The Dynamics Of Motorcycle Crashes

A Global Survey of 1578 Motorcyclists

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Abstract

An online survey was carried out in 2019 which focused on motorcyclists who had been involved in a crash. The survey was disseminated throughout Europe, the USA, Asia, Australia and South America in order to get as much of a global response as possible.

The study extends and expands a pilot study based on a survey of motorcyclists whose motorcycles were fitted with the technology of Advanced (anti-lock) Braking Systems (ABS), which was carried out in 2016/2017. This research involved in the analysis of the study are most importantly riders bringing their personal experience and their expertise above that of simple academia.

A sample of 1,578 motorcycle riders from 30 different countries answered a questionnaire which included 39 questions on much more than the typical parameters of crashes. Particular focus was put on questions most relevant to motorcycles like the use of protective equipment and assistance systems, in particular ABS. Many interviewees provided comments throughout the questionnaire and n.832 provided further descriptions of their crashes, which allows deep insight to the dynamics of crashes and their circumstances, which would not be captured in a usual survey.

The survey's overall results highlight the relationship between speed, protective equipment, assistance systems and injuries, as well as how post-crash motions change the patterns of crash occurrence and injury outcome.

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Cover photo: Joachim Sjöström

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Research Team

The research team has wide experience in the study of motorcycle crashes such as those conducted by James Ouellet who co-authored the seminal Hurt Report as well as other groundbreaking studies on motorcycle crash investigations[1]; Elaine Hardy's involvement in EU PTW research projects and studies of motorcycle safety, including reporting crash investigations[2]. Research on infrastructure and training by Martin Winkelbauer[3] and in-depth accident investigation (e.g.MAIDS, SaferWheels, DaCoTA) by Dimitri Margaritis[4]. The latter two researchers collaborated in the OECD/ITF research report, "Improving Safety for Motorcycle, Scooter and Moped Riders[5].

Short Curriculum Vitae of all authors can be found in Annex V:

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[1]Ouellet JV, How the timing of motorcycle accident investigation affects sampling and data outcome; *Proceedings, International Motorcycle Safety Conference,* Motorcycle Safety Foundation, Irvine, CA, 2006.
Ouellet JV & Kasantikul V, Rider training and collision avoidance in Thailand and Los Angeles motorcycle crashes; Proceedings, Int. Motorcycle Safety Conference, Motorcycle Safety Foundation, Irvine, CA, 2006

[2]Elaine Hardy PhD Northern Ireland Motorcycle Fatality Report 2012. *http://righttoride.org.uk/documents/Northern_Ireland_Motorcycle_Fatality_Report_2012.pdf*

[3]*http://transit.gencat.cat/web/.content/documents/congressos_i_jornades/01_I_jornada_dialeg_SV_motocicletes/I_jornada_dialegs_SV_motos-05-Martin-Winkelbauer.pdf*

[4]*http://www.ircobi.org/wordpress/downloads/irc18/pdf-files/78.pdf*

[5]*https://www.svmc.se/smc_filer/SMC%20centralt/Rapporter/2016/OECD%20Report_Improving%20safety%20for%20motorcycle.pdf*

Executive Summary

Motorcycle crash causation research has for many years been the domain of academic experts and government departments with an interest in reducing road casualties such as advocating motorcycle improvements to benefit the rider, through technology, better training, as well as improving the environment through cleaner emissions.

Crash investigators such as police investigators or a dedicated Forensic Science team of investigators are those who go out to crash scenes in real time where the crash site is closed to public and the investigators are on scene within a couple of hours[6]. It is this type of detail which offers a true understanding of the dynamics of road traffic crashes which is carried out by specific teams of police or forensic crash investigators, unless funding is made available to private sector teams prepared to go out at all hours and investigate crashes in real time. The landmark Hurt study in Los Angeles, California was the first of this type in 1981. Later studies in Thailand were carried out by part of the same team in 1999 - 2002 focussing on motorcycles.

In Europe there are investigators and teams who use the same principles, however the limitations to these crash scene investigations are that they are typically "follow ups" or rather the investigators attend the scenes at a later date to that of the crash, even weeks after the event[7]. Part of the reason is because the results of these cases are either kept confidential by police or the Coroner's Office and not made available for scrutiny by interested analysts. This means that information and precious data from the crash scene are lost, the consequences are that important details are missing or are incomplete.

The "Dynamics of Motorcycle Crashes" survey cannot take the place of a bona fide real time crash investigation by expert investigators. But what it can do is to provide the voice of the person directly involved in the crash, who understands first-hand what happened, possibly why it happened and how it happened.

Committed motorcyclists, of whom there are many who responded to this survey, love to explain, discuss, comment and give their considered opinions. This survey has allowed them to do exactly that. The respondents were given ample space to write as much as they felt necessary to explain from their perspective, what happened and whose fault they thought it was. In the case of the single crashes, there were those who simply accepted responsibility for lack of attention, making mistakes, or just not understanding the situation in front of them.

In this survey, a sample of 1,578 motorcycle riders from 30 different countries answered a questionnaire which included 39 questions on much more than the typical parameters of crashes. Particular focus was put on questions most relevant to motorcycles like the use of protective equipment and assistance systems, in particular ABS (Advanced Braking Systems). Overall, n.832 riders provided further descriptions of their crashes, which allows deep insight to the dynamics of crashes and their circumstances, which would not be captured in a usual tick box survey.

What became evident from their responses, was that orthodox motorcycle accident analysis appears to be "looking the wrong way". Typically, motorcycle accident studies have identified human error as the major cause of collisions. Examples of this used are the consumption of

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[6] Motorcycle Fatality Report Northern Ireland (2012); *https://investigativeresearch.org/ni-motorcycle-fatality-report-2012/*. Pedestrian Fatality Report Northern Ireland (2014) *www.investigativeresearch.org*; *https://investigativeresearch.org/ni-pedestrian-fatality-report-2014/*. Vehicle Occupant Fatality Report (2015); *https://investigativeresearch.org/northern-ireland-vehicle-