (32.4)
25–40km/h	42 (56.8)	130 (39.7)	8 (53.3)	28 (39.4)
45+ km/h	8 (10.8)	117 (35.8)	1 (6.7)	20 (28.2)

[a] Independent t-test
[b] Significant at $p \leq 0.05$ for most severe crash
[c] Significant at $p \leq 0.05$ for most recent crash within past 12 months

Table 3.4: Unadjusted and adjusted odds ratio of motorcycle injury sustained at most severe crash; Bamenda, Cameroon

	Most severe crash (n = 427)	
Characteristics	**Unadjusted OR (95%CI)**	**Multivariate adjusted OR (95%CI)**
Age, [years]		
18–24	1.00	1.00
25–34	1.12 (0.64-1.93)	0.89 (0.39-2.00)
35 and older	1.20 (0.59-2.42)	0.67 (0.24-1.87)
Sleep duration [hours/day]	0.96 (0.82-1.11)	0.98 (0.81-1.20)
Smoking status		
Non smoker	1.00	1.00
Current smoker	2.38 (0.99-5.74)	**4.81 (1.04-22.20)**
Alcohol use		
No	1.00	1.00
Yes	0.96 (0.57-1.63)	0.78 (0.39-1.20)
Motorcycle registration		
No	1.00	1.00
Yes	1.47 (0.88-2.45)	1.86 (0.93-3.73)
Riding experience		
Less than 1 year	1.00	1.00
1–2 years	1.04 (0.45-2.40)	1.19 (0.42-3.40)
3–4 years	**3.09 (1.31-7.26)**	**4.68 (1.55-14.12)**
5 years or more	1.90 (0.91-3.98)	**3.09 (1.07-8.93)**
Time of operation		
Nighttime (7pm–10pm)	1.00	1.00
Daytime/Dusk only (6am–7pm)	0.91(0.47-1.75)	0.90 (0.37-2.22)
Collision type		
Multi-vehicle collision	1.00	1.00
Single vehicle collision	0.83 (0.50-1.37)	0.78 (0.36-1.66)
Impact collision		
Rear	1.00	1.00
Front	2.12 (0.99-4.57)	2.37 (0.90-6.24)
Side	**5.42 (1.36-21.59)**	**6.22 (1.18-32.83)**
Road was paved		
No	1.00	1.00
Yes	1.34 (0.82-2.18)	1.66 (0.77-3.61)
Road condition at time of crash		
Other (bump, dip, oil spill, garbage)	1.00	1.00
Dust/Gravel	1.69 (0.66-4.32)	1.65 (0.50-5.49)
Mud	0.68 (0.25-1.86)	0.94 (0.21-4.29)
Pothole	1.38 (0.75-2.51)	1.75 (0.80-3.82)
Wore helmet at time of crash		
No	1.00	1.00
Yes	0.87 (0.53-1.42)	0.75 (0.38-1.47)
Estimated speed		
5–20km/h	1.00	1.00
25–40km/h	0.93 (0.52-1.65)	1.09 (0.54-2.18)
45+ km/h	**4.39 (1.88-10.26)**	**4.67 (1.64-13.25)**

CI = Confidence interval
Significant increased or reduced odds are bolded

REFERENCES

1. Peden MM, Scurfield R, Sleet D, et al. *World Report on Road Traffic Injury Prevention*.; 2004. doi:10.1016/j.puhe.2005.09.003.

2. Ameratunga S, Hijar M, Norton R. Road-traffic injuries: confronting disparities to address a global-health problem. *Lancet*. 2006;367(9521):1533-1540. doi:10.1016/S0140-6736(06)68654-6.

3. World Health Organization (WHO). *Global Status Report on Road Safety 2018*. Geneva, World Health Organization; 2018.

4. World Health Organization (WHO). *Global Health Estimates 2016: Deaths by Cause, Age, and Sex 2000-2016*. Geneva, Switzerland; 2018. http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html. Accessed December 19, 2016.

5. World Health Organization (WHO). *Global Status Report on Road Safety 2015*. Geneva; 2015.

6. Murray CJL, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2197-2223. doi:10.1016/S0140-6736(12)61689-4.

7. Mathers CD, Boerma T, Ma Fat D. Global and regional causes of death. *Br Med Bull*. 2009;92(1):7-32. doi:10.1093/bmb/ldp028.

8. Chisholm D, Naci H, Hyder a. a., Tran NT, Peden M. Cost effectiveness of strategies to combat road traffic injuries in sub-Saharan Africa and South East Asia: mathematical modelling study. *Bmj*. 2012;344(mar02 1):e612-e612. doi:10.1136/bmj.e612.

9. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med*. 2006;3(11):2011-2030. doi:10.1371/journal.pmed.0030442.

10. Odero W, Garner P, Zwi A. Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. *Trop Med Int Heal*. 1997;2(5):445-460. doi:10.1111/j.1365-3156.1997.tb00167.x.

11. Raman NH, Bahharuddin KA, Mohamad SM. Burden of motorcycle-related injury in Malaysia. *Int J Emerg Med*. 2015;8:17-015-0065-4. eCollection 2015. doi:10.1186/s12245-015-0065-4 [doi].

12. Nantulya VM. The neglected epidemic: road traffic injuries in developing countries. *Bmj*. 2002;324(7346):1139-1141. doi:10.1136/bmj.324.7346.1139.

13. National Center for Statistics and Analysis. *Motorcycles: 2015 Data (Updated, Traffic Safety Facts. Report No. DOT HS 812 353)*. Washington, DC; National

Highway Traffic Safety Administration; 2017.

14. Lin MR, Kraus JF. Methodological issues in motorcycle injury epidemiology. *Accid Anal Prev*. 2008;40(5):1653-1660. doi:10.1016/j.aap.2008.05.005.

15. Blincoe L, Miller TR, Zaloshnja E, Lawrence BA. *The Economic and Societal Impact Of Motor Vehicle Crashes, 2010*. Washington, DC; 2015. doi:10631-052814-v8.

16. Ad Hoc Committee on Health Research Relating to Future Intervention Options. *Investing in Health Research and Development*. Geneva, World Health Organization; 1996. (TDR/Gen/96.2).

17. International Monetary Fund. *Regional Economic Outlook: Sub-Saharan Africa Restarting the Growth Engine*. (Allard C, Robinson D, eds.). Washington, DC: International Monetary Fund, Publication Services; 2017. http://www.imf.org/en/Publications/REO/SSA/Issues/2017/05/03/sreo0517#chap3.

18. 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). doi:10.1371/journal.pone.0148511.

19. Kauky CG, Kishimba RS, Urio LJ, Abade AM, Mghamba JM. Prevalence of helmet use among motorcycle users in Dar Es Salaam, Tanzania. *Pan Afr Med J*. 2015;20:1-7. doi:10.11604/pamj.2015.20.438.5659.

20. Sisimwo PK, Mwaniki PK, Bii C. Crash characteristics and injury patterns among commercial motorcycle users attending Kitale level IV district hospital, Kenya. *Pan Afr Med J*. 2014;19:1-7. doi:10.11604/pamj.2014.19.296.4885.

21. Olakulehin OA, Adeomi AA, Oakanbi O, Itie CJ, Olanipekun OO, Silori O. Perception and Practice of Helmet Use among Motorcycle Riders in a Semi-Urban Community in Southwestern Nigeria. *IOSR J Dent Med Sci Ver I*. 2015;14(2):2279-2861. doi:10.9790/0853-14214120124.

22. Tran TM, Fuller AT, Kiryabwire J, et al. Distribution and characteristics of severe traumatic brain injury at mulago national referral hospital in Uganda. *World Neurosurg*. 2015;83(3):269-277. doi:10.1016/j.wneu.2014.12.028.

23. Agbor AM, Chinedu AC, Ebot-Tabil B, Naidoo S. Dentofacial injuries in commercial motorcycle accidents in Cameroon: Pattern and cost implication of care. *Afr Health Sci*. 2014;14(1):77-82. doi:10.4314/ahs.v14i1.12.

24. Chichom-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C, Ngowe-Ngowe M. 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(1):915.

doi:10.1186/s12889-015-2290-4.

25. Ngaroua D, Neossi N, Amvene JM, Mefire AC, Eloundou N. Epidemiology and Pattern of Road Traffic Injuries in Ngaoundéré , Cameroon : a Retrospective Hospital Based Study Prior to the Implementation of a Formal Trauma Registry. *J Med Heal Sci*. 2014;15(June):1-8.

26. Samuel JC, Sankhulani E, Qureshi JS, et al. Under-reporting of road traffic mortality in developing countries: Application of a capture-recapture statistical model to refine mortality estimates. *PLoS One*. 2012;7(2). doi:10.1371/journal.pone.0031091.

27. Adeloye D, Thompson J, Akanbi MA, et al. The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis. *WHO Bull*. 2016;(April):1-23. doi:10.2471/BLT.15.163121.

28. Institut National de la Statistique. *Annuaire Statistique Du Cameroun*. Yaoundé, Cameroun; 2013. www.statistics-cameroon.org.

29. Townsend C, Beauchamp RD, Evers BM, Mattox KL. *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. 20th ed. (Townsend C, Beauchamp RD, Evers BM, Mattox KL, eds.). Philadelphia, PA: Elsevier Health Sciences; 2016.

30. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source Code Biol Med*. 2008;3:1-8. doi:10.1186/1751-0473-3-17.

31. Mickey RM, Greenland S. The Impact of Confounder Seleection Criteria on Effect Estimation. *Am J Epidemiol*. 1989;129(1):125-137.

32. David W. Hosmer, Jr. SL, Sturdivant RX. *Applied Logistic Regression*. 3rd ed. Hoboken, New Jersey: John Wiley & Sons; 2013.

33. Hosmer DW, Taber S, Lemeshow S. The importance of assessing the fit of logistic regression models: A case study. *Am J Public Health*. 1991;81(12):1630-1635. doi:10.2105/AJPH.81.12.1630.

34. Chalya PL, Ngayomela IH, Mabula JB, et al. Injury outcome among helmeted and non-helmeted motorcycle riders and passengers at a tertiary care hospital in north-western Tanzania. *Tanzan J Health Res*. 2014;16(4):1-10. doi:10.4314/thrb.v16i2.4.

35. Nwadiaro HC, Ekwe KK, Akpayak IC, Shitta H. Motorcycle injuries in north-central Nigeria. *Niger J Clin Pract*. 2011;14(2):186-189. doi:10.4103/1119-3077.84012.

36. Kudebong M, Wurapa F, Nonvignon J, Norman I, Awoonor-Williams JK, Aikins M. Economic burden of motorcycle accidents in Northern Ghana. *Ghana Med J*. 2011;45(4):135-142. doi:10.4314/gmj.v45i4.

37. Sufiyan M, Ahmad S. Knowledge, attitude and compliance with safety protective devices among commercial motorcyclists in Tudun-Wada Zaria, North-Western Nigeria. *Ann Niger Med*. 2012;6(2):80. doi:10.4103/0331-3131.108126.

38. Johnson O. Prevalence and pattern of road traffic accidents among commercial motorcyclists in a city in Southern Nigeria. *Educ Res*. 2012;3(June):537-542.

39. SacksJ.J., NelsonD.E. Smoking and injuries: an overview. *Prev Med (Baltim)*. 1994;23(4):515-520. doi:10.1006/pmed.1994.1070.

40. Bellew B, Winstanley M. Smoking and accidents. In: Scollo M, Winstanley M, eds. *Tobacco in Australia: Facts and Issues.* Melbourne: Cancer Council Victoria; 2011. http://www.tobaccoinaustralia.org.au/chapter-3-health-effects/3-19-smoking-and-accidents.

41. Drobes DJ. Concurrent Alcohol and Tobacco Dependence. National Institute of Alcohol Abuse and Alcoholism. https://pubs.niaaa.nih.gov/publications/arh26-2/136-142.htm. Published 2002. Accessed August 9, 2018.

42. NIAAA. Alcohol and Tobacco. *Natl Inst Alcohol Abus Alcohol*. 1998;39. https://pubs.niaaa.nih.gov/publications/aa39.htm.

43. Tchaya Z, Bandolo GM, Bassompierre L. Tramadol: Cameroon's low-budget opioid crisis. http://www.france24.com/en/20180423-focus-cameroon-tramadol-drug-opiods-crisis-schools-education-rehab-addiction.

44. Melo N. Cameroon: Alarming consumption of tramadol in the North West Region. http://www.cameroon-info.net/article/cameroon-alarming-consumption-of-tramadol-in-the-north-west-region-297690.html. Published 2017. Accessed July 17, 2018.

45. Mbonwoh N. Cameroon: "Tramadol Is a Social Malaise." January 2018. https://allafrica.com/stories/201801300214.html.

46. Rutter DR, Quine L. Age and experience in motorcycling safety. *Accid Anal Prev*. 1996;28(1):15-21. doi:10.1016/0001-4575(95)00037-2.

47. Mullin B, Jackson R, Langley J, Norton R. Increasing age and experience: are both protective against motorcycle injury? A case-control study. *Inj Prev*. 2000;6(1):32-35. doi:10.1136/ip.6.1.32.

48. Chang HL, Yeh TH. Motorcyclist accident involvement by age, gender, and risky behaviors in Taipei, Taiwan. *Transp Res Part F Traffic Psychol Behav*. 2007;10(2):109-122. doi:10.1016/j.trf.2006.08.001.

49. Chukwugozi RP. Assessment of Public Enlightenment Programme on Crash Helmet Usage among Motorcyclists in Akure Metropolis , Nigeria. *Bri J Arts Soc Sci*. 2014;18(I):1-9.

50. Konings P. Solving Transportation Problems in African Cities : Innovative

Responses by the Youth in Douala , Cameroon. *Afr Today*. 2006;53(1):35-50.

51. Sexton B, Baughan C, Elliott M, Maycock G. *The Accident Risk of Motorcyclists*. Crowthorne, England; 2004. doi:TRL607.

52. Bhatti J a, Sobngwi-Tambekou J, Lagarde E, Salmi L-R. Situational factors associated with road traffic crashes: a case-control study on the Yaoundé-Douala road section, Cameroon. *Int J Inj Contr Saf Promot*. 2010;17(January 2015):215-222. doi:10.1080/17457301003728510.

53. Tay R, Rifaat SM. Factors contributing to the severity of intersection crashes. *J Adv Transp*. 2007;41(3):245–265. doi:10.1002/atr.5670410303.

54. Choi E-H. Crash factors in intersection-related crashes: an on-scene perspective. 2010;(September):37. doi:http://dx.doi.org/10.1037/e621942011-001.

55. Lin MR, Kraus JF. A review of risk factors and patterns of motorcycle injuries. *Accid Anal Prev*. 2009;41(4):710-722. doi:10.1016/j.aap.2009.03.010.

56. Deogratias E, Indupuru VK, Hovey P. Identification of Risk Factors Associated with Motorcycle-Related Fatalities in Ohio. *J Transp Eng*. 2011;137(7):474-480. doi:10.1061/(ASCE)TE.1943-5436.0000229.

57. Garrison HG, Mckay MP, Gotschall CS, Newgard CD. *Recent Trends in Fatal Motorcycle Crashes: An Update*. Vol 50.; 2007. doi:10.1016/j.annemergmed.2007.06.010.

58. Shibata A, Fukuda K. Risk factors of fatality in motor vehicle traffic accidents. *Accid Anal Prev*. 1994;26(3):391-397. doi:https://doi.org/10.1016/0001-4575(94)90013-2.

59. Yannis G, Golias J, Papadimitriou E. Driver age and vehicle engine size effects on fault and severity in young motorcyclists accidents. *Accid Anal Prev*. 2005;37(2):327-333. doi:10.1016/j.aap.2004.10.003.

60. Rajesh R, Srinath R, Sasikumar R, Subin B. Modeling safety risk perception due to mobile phone distraction among four wheeler drivers. *IATSS Res*. 2016. doi:10.1016/j.iatssr.2016.08.002.

61. Mohan D, Tiwari G, Khayesi M, Nafukho FM. Road traffic injury prevention training manual. 2006:1-126.

62. Staton C, Vissoci J, Gong E, et al. Road traffic injury prevention initiatives: A systematic review and metasummary of effectiveness in low and middle income countries. *PLoS One*. 2016;11(1):1-15. doi:10.1371/journal.pone.0144971.

CHAPTER 4: PATTERNS, SEVERITY, AND POST-CRASH MANAGEMENT OF INJURIES AMONG COMMERCIAL MOTORCYCLE RIDERS IN BAMENDA, CAMEROON

ABSTRACT

Background: The aim of this paper was to provide an overview of patterns, severity, and post-crash management of injuries among commercial motorcycle riders in Bamenda, Cameroon.

Methods: A population-based cross-sectional study was conducted among consented commercial motorcycle riders in Bamenda, Cameroon. Data were collected from July 12 to 26, 2017. Riders were administered a questionnaire to collect information on sociodemographic and injury characteristics for their most severe and most recent crash within the past 12 months.

Results: Among the 427 commercial motorcycle riders who reported a most severe crash, 80.8% sustained one or more anatomic injuries, totaling 685 injuries. Among 91 riders who reported a most recent crash within the past 12 months, 80.2% sustained one or more anatomic injuries for a total of 112 injuries. Overall, common reported injury types were abrasions, lacerations, and swellings to the head, neck, and extremity anatomic regions. The mean injury severity score (ISS) of injured riders at the most severe crash was 4.0 (SD = 4.3; range = 1 – 26) and for the most recent crash within the past 12 months the mean ISS was 3.6 (SD = 4.0; range = 1 – 21). Compared to riders with minor injuries, more severely injured riders who reported a most severe crash had lower education ($p = 0.027$), sought post-crash care at a medical facility ($p < 0.001$), and incurred longer hospitalization ($p < 0.001$) and higher treatment expenses ($p < 0.001$). Additionally, severely injured riders had higher property damage and associated costs. Riders with severe injuries sustained at the most recent crash within the past 12 months were more likely to get admitted to a medical facility ($p = 0.025$)

and incur higher treatment expenses (p = 0.048). In general unemployment after a crash was more likely among riders who sustained severely injuries than among riders with minor injuries.

Conclusion: Although most reported injuries were non-life-threatening, such injuries strengthened with unmet post-crash care services impose high social, psychological, and economic burdens on injured riders and their household. Findings from this study suggest the need for an assessment of human, vehicle, and environmental factors towards commercial motorcycle-related injury and a comprehensive evaluation of post-crash care services.

INTRODUCTION

Few studies have examined the patterns and types of injuries sustained by commercial motorcyclists involved in crashes despite the high associative fatality rates. While a few conducted studies have focused on hospitalized motorcyclists and fatalities, none have focused on commercial motorcycle riders who suffered from non-life threatening injuries and did not seek medical care.

Motorcycle crash-related morbidity and mortality are highest compared to other types of vehicle road users.[1] Motorcyclists are at high risk of head, neck, face, and traumatic brain injuries from road traffic crashes.[2–5] Motorcyclists lack external protection provided by vehicle structure, have no internal protection from air bags and seat belts, have an increased likelihood to be ejected in a collision, and are relatively unstable when operating on different riding surfaces at high speeds.[6] Inadequate road infrastructure, speeding, alcohol or psychoactive drug use, inadequate protective gear, ineffective traffic regulations and laxative enforcement, and insufficient safety training have been identified as underlying factors irrespective of location and injury severity.[7]

Motorcycle riders often sustain multiple head and extremity injuries when involved in a crash.[7–9] The head and extremities are often the first point of anatomic contact with an object after motorcycle ejection.[10,11] Head injuries are often fatal while extremity injuries can be severe. The degree of injury severity depends on a combination of specific factors (human, vehicle, and environment) that present during the pre-crash, crash, and post-crash phases. Regrettably, the underdeveloped post-crash care systems in LMICs may increase injury severity. The lack of emergency medical services or inaccessibility to medical services can reduce rider's recovery.[1] In

many LMICs, few crash victims receive any treatment at the scene and fewer even hope to be transported to a medical facility when severely injured.[12] In sub-Saharan Africa, any first-aid or transportation of injured victims to a treatment facility is often provided by untrained bystanders or other commercial motorcycle riders which at times involves a sandwich of the victim between a rider and another person for stabilization on a motorcycle. Paradoxically, post-crash care offered by untrained personnel to save a life and reduce injury severity may at times result in serious neurological damage during extrication process or transportation without adequate immobilization.[13]

In addition to morbidity and mortality, RTIs impose enormous financial, social, and psychological burdens on the well-being of individuals, households, and the society.[5] Most commercial motorcycle riders are male and family financial providers. [14] Injury upon family financial providers can result in catastrophic casualty-related costs (i.e., loss of earnings, medical bills, and funeral cost) and property damage. For some injured victims, local drug stores or traditional African medicine are the only affordable and available treatment options.

In many sub-Saharan cities, the priority of reducing road traffic crashes and injuries especially among commercial motorcycle riders has been prevention. While an important step to mitigate the high rates of RTIs, the reality is that crashes and injuries will continue to occur on Africa's roads. Although some motorcycle riders may escape uninjured after a crash, most do sustain injuries which range from minor to critical. In sub-Saharan Africa, many road traffic fatalities occur at the scene or prehospital phase.[15] Many of these road traffic fatalities are preventable. Due to the lack of proper post-crash care systems in many sub-Saharan cities, the consequences of crashes

among commercial motorcycle riders often lead to severe physical injuries, disabilities, or death.[16,17] The continuum of events that transpire after a crash determines the chances of survival and the quality of life of the injured motorcycle rider. Even though LMICs are shifting towards time-interval diseases, their post-crash care systems are not prepared for the dynamic shift. Post-crash care services are ever more needed. Instituting effective and efficient post-crash care delivery systems is therefore essential in mitigating injury severity and improving the quality of life of crash survivors.[18]

Several research studies conducted in LMICs have used hospital records to assess the degree of injury severity among different type of road users.[19–22] While these studies have provided relevant information about injury severity, the use of hospital records pose challenges of incompleteness given they are not designed to be comprehensive surveillance systems.[23] Motorcycle riders with severe injuries tend to seek medical care and may be included in hospital records while those without injuries, minor injuries, or who die at the scene may not. Additionally, high out-of-pocket payments as the sole payment mechanism for healthcare services in many sub-Saharan Africa countries prevent many injured persons from seeking medical care.[24,25] Consequently, crash data records are nonexistent for lower injury severities.

The aim of this paper is to provide an overview of patterns, severity, and post-crash management of injuries among commercial motorcycle riders in Bamenda, Cameroon. Riders were asked information about their most severe crash and the most recent crash within the past 12 months. The introduction of population based surveys present an alternative approach to collect information on types and patterns of motorcycle-related injuries especially those that hospital records fail to capture.

METHODS

Study Design and Population

A cross-sectional study collected data from commercial motorcycle riders in Bamenda, Cameroon from July 12 to 26, 2017. Motorcycle riders were interviewed Tuesday through Saturday during non-business rush hours between 10am and 4pm. To be eligible, participants had to be a commercial motorcycle rider, be aged 18 years or older, operate within the city of Bamenda, and have the ability to provide informed consent in pidgin or English. Commercial motorcycle riders were recruited from 15 major road intersections across the city and from two market places within the city. Data were collected by five trained interviewers using an electronic questionnaire via computer assisted personal interview. This study defined a motorcycle as a two-wheeled motor vehicle and a commercial motorcycle rider as a person who operates a motorcycle and transports passengers for a fare.[26] The most severe crash was defined as the worst crash the participant ever had on a commercial motorcycle.

Measures

Sociodemographic, injury, and post-crash information were obtained for the most severe crash and the most recent crash within the past 12 months. The most severe crash was defined as the worst crash the motorcycle rider was ever involved in operating as a commercial motorcycle rider. If riders had multiple crashes, they provided information for what they perceived as the most severe crash. Additional information was obtained for riders who had a recent crash within the past 12 months. If riders had multiple crashes within the past 12 months, information about the most recent crash was obtained. In the case where the most severe crash was also the most

recent crash, this event was classified as both the most severe and the most recent crash within the past 12 months. Sociodemographic included gender, age, educational level (primary or lower, secondary, high school or higher), smoking status (current smoker or nonsmoker), alcohol use (yes or no), and sleep duration (number of hours).

Injury characteristics included anatomic injury patterns and severity. Details about the type of injury sustained (e.g., abrasion, laceration, sprain, fracture, swelling, concussion, whiplash, or blunt) and the injured anatomic region (head and neck, face, chest, abdomen, extremities, and external) were collected from participants involved in a crash during commercial motorcycle ridership. The severity of each injury was documented using two standardized measures; the Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS).[27,28] Each self-reported injury type was carefully assigned an ordinal AIS score from the AIS-90 coding dictionary.[29] Scores ranged from 1 to 6 and were categorized as; (minor = 1, moderate = 2, serious = 3, severe = 4, critical = 5, and maximal = 6).[30] In participants with multiple injuries, the maximum AIS was retained for each anatomic region. [30] Injury severity scores were derived as the sum of the squared AIS values of the three most severely injured anatomic regions. The ISS is an ordinal scale which ranges from 1 to 75. In this study, ISS was categorized as injury severity; (minor = 1-3, severe = 4-75). An injury was considered minor if it required little or no treatment and no hospitalization or bed rest (e.g. abrasions and sprains). An injury was defined as severe if it required medical treatment, hospitalization, and bed rest (e.g. lacerations, fractures, and concussions). Fatalities were not included in this study. Riders were considered uninjured if they did not report an injury related to a crash.

Information about post-crash care and property damage included the type of treatment received, pre-treatment delay (within an hour, within a day, after a day), whether surgery was performed, whether admitted to medical facility (hospital, clinic, health center), length of stay in medical facility, treatment costs, payment mechanism for treatment, loss of personal possessions, whether unemployed as result of crash, whether motorcycle was reparable, and cost of motorcycle repairs.

The current study was reviewed and approved by three institutional review boards; the University of California San Diego Human Research Protections Program in the United States (Project # 161701SW), the Bamenda Regional Hospital Institutional Review Board and the Provincial Delegate's Office for Ministry of Health (No. 382/NWR/RDPH) in Bamenda Cameroon.

Statistical analyses

Information of riders without injury status was not analyzed. Demographic and injury characteristics among motorcycle riders were assessed for differences by using the Pearson's Chi-square test, Fisher's Exact test, or independent t-test where appropriate. Comparisons across groups by injury severity were examined using the independent t-test for continuous variables and the Pearson's Chi-square and Fisher's Exact tests for categorical variables. All analyses were conducted using Statistical Package for the Social Science (SPSS) version 21 (Chicago, IL: SPSS Inc.) and Statistical Analysis Software (SAS), version 9.3 (SAS Institute, Inc., Cary, NC). Statistical significance was set at $p \leq 0.05$.

RESULTS

Population Characteristics

Information from 552 consenting motorcycle riders was obtained about any injuries sustained in the most severe crash and the most recent crash within the past 12 months as presented in Figure 4.1. All riders were male. A total of 427 (77.4%) riders were involved in at least one motorcycle crash during their lifetime as a commercial motorcycle rider. The mean age of injured riders for the most severe crash was 29 years (SD = 7, range = 18–55) with 51% of them aged 25–34 years. Furthermore, riders were asked if they were injured in a crash within the past 12 months. A total of 73 riders reported sustaining an injury within the past 12 months. Their mean age was 28 years (SD = 8, range = 18–55) with 48% of them aged 25–34 years.

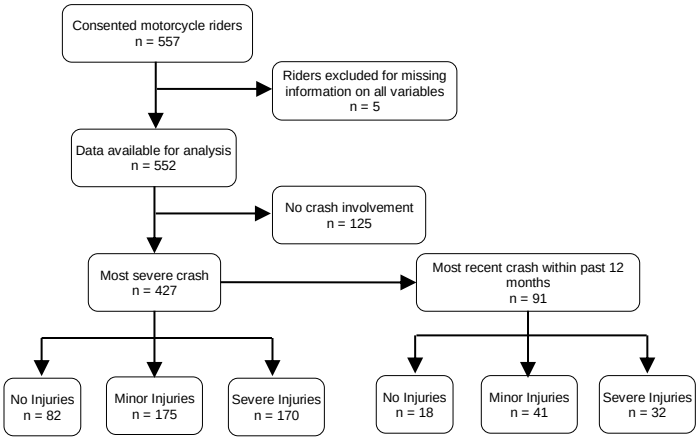


Figure 4.1: Crash and injury events of commercial motorcycle riders in Bamenda, Cameroon

Injury Prevalence and Severity

The most severe crash: As reported, 345 (80.8%) riders sustained one or more anatomic injuries amounting to 685 injuries. The average ISS of injured riders at the most severe crash was 4.0 (SD = 4.3; range = 1–26). Among all injured riders, 170 (49.3%) sustained severe anatomic injuries for a total of 445 (65%) injuries. Severely injured riders had significant lower education than those with minor injuries (p = 0.027).

The most recent crash within the past 12 months: Among the 427 riders reporting a crash, 91 reported their most recent crash happened within the past 12 months. Furthermore, 73 (80.2%) riders sustained one or more anatomic injuries at the most recent crash within the past 12 months for a total of 112 injuries. Of these riders, 32 (43.8%) sustained severe anatomic injuries for a total of 65 injuries. The average ISS of injured riders at the most recent crash within the past 12 months was 3.6 (SD = 4.0; range = 1–21). Riders classified with a severe injury were significantly older ($p < 0.001$), slept longer ($p < 0.001$) on average, and had a lower education ($p = 0.037$) than riders with a minor injury.

Anatomic Injury Patterns

Figure 4.2 depicts a distribution of minor and severe anatomic injuries sustained by commercial motorcycle riders from the most severe crash and the most recent crash within the past 12 months.

The most severe crash: A majority of reported injury incidents (65%) were classified as severe. Overall, most injury occurrences were to the lower extremity (48%), upper extremity (26.4%), and the head and neck (15.2%) anatomic regions. The most frequent types of injuries sustained were abrasions (45%), swellings (16.4%), and lacerations (15.4%), irrespective of injury severity.

The most recent crash within the past 12 months: Similarly, most reported injuries in the past 12 months had an injury severity rating of severe. Irrespective of injury severity, most injury occurrences were to the anatomic regions of the lower extremity (49.1%), upper extremity (26.8%), and the head and neck (16.1%) with abrasions (53.6%), swellings (17%), and lacerations (14.3%) being the most frequent types of

injuries sustained.

Potential differences between injuries sustained at the most severe crash and the most recent crash within the past 12 months were explored given that occurrences of reported severe crashes were not always within the same time frame. There were no significant differences between the distribution and anatomic pattern of injuries sustained at the most severe crash and the most recent crash within the past 12 months.

Post-crash Management

Indicators of post-crash management for the most severe crash and the most recent crash within the past 12 months are presented in Table 4.1. In this study, post-crash management encompassed activities carried out at the crash scene, medical or treatment facility, and damage assessment.

The most severe crash: There were significant post-crash management differences between riders who sustained severe injuries and those with minor injuries. Most injured riders sought medical treatment after the crash incident, with over a half of them being severely injured (61.6%; $p < 0.001$). Although a total of 68% of injured riders sought treatment within the first hour after the crash, there were no significant differences by injury status. As expected, most injured riders admitted to a medical facility sustained severe injuries ($p = 0.006$). Their average length of stay at the medical facility was 15.6 days (SD = 25.4; range =1–120 days), almost five times longer than riders with minor injuries. Overall, very few riders had surgery with all of them classified as having a severe injury ($p = 0.023$). On average, the treatment cost of severely injured riders was over five times higher than that of riders with minor injuries ($p =$

0.008), with most paying out-of-pocket.

Property damage has been used in some studies as a measure of crash severity or social and economic burden.[31–33] Overall, most injured riders did not lose personal possessions at the scene of the crash; about 57.9% of severely injured riders lost personal possessions compared to riders with minor injuries ($p = 0.045$). Overall motorcycles of most injured riders were repairable, although 65.7% of motorcycles operated by the severely injured were unrepairable compared to those of riders with minor injuries ($p < 0.001$). On average, severely injured riders spent twice as more in motorcycle repair cost compared to riders who sustained minor injuries ($p < 0.001$). Finally, twice as many severely injured riders became unemployed due to injuries and/or property damage ($p < 0.001$).

The most recent crash within the past 12 months: An examination of post-crash indicators among injured riders for the most recent crash within the past 12 months showed that more severely injured riders in comparison to riders with minor injuries were admitted to a medical facility ($p = 0.025$), paid eight times higher for treatment cost ($p = 0.048$), lost more personal possessions at the crash scene ($p = 0.001$), and were more likely to be unemployed due to injuries and/or property damage ($p = 0.022$).

DISCUSSION

Findings from this study showed that most sustained injuries were to the extremities and head and neck anatomic regions. Abrasions, swellings, and lacerations were the most common type of injuries sustained. As expected, severely injured riders sustained more anatomic injuries than riders with minor injuries. Demographic and post-crash management indicators identified in this study showed that, in comparison

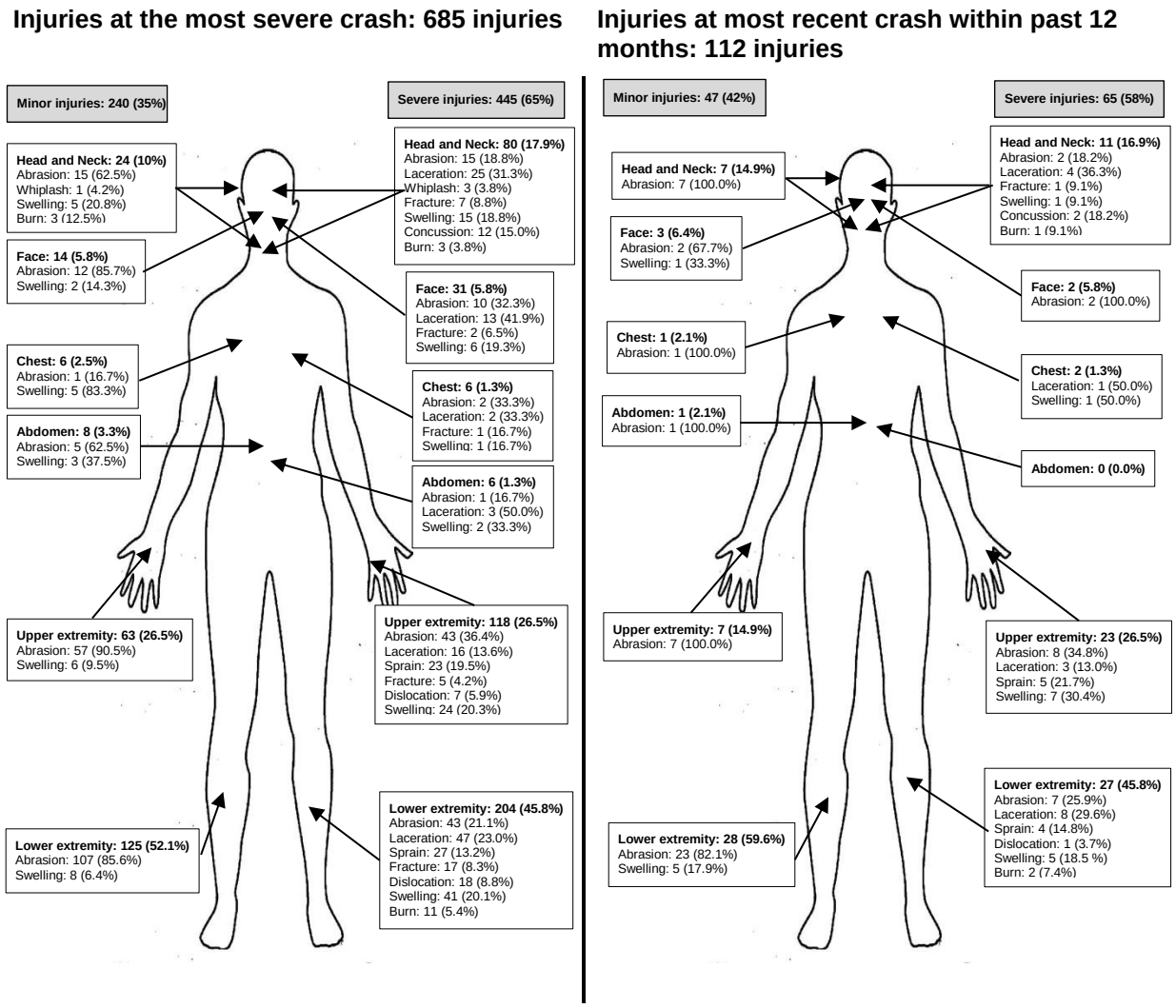


Figure 4.2: Anatomic distribution of minor and severe injuries among riders

with minor injured riders, those who sustained severe injuries as reported in their most severe crash had a lower education, slept slightly longer on average, had longer stay at a medical facility when admitted, and incurred higher out-of-pocket treatment expenses. Severely injured riders were also likely to lose personal possessions at the crash scene, spend more on motorcycle repairs, and become unemployed as a result of their injuries. In addition, riders who sustained severe injuries for the most recent crash within the past 12 months were more likely to get admitted to a medical facility,

had higher treatment expenses, and became unemployed due to their injuries.

In this study, abrasions, lacerations, and swellings were the most recurrent injury types which occurred at three anatomic regions; head and neck, upper extremity, and lower extremity. These findings are consistent with those from several other studies that examined injury severity patterns among motorcycle riders. [2,4,7,19,34–37] These findings are concerning but not surprising considering that 222 (64.3%) of the 345 injured riders in this study reported not wearing a helmet at the most severe crash (54 out of 73 injured riders did not wear a helmet for the most recent crash within the past 12 months). Non-life threatening injuries to the extremities continue to be the leading cause of morbidity and loss of productivity among motorcycle riders while head injuries remain the leading cause of death.[2,9,38,39] Furthermore, non-helmeted riders are more likely to sustain head-related injuries than helmeted riders.[40,41]

The lower frequency of head and neck injuries among riders may be paradoxical given that most riders do not wear a helmet. This study did not account for riders who died at the scene or may have suffered from disabilities that prevent them from operating as a commercial motorcycle rider. Additional research is required to account for all levels of injury severity. In this study, most injuries sustained were non-fatal to the extremities and frequently abrasions, lacerations, and swellings. A previous study showed that about 30-70% of riders involved in motorcycle crashes had injuries to the lower extremity.[7] Although helmet use was very low among injured riders; several studies across different populations have confirmed the protective benefits from proper helmet use.[42–44] Similarly, riders who wear protective clothing and have installed crash bars on their motorcycle may be less susceptible to severe extremity injuries.[20,23]

Injured riders who sustained life-threatening injuries or who were pronounced dead at the scene were not included in this study which may have introduced a fatality bias. Such information was not possible to collect considering riders with higher levels of injury severity may no longer operate as commercial motorcycle riders. However, the fact that this study was able to provide an injury profile of the injured riders and not just the number of injured riders has added implications to post-crash management.

Some studies show lower education is associated with higher risk of injury.[45,46] Motorcycle riders with higher education may be more cautious on the road. This study showed that severely injured riders were more likely to have a lower education compared to riders with a minor injury. Anecdotal evidence suggests that a majority of commercial motorcycle riders operate without the required rider training, education, and license. Commercial motorcycle riders do not value a license as an endorsement of completing the satisfactory requirements to safely operate a motorcycle; rather view it as a source of government revenue. The lack of formal training and licensure in Bamenda suggest a laxity to traffic safety policies and law enforcement. This has instigated a phenomenon whereby riders acquire skills by trial-and-error or by self-learning. Formal training to operate a motorcycle on a public road is a skillset required by all riders irrespective of their education level.

Trauma experts consider that the first 60 minutes after a crash, referred to as the “golden hour” is the most effective period of saving lives or reducing injury severity.[13,47] Although not significantly different but expected, more riders with severe injuries sought treatment in a timely manner compared to riders with minor injuries. Another study conducted in Limbe, Cameroon showed that 72% of RTI patients sought

treatment at the regional hospital within the golden hour.[48] Among the severely injured riders who sought medical treatment, 12.6% did not present within the first hour. Interestingly, seven riders with a severe injury sought traditional African medicine.

An examination of post-crash indicators in this study showed higher health and financial burdens among riders with severe injuries. In this study, about two-thirds of severely injured riders who provided information for the most severe crash sought treatment at a medical facility for which they paid a higher treatment cost and stayed longer, on average, when admitted. However, most severely injured riders who reported a crash within the past 12 months sought treatment at a local drugstore or were self-medicated. These findings highlight the undisputed need for an adequate post-crash care system and a revision of the current fee-for-service payment model for medical services used in Cameroon. Some of the current barriers to post-crash care management in Bamenda, Cameroon are the general absence of post-crash care services to injured riders or when available, the involvement of untrained bystanders, chaotic scenes with lack of coordination, rudimentary emergency medical services, poor road infrastructure, and poor hospital-based care. Many injured riders will resort to self-medication, drugstore consultation, and traditional African medicine due to economic constraints.[49] An evaluation of emergency care in Yaoundé (the capital of Cameroon) indicated that only 7% of persons with emergency conditions used emergency units citing high cost as the primary reason for not seeking emergency services. [50] In addition, these emergency services are provided by the French Service d'Aide Médicale Urgente (SAMU) prepaid system with human and physical resource challenges.[50]

Loss of valuables, property damage, cost of repairs, medical cost, and loss of productivity are some of the indicators used to assess crash cost burden. These measurements can be used to inform motorcycle riders of the value in safe ridership. Likewise, local transportation and insurance stakeholders can be informed of economic benefits from a comprehensive crash cost assessment. In this study, about a quarter of injured riders lost valuable possessions at the crash scene and required motorcycle repairs. Severely injured riders spent twice as much, on average, for repairs compared to riders with minor injuries. Immediately after a crash, victims are often disoriented and thieves sometimes pose as bystanders willing to provide first aid but steal the personal possessions of crash victims. This is even more common among the critically injured. Insurance companies in Cameroon sometimes may not honor their contracts, thereby forcing the injured riders to negotiate about vehicle repairs at the crash scene rather than seek urgent post-crash medical care. Crashes and injuries impose high direct and indirect costs added to the psychological and social burden of injured riders and their household. To cover some of the incurred cost, some injured riders may resort to borrowing, using savings, and/or selling assets, which results in additional financial stress.

There are a few limitations to the current study. First, all information obtained from riders at the most severe crash and the most recent crash within the past 12 months were self-reported and could not be independently validated. This raises the possibility of recall bias. Some riders may fail to recall specific details if the most severe crash event was not recent or if the crash event or sustained injury impaired their memory. Additionally, riders with more than one self-evaluated severe crash may

inaccurately recall details from one crash or confuse specifics from one event with another. Second, it is possible that some riders may have unknowingly underreported their injuries. Considering riders' low education level and that some did not seek medical attention after the most severe crash, internal injuries were not reported. Moreover self-evaluated minor injuries tend to be misclassified compared to severe injuries which may be assessed by a medical practitioner. Third, reported injuries were assumed to have fully developed at the time of the most severe crash and were limited to surviving riders. This study did not account for injuries developed after the crash due to inefficient post-crash medical care. Fourth, the current study obtained injury type from a questionnaire and assigned scores to each type of injury for the computation of injury severity scores (ISS). Every effort was made to accurately code injuries. A general limitation of the ISS is that it considers only the worst injury per anatomic region, is unable to evaluate multiple injuries in the same anatomic region, and does not account for any pre-existing medical conditions. Furthermore, only external injuries were considered in this study. The current study categorized injury severity into minor (requiring little or no treatment and no hospitalization or bed rest) and severe (requiring medical treatment, hospitalization, and bed rest) which may have led to misclassification of injury severity depending on the assigned ISS. Finally, the results of this study are not generalizable to commercial motorcycle riders killed at the scene of the crash.

In spite of the limitations, there are several strengths to this study. This is the first population based cross-sectional study that sought to identify and examine anatomic patterns, severity, and post-crash management of injuries among commercial

motorcycle riders in Bamenda, Cameroon. Most importantly, this study obtained information about injury types and severity which could not be obtained otherwise given the lack of surveillance systems, police reports, insurance records, and hospital records. Although not a primary focus of the paper, this paper points out the need for basic but effective post-crash care systems that can significantly reduce the burden of death from RTIs.

This study offers additional insight into injury severity and the anatomic distribution of injuries among commercial motorcycle riders in Bamenda, Cameroon. Previous studies have used hospital records to assess injury severity among commercial motorcycle riders in other Cameroonian cities.[22,36,51] Because hospital records may exclude minor injuries it is important to combine different data sources with the ability to investigate and compare important standardized injury and post-crash characteristics which are not ordinarily available. Although most of the study participants sustained non-life-threatening injuries, findings from this study highlight the need for additional evaluation of human, vehicle, and environmental factors affecting commercial motorcycle injury severity. Non-life-threatening injuries will continue to be the leading cause of morbidity among commercial motorcycle riders, if unaddressed. With an unprecedented increase in the number of motorcycle-related injuries, disability, and mortality, this paper suggests the importance of a comprehensive assessment of the unmet post-crash care needs that form an integral part of mitigation efforts towards greater levels of injury severity and premature death from RTIs.

Acknowledgments

Chapter 4, in full, is currently being prepared for publication of the material. Co-

authors include Alcaraz, John; Shaffer, Richard; Stockman, Jamila; Al-Delaimy, Wael; Hill, Linda. The dissertation author is the primary author of this material. This work was supported by the Inamori Fellowship Program [2017]; the University of California San Diego (UCSD) International Institute [2017]; and the UCSD Global Health Institute [2017]. These organizations had no involvement in the study design; collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication.

Table 4.1: Post-crash indicators of commercial motorcycle riders, by injury severity; Bamenda, Cameroon

Characteristic	Most severe crash			Most recent crash within past 12 months		
	Minor injury (n = 175) n (%)	Severe injury (n = 170) n (%)	*p*-value	Minor injury (n = 41) n (%)	Severe injury (n = 32) n (%)	*p*-value
Type/location of treatment (n = 340; n = 69)			<0.001			0.323
No treatment	39 (90.7)	4 (9.3)		9 (69.2)	4 (30.8)	
Self-medicated	53 (63.1)	31 (36.9)		20 (55.6)	16 (44.4)	
Traditional African medicine	0 (0.0)	7 (100.0)		5 (41.7)	7 (58.3)	
Medical facility	79 (38.4)	127 (61.6)		2 (100.0)	0 (0.0)	
Pre-treatment delay (n = 292; n = 49)			0.504			0.299
Within an hour	108 (46.0)	127 (54.0)		19 (54.3)	16 (45.7)	
Within a day	19 (40.4)	28 (59.6)		5 (0.0)	7 (100.0)	
After a day	3 (30.0)	7 (70.0)		2 (100.0)	0 (0.0)	
Admission to medical facility (n = 205; n = 24)			<0.001			0.025
Yes	16 (22.5)	55 (77.5)		1 (14.3)	6 (85.7)	
No	63 (47.0)	71 (53.0)		11 (64.7)	6 (35.3)	
Length of stay at medical facility (n = 67; n = 7) *			0.009			0.484
mean ± SD	3.4 ± 3.0	15.9 ± 25.4		1.0 ± 1.0	15.8 ± 18.2	
median (range)	2 (1-10)	7 (1-120)		1 (1-1)	7 (2-45)	
Surgery performed (n = 206; n = 25)			0.023			
Yes	0 (0.0)	8 (100.0)		0 (0.0)	0 (0.0)	
No	79 (39.9)	119 (60.1)		12 (48.0)	13 (52.0)	
Cost of medical treatment [1000frs] (n = 202; n = 24) *			<0.001			0.048
mean ± SD	14.88 ± 20.43	80.65 ± 212.16		8.54 ± 13.85	73.14 ± 100.5	
median (range)	7 (0.6-120)	17.32 (1.5-200)		3 (1.8-50)	28.93 (1-280)	
Payment mechanism for treatment (n = 296; n = 48)			0.398			0.502
Out of pocket	129 (44.6)	9 (55.4)		24 (53.3)	21 (46.7)	
Insurance	2 (28.6)	5 (71.4)		1 (33.3)	2 (66.7)	
Loss of personal possession (n = 344; n = 70)			0.045			0.001
Yes	40 (42.1)	55 (57.9)		1 (10.0)	9 (90.0)	
No	135 (54.2)	114 (45.8)		39 (65.0)	21 (35.0)	
Motorcycle was reparable (n = 344; n = 69)			0.038			0.433
Yes	163 (52.7)	146 (47.3)		35 (58.3)	25 (41.7)	
No	12 (34.3)	23 (65.7)		4 (44.4)	5 (55.6)	
Cost of motorcycle repair [1000frs] (n = 298; n = 60)			<0.001			0.117
mean ± SD	7.25 ± 9.93	15.04 ± 17.62		6.27 ± 7.3	9.95 ± 10.33	
median (range)	3.5 (0-60)	10 (0-120)		3 (0-30)	6.5 (0.7-45)	
Unemployed due to injury (n = 345; n = 71)			<0.001			0.022
Yes	52 (33.8)	102 (66.2)		9 (37.5)	15 (62.5)	
No	123 (64.4)	68 (35.6)		31 (66.0)	16 (34.0)	

* Independent t-test
Covariate significant at $p \leq 0.05$

REFERENCES

1. Nantulya VM. The neglected epidemic: road traffic injuries in developing countries. *Bmj*. 2002;324(7346):1139-1141. doi:10.1136/bmj.324.7346.1139.

2. Ankarath S, Giannoudis P., Barlow I, Bellamy M., Matthews S., Smith R. Injury patterns associated with mortality following motorcycle crashes. *Injury*. 2002;33(6):473-477. doi:10.1016/S0020-1383(02)00048-7.

3. Akaateba MA, Amoh-Gyimah R, Yakubu I. A cross-sectional observational study of helmet use among motorcyclists in Wa, Ghana. *Accid Anal Prev*. 2014;64:18-22. doi:10.1016/j.aap.2013.11.008.

4. Agbor AM, Chinedu AC, Ebot-Tabil B, Naidoo S. Dentofacial injuries in commercial motorcycle accidents in Cameroon: Pattern and cost implication of care. *Afr Health Sci*. 2014;14(1):77-82. doi:10.4314/ahs.v14i1.12.

5. Mohan D, Tiwari G, Khayesi M, Nafukho FM. Road traffic injury prevention training manual. 2006:1-126.

6. Blincoe L, Miller TR, Zaloshnja E, Lawrence BA. *The Economic and Societal Impact Of Motor Vehicle Crashes, 2010*. Washington, DC; 2015. doi:10631-052814-v8.

7. Lin MR, Kraus JF. A review of risk factors and patterns of motorcycle injuries. *Accid Anal Prev*. 2009;41(4):710-722. doi:10.1016/j.aap.2009.03.010.

8. Kraus JF, Rice TM, Peek-Asa C, McArthur DL. Facial trauma and the risk of intracranial injury in motorcycle riders. *Ann Emerg Med*. 2003;41(1):18-26. doi:10.1067/mem.2003.1.

9. Kraus JF. Epidemiology of head injury. In: Cooper PR, ed. *Head Injury*. 2nd ed. Baltimore, MD: Williams & Wilkins; 1989:1-19.

10. Chalya PL, Ngayomela IH, Mabula JB, et al. Injury outcome among helmeted and non-helmeted motorcycle riders and passengers at a tertiary care hospital in north-western Tanzania. *Tanzan J Health Res*. 2014;16(4):1-10. doi:10.4314/thrb.v16i2.4.

11. Raman NH, Bahharuddin KA, Mohamad SM. Burden of motorcycle-related injury in Malaysia. *Int J Emerg Med*. 2015;8:17-015-0065-4. eCollection 2015. doi:10.1186/s12245-015-0065-4 [doi].

12. Sasser S, Varghese M, Kellermann A, Lormand J. *Prehospital Trauma Care Systems*. Geneva, World Health Organization; 2005.

13. Bigdeli M, Khorasani-Zavareh D, Mohammadi R. Pre-hospital care time intervals among victims of road traffic injuries in Iran. A cross-sectional study. *BMC Public Health*. 2010;10. doi:10.1186/1471-2458-10-406.

14. Yakubu AT. Determinants of Earnings among Commercial Motorcycle Operators in Kwara State , Nigeria. *Int J Econ Manag Sci*. 2012;2(2):11-17.

15. Schlottmann F, Tyson AF, Cairns BA, Varela C, Charles AG. Road traffic collisions in Malawi: Trends and patterns of mortality on scene. *Malawi Med J*. 2017;29(4):301-305. doi:10.4314/mmj.v29i4.4.

16. World Health Organization (WHO). Post-Crash Response. 2016.

17. Nkemtendong Tolefac P, Njamen Nana T, Mefire Chichom A, et al. Challenges in Emergency Medical Services in a ResourceLimited Setting in Sub-Sahara Africa; Perspectives from Cameroon: a Review Article. *Int Ann Med*. 2017;1(10). doi:10.24087/IAM.2017.1.10.308.

18. Mock C, Arreola-Risa C, Quansah R. Strengthening care for injured persons in less developed countries: A case study of Ghana and Mexico. *Inj Control Saf Promot*. 2003;10(2):45-51. doi:10.1076/icsp.10.1.45.14114.

19. 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. *Am J Public Health*. 1996;86(1):41-45. doi:10.2105/AJPH.86.1.41.

20. Lin MR, Kraus JF. Methodological issues in motorcycle injury epidemiology. *Accid Anal Prev*. 2008;40(5):1653-1660. doi:10.1016/j.aap.2008.05.005.

21. Chichom-Mefire A, Palle-Ngunde J, Fokam PG, Mokom-Awa A, Njock R, Ngowe-Ngowe M. Injury patterns in road traffic victims comparing road user categories: Analysis of 811 consecutive cases in the emergency department of a level I institution in a low-income country. *Int J Surg Open*. 2018;10(December):30-36. doi:10.1016/j.ijso.2017.11.005.

22. Chichom-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C, Ngowe-Ngowe M. 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(1):915. doi:10.1186/s12889-015-2290-4.

23. Hazen A, Ehiri JE. Road traffic injuries: hidden epidemic in less developed countries. *J Natl Med Assoc*. 2006;98(1):73-82.

24. World Health Organization (WHO). Paying for health services. http://www.who.int/mediacentre/factsheets/fs320.pdf. Published 2005. Accessed November 21, 2018.

25. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C. Policy and Practice Components of emergency medical systems. *Bull World Health Organ*. 2005;83(8).

26. Haque MM, Chin HC, Huang H. Modeling fault among motorcyclists involved in

crashes. *Accid Anal Prev*. 2009;41(2):327-335. doi:10.1016/j.aap.2008.12.010.

27. Copes WS, Champion HR, Sacco WJ, Lawnick MM, Keast SL BL. The injury severity score revisited. *J Trauma-Injury Infect Crit Care*. 1988;28(1):69-77.

28. Baker SP, O'Neill B, Haddon Jr W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma Acute Care Surg*. 1974;14(3):187-196.

29. The Medical Algorithms Company Limited. Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS). https://www.medicalalgorithms.com/abbreviated-injury-scale-ais-and-the-injury-severity-score-iss. Published 2018. Accessed September 10, 2017.

30. Stevenson M. An overview of the injury severity score and the new injury severity score. *Inj Prev*. 2001;7(1):10-13. doi:10.1136/ip.7.1.10.

31. Blincoe LJ, Miller TR, Zaloshnja E, Lawrence BA. *The Economic and Societal Impact Of Motor Vehicle Crashes , 2010 (Revised)*. Vol Report No. Washington, DC; National Highway Traffic Safety Administration; 2015.

32. Connelly LB, Supangan R. The economic costs of road traffic crashes: Australia, states and territories. *Accid Anal Prev*. 2006;38(6):1087-1093. doi:10.1016/j.aap.2006.04.015.

33. Kudebong M, Wurapa F, Nonvignon J, Norman I, Awoonor-Williams JK, Aikins M. Economic burden of motorcycle accidents in Northern Ghana. *Ghana Med J*. 2011;45(4):135-142. doi:10.4314/gmj.v45i4.

34. Fitzharris M, Dandona R, Kumar GA, Dandona L. Crash characteristics and patterns of injury among hospitalized motorised two-wheeled vehicle users in urban India. *BMC Public Health*. 2009;9:11. doi:10.1186/1471-2458-9-11.

35. Sisimwo PK, Mwaniki PK, Bii C. Crash characteristics and injury patterns among commercial motorcycle users attending Kitale level IV district hospital, Kenya. *Pan Afr Med J*. 2014;19:1-7. doi:10.11604/pamj.2014.19.296.4885.

36. Chichom Mefire A, Etoundi Mballa GA, Azabji Kenfack M, Juillard C, Stevens K. Hospital-based injury data from level III institution in Cameroon: Retrospective analysis of the present registration system. *Injury*. 2013;44(1):139-143. doi:10.1016/j.injury.2011.10.026.

37. Micaela M. Esquivel, Uribe-Leitz T, Kaggya K, Long C, G.Weiser T, M.Wren S. Analysis of a Hospital-Based Trauma Registry in Rural Cameroon: Description of Initial Results and Recommendations. *J Am Coll Surg*. 2015;221(4):S86-S87. doi:doi.org/10.1016/j.jamcollsurg.2015.07.196.

38. Segui-Gomez M, MacKenzie EJ. Measuring the public health impact of injuries. *Epidemiol Rev*. 2003;25(5):3-19. doi:10.1093/epirev/mxg007.

39. McClure RJ, Douglas RM. The public health impact of minor injury. *Accid Anal Prev*. 1996;28(4):443-451. doi:10.1016/0001-4575(96)00012-7.

40. 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. *Accid Anal Prev*. 1995;27(3):363-369. doi:10.1016/0001-4575(94)00079-2.

41. Gopalakrishna G, Peek-Asa C, Kraus JF. Epidemiologic features of facial injuries among motorcyclists. *Ann Emerg Med*. 1998;32(4):425-430.

42. MacLeod JB a, Digiacomo JC, Tinkoff G. An evidence-based review: helmet efficacy to reduce head injury and mortality in motorcycle crashes: EAST practice management guidelines. *J Trauma*. 2010;69(5):1101-1111. doi:10.1097/TA.0b013e3181f8a9cc.

43. Fuentes-pumarola C, Bertran C, Gras ME, et al. Helmet Use for the Prevention of Brain Injuries in Motorcycle Accidents. In: Agrawal PA, ed. *Brain Injury-Functional Aspects, Rehabilitation and Prevention*. InTech; 2012:226.

44. Hung D V, Stevenson MR, Ivers RQ. Prevalence of helmet use among motorcycle riders in Vietnam. *Inj Prev*. 2006;12:409-413. doi:10.1136/ip.2006.012724.

45. Peden MM, Scurfield R, Sleet D, et al. *World Report on Road Traffic Injury Prevention*.; 2004. doi:10.1016/j.puhe.2005.09.003.

46. Zambon F, Hasselberg M. Socioeconomic differences and motorcycle injuries: Age at risk and injury severity among young drivers. A Swedish nationwide cohort study. *Accid Anal Prev*. 2006;38(6):1183-1189. doi:10.1016/j.aap.2006.05.005.

47. Rogers FB, Rittenhouse KJ, Gross BW. The golden hour in trauma: Dogma or medical folklore? *Injury*. 2015;46(4):525-527. doi:10.1016/j.injury.2014.08.043.

48. Chichom-Mefire A, Nwanna-Nzewunwa OC, Siysi VV, Feldhaus I, Dicker R, Juillard C. Key findings from a prospective trauma registry at a regional hospital in Southwest Cameroon. *PLoS One*. 2017;12(7):e0180784. doi:10.1371/journal.pone.0180784.

49. Commeyras C, Ndo JR, Merabet O, Kone H, Rakotondrabe FP. Caractéristiques de la consommation de soins et de médicaments au Cameroun. *Cah Santé*. 2006;16(1):13-19. doi:10.1684/SAN.2006.0002.

50. Ro YS, Shin SD, Jeong J, et al. Evaluation of demands, usage and unmet needs for emergency care in Yaoundé, Cameroon: A cross-sectional study. *BMJ Open*. 2017;7(2):1-10. doi:10.1136/bmjopen-2016-014573.

51. McGreevy J, Stevens KA, Ekeke Monono M, et al. Road traffic injuries in Yaoundé, Cameroon: A hospital-based pilot surveillance study. *Injury*.

2014;45(11):1687-1692. doi:10.1016/j.injury.2014.05.001.

CHAPTER 5: RECOMMENDED STRATEGIES FOR PREVENTION OF CRASH AND INJURY AND DELIVERY OF PREHOSPITAL CARE TO COMMERCIAL MOTORCYCLE USERS

Road traffic crashes are currently the leading cause of death among persons aged 15-29 years and one of the leading causes of death among persons aged 5-44 years.[1] Furthermore, road traffic crashes are the eight leading cause of death worldwide and predicted to be the fifth leading cause of death by 2030.[2] Yearly, the lives of an estimated 1.35 million people worldwide are cut short due to road traffic injuries (RTIs), with an additional 50 million non-fatal-related injuries incurred and an RTI burden of 76 million disability-adjusted life years.[3] Cameroon, like many low and middle income countries (LMICs), has experienced a modal shift in urban public transportation from motor vehicles to motorcycles. Economic growth, the absence of reliable public transportation systems, traffic, unemployment, and motorcycle affordability are some of the factors responsible for the rapid growth of commercial motorcycles on Cameroon's roads. While the government has seized the opportunity of commercial motorcycling as a mechanism to curb unemployment, it has failed to implement directives to ensure the safety of riders, passengers, and other types of road users.

Any concerted efforts among key stakeholders to develop effective road safety policies and interventions in Cameroon has focused on engineering, economic, and legislative perspectives but failed to fully integrate research, the public health sector, and the opinion of commercial motorcycle unions. Policies have often been socio-politically driven, forcefully enforced, and often viewed by the general public as a source of revenue for local sectors of the government. A comprehensive safety program is necessary to prevent crashes, mitigate crash-related injury and severity, and provide post-crash care and treatment to crash victims.

For effective road traffic crash prevention purposes, predisposing factors must be identified and a causal association established between risk factors and road traffic crashes. Although some associations between risk factors and crash or injury outcome may be confounded by unknown, not fully understood, misclassified, or unmeasured risk factors, an assessment of these factors can provide valuable information to recommend and develop targeted intervention programs to mitigate road traffic crash and injury. Even though focus should be placed on preventing crashes (primary prevention), it is inevitable road traffic crashes will continue to occur on Cameroon's roads and preventive efforts should extend through prevention of injury (secondary prevention) to mitigating severity of sustained injuries (tertiary prevention).

The Haddon Matrix as a conceptual framework for injury prevention meshes the concepts of the epidemiologic triad with the three prevention phases (primary, secondary, and tertiary) to provide strategies for the development of an effective commercial motorcycle safety program.[4–6] We employ the Haddon Matrix shown in Table 5.1 as an effective tool to identify determinants of crash, facilitate the development of appropriate countermeasures to prevent crash and injury occurrence, and advise post-crash care management.

Table 5.1: Haddon matrix of recommended strategies for crash and injury prevention and post-crash care among commercial motorcycle users

	Host (rider/passenger)	**Vehicle** (motorcycle)	**Physical Environment**	**Social Environment**
Primary Prevention Measures focused on crash prevention	• Sex • Age • Promote better sleep habits and nutrition • Reduce or prevent impaired riding and drug use • Encourage helmet use and protective gear • Mandatory rider training and licensing • Encourage single rider to passenger ratio • Advocate riding below posted speed limits	• Recommend routine motorcycle maintenance • Ensure motorcycles have working headlamps, taillights, and turn signals • Install reflective stripes on motorcycles • Installing back support for passengers • Providing helmets to passengers	• Install traffic lights at busy intersections • Reduce speed limits with speed bumps and humps • Road signs should be visible • Street lighting at night • Repair pothole • Be informed of current weather and road conditions	• Use police to control traffic • Educate public to avoid placing objects on road or throwing oil or water on roads • Educate public and transportation agency to remove objects on road when identified • Mandate and enforce comprehensive laws on licensing, helmet use, work hour limits, speed limits, maximum occupants
Secondary Prevention Measures focused on injury prevention	• Wear fastened helmet • Encourage use of conspicuity and protective clothing • Encourage road user awareness	• Encourage use of good quality helmet • Install leg guards on motorcycles • Motorcycle manufacturers should install speeding alerts • Install alcohol interlock on motorcycle	• Clear roads of obstacles • Clearly demarcate road construction sites • Install signs warning of poor road conditions	
Tertiary Prevention Measures focused on reducing injury severity and integrating rehabilitation	• Capability to call for medical assistance • Ability to self-administer first aid • Ability to report preexisting conditions and if impaired or on drugs • Ability to secure personal possession	• Install GPS devices to on motorcycles to signal crash location • Install motorcycle alert systems to signal EMS and police	• Initiate emergency call numbers • Provision and accessibility of EMS care • Ensure trauma care centers are equipped with material and staff • Initiate emergency treatment before payment option • Implement motorcycle EMS • Develop rehabilitation programs and provide psychosocial support • Ensure job security	• Teach riders and bystanders basic first aid skills and how to stabilize crash victims • Educate public about victim extraction and managing crash scene • Encourage Good Samaritan policy and public recognition for heroic efforts • Educate public about right-of-way to EMS vehicles • Subsidize treatment costs

RECOMMENDATIONS FOR PREVENTION OF CRASHES AND INJURIES

1) Improve attitudes and behavior of commercial motorcycle users

Age and Gender: Age and gender are not modifiable variables but considered predisposing factors that interact with other risk factors associated with the effects of crash occurrence and injury sustainment. In Cameroon, a majority of commercial motorcycle riders are male between the ages of 16 and 34 years. Speeding, impaired riding, and riding experience may differ between younger and older riders. Using appropriately categorized age groups during research design and analysis can deduce age-related characteristics needed to develop tailored crash prevention and intervention programs.

Reduce or prevent impaired riding: Riding under the influence of alcohol or other psychoactive drugs can impair the rider's motor skills and increase risk of crash and injury among road users. In this study, current smoking status was associated with increased odds of crash and injury involvement. In addition, motorcyclists who consumed alcohol were at increased odds of crash involvement. Although nicotine in itself may not be a causal factor for crash occurrence, we strongly postulated cigarette smoking as a surrogate for cannabis and tramadol use (an opioid) among commercial motorcycle riders.[7–12] Some study participants informed the Principal Investigator that Tramadol use was common among younger riders. Measures can be put in place to reduce impaired riding.

To effectively control tramadol use among motorcyclists and other sectors of the population, the Cameroonian government needs to establish a law enforcement agency that will combat tramadol smuggling and distribution at the regional and

national levels. Unannounced sobriety checkpoints should be implemented enabling police to randomly screen for motorcycle riders and other road users for signs of impairment. Penalties should vary from teachable moments for first time offenders to motorcycle impoundment for repeated offenders. Ordinances for alcohol serving establishments to regulate the sale of alcohol to riders and other motor vehicle users should be enforced and incentives offered to such establishments that identify and report impaired riders or other motor vehicle users to law enforcement. Posters with messages discouraging patrons from purchasing alcoholic beverages should be visible throughout alcohol serving establishments. Furthermore, media campaigns should be employed to educate riders about the dangers of impaired riding and discourage them from engaging in impaired riding or face the associated legal consequences.

Mandate and enforce speed reduction: Speed is a major risk factor in the severity of road traffic crashes and injuries. At the time of impact, the crash speed significantly contributes to the likelihood of an injury occurrence and the severity of the sustained injury. In the current study, the odds of crash involvement and injury sustainment were higher among commercial motorcycle riders who were travelling at speeds of 45km/h or more at the time of impact. A motorcycle travelling at 40km/h requires about 9 meters of stop distance on a dry paved road (13m on a wet paved road). The stop distance could be even longer on muddy or dusty roads.[14] Riding at the speed of traffic flow but within the posted speed limits are recommended to reduce risk of crash.[13] In Cameroon, speed bumps have proven to be an effective approach to speed management and traffic calming. Speed bumps are often installed within

urban areas and on frontiers of highway communities. Although speed bumps have been demonstrated to effectively reduce vehicle speeds and have a protective effect on crashes in general, installed speed bumps can have detrimental effects on the safety of motorcyclists. The Bamenda municipality does not have technical requirements or permits for the installment of speed bumps. Speed bumps are often a reaction of the private community to prevent accidents within urban streets in neighborhoods. These privately installed speed bumps are often not of the appropriate height, unmarked, or lack warning signs to alert vehicle users. Motorcyclists unfamiliar with such sections of the road are often involved in single-vehicle collisions.

Legislation on speed limits exist but are not enforced, therefore awareness of the consequences of excessive speed and the benefits of riding at safe speeds is essential. Installing speed monitoring check points, motorcycle speeding alerts, and electronic advisory speed signs should be implemented to calm speed. In addition, the Department of Transportation and Bamenda municipality should adapt speed calming methods appropriate for the Bamenda urban area, mandate standards for the installment of speed bumps and humps. Enacting and enforcing legislation on speed limits should be implemented at the municipal and national levels.

Encourage better sleep habits and nutrition: Sleep and nutrition are often overlooked in road traffic research. Fatigue and improper nutrition can lead to impaired riding. Commercial motorcycle riders work long hours which often span from 5am – 8pm. Some riders are compelled to work extended hours if in financial stress or when the required amount to pay the daily leasing fee is not met. Fatigue

is common among commercial motorcycle riders and while some take siestas others ride while tired or drowsy which can impair reaction times and judgment. Riders should be encouraged to get adequate rest of 7-8 hours and take siestas during work hours. In addition, proper hydration and energy-sustaining foods are essential to keep the rider physically fit and mentally alert. Media campaigns messages should be employed to highlight the benefits of proper sleep and eminent risk of riding while fatigue.

At lunch, it is common for motorcycle riders to consume carbohydrate-heavy meals accompanied by an alcoholic drink. The drowsy effects of a high-carb meal combined with alcohol and fatigue can be detrimental to the rider's ability to effectively operate a motorcycle and make proper judgements on the road. Nutritionists can educate and recommend motorcycle riders appropriate nutrition guidelines.

2) **Improve visibility and protection of commercial motorcycle users**

Increase rider and motorcycle conspicuity: Researchers agree that motorcycle conspicuity is a major factor that is associated with crash risk. [16,17] Increased motorcycle conspicuity enhances the possibility to be seen by other road users especially in low lighted environments. Administrators of the Bamenda city council have issued communiques requesting commercial motorcycle riders to have their motorcycle fuel tanks painted yellow (the official taxi color in Cameroon) and wear regulatory vests or face sanctions.[15] Motorcycle riders view regulatory jackets as a source of revenue for the city council and not a road safety measure. Educating riders about the benefits of conspicuity as a road safety measure to increase

visibility especially at night is vital in crash prevention. In addition to wearing a highly-visible reflective vest, conspicuity can be increased by wearing other reflective clothing and helmet, installing reflective stripes on different surfaces of the motorcycle, and running the headlamps when riding. Passengers should also be encouraged to wear conspicuity vests when using a motorcycle. Safety campaigns are needed to advocate the importance of conspicuity to motorcycle users. Fluorescent yellow-green or red-orange vests are readily available and should be included as a gift to riders who register their motorcycles. Because conspicuity vests are inexpensive, influential persons in the community can donate vests as part of their philanthropic efforts.

Increase rider and passenger protection: Head injuries are the leading cause of death and major trauma injury for motorcycle users. Helmet use has proven to be effective in prevention of motorcycle crash-related injuries. In 2016, helmets saved the lives of an estimated 1,859 United States motorcyclists and would have saved an additional 802 if those riders wore a helmet.[18] Helmets are 37% and 41% effective in preventing fatal injuries among motorcycle riders and passengers, respectfully.[19] If worn correctly, helmets can reduce risk of fatal injuries by 42% and head injuries by 69%.[20] Despite the effectiveness of helmets in reducing head injury, very few countries have comprehensive helmet laws for motorcycle users. The current motorcycle helmet law in Cameroon legislate the use of helmets to riders and passengers, however these laws have not been enforced. Findings from the current study showed that most injuries sustained were to the head and extremity anatomic areas.

Education strategies, social influence, enforcement, and helmet safety campaigns are essential tools in reinforcing the benefits of helmet use and promoting continuous and proper helmet use. The Cameroon Ministry of Transportation should ensure that helmets should accompany all motorcycle sales, be of high quality, include a visor for eye protection, and available at an affordable cost to motorcycle users. Most helmets used by commercial motorcycle riders are either designed as open face or half helmets. However of the few riders who wear helmets, the half helmet design is preferred given it is conducive to the hash hot dry weather and that riders can easily hear passengers calling for a ride. In addition to helmets, riders should be encouraged to wear protective clothing such as gloves, clothing with padding on the knee and elbow regions, and boots. Leather gloves provide a better grip and protect the rider's hands in a crash. Leather jackets help protect the rider's chest from cold wind and boots protects their feet and ankles. Encourage single rider to passenger ratio: Motorcycles are designed for a rider and passenger. Commercial motorcycle riders often carry two or more passengers to maximize profit. It is common to observe commercial motorcycle riders carrying more than two passengers depending on the body size of passengers. Findings from the current study showed that commercial motorcycle riders with two or more passengers were at increased odds of crash involvement and sustaining an injury. Commercial motorcycle riders should be encouraged to carry a single passenger per trip and avoid carrying passengers who may be impaired. Furthermore, the Department of Transportation should legislate laws that regulate the number of passengers on a motorcycle. Police enforcement should ensure that riders comply

with the single rider to passenger ratio law.

Encourage routine maintenance of motorcycles: Motorcycle malfunctions may contribute to a collision or may increase injury severity. It is common to find commercial motorcycles with no working headlamps, turn signals, taillights, or conspicuity stipes. In some cases riders tailgate motor vehicles at night to use their light or use flashlights in place of headlamps. Riders should be encouraged to routinely maintain their motorcycles such as maintaining tire pressure, inspect tire tread, and clean and oil chains. Most importantly, law enforcement should ensure motorcycles are equipped with working lights and impound motorcycles that do not meet required on-road operation standards.

3) Formulate, implement, and enforce road safety policies

Implement mandatory rider/passenger training and licensing: Several road traffic crash and injury prevention programs have focused on human behavior which is modifiable through education. Most commercial motorcycle riders are not trained on the basic skills and knowledge required to safely operate on the roads. Rider education programs taught by trained instructors at a reduced cost or free of charge should be encouraged. In addition, an achievement certificate and licensing which empowers the rider about attaining the required riding skills should be delivered. Mandatory rider and passenger training, rider licensing, and refresher courses are recommended and should incorporate safety health education components. While it is important for police to enforce training and licensing, such enforcement should be incentivized to encourage ridership training.

Implement public education road safety campaigns: Education and awareness

campaigns will engage riders, passengers, other road users, and the general public about positive attitudes and behaviors to improve road safety. Campaigns should inform riders to reduce their speed, highlight the serious consequences of alcohol and drug impaired riding, the risk of riding at night or in poor visibility, the proper use of helmets and protective gear, increase conspicuity, and maintaining single rider-passenger motorcycle occupancy. Moreover, the public should be educated to avoid placing objects on the road or throwing waste water and oily substances on the road. While such practices may provide temporal relief from dust, they pose greater risk to motorcyclists. Enhancing road safety knowledge among commercial motorcycle users need not be limited to individuals but should engage the public and other stakeholders. For example, motorcycle sale agents can demonstrate proper helmet use and the benefits of always wearing one.

Improve the safety of road environment and traffic management: Improving the safety of the road environment is vital in reducing crashes among all type of road users. Most of the roads in Bamenda are unpaved while the few paved stretches of road are filled with potholes. The narrow roads have an effect on traffic flow and density causing motorcycle riders to weave in and out of traffic. This increases their risk of a crash if within the blind spot of another motor vehicle user. Improving road infrastructure is critical to improving overall road safety. Maintaining good road surfaces, designating specific lanes for motorcycles, installing traffic signs and lights, installing bumps and humps, clearance of roadside hazards, and replacement of crash hotspot intersections with roundabouts to calm traffic are effective techniques to improve the safety of the road environment and manage

traffic flow.

RECOMMENDATIONS FOR DELIVERY OF POST-CRASH CARE TO THE INJURED

The general emphasis to reduce rates of crash, injury, disability, and death has been on prevention, and it should be. However, crashes will continue to occur and injured victims need care to prevent disability and death. An injured commercial motorcycle user's prospect to a timely recovery, avoidance of disability and death, and full rehabilitation into their daily work routine depends on whether the injured user received post-crash care, the timing of care delivered and the quality of care received. This section focuses on prehospital care, the first of the three components of post-crash care; prehospital, hospital, rehabilitation. Most Cameroonian cities do not have prehospital emergency medical services and trauma care systems, therefore prehospital care is vital in improving the quality of life of injured commercial motorcycle users. Furthermore, this section intends to provide pragmatic recommendations to develop a basic and effective prehospital care trauma system which can decrease death and disability among injured commercial motorcycle users.

Engage bystanders in providing prehospital care: Even in the most sophisticated prehospital care systems, bystanders are the first at the scene and should be encouraged and given the duty to assist if willing. In Cameroon, the role of bystanders at the crash scene often revolves between individual curiosity and humanitarian assistance. Crash scenes tend to be chaotic with no coordination except when a police officer is present. At times bystanders may get frustrated given the lack of police knowledge about prehospital care and sense of urgency.

While some bystanders sprint into action to help crash victims, most have limited knowledge about prehospital care and may increase the victim's injury severity. Some bystanders, though willing to assist victims, may be concerned about exposure to infectious diseases from bleeding victims.

Bystanders should be encouraged to take certified first aid courses offered by trained personnel which will provide them skills to provide assistance to surviving injured persons. Bystanders should also be educated on how to secure a scene to prevent further crashes, how to extricate victims away from the vehicle, how to control the crowd at the crash scene, and how to stabilize and transport crash victims to the nearest medical facility. Although legal consequences of harm caused by a bystander to the victim are unusual in Cameroon, the "Good Samaritan" law is recommended to protect bystanders.

Train motorcycle riders as first responders: Each motorcycle rider as part of their licensing should be taught life-saving first aid skills followed by periodic refresher sessions offered by certified nurses or student nurses. Moreover, at least three riders at each motorcycle operation station should be dedicated as first responders and be available to provide first aid to any injured rider or passenger in that vicinity. Trained first responders can collect valuable data used to identify cause of crash, frequency and type of injuries, and crash locations. Such first responders will be able to quickly transport seriously injured victims to a nearby medical facility.

Secure essential equipment and supplies for first responders: Bystanders willing to assist victims with first aid rarely have access to the equipment of supplies. Commercial motorcycle riders are often stationed at market places, travel agencies,

or at intersections of major street and streets leading into neighborhoods. First aid kits with essential supplies such as disposable gloves, bandages, alcohol, and antiseptic wipes should be made available to each syndicate where the riders are stationed. In addition, first responders should be trained to assess the injury severity of the victims and use other available material to stabilize the injured victim before transporting to the hospital.

Recruit and train advance prehospital care providers**:** Emergency medical services focus on the provision of urgent medical interventions. Unfortunately, these services are nonexistent in Bamenda. Common barriers are lack of ambulance vehicles to transport crash victims, poor road infrastructure which prevents timely access to the crash site and transportation of crash victims to a medical facility, lack of trained personnel to provide emergency medical care, poor communication networks, unaffordable fees for emergency medical services, and cultural believes associated with ambulances and death people. Nonetheless, regardless of these barriers emergency medical services should be available to attend promptly to injured victims, stabilized them, and transport them to a medical care facility. One solution is to recruit and train nurses as advanced prehospital care providers or emergency medical care providers who will be stationed at different locations within Bamenda. Dispatching emergency medical services to the crash scene by motorcycle response units equipped with first aid medical supplies can significantly reduce the response time thereby significantly increasing the victim's likelihood of survival.

Motorcycle response units and motorcycle ambulances: Motor vehicle ambulances acquired by the government or received as a donation have spent most of their

lifespan off the streets. These ambulances are not maintained or repaired due to lack of funds, spare parts, or in some cases the vehicles are not designed for the poor road conditions. Roads get congested in Bamenda during rush hours making it difficult for injured victims to be transported to medical facilities in a timely manner. A possible solution is the use of motorcycle response units which can get through heavy traffic faster and reduce response times.[21] Although not a new concept, it is difficult to comprehend why many LMICs have not fully implemented motorcycle ambulances into their EMS systems. Motorcycle ambulances can be designed with a padded stretcher carriage that can be attached to a two-wheeled motorcycle and capable of navigating in tight spaces on the poor conditioned and congested roads. Motorcycle response units require less operational costs compared to motor vehicle response units. Another option is the more stable three-wheeled motorcycle ambulance which provides more protection for its occupants and can contain more clinical material.

Install global positioning system devices on motorcycles to signal crash location: Even though streets and some intersections are named, houses are not numbered making it a challenge for bystanders to accurately provide crash location details. An EMS system is only effective if the ambulance and advanced first responders can access and arrive the crash location promptly. One solution is to install global positioning systems (GPS) devices on motorcycles that will dispatch crash location signals to the emergency medical service for a more efficient response.[22] EMS can in turn use GPS navigation systems to identify the best route to access the crash location by avoiding congested roads or roads under construction.

CONCLUSION

Effective motorcycle-related crash and injury prevention revolves around primary, secondary, and tertiary prevention strategies. The three components of post-crash care – prehospital, hospital, and rehabilitation are essential to facilitate recovery and improve quality of life of the injured. A basic form of emergency medical services which incorporates bystanders and first responders proves to be the most effective method of injury control in Bamenda and other Cameroonian urban areas. Educational strategies are essential to encourage positive behavioral modifications of commercial motorcycle users and the general public and to highlight the benefits of road safety. Moreover, it is essential for injury control programs to be community based and engage stakeholders such as motorcycle unions, medical services, and the local government. Prevention and intervention programs tailored towards at-risk commercial motorcycle users combined with legislation and enforcement of mandated laws are required. In addition, post-crash management strategies to mitigate injury severity of commercial motorcycle crash should focus on prehospital care.

REFERENCES

1. World Health Organization (WHO). *Global Status Report on Road Safety 2018*. Geneva, World Health Organization; 2018.

2. WHO. Injuries and violence: The facts. *World Heal J*. 2004;1:1-6.

3. Murray CJL, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2197-2223. doi:10.1016/S0140-6736(12)61689-4.

4. Barnett DJ, Balicer RD, Blodgett D, Fews AL, Parker CL, Links JM. The application of the Haddon matrix to public health readiness and response planning. *Environ Health Perspect*. 2005;113(5):561-566. doi:10.1289/ehp.7491.

5. Haddon W. Advances in the epidemiology of injuries as a basis for public policy. *Public Health Rep*. 1980;95(5):411-421. doi:10.2307/4596353.

6. Runyan CW. Using the haddon matrix: Introducing the third dimension. *Inj Prev*. 2015;21(2):126-130. doi:10.1136/ip.4.4.302rep.

7. Yunusa U. Determinants of Substance Abuse among Commercial Bus Drivers in Kano Metropolis, Kano State, Nigeria. *Am J Nurs Sci*. 2017;6(2):125. doi:10.11648/j.ajns.20170602.16.

8. Melo N. Cameroon: Alarming consumption of tramadol in the North West Region. http://www.cameroon-info.net/article/cameroon-alarming-consumption-of-tramadol-in-the-north-west-region-297690.html. Published 2017. Accessed July 17, 2018.

9. Tchaya Z, Bandolo GM, Bassompierre L. Tramadol: Cameroon's low-budget opioid crisis. http://www.france24.com/en/20180423-focus-cameroon-tramadol-drug-opiods-crisis-schools-education-rehab-addiction.

10. Amadou I. Usages du Tramadol à des fins non médicales par les moto-taxi de la ville de Garoua. 2014.

11. Mbonwoh N. Cameroon: "Tramadol Is a Social Malaise." January 2018. https://allafrica.com/stories/201801300214.html.

12. Nofuru N. Abuse of Pain Medication Still Common In Cameroon, Despite Ban on Drug. *Global Press Journal*. https://globalpressjournal.com/africa/cameroon/abuse-pain-medication-still-common-cameroon-despite-ban-drug/. Published April 27, 2016.

13. DMV California. California Driver Handbook - Laws and Rules of the Road. https://www.dmv.ca.gov/portal/dmv/detail/pubs/hdbk/speed_limits++. Accessed April 15, 2019.

14. The State of Queensland. Stopping distances: speed and braking. https://www.qld.gov.au/transport/safety/road-safety/driving-safely/stopping-distances. Published 2016. Accessed December 4, 2019.

15. Mimi Mefo Info. Mezam Senior Divisional Officer Unveils Riot Act For Bike Riders. http://mimimefoinfos.com/2019/03/16/mezam-senior-divisional-officer-unveils-riot-act-for-bike-riders/.

16. Al-Awar Smither J, Torrez LI. Motorcycle Conspicuity: Effects of Age and Daytime Running Lights. *Hum Factors J Hum Factors Ergon Soc*. 2010;52(3):355-369. doi:10.1177/0018720810374613.

17. Torrez LI. Motorcycle conspicuity: The effects of age and vehicular daytime running lights. 2008.

18. National Highway Traffic Safety Administration. *Motorcycle*. Washington, DC; 2017. https://www.cdc.gov/motorvehiclesafety/mc/index.html.

19. NHTSA. Traffic Safety Facts: Motrocycles - 2013 Data. *NHTSA*. 2015;(May):1-8. doi:http://dx.doi.org/10.1016/j.annemergmed.2013.12.004.

20. World Health Organization (WHO). *Global Status Report on Road Safety 2015*. Geneva; 2015.

21. Soares-Oliveira M, Egipto P, Costa I, Cunha-Ribeiro LM. Emergency motorcycle: has it a place in a medical emergency system? *Am J Emerg Med*. 2007;25(6):620-622. doi:10.1016/j.ajem.2006.11.030.

22. Lin CS, Chang H, Shyu KG, et al. A method to reduce response times in prehospital care: The motorcycle experience. *Am J Emerg Med*. 1998;16(7):711-713. doi:10.1016/S0735-6757(98)90185-1.

CHAPTER 6: DISCUSSION AND CONCLUSION

DISCUSSION

The research presented in this dissertation sought to provide an overview of the determinants and distribution of crashes and injuries among commercial motorcycle users in Bamenda, Cameroon. The following specific objectives were elucidated in this dissertation: (1) Estimate the prevalence of crashes (lifetime and period) and examine underlying factors among commercial motorcycle riders and passengers, (2) Estimate injury prevalence and identify associated factors among commercial motorcycle riders, and (3) Provide an overview of patterns, severity, and post-crash management of injuries among commercial motorcycle riders. Given the dearth of regional and national information about motorcycle crashes and injuries, this research employed information of consented participants, when available, for the most severe crash and the most recent crash within the past 12 months.

Chapter 2 informs the literature by provision of the current burden of motorcycle crashes among commercial motorcycle riders and passengers and the examination of underlying factors that predispose motorcycle crash as established by research studies in other countries. Findings from this study showed high crash prevalence among commercial motorcycle users. Specifically, findings showed that the odds of motorcycle crash involvement were higher among male riders who currently smoked, used alcohol, carried more than two passengers, and had three of more years of on-road riding experience. Furthermore, after adjusting for type of vehicle collision, the odds of single-vehicle collision were higher among riders and passengers who used alcohol, and among riders who rode at estimated speeds of 45km/h or more on poor condition paved roads. In general, results suggested high crash rates which may be primarily

influenced by behavioral factors and poor road conditions.

Chapter 3 provided an overview of the burden of injury on motorcycle riders. Riders who were ever involved in a crash reported whether they sustained injuries for the most severe crash and the most recent crash within the past 12 months, when applicable. Results demonstrated high injury prevalence among riders for the most severe crash (lifetime prevalence) and most recent crash within the past 12 months (period prevalence). For the most severe crash, riders were at increased odds of sustaining an injury if they currently smoked, were involved in a side impact collision, had three or more years of on-road riding experience, and were speeding (45km/h or more). Although this study identified underlying factors associated to injury, additional research is suggested to investigate the difference in injury severity adjusting for different types of collision, impact, and other environmental indicators.

Chapter 4 enriches the current understanding of patterns, severity, and post-crash management of non-fatal injuries among commercial motorcycle riders. Results from this study were consistent with those from other studies indicative of injury patterns to the head and extremity anatomic regions. For the most severe crash and when compared to riders with minor injuries, severely injured riders had a lower education, sought medical treatment within the first hour, incurred longer hospitalization and higher treatment expenses, and lost personal belongings at the crash scene. In addition, riders who sustained severe injuries within the past 12 months incurred higher medical expenses upon admission to a medical facility as a result of their injuries. Results from this study demonstrate the significant impact of injury to health, economic, social, and psychological burden to commercial motorcycle riders.

Chapter 5 recommends strategies for prevention of crash and injury and delivery of prehospital care to commercial motorcycle users. Manuals and reports on road traffic prevention have been prepared by the World Health Organization and some high-income and middle-income countries on effective strategies to improve road safety and the delivery of post-crash care to victims. While several of the recommendations in these manuals are applicable to most roads and its users, it is important to supplement and substitute some of these strategies with those tailored to roads of LMIC. This chapter provided a continuum of road safety recommendations taking into consideration local sociocultural and sociopolitical contexts.

Research strengths and limitations

There are several strengths to this dissertation research. This study is the first population-based cross sectional study to examine regional predisposing factors associated with road traffic crash and injury in Bamenda, Cameroon. This research was able to ascertain crash and injury information to provide lifetime and period prevalence estimates. Moreover, this study concentrated on commercial motorcycle riders with non-fatal injuries which are often missed by medical facilities. Furthermore, this dissertation research was able to obtain information about the locations and types of anatomic injury sustained by commercial motorcycle users. Given the lack of surveillance systems, police reports, insurance records, and hospital records, this research provided valuable baseline information which can be used to design more robust studies.

Despite the strengths of this research, there were some limitations to the study. The research study was cross-sectional in design and did not permit the assessment of

causal associations. All information obtained from study participants were self-reported and could not be validated by other sources. Therefore, there is a possibility of biased information due to poor recall or inaccuracy. In addition, there is the potential of interviewer bias since participants were not selected using a randomized approach. There were some nomenclature challenges which were not fully understood by the principal investigator and interviewers but were evident during data collection and noted. For example, most participants completed the questionnaire in pidgin in which passengers are considered to “climb” a motorcycle instead of riding. Crashes are associated with airplanes and accidents with other motor vehicles. Although we defined crash in this study as a physical contact between a motorcycle and another vehicle, person, or road side objects as well as falls; crash was referred to as accident during interviews. Finally, the dissertation study focused on non-fatal injuries, excluding riders who may have been severely disabled, stopped riding due to a crash or injury, or lost their life from a motorcycle-related crash. Prevalence estimates from this dissertation work may be underestimated given crash and injury associated to fatality was not included in analysis. There are no hospital or police records of fatalities due to motorcycle crashes.

Challenges to the dissertation research

This dissertation research was conducted during a period of political unrest in Bamenda, Cameroon which started nine months before the inception of the research study. During the data collection period, the city was shut down on Mondays for any economic activity. Data collection was a sensitive issue and the principal investigator had to assure participants that they were not being recorded, no identifiable information

was to be collected, monetary incentives were not bribes, the project was not funded by the Cameroon government, and that collected information was not going to be shared with the Cameroon government. Even with assurances there were riders and passengers who made it clear that they wanted nothing to do with the study even before approached by an interviewer.

The political unrest in Bamenda posed two methodological challenges. Commercial motorcycle riders could not be randomly selected for study participation since randomization could have been perceived by some riders as a special selection and would have distraught those who would have liked to participate but could not if not selected. The second challenge dealt with lack of information to compute the response rate. Some riders and passengers who wanted nothing to do with the study also indicated that data collection will be jeopardized if they observe an interviewer make any note of them. For the safety of the principal investigator and interviewers, any riders and passengers who declined to participate in the study were thanked for their time and a clear indication provided that no related information was collected. However, refusal of any commercial motorcycle users to participate in the study was not associated to the study objectives but to regional insecurity.

Helmet use could not be fully examined in the current study. Although the principal investigator observed some riders with half-helmet designs which are sold with the motorcycle, it was noted that riders considered half-helmets with a visor as a full-helmet design. Some riders reported wearing a helmet daily and even though a helmet was not physically observed by the principal investigator during the interview, such riders often indicated that a helmet was worn when they commuted to and from

home which was on the outskirts of the city.

Recommendations for future research

This dissertation research was not able to fully address the effects of helmet use on commercial motorcycle users. We suggest a comprehensive research study to investigate the perceptions of commercial motorcycle users about helmet use. Further research specific to the region is needed to highlight the benefits and protective effects of helmet use during a crash to commercial motorcycle users. Such research should go in depth to highlight the severity of injury that can be sustained if not wearing the right helmet or if the helmet is not properly worn.

In order to fully understand the riding behavior of commercial motorcycle riders, crash and injury contributing factors, and the severity of the crash and injury it is essential to conduct a naturalistic study. Sensors and other accurate data collection instruments installed on motorcycles can provide time-series data used to better understand the causes of crashes, near-crashes, and injuries. Naturalistic studies can identify locations with high crash propensity and suggest appropriate measures to increase location-specific safety. In addition, findings from naturalistic studies can be employed to design rider education and training programs to improve road safety.

CONCLUSION

This dissertation research sought to estimate the prevalence of road traffic crashes and injuries among commercial motorcycle users, examine underlying predisposing factors associated with crash occurrence and injury sustainment, and to evaluate the severity and pattern of non-fatal injuries. It is eminent, commercial motorcycles now form an integral part of the transportation network and will remain so

until sub-Saharan governments and key stakeholders can integrate young men into the formal economy. Moreover, crashes will continue to occur on Africa's roads due to the poor infrastructure and unenforced traffic regulations. Prevention of RTIs among commercial motorcycle users should become a priority and should expand to post-crash management.

Injury prevention gains are achieved incrementally and begin with baseline data that may help to identify future priorities. Road traffic crashes on Africa's roads can be predicted and with the appropriate tools, prevented. Findings from this dissertation work highlighted some of the predisposing factors associated with crash and injury among commercial motorcycle users and demonstrate the urgent need for the development and implementation of comprehensive road safety strategies. A successful road safety strategy in Cameroon requires a total commitment of the government with the support of key stakeholders to identify local safety problems, develop a multidisciplinary approach to road safety, provide adequate resources for road traffic research, and to develop, enact, and enforce research-driven road traffic policies and legislation. This is the way forward.

APPENDIXES

Appendix A: Institutional Review Board (IRB) Study Approval Letters

161701SW

UNIVERSITY OF CALIFORNIA, SAN DIEGO
HUMAN RESEARCH PROTECTIONS PROGRAM

TO: Dr. Che Wankie

RE: Project #161701SW Epidemiology of motorcycle-related crash characteristics and injuries in Bamenda, Cameroon: A cross-sectional study

Dear Dr. Wankie:

The above-referenced project was reviewed and approved by one of this institution's Institutional Review Boards in accordance with the requirements of the Code of Federal Regulations on the Protection of Human Subjects (45 CFR 46 and 21 CFR 50 and 56), including its relevant Subparts. This approval, based on the degree of risk, is for 365 days from the date of **IRB review and approval** unless otherwise stated in this letter. The regulations require that continuing review be conducted on or before the 1-year anniversary date of the IRB approval, even though the research activity may not begin until some time after the IRB has given approval.

The IRB determined that this project presents no more than minimal risk to human subjects in that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

Waiver of documented written consent has been granted for this study under CFR 46.117 (c)(2) the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is required outside the research for the survey portion of the study. Consent will be implied with the initiation and/or completion of the online survey after review of study information.

Date of IRB review and approval: **11/29/2016**

On behalf of the UCSD Institutional Review Boards,

/la

Anthony Magit, M.D.
Director
UCSD Human Research Protections Program
858-246-HRPP (858-246-4777); hrpp@ucsd.edu

Note: IRB approval does not constitute funding **or other institutional required approvals.** Should your studies involve other review committees such as Office of Clinical Trials Administration (OCTA), Office of Coverage Analysis Administration (OCAA), Conflict of Interest (COI), Protocol Review Monitoring Committee (PRMC), and committees under Environmental Health & Safety (EH&S) such as Institutional Biosafety Committee (IBC), Human Exposure Committee (HERC), and RSSC (Radiation Safety and Surveillance Committee), it is the researchers responsibility to ensure that all approvals are in place prior to conducting research involving human subjects or their related specimens.

Approval release date: 1/18/2017

161701SW

UNIVERSITY OF CALIFORNIA, SAN DIEGO
HUMAN RESEARCH PROTECTIONS PROGRAM

TO: Dr. Che Wankie

RE: Project #161701SW
Epidemiology of motorcycle-related crash characteristics and injuries in Bamenda, Cameroon: A cross-sectional study

Dear Dr. Wankie:

The above-referenced project was reviewed and approved by one of this institution's Institutional Review Boards in accordance with the requirements of the Code of Federal Regulations on the Protection of Human Subjects (45 CFR 46 and 21 CFR 50 and 56), including its relevant Subparts. This approval, based on the degree of risk, is for 365 days from the date of **IRB review and approval** unless otherwise stated in this letter. The regulations require that continuing review be conducted on or before the 1-year anniversary date of the IRB approval, even though the research activity may not begin until some time after the IRB has given approval.

The IRB determined that this project presents no more than minimal risk to human subjects in that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

Waiver of documented written consent has been granted for this study under CFR 46.117 (c)(2) the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is required outside the research for the survey portion of the study. Consent will be implied with the initiation and/or completion of the online survey after review of study information.

Date of IRB review and approval: **11/2/2017**

On behalf of the UCSD Institutional Review Boards,

/la

Anthony Magit, M.D.
Director
UCSD Human Research Protections Program
858-246-HRPP (858-246-4777); hrpp@ucsd.edu

Note: IRB approval does not constitute funding **or other institutional required approvals.** Should your studies involve other review committees such as Office of Clinical Trials Administration (OCTA), Office of Coverage Analysis Administration (OCAA), Conflict of Interest (COI), Protocol Review Monitoring Committee (PRMC), and committees under Environmental Health & Safety (EH&S) such as Institutional Biosafety Committee (IBC), Human Exposure Committee (HERC), and RSSC (Radiation Safety and Surveillance Committee), it is the researchers responsibility to ensure that all approvals are in place prior to conducting research involving human subjects or their related specimens.

Approval release date: 12/20/2017

REPUBLIQUE DU CAMEROUN

Paix - Travail - Patrie

MINISTERE DE LA SANTE PUBLIQUE

DELEGATION REGIONALE DU
NORD OUEST

Fax: 233 36 11 04
Tel: 233 363 289

N°382/NWR/RDPH

REPUBLIC OF CAMEROON

Peace - Work - Fatherland

MINISTRY OF PUBLIC HEALTH

REGIONAL DELEGATION FOR THE
NORTH WEST

BAMENDA, the 20 MAR 2017

THE REGIONAL DELEGATE
Le Délégué Régional

TO WHOM IT MAY CONCERN

Subject: **AUTHORIZATION TO CARRY OUT RESEARCH**

CHE WANKIE, a fourth year doctoral student in the Joint Doctoral Program in Epidemiology between San Diego State University and University of California at San San Diego, is authorized to carry out research at the Bamenda Regional Hospital and in the Health units of the Bamenda Health District. This work is titled "Epidemiology of motorcycle-related crash characteristics and injuries in Bamenda, Cameroon: A cross sectional study".

You are hereby requested to give him the support needed to achieve the objective throughout the research period.

This authorization is issued to serve the purpose for which it is intended.

THE REGIONAL DELEGATE OF PUBLIC HEALTH

Cc:
- Concern
- File

D. Mazia Fon Matilda
MD-MPH

REPUBLIQUE DU CAMEROUN
PAIX TRAVAIL PATRIE
-=-=-=-=-=-=-
MINISTERE DE LA SANTE PUBLIQUE
****
DELEGATION REGIONALE
DU NORD-OUEST
-=-=-=-=-=-=-
HOPITAL REGIONAL DE BAMENDA
TEL: 33 36 11 08 OR 33 36 18 19
P.O. BOX 818

REPUBLIC OF CAMEROON
PEACE WORK FATHERLAND
-=-=-=-=-=-=-
MINISTRY OF PUBLIC HEALTH
****
REGIONAL DELEGATION FOR
THE NORTH WEST
-=-=-=-=-=-=-
REGIONAL HOSPITAL BAMENDA

BAMENDA THE 15 MARS 2017

Che Wankie
4th Year Doctoral Student,
Epidemiology,
University of California, San Diego/
San Diego State University.

SUBJECT: **IRB APPROVAL**

Re: "**Epidemiology of Motorcycle-related Crash Characteristics and Injuries in Bamenda, Cameroon: A Cross-sectional Study.**"

Following review by the Regional Hospital Institutional Review Board (IRB) on 15th March 2017, of your study proposal and related documents; Given that there are no direct physical, psychological, social, or legal risks to the participants; you have received approval of your request to carry out the afore-mentioned study in the three councils of the Bamenda City Council of the North West Region. Recruitment should be as carefully as possible and proper counseling should be a pre requisite for obtaining consent from the patients. As required, all information collected from patients should remain strictly confidential.

You are requested to work with the administration of the various motorbike riders' trade unions to facilitate your integration.

This approval is valid for a period of one year and so renewal or extension will be necessary to continue this study. You are also requested to submit a copy of your final report to this IRB at the end of the study.

If you have further questions, please feel free to contact me directly.

The Chairman
IRB/IEC Regional Hospital Bamenda

DR. LEO NJOCK AYUK

Appendix B: Survey (English Version)

Epidemiology of commercial motorcycle-related crashes and injuries in Bamenda, Cameroon: A cross-sectional study

Note: The presented questionnaire does not display skip patterns or other features that were used in Qualtrics.

CONSENT

Before we begin, we would like to make sure you qualify for this study. Please answer the following:

☐ I AM 18 years of age or older and USE a motorcycle

Who is conducting the study, why you have been asked to participate, how you were selected, and what is the approximate number of participants in the study?
Che Wankie is conducting a research study about motorcycle-related crashes, injuries, and associated factors. Che Wankie is a doctoral student in the UCSD/SDSU Joint Doctoral Program in Public Health, Epidemiology. This research study is in partial satisfaction of the requirements for the degree Doctor of Philosophy in Public Health (Epidemiology). He will be working under the close supervision of his dissertation committee. You have been asked to participate in this study because you use a motorcycle and are 18 years or older.

Why is this study being done?
The purpose of this study is to investigate motorcycle crash-related factors, understand ridership behaviors, measure the effect of helmet use on risk of injury, and measure the effect of motorcycle-vehicle crash configurations on severity of injury among motorcyclists in Bamenda, Cameroon.

What will happen to you in this study and which procedures are standard of care and which are experimental?
If you agree to be in this study, the following will happen:

- You will be assigned a unique participant identification number for the study only.
- You will be asked questions from a questionnaire about motorcycle ridership. The survey will be conducted in a private area with only the interviewer and yourself.
- You may skip questions that you do not feel comfortable answering at any time.

How much time will each study procedure take, what is your total time commitment, and how long will the study last?
The questionnaire should take approximately 30-60 minutes to complete.

What risks are associated with this study?
Participation in this study may involve some added risks or discomforts. There may be a potential for the loss of confidentiality. The information that you provide during the interview will be kept confidential, and will be used for this study only. The responses you provide will be completely confidential and you will not be asked to provide your name on any documents associated with the project. Only project personnel will have access to this information. There are many confidentiality safeguards in place, so any unintentional release of confidential information is highly unlikely. Results from this project may be published in summary form in a technical report, manuscript, or scientific presentation; however, publication or presentation will not reveal your identity in any way, and your rights and safety will be protected. Research records will be kept confidential to the extent allowed by law. Research records may

be reviewed by the UCSD Institutional Review Board. Because this is a research study, there may also be some unknown risks that are currently unforeseeable. You will be informed of any significant new findings.

What benefits can be reasonably expected?
There may or may not be any direct benefit to you from participating this study however, your participation will provide information that can be used to improve road safety. The investigator, however, may learn more about motorcycle-related crashes, injuries, and associated factors, and society may benefit from this knowledge.

Can you choose to not participate or withdraw from the study without penalty or loss of benefits?
Participation in research is entirely voluntary. You may refuse to participate or withdraw or refuse to answer specific questions in an interview or on a questionnaire at any time without penalty or loss of benefits to which you are entitled.

Can you be withdrawn from the study without your consent?
The researcher may remove you from the study without your consent if the researcher feels it is in your best interest or the best interest of the study. You may also be withdrawn from the study if you do not follow the instructions given you by the study personnel.

Will you be compensated for participating in this study?
In compensation for your time, you will receive 500 frs CFA for participating in this research.

Are there any costs associated with participating in this study?
There will be no cost to you for participating in this study.

What about your confidentiality?
Research records will be kept confidential to the extent allowed by law. No participant identifier information will be collected. All collected data will be encrypted and saved on a password protected portable hard drive and onto a secure server. Research records may be reviewed by the UCSD Institutional Review Board.

Who can you call if you have questions?
Che Wankie has explained this study to you and answered your questions. If you have other questions or research-related problems, you may reach Che Wankie at +237 676352910 or by email at cwankie@ucsd.edu. You may call the Human Research Protections Program Office at (858) 657-5100 to inquire about your rights as a research subject or to report research-related problems.

Your signature and consent to take part in this project
I have read the information in this consent document. I have been given an opportunity to ask questions about this project and its procedures and risks, as well as any of the other information contained in this consent document. I understand what the project is about and how and why it is being conducted. I voluntarily consent to participate in this project by signing below. I have received a copy of this consent form for my records.

- ○ I Agree to participate
- ○ I Disagree to participate

Interviewer: Enter your name. _____

I acknowledge that the participant has read the consent document and indicated his/her comprehension of the study and that his/her participation is voluntary.

- ○ Initials _____

DEMOGRAPHICS

What type of motorcycle user are you?

- ○ Rider
- ○ Passenger

Q101 **What is your gender?**

- ○ Male
- ○ Female

Q102 **In what year were you born?**

_____

Q102a **How old are you?**

_____

Q103 **What is your highest level of education?**

- ○ Did not attend school
- ○ Primary
- ○ Secondary
- ○ High school
- ○ Some University
- ○ University

Q104 **What is your current marital status?**

- ○ Single
- ○ Married
- ○ Living with partner
- ○ Widowed
- ○ Divorced/Separated

Q105 **How many children do you have?**

_____

Q106 **What is your religious affiliation?**

- ○ Christian
- ○ Muslim
- ○ Traditional
- ○ No religious affiliation

Q107 **In what quarter (neighborhood) do you live?**

_____

Q108 **How many cigarettes do you smoke per day?**

- ○ I do not smoke
- ○ 1 - 10 cigarettes
- ○ 11 - 20 cigarettes
- ○ 21 - 30 cigarettes
- ○ More than 30 cigarettes

Q109 **How often do you have a drink containing alcohol?**

- ○ Never
- ○ Monthly
- ○ 2-4 times a month
- ○ 2-3 times a week
- ○ 4 or more times a week

Q110 **How many standard drinks containing alcohol do you have when you drink? (65cl bottle beer, mug of palm wine, mug of shah, glass of wine, 1 shot whiskey)**

- ○ 1 or 2 drinks
- ○ 3 or 4 drinks
- ○ 5 or 6 drinks
- ○ 7 to 9 drinks
- ○ 10 or more drinks

Q111 **Have you consumed alcohol in the past 24 hours?**

- ○ Yes
- ○ No

Q112 **How many hours of actual sleep do you get at night?**

Circle one number 0 1 2 3 4 5 6 7 8 9 10 11 12

Q113 **Do you take a nap during the day?**

- ○ Yes
- ○ No

Q114 **About how long is your nap? Please enter minutes between 0 and 90**

_____

Q115 **Do you have any visual impairment?**

- ○ No
- ○ Nearsighted
- ○ Farsighted

Q116 **Do you wear eyeglasses?**

- ○ Yes
- ○ No

Q117 **Do you use drugs?**

- ○ Yes
- ○ No

Q118 **What type of drugs do you use? Please select all that apply.**

- ☐ Marijuana (Mbanga)
- ☐ Tchap
- ☐ Cocaine (Caillou)
- ☐ Heroine
- ☐ Tramadol / Tramore
- ☐ Other _____

RIDERSHIP (RIDER)

q201D **Who is the owner of the motorcycle you operate?**

- ○ Myself
- ○ My family
- ○ My employer
- ○ It is rented
- ○ Balance and take

q203D **Is the motorcycle registered?**

- ○ Yes
- ○ No
- ○ I don't know

q204D **What is the primary use of the motorcycle? Please select all that apply.**

- [ ] Commercial transportation
- [ ] Private transportation
- [ ] Company use

q205D **At what times of the day do you mostly ride your motorcycle? Please select all that apply.**

- [ ] 6am – 10am
- [ ] 10am – 12pm
- [ ] 12pm – 3pm
- [ ] 3pm – 7pm
- [ ] 7pm – 10pm
- [ ] 10pm – 6am

q206D **How long have you been riding a motorcycle?**

- ○ Less than 3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q207D **Where did you learn how to ride a motorcycle? Please select all that apply.**

- [ ] Driving school
- [ ] Family member
- [ ] Friend
- [ ] Self-taught
- [ ] Other _____

q208D **How long did you train to ride a motorcycle?**

- ○ 1 day – 7 days
- ○ 1 – 2 weeks
- ○ 3 weeks – 1 month
- ○ More than 1 month

q209D **How often do you ride a motorcycle?**

- ○ Daily or almost daily
- ○ At least 3 times a week

- ○ Once or twice a week
- ○ 2 – 3 times a month
- ○ Once a month or less

q210D **What type of driver's license do you have?**

- ○ Full license
- ○ Temporal permit
- ○ Learner's permit
- ○ None

q211D **What is the category of driver's license? Please select all that apply.**

- ☐ A
- ☐ A1
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F
- ☐ G
- ☐ Don't know

q212D **How long have you had a driver's license?**

- ○ Less than 3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q213D **Do you belong to the Syndicate?**

- ○ Yes
- ○ No

q214D **Which Syndicate do you belong to?**

_____

q215D **Why do you not belong to a syndicate?**

- ○ Your reason _____
- ○ Prefer not to answer

q216D **On average, how many passengers do you carry per trip?**

- ○ One only
- ○ One or Two
- ○ Sometimes more than two
- ○ I only carry cargo

q217D **What is the most number of passengers you have ever carried on one trip?**

_____

q218D **On average, how many trips do you make per hour?**

_____

q219D **On average, how much do you charge each passenger per trip?**

- ○ 100 frs CFA
- ○ 125 frs CFA
- ○ 150 frs CFA
- ○ 175 frs CFA
- ○ 200 frs CFA
- ○ 225 frs CFA
- ○ 250 frs CFA
- ○ other _____

q220D **On average, how much money do you make in total by the end of your shift?**

- ○ frs CFA _____

q221D **How much do you give your employer by the end of your shift?**

- ○ frs CFA _____
- ○ I do not have an employer

q222D **How much does your employer pay you per day?**

- ○ frs CFA _____

RIDERSHIP (PASSENGER)

q201P **How often do you ride a motorcycle?**

- ○ Everyday
- ○ At least 3 times a week
- ○ Once or twice a week
- ○ 2 – 3 times a month
- ○ Once a month or less

q202P **What is your reason for using a motorcycle? Please select all that apply.**

- ☐ It takes me to my door step
- ☐ Cheaper fare
- ☐ Faster way to get to destination
- ☐ I use it for short distances
- ☐ I like the cool breeze
- ☐ Other _____

q203P **Where do you often take a motorcycle ride to? Please select all that apply.**

- ☐ School
- ☐ Work
- ☐ Market
- ☐ Bar
- ☐ Visiting friends/family
- ☐ Church
- ☐ Other _____

q204P **On average, how many trips do you take per day?**

_____

q205P **When riding (climbing), do you allow the rider to carry another passenger?**

- ○ Yes
- ○ No

q206P **Including yourself, what are the most number of people you have shared a motorcycle with?**

- ○ One
- ○ Two
- ○ Three
- ○ Four
- ○ Five
- ○ Other _____

q207P **On average, how much do you spend on commercial motorcycle transportation per day?**

- ○ frs _____

q208P **At what times of the day do you mostly travel by motorcycle? Please select all that apply.**

- ☐ 6am – 10am
- ☐ 10am – 12pm

- [ ] 12pm – 3pm
- [ ] 3pm – 7pm
- [ ] 7pm – 10pm
- [ ] 10pm – 6am

q209P **For how long have you been using a motorcycle?**

- ○ 0-3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q210P **Do you know how to drive a motorcycle?**

- ○ Yes
- ○ No

q211P **For how long have you been driving a motorcycle?**

- ○ 0-3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q212P **How long did you train to ride a motorcycle?**

- ○ 1 day – 7 days
- ○ 1 – 2 weeks
- ○ 3 weeks – 1 month
- ○ More than 1 month

q213P **Where did you learn how to ride a motorcycle? Please select all that apply.**

- [ ] Driving school
- [ ] Family member
- [ ] Friend
- [ ] Self-taught
- [ ] Other _____

q214P **Do you currently ride a motorcycle?**

- ○ Yes
- ○ No

q215P **Why do you not currently ride a motorcycle?**

- ○ Motorcycle nonfunctional
- ○ I had an accident
- ○ I now own a car
- ○ I lost a close one in an accident
- ○ It is not safe
- ○ Other _____

SAFETY AND PROTECTION (RIDER)

Q301 **Do you wear any of the following safety clothing?**

- ☐ Helmet
- ☐ Gloves
- ☐ Goggles
- ☐ Boots
- ☐ None

Q302 **How often do you wear a helmet?**

- ○ Daily
- ○ Several times a week
- ○ Once a week
- ○ 2 – 3 times a month
- ○ Once a month or less
- ○ None

Q303 **What type of helmet do you wear?** Please select all that apply.

- ☐ Full-face
- ☐ Open-face
- ☐ Half-head

Q304 **What are the reason(s) for not wearing a helmet?** Please select all that apply.

- ☐ It is expensive

- [ ] Rider does not provide one
- [ ] Scared of diseases
- [ ] I get too hot
- [ ] It is heavy to carry around
- [ ] Interferes with my hairstyle
- [ ] Interferes with my driving
- [ ] There is no law or penalty for not wearing one
- [ ] I know that I will not get an accident
- [ ] Afraid it will get stolen
- [ ] Most riders do not wear one
- [ ] I mostly do short distances
- [ ] Other _____

Q305p **Would you wear a helmet if the rider gives you one?**

- ○ Yes
- ○ No
- ○ Maybe

Q305d **Does your passenger(s) wear a helmet?**

- ○ Yes
- ○ No
- ○ Sometimes

Q306 **Do you provide a helmet for your passenger(s)?**

- ○ Yes
- ○ No
- ○ Sometimes

Q307 **Do you wear any reflective clothing?**

- ○ Yes
- ○ No

Q308 **How often do you wear reflective clothing?**

- ○ Daily
- ○ Several times a week
- ○ Once a week
- ○ 2 – 3 times a month
- ○ Once a month or less

Q309 **Did you buy the reflective clothing?**

- ○ Yes
- ○ No

Q310 **Does the motorcycle you ride have any reflective areas?**

- ○ Yes
- ○ No

Q311 **Does your motorcycle have working headlamps?**

- ○ Yes
- ○ No

Q312 **Does your motorcycle have working trafficators (indicators)?**

- ○ Yes
- ○ No

Q313 **Who maintains the motorcycle you ride?**

- ○ Myself
- ○ Professional mechanic
- ○ Friend
- ○ Owner

CRASHES

q401 **How many accidents have you been involved in as a commercial motorcyclist?**

_____

MOST SEVERE CRASH

q402 **The following questions are about your most SEVERE accident.**

In what month did your most SEVERE accident occur?

▼ January ... December

q402b **In what year did your most SEVERE accident occur?**

_____

q403 **Where did the accident occur?**

_____

q404 **On what day of the week did the accident occur?**

- ○ Mon
- ○ Tue
- ○ Wed
- ○ Thu
- ○ Fri
- ○ Sat
- ○ Sun

q405 **At what time of the day did the accident occur?**

- ○ 6am – 10am
- ○ 10am – 12pm
- ○ 12pm – 3pm
- ○ 3pm – 7pm
- ○ 7pm – 10pm
- ○ 10pm – 6am

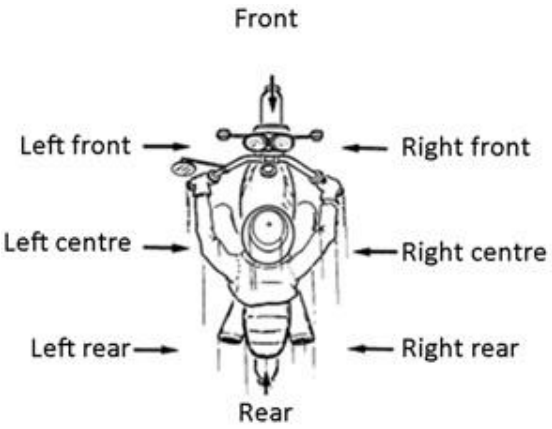
q406 **What was the collision type?**

- ○ Motorcycle – Car/lorry
- ○ Motorcycle – Motorcycle
- ○ Motorcycle – Bicycle
- ○ Motorcycle – Pedestrian
- ○ Motorcycle – Animal
- ○ Motorcycle – Obstacle
- ○ Fall-off
- ○ Other _____

q407 **What was the location of impact?**

- ○ **Head on side**
- ○ **Head on**
- ○ **Head on rear**
- ○ **Side swipe**
- ○ **Side on head**
- ○ **Rear end**

q408 **Where was the crash impact point?**



q409 **How many people were on the motorcycle at the time of the accident?**

- None
- One
- Two
- Three
- Four
- Five
- Six
- Seven or more

q410 **Was anyone injured at the time of accident?**

- Yes
- No
- Don't know

q411 **Did anyone die at the time of accident?**

- Yes
- No
- Don't know

q412 **Was there any cargo on the motorcycle at the time of the accident?**

- Yes
- No

q413 **Was the road tarred where you had the accident?**

- Yes
- No

q413 **What was the road condition at the time of accident? Please select all that apply.**

- [ ] Dusty
- [ ] Muddy
- [ ] Gravel
- [ ] Pothole
- [ ] Speed bumps
- [ ] Other _____

q414 **What was your estimated speed at the time of the accident? (km/h)**

- ○ 5
- ○ 10
- ○ 15
- ○ 20
- ○ 25
- ○ 30
- ○ 35
- ○ 40
- ○ 45
- ○ 50
- ○ 55
- ○ 60
- ○ 65
- ○ 70
- ○ 75 or more

q415 **Were you distracted by any of the following before the accident? Please select all that apply.**

- [ ] By passenger
- [ ] Lost balance
- [ ] Using cell phone
- [ ] Fell asleep
- [ ] Smoking
- [ ] Eating or drinking
- [ ] Object on road
- [ ] Something dropped off
- [ ] Other _____

q416 **Were you wearing a helmet at the time of the accident?**

- ○ Yes
- ○ No

q417 **Did you do any of the following before the accident? Please select all that apply.**

- ☐ Drink alcohol
- ☐ Take Medication
- ☐ Take drugs
- ☐ None

q418 **When did you seek treatment after the accident?**

- ○ Less than one hour
- ○ 1 – 6 hours
- ○ 7 – 24 hours
- ○ After one day
- ○ Other _____

q419 **Where did you receive treatment?**

- ○ At home
- ○ Pharmacy
- ○ Traditional doctor
- ○ Private clinic
- ○ Hospital
- ○ I did not get treatment

q420 **Where you admitted to the hospital after consulting?**

- ○ Yes
- ○ No

q421 **Did you have surgery?**

- ○ Yes
- ○ No

q422 **How many days did you spend in the hospital?**

_____

q423 **What was your total hospital cost for treatment?**

_____

q424 **How did you pay for treatment? Please select all that apply.**

- ☐ Out of my pocket

- [ ] Family funds
- [ ] Health insurance
- [ ] Borrowed from friend
- [ ] Borrowed from njiangi
- [ ] Borrowed from credit union
- [ ] Borrowed from bank
- [ ] The rider

q425 **Did you lose any property as a result of the accident?**

- ○ Yes
- ○ No

q426 **Did you become unemployed as a result of the accident?**

- ○ Yes
- ○ No

q427 **Was the motorcycle you were riding at the time of the crash reparable?**

- ○ Yes
- ○ No

q428 **How much did it cost you for repairs?**

_____

q429 **What body part(s) did you injure? Please select all that apply.**

- [ ] Head
- [ ] Face
- [ ] Neck
- [ ] Chest
- [ ] Abdomen
- [ ] Back/Spine
- [ ] Arms
- [ ] Legs
- [ ] External

q429a **What type of injury did you sustain on your Head**? **Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Fracture
- [ ] Swelling
- [ ] Concussion

- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429b **What type of injury did you sustain on your Face? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429c **What type of injury did you sustain on your Neck? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Whiplash
- [ ] Burn

q429d **What type of injury did you sustain on your Chest? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429e **What type of injury did you sustain on your Abdomen? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Swelling
- [ ] Blood clot

- [ ] Blunt
- [ ] Burn

q429f **What type of injury did you sustain on your Back? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429g **What type of injury did you sustain on your Arms? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429h **What type of injury did you sustain on your Legs? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429i **What type of injury did you sustain on your External body? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut

- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

DID MOST SEVERE CRASH OCCUR WITHIN THE PAST 12 MONTHS?

q430 **How many accidents were you involved in while riding a motorcycle in the past 12 months? If NONE enter 0**

_____

q430check **You said you had _____accidents in your lifetime but also said you had** _____ accidents in the **past 12 months? Please enter correct number of accidents in the past 12 months.**

_____

recentsevere **Did your most SEVERE accident happen in the past 12 months?**

- ○ Yes
- ○ No

MOST RECENT CRASH WITHIN THE PAST 12 MONTHS

q431 **The following questions are about your most RECENT accident which occurred within the past 12 months.**

In what month did your most RECENT accident occur?

▼ January ... December

q432 **Where did the accident occur?**

_____

q433 **On what day of the week did the accident occur?**

- ○ Mon
- ○ Tue
- ○ Wed
- ○ Thu
- ○ Fri
- ○ Sat
- ○ Sun

q434 **At what time of the day did the accident occur?**

- ○ 6am – 10am
- ○ 10am – 12pm

- ○ 12pm – 3pm
- ○ 3pm – 7pm
- ○ 7pm – 10pm
- ○ 10pm – 6am

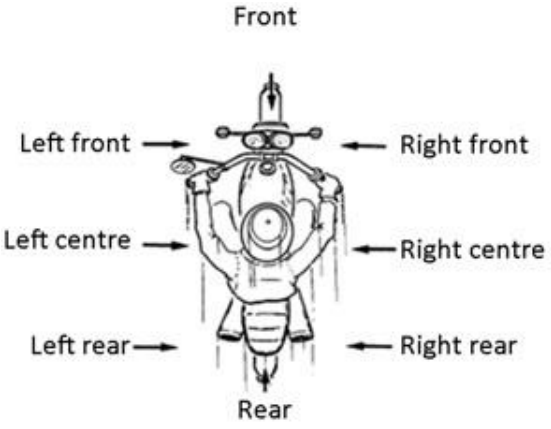
q435 **What was the collision type?**

- ○ Motorcycle – Car/lorry
- ○ Motorcycle – Motorcycle
- ○ Motorcycle – Bicycle
- ○ Motorcycle – Pedestrian
- ○ Motorcycle – Animal
- ○ Motorcycle – Obstacle
- ○ Fall-off
- ○ Other _____

q436 **What was the location of impact?**

- ○ **Head on side**
- ○ **Head on**
- ○ **Head on rear**
- ○ **Side swipe**
- ○ **Side on head**
- ○ **Rear end**

q437 **Where was the crash impact point?**



q438 **How many people were on the motorcycle at the time of the accident?**

- ○ None
- ○ One

- ○ Two
- ○ Three
- ○ Four
- ○ Five
- ○ Six
- ○ Seven or more

q439 **Was anybody injured at the time of accident?**

- ○ Yes
- ○ No
- ○ Don't know

q440 **Did anyone die at the time of accident?**

- ○ Yes
- ○ No
- ○ Don't know

q441 **Was there any cargo on the motorcycle at the time of the accident?**

- ○ Yes
- ○ No

q442 **Was the road tarred where you had the accident?**

- ○ Yes
- ○ No

q443 **What was the road condition at the time of accident? Please select all that apply.**

- ☐ Dusty
- ☐ Muddy
- ☐ Gravel
- ☐ Pothole
- ☐ Speed bumps
- ☐ Other _____

q444 **What was your estimated speed at the time of the accident? (km/h)**

- ○ 5
- ○ 10
- ○ 15
- ○ 20
- ○ 25

- ○ 30
- ○ 35
- ○ 40
- ○ 45
- ○ 50
- ○ 55
- ○ 60
- ○ 65
- ○ 70
- ○ 75 or more

q445 **Were you distracted by any of the following before the accident? Please select all that apply.**

- ☐ By passenger
- ☐ Lost balance
- ☐ Using cell phone
- ☐ Fell asleep
- ☐ Smoking
- ☐ Eating or drinking
- ☐ Moving object on road
- ☐ Shoe came off
- ☐ Other _____

q446 **Were you wearing a helmet at the time of the accident?**

- ○ Yes
- ○ No

q447 **Did you do any of the following before the accident? Please select all that apply.**

- ☐ Drink alcohol
- ☐ Take Medication
- ☐ Take drugs
- ☐ None

q448 **When did you seek treatment after the accident?**

- ○ Less than one hour
- ○ 1 – 6 hours
- ○ 7 – 24 hours
- ○ After one day

- ○ Other _____

q449 **Where did you receive treatment?**

- ○ At home
- ○ Pharmacy
- ○ Traditional doctor
- ○ Private clinic
- ○ Hospital
- ○ I did not get treatment

q450 **Where you admitted to the hospital after consulting?**

- ○ Yes
- ○ No

q451 **Did you have surgery?**

- ○ Yes
- ○ No

q452 **How many days did you spend in the hospital?**

_____

q453 **What was your total hospital cost for treatment?**

_____

q454 **How did you pay for treatment? Please select all that apply.**

- ☐ Out of my pocket
- ☐ Family funds
- ☐ Health insurance
- ☐ Borrowed from friend
- ☐ Borrowed from njiangi
- ☐ Borrowed from credit union
- ☐ Borrowed from bank
- ☐ The rider

q455 **Did you lose any property as a result of the accident?**

- ○ Yes
- ○ No

q456 **Did you become unemployed as a result of the accident?**

- ○ Yes
- ○ No

q457 **Was the motorcycle you were riding at the time of the crash reparable?**

- ○ Yes
- ○ No

q458 **How much did it cost you for repairs?**

_____

q459 **What body part(s) did you injure? Please select all that apply.**

- ☐ Head
- ☐ Face
- ☐ Neck
- ☐ Chest
- ☐ Abdomen
- ☐ Back/Spine
- ☐ Arms
- ☐ Legs
- ☐ External

q459a **What type of injury did you sustain on your Head**? **Please select all that apply.**

- ☐ Bruise
- ☐ Deep cut
- ☐ Fracture
- ☐ Swelling
- ☐ Concussion
- ☐ Blood clot
- ☐ Blunt
- ☐ Burn

q459b **What type of injury did you sustain on your Face? Please select all that apply.**

- ☐ Bruise
- ☐ Deep cut
- ☐ Fracture
- ☐ Swelling
- ☐ Blood clot
- ☐ Burn

q459c **What type of injury did you sustain on your Neck? Please select all that apply.**

- ☐ Bruise

- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Whiplash
- [ ] Burn

q459d **What type of injury did you sustain on your Chest? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q459e **What type of injury did you sustain on your Abdomen? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q459f **What type of injury did you sustain on your Back? Please select all that apply.**

- [ ] Bruise
- [ ] Deep cut
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q459g **What type of injury did you sustain on your Arms? Please select all that apply.**

- ☐ Bruise
- ☐ Deep cut
- ☐ Sprain
- ☐ Fracture
- ☐ Dislocation
- ☐ Swelling
- ☐ Blood clot
- ☐ Burn

q459h **What type of injury did you sustain on your Legs? Please select all that apply.**

- ☐ Bruise
- ☐ Deep cut
- ☐ Sprain
- ☐ Fracture
- ☐ Dislocation
- ☐ Swelling
- ☐ Blood clot
- ☐ Burn

q459i **What type of injury did you sustain on your External body? Please select all that apply.**

- ☐ Bruise
- ☐ Deep cut
- ☐ Swelling
- ☐ Blood clot
- ☐ Burn

THANK YOU FOR YOUR TIME

END OF SURVEY

Appendix C: Survey (Pidgin Version)

Research about how people weh dem di use bend skin for Bamenda, Cameroon di get accident and the kind of injury dem di get

CONSENT

Before we start, we want make sure say you qualify for answer these questions. I beg answer this question:

☐ I be at least 18 years old and di use motorcycle

***Na who di do the research, why we di ask you for join, how we choose you, and weti be the number of people weh we want make them join the research*?**
Che Wankie di do this research for understand motorcycle accidents, injuries, and things them weh them di cause accidents. Che Wankie di go school for get e phd for public health. This research na part of e school work so that e fit get this degree for Public Health. E go di do this work with some of e teachers and dem go make sure e do good work. We don choose you for because you di use motorcycle and you be 18 years old or you old pass 18 years.

Na why we di do this research?
The reason for this research na for understand weti di cause motorcycle accidents for drivers dem and passengers, for understand weti people dem di behave and act when dem ride motorcycle, we want check the kind injury weh people weh dem no di use helmet fit get, and for calculate how serious your injury fit be if motorcycle jam motor.

Weti g happen if you join this research and which things dem be standard and which them na experiment?
If you gree say you want join this research, e find say make you know weti fit happen: Them go give you ID number for only this research. Them go use some questionnaire for ask you questions about the way you di use motorcycle. Dem go do the survey for private place and na only you and the person weh e di ask you questions go be there. You fit skip question weh you feel comfortable for answer anytime.

How much time e go take for do each thing for this research, the total time weh e go take you for this research and the time weh the research go take?
The questionnaire go take about 30-60 minutes for finish am.

Weti be the risk weh you fit get if you join this research?
If you join this research, you fit get some small risk. E be possible say some man fit know who you be. We go make sure say no other person go hear the things dem weh you tell we for this research. We no go tell any person weti weh you tell we and we not go ask you your name because say we no want make some person fit sabe who be tell we something. Na only people weh dem di work for this research go fit know weti weh people be tell we. We don make sure say all the things them weh you tell we go stay for house. We no go tell any other person the

things them we you tell we. Time weh we finish this project we go calculate things dem weh people tell we then print am for some report and science book. We want tell you say no man weh we interview e go see e name for that book. We go print na things dem weh all man talk as a group. No man go fit know which things dem weh you be tell we. We go make sure say we follow things them weh na law. E be possible say my some people for my school weh dem di call am UCSD go see whether I di do things according to the law. Because say na research weh we di do, e be possible say you go get some small risk. If we think say some risk go be, we go tell you about the kind risk.

Which kind of benefits you fit get?
Sometime you no go get direct benefit when you join this research but the things them weh you tell we go helep for make sure say plenty people dem no get accidents. The big man for this project go know weti di really happen time weh motorcycle get accident, the kind injury, the things dem weh the cause the accidents and how we all fit benefit from the things dem weh you tell we.

You fit choose whether you no want for join or no you want commot from the research and you no loss any thing?
No man go force you for join this research. Na you di decide if you want join. If you join, you fit commot at anytime and no man go blame you. You no go loss anything. You fit also decide say you no go answer some question if you think say na private information.

You think say them fit move you from this research weh you no tell we?
The patron for this research fit move you if e think say the project di bother you or if e think say you no qualify for join the project. Dem fit move you for the project if you decide for do things dem weh we no want for the project or you no want hear thing weh we want tell you.

We go give you some small thing because you join this research?
Because you join this research and we don take your time, we go give you some small thing. We go give you 500 frs for your time.

Weti e go cost me for join this study?
E no go cost you anything for join this research.

What about your security?
All the information weh we collect go stay private and na the law. We no go ask any information weh person fit use for discover who you be. We go lock all the information weh we collect for safe. We want tell you say if something happen then some committee for my school (UCSD) go want for check whether I make mistake.

If you get questions, who you fit call?
Che Wankie do explain all thing weh we go do for this research and e don answer your questions. If you get more questions weh you want ask about this research you fit call e using this number +237676352910 or you fit email e using cwankie@ucsd.edu. You fit also call the

Research Office for this phone number, (858) 657-5100, for know about your rights as person weh e want do this research like participant and for report anything weh e no correct.

Your signature and say you confirm say you want join this project

I don read/hear the information for this document. Dem don give me the chance for ask questions about the project and the risk weh I fit get if I join the project as well as other things dem for this document. I understand wetio the project be about and how and why dem di do the study. I don choose for join this project and I go sign for here. I don get copy of this document for keep am.

- ○ I gree for join this research
- ○ I no gree for join this research

Interviewer: Enter your name. _____

I acknowledge that the participant has read the consent document and indicated his/her comprehension of the study and that his/her participation is voluntary.

- ○ Initials _____

DEMOGRAPHICS

Na which kind type of motorcycle user you be?

- ○ Driver
- ○ Passenger

Q101 **You be man or woman?**

- ○ Man
- ○ Woman

Q102 **Na for which year dem born you?**

_____

age **Na how old you be?**

_____

Q103 **Weti be the highest level for school weh you go?**

- ○ I no ever go school

- ○ Primary school
- ○ Secondary school
- ○ High school
- ○ I no finish University
- ○ University

Q104 **Weti be your married situation?**

- ○ I never married
- ○ I married
- ○ Come we stay/ I di stay with small thing
- ○ My woman/man don die
- ○ I don divorce

Q105 **How many pikin dem you get?**

_____

Q106 **Weti be your religion?**

- ○ Christian
- ○ Muslim
- ○ Traditional
- ○ I do believe in religion

Q107 **You di stay na for which quarter?**

_____

Q108 **Na how many cigarettes you di smokam for one day?**

- ○ I no di smoke
- ○ I di smoke 1 - 10 cigarettes for one day
- ○ 1 di smoke 11 - 20 cigarettes for one day
- ○ I di smoke 21 - 30 cigarettes for one day
- ○ I di smoke more than 30 cigarettes for one day

Q109 **How much mimbo containing alcohol you di drink for normal day? e.g., Beer, whiskey, mbuh, shah, wine, afofo**

- ○ I no di drink
- ○ Every month
- ○ 2-4 times for one month
- ○ 2-3 times for one week
- ○ 4 or more times for one week

Q110 **For day weh you drink, how much mimbo weh e contain alcohol you di drink? (65cl bottle beer, mug of palm wine, mug of shah, glass of wine, 1 shot whiskey)**

- ○ 1 or 2 drinks
- ○ 3 or 4 drinks
- ○ 5 or 6 drinks
- ○ 7 to 9 drinks
- ○ 10 or more drinks

Q111 **You drink any mimbo inside the past 24 hours?**

- ○ Yes
- ○ No

Q112 **Na how many hours weh you di sleep each night?**

Pick only one 0 1 2 3 4 5 6 7 8 9 10 11 12

Q113 **You di sleep small for day time?**

- ○ Yes
- ○ No

Q114 **Na how long you di sleep small for day time? Please enter minutes between 0 and 90**

_____

Q115 **You get any eye problem?**

- ○ No
- ○ I no di see things far way
- ○ I no di see things near me

Q116 **You di wear eyeglasses?**

- ○ Yes
- ○ No

Q117 **You di take drugs make ei give you courage and power for work?**

- ○ Yes
- ○ No

Q118 **Na which kind drugs you di use? Select all possible answers.**

- ☐ Marijuana (Mbanga)
- ☐ Tchap
- ☐ Cocaine (Caillou)
- ☐ Heroine
- ☐ Chamore
- ☐ other kind _____

RIDERSHIP (RIDER)

q201D **Na who own the motorcycle weh you di drive am?**

- ○ Na my own
- ○ Na my family
- ○ Na my patron
- ○ I di rent am
- ○ Balance and take

q203D **Dem register dis motorcycle weh you di drive am?**

- ○ Yes
- ○ No
- ○ I no know

q204D **Weti be the main reason why you di use this motorcycle? Select all possible answers**

- [ ] For carry passengers
- [ ] Na for private use
- [ ] Na for company use

q205D **Na for which time of the day weh you di mostly drive your motorcycle? Select all possible answers**

- [ ] between 6am – 10am
- [ ] between 10am – 12pm
- [ ] between 12pm – 3pm
- [ ] between 3pm – 7pm
- [ ] between 7pm – 10pm
- [ ] between 10pm – 6am

q206D **Na how long weh you don di drive motorcycle?**

- ○ Less than 3 months
- ○ For 4-7 months
- ○ For 8-12 months
- ○ For 1-2 years
- ○ For 2-4 years
- ○ For 5 or more years

q207D **Na where you learn how for drive motorcycle? Select all possible answers**

- [ ] For driving school
- [ ] Na family member teach me
- [ ] Na my friend teach me
- [ ] I be teach myself
- [ ] Other _____

q208D **Na how long you be train for drive motorcycle?**

- ○ 1 day – 7 days
- ○ 1 – 2 weeks
- ○ 3 weeks – 1 month
- ○ For more than 1 month

q209D **How many times you di normally drive motorcycle?**

- ○ Almost everyday
- ○ At least 3 times for one week
- ○ One or two times for one week
- ○ 2 – 3 times for one month
- ○ One time for one month

q210D **Na which kind driver's license you get?**

- ○ Full license
- ○ Temporal permit
- ○ Learner's permit
- ○ I no get license

q211D **Na which kind of driver's license you get? Select all possible answers**

- ☐ A
- ☐ A1
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F
- ☐ G
- ☐ I no know

q212D **Na how long you don get driver's license?**

- ○ Less than 3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q213D **You be member for “Okada” trade union (syndicate)?**

- ○ Yes
- ○ No

q214D **Na which "Okada" trade union (syndicate) weh you dey?**

_____

q215D **Why you no join "Okada" trade union (syndicate)?**

- ○ Weti be your reason _____
- ○ I no want answer

q216D **How many passengers you di carry one time on top your motorcycle?**

- ○ Na only one passenger
- ○ One or Two passengers
- ○ Sometimes I di carry more than two passengers
- ○ I di only carry cargo

q217D **Weti be the most number of passengers weh you don ever carry for one waka (trip)?**

_____

q218D **About how many waka (trips) you di make every hour?**

_____

q219D **Around how much you di ask each passenger for pay you for one waka (trip)?**

- ○ 100 frs CFA
- ○ 125 frs CFA
- ○ 150 frs CFA
- ○ 175 frs CFA
- ○ 200 frs CFA
- ○ 225 frs CFA
- ○ 250 frs CFA
- ○ other amount _____

q220D **Around how much money you di make when you finish work everyday?**

- ○ frs CFA _____

q221D **How much money you di give patron after you finish work everyday?**

- ○ frs CFA _____
- ○ I no get patron

q222D **How much your patron di settle you every day?**

- ○ frs CFA _____

RIDERSHIP (PASSENGER)

q201P **How often you di climb/use motorcycle?**

- ○ Everyday
- ○ At least 3 times for one week
- ○ One or two times a week
- ○ 2 – 3 times a month
- ○ One time a month or less

q202P **Weti be the reasons why you di use motorcycle? Select all possible answers**

- ☐ Motorcycle di take me for my front door
- ☐ E cheap
- ☐ I di reach place weh I di go quick quick
- ☐ I di use motorcycle for short distances
- ☐ I like the cool breeze
- ☐ Other _____

q203P **Na where you di mostly take okada for go? Select all possible answers**

- ☐ For school
- ☐ For work
- ☐ For market
- ☐ For bar/club
- ☐ For go visit friends/family
- ☐ Church
- ☐ Other reason _____

q204P **On average, how many times you di climb okada for one day?**

_____

q205P **When you climb bend skin, you di gree make driver carry another passenger?**

- ○ Yes
- ○ No

q206P **If you add yourself, weti be the highest number of people weh you dong climb bend skin one time with dem?**

- ○ One
- ○ Two
- ○ Three
- ○ Four
- ○ Five
- ○ Other _____

q207P **Around how much you di pay for one waka?**

- ○ frs CFA _____

q208P **Na for which time of the day weh you di mostly use motorcycle? Select all possible answers**

- ☐ 6am – 10am
- ☐ 10am – 12pm
- ☐ 12pm – 3pm
- ☐ 3pm – 7pm
- ☐ 7pm – 10pm
- ☐ 10pm – 6am

q209P **How long you don di climb or use motorcycle?**

- ○ 0-3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years

- ○ 5 or more years

q210P **You know how for drive motorcycle?**

- ○ Yes
- ○ No

q211P **Na how long you don di drive motorcycle?**

- ○ 0-3 months
- ○ 4-7 months
- ○ 8-12 months
- ○ 1-2 years
- ○ 2-4 years
- ○ 5 or more years

q212P **How long you train for drive motorcycle?**

- ○ 1 day – 7 days
- ○ 1 – 2 weeks
- ○ 3 weeks – 1 month
- ○ More than 1 month

q213P **Na where you learn how for drive motorcycle? Select all possible answers**

- ☐ For driving school
- ☐ Na family member teach me
- ☐ Na my friend teach me
- ☐ I teach myself
- ☐ Other _____

q214P **You di drive motorcycle now?**

- ○ Yes
- ○ No

q215P **Why you no di drive motorcycle now?**

- ○ My motorcycle no di work

- ○ I be get accident
- ○ I get motor now
- ○ Some person weh I know be die
- ○ E no be safe
- ○ Other _____

SAFETY AND PROTECTION

Q301 **You di wear any clothes weh e fit protect you?** Select all possible answers.

- ☐ Helmet
- ☐ Gloves
- ☐ Eye glass
- ☐ Boots
- ☐ Nothing

Q302 **How many times you di wear helmet?**

- ○ Everyday
- ○ Sometimes inside one week
- ○ One time for one week
- ○ 2 – 3 times for one month
- ○ One time or less for one month
- ○ I no di wear helmet

Q303 **Na which kind of helmet weh you di wear am?** Select all possible answers.

- ☐ Full-face
- ☐ Open-face
- ☐ Half-head

Q304 **Weti be the reasons weh you no di wear helmet?** Select all possible answers.

- ☐ E dear too much
- ☐ Driver does not provide one
- ☐ Scared of diseases
- ☐ E di make my head hot

- [ ] E heavy for carry am around
- [ ] E di spoil me hairstyle
- [ ] I no fit drive fine when I wear helmet
- [ ] No be law for wear helmet and no punishment no dey
- [ ] I know say I no go get accident
- [ ] I di fear say dem go tiff my helmet
- [ ] Plenty drivers dem no di wear helmet
- [ ] Most of the time I di do na short distance
- [ ] Other reason _____

Q305p **If driver give you helmet you go wear am?**

- ○ Yes
- ○ No
- ○ Maybe

Q305d **Any of your passenger di wear helmet?**

- ○ Yes
- ○ No
- ○ Sometimes

Q306 **You di give helmet for your passenger make e wear am?**

- ○ Yes
- ○ No
- ○ Sometimes

Q307 **You di wear any clothes weh e di shine for night?**

- ○ Yes
- ○ No

Q308 **How many times you di wear clothes weh e di shine for night?**

- ○ Everyday
- ○ Some times for one week
- ○ One time for one week

- ○ 2 – 3 times for one month
- ○ One time or less for one month

Q309 **Na you buy the clothes weh e di shine for night?**

- ○ Yes
- ○ No

Q310 **The motocycle weh you di drive get reflector?**

- ○ Yes
- ○ No

Q311 **The head lamp for the motorcycle weh you di drive di work?**

- ○ Yes
- ○ no

Q312 **The trafficators for your motorcycle di work?**

- ○ Yes
- ○ No

Q313 **Na who di fix the motorcycle weh you di drive when e spoil?**

- ○ Na me sef sef
- ○ Na mechanic
- ○ Na my friend
- ○ Na patron

CRASHES

q401 **How many accidents you don get with motorcycle since weh dem born you?**

_____

MOST SEVERE CRASH

q402 The following questions na about your most SERIOUS accident.

Na which month your most SERIOUS accident be happen?

▼ January ... December

q402b
Na which year your most SERIOUS accident be happen?

_____

q403 **Na where this accident be happen?**

_____

q404 **Na for which day weh this accident be happen?**

- ○ Monday
- ○ Tuesday
- ○ Wednesday
- ○ Thursday
- ○ Friday
- ○ Saturday
- ○ Sunday

q405 **Na which time weh this accident be happen?**

- ○ 6am – 10am
- ○ 10am – 12pm
- ○ 12pm – 3pm
- ○ 3pm – 7pm
- ○ 7pm – 10pm
- ○ 10pm – 6am

q406 **Na weti be be the cause of the accident?**

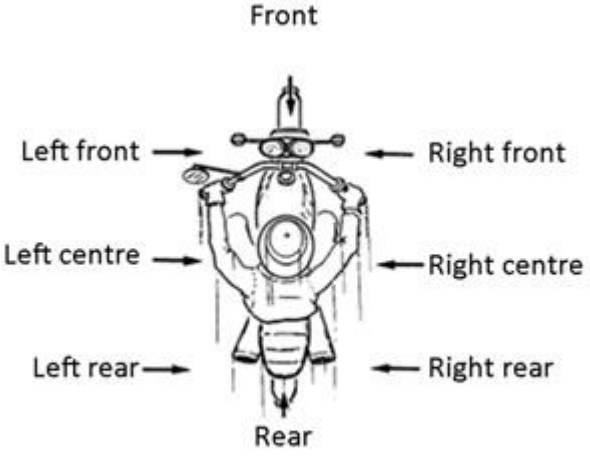
- ○ Motorcycle be jam moto/truck (camion)
- ○ Motorcycle be jam motorcycle

- ○ Motorcycle be jam bicycle
- ○ Motorcycle be jam person
- ○ Motorcycle be jam animal
- ○ Motorcycle be jam something for road
- ○ I be fall me sef sef
- ○ Other _____

q407 Na how the accident be happen?

- ○ I be jam motor for e side
- ○ I be jam motor for front
- ○ I be jam motor for back
- ○ The motor brush me
- ○ Motor be jam me for side
- ○ Motor be jam me for back

q408 **Na for which place for your motorcycle weh you be jam am?**



q409 **How many passengers be dey on top your moyorcycle time weh you be get the accident?**

- ○ None
- ○ One
- ○ Two
- ○ Three

- ○ Four
- ○ Five
- ○ Six
- ○ Seven or more

q410 **Any of the passengers be get injury time weh the accident be happen?**

- ○ Yes
- ○ No
- ○ I no know

q411 **Any of the passengers be die time weh the accident be happen?**

- ○ Yes
- ○ No
- ○ I no know

q412 **You be carry cargo time weh the accident be happen?**

- ○ Yes
- ○ No

q413 **Dem be tar road for the place weh you be get the accident?**

- ○ Yes
- ○ No

q413 **Weti be be the condition for the road time weh you be get the accident? Select all possible answers**

- ☐ Dust for road
- ☐ Mud
- ☐ Gravel
- ☐ Pothole
- ☐ Speed bumps
- ☐ Other _____

q414 **Na which speed you be di drive time weh you be get the accident? (km/h)**

- ○ 5
- ○ 10
- ○ 15
- ○ 20
- ○ 25
- ○ 30
- ○ 35
- ○ 40
- ○ 45
- ○ 50
- ○ 55
- ○ 60
- ○ 65
- ○ 70
- ○ 75 or more

q415 **Any of this things dem be make am make you get accident? Select all possible answers**

- ☐ Na my passenger make me get accident
- ☐ I be lost balance
- ☐ I be di use cell phone
- ☐ I be start for sleep
- ☐ I be di smoke
- ☐ I be di chop or drink
- ☐ Something be dey for road
- ☐ Something be fall
- ☐ Other _____

q416 **You be wear helmet time weh the accident be happen?**

- ○ Yes

- ○ No

q417 **You be do any of this things dem before the accident be happen? Select all possible answers**

- ☐ Drink alcohol (beer, shah, mbuh, wine, whisky)
- ☐ Take Medicine
- ☐ Take drugs
- ☐ Nothing

q418 **Na when you be try for get treatment after the accident be happen?**

- ○ Less than one hour
- ○ Between 1 – 6 hours
- ○ Between 7 – 24 hours
- ○ After one day
- ○ Other _____

q419 **Na where you be get treatment?**

- ○ I be stay for house
- ○ I be go pharmacy
- ○ I be go see Ngambe doctor
- ○ I be go private clinic
- ○ I be go hospital
- ○ I no be get treatment

q420 **Dem be admit you for hospital after you be consult?**

- ○ Yes
- ○ No

q421 **Dem be operate you?**

- ○ Yes
- ○ No

q422 **How many days you be stay for hospital?**

_____

q423 **Na how much you be pay hospital for your treatment?**

_____

q424 **How you be pay for treatment? Select all possible answers**

- [ ] I be pay cash
- [ ] My family be pay
- [ ] Na health insurance be pay
- [ ] I borrow money from my friend
- [ ] I borrow from njiangi
- [ ] I borrow from credit union
- [ ] I borrow from bank
- [ ] The driver

q425 **You be loss any property because of the accident?**

- ○ Yes
- ○ No

q426 **You be loss your work because of the accident?**

- ○ Yes
- ○ No

q427 **Dem be fix the motorcycle weh you be di ride am time weh you be get the accident?**

- ○ Yes
- ○ No

q428 **How much e be cost you for fix the motorcycle?**

_____

q429 **Na for which part dem for your body wey you be get injury? Select all possible answers**

- [ ] Head
- [ ] Face
- [ ] Neck
- [ ] Chest
- [ ] Abdomen (Around my belly)
- [ ] Back/Spine

- [ ] Hands
- [ ] Foot
- [ ] Outside skin

q429a **Na which kind injury you be get for your Head?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Fracture
- [ ] Swelling
- [ ] Concussion
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429b **Na which kind injury you be get for your Face?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429c **Na which kind injury you be get for your Neck?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Whiplash
- [ ] Burn

q429d **Na which kind injury you be get for your Chest?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound

- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429e **Na which kind injury you be get for your Belleh?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429f **Na which kind injury you be get for your Back?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q429g **Na which kind injury you be get for your Hands?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429h **Na which kind injury you be get for your Foot?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q429i **Na which kind injury you be get for your Outer body?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

DID MOST SEVERE CRASH OCCUR WITHIN THE PAST 12 MONTHS?

q430 **How many accidents weh you don get as you di ride motorcycle inside the past 12 months?**

_____

q430check You talk say you be get _____ accidents for your life but also talk say you be get _____ accidents inside the past 12 months? I beg enter the correct number of accidents weh e happen inside the past 12 months.

_____

Your most SERIOUS accident be happen inside the past 12 months?

- ○ Yes
- ○ No

MOST RECENT CRASH WITHIN THE PAST 12 MONTHS

q431 The following questions na about your most RECENT accident, that mean say accident weh e just happen.

Na which month your most RECENT accident be happen?

▼ January ... December

q432 **Na where this accident be happen?**

_____

q433 **Na for which day weh this accident be happen?**

- ○ Monday
- ○ Tuesday
- ○ Wednesday
- ○ Thursday
- ○ Friday
- ○ Saturday
- ○ Sunday

q434 **Na for which time weh this accident be happen?**

- ○ 6am – 10am
- ○ 10am – 12pm
- ○ 12pm – 3pm
- ○ 3pm – 7pm
- ○ 7pm – 10pm
- ○ 10pm – 6am

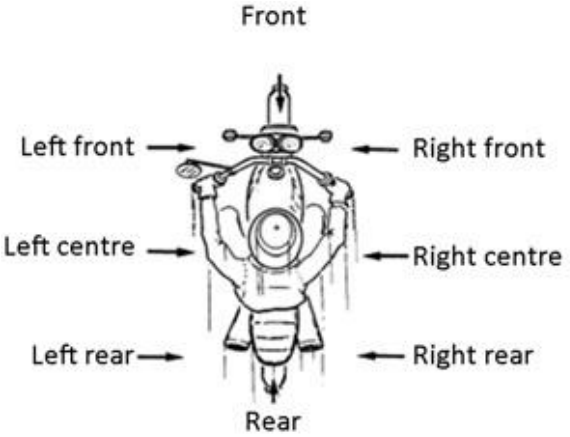
q435 **Na which kind motor or thing you be get accident with?**

- ○ Motorcycle be jam motor/Camion
- ○ Motorcycle be jam motorcycle
- ○ Motorcycle be jam bicycle
- ○ Motorcycle be jam pedestrian (Person)
- ○ Motorcycle be jam animal
- ○ Motorcycle be jam something for road
- ○ I be fall me sef sef
- ○ Other reason _____

q436 **Na which side weh dem be jam you?**

- ○ I be jam motor for e side
- ○ I be jam motor for front
- ○ I be jam motor for back
- ○ The motor be brush me
- ○ Motor jam by side
- ○ Motor jam me for back

q437 **Na for which side weh you be get contact?**



q438 **How many passengers be dey on top the motorcycle time weh the accident be happen?**

- ○ None
- ○ One
- ○ Two
- ○ Three
- ○ Four
- ○ Five
- ○ Six
- ○ Seven or more

q439 **Any of the passengers be get injury time weh the accident be happen?**

- ○ Yes
- ○ No

- ○ I no know

q440 **Any of the passengers be die time weh the accident be happen?**

- ○ Yes
- ○ No
- ○ I no know

q441 **You be carry cargo time weh the accident be happen?**

- ○ Yes
- ○ No

q442 **Dem be tar road for the place weh you be get the accident?**

- ○ Yes
- ○ No

q443 **Weti be be the condition for the road time weh you be get the accident?** Select all possible answers

- ☐ Dust
- ☐ Mud
- ☐ Gravel
- ☐ Pothole
- ☐ Speed bumps
- ☐ Other _____

q444 **Na which speed you be di drive time weh you be get the accident? (km/h)**

- ○ 5
- ○ 10
- ○ 15
- ○ 20
- ○ 25
- ○ 30
- ○ 35

- ○ 40
- ○ 45
- ○ 50
- ○ 55
- ○ 60
- ○ 65
- ○ 70
- ○ 75 or more

q445 **Any of this things dem be distract you time weh you be get the accident?** Select all possible answers

- ☐ By passenger
- ☐ I lost balance
- ☐ I be di use cell phone
- ☐ I be start for sleep
- ☐ I be di smoke
- ☐ I be di chop or drink
- ☐ Something be pass for my front
- ☐ My shoe be comot my foot
- ☐ Other _____

q446 **You be wear helmet time weh the accident be happen?**

- ○ Yes
- ○ No

q447 **You be do any of this things before the accident be happen?** Select all possible answers

- ☐ Drink alcohol
- ☐ Take Medicine
- ☐ Take drugs
- ☐ Nothing

q448 **Na when you be try for get treatment after the accident?**

- ○ Less than one hour

- ○ Inside 1 – 6 hours
- ○ Inside 7 – 24 hours
- ○ After one day
- ○ Other _____

q449 **Na where you be receive treatment?**

- ○ For house
- ○ I be go pharmacy
- ○ I be go ngambe doctor
- ○ I be go private clinic
- ○ I be go hospital
- ○ I no be get treatment

q450 **Dem be admit you for hospital after you be consult?**

- ○ Yes
- ○ No

q451 **You be get surgery?**

- ○ Yes
- ○ No

q452 **How many days you be spend for hospital?**

_____

q453 **Na how much you be pay hospital for your treatment?**

_____

q454 **Na how you be pay for treatment?** Select all possible answers

- ☐ I be pay cash
- ☐ My family be pay
- ☐ I be use health insurance
- ☐ I borrow money from my friend
- ☐ I borrow from njiangi
- ☐ I borrow from credit union
- ☐ I borrow from bank

- [ ] The driver

q455 **You be loss any property because of the accident?**

- ○ Yes
- ○ No

q456 **You be loss your work because of the accident?**

- ○ Yes
- ○ No

q457 **Dem be fix the motorcycle weh you be di drive am time weh you be get the accident?**

- ○ Yes
- ○ No

q458 **How much e be cost for fix the motorcycle?**

_____

q459 **Na for which part of your skin weh you be get injury?** Select all possible answers

- [ ] Head
- [ ] Face
- [ ] Neck
- [ ] Chest
- [ ] Abdomen (Around me belly)
- [ ] Back/Spine
- [ ] Hands
- [ ] Foot
- [ ] Outside skin

q459a **Na which kind injury you be get for your Head?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Fracture
- [ ] Swelling
- [ ] Concussion
- [ ] Blood clot
- [ ] Blunt

- [ ] Burn

q459b **Na which kind injury you be get for your Face?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q459c **Na which kind injury you be get for your Neck?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Whiplash
- [ ] Burn

q459d **Na which kind injury you be get for your Chest?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Fracture
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q459e **Na which kind injury you be get for your Belleh?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt

- [ ] Burn

q459f **Na which kind injury you be get for your Back?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Blunt
- [ ] Burn

q459g **Na which kind injury you be get for your Arms?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q459h **Na which kind injury you be get for your Foot?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound
- [ ] Sprain
- [ ] Fracture
- [ ] Dislocation
- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

q459i **Na which kind injury you be get for your Outer body?** Select all possible answers

- [ ] Bruise
- [ ] Deep wound

- [ ] Swelling
- [ ] Blood clot
- [ ] Burn

THANK YOU FOR YOUR TIME
END OF SURVEY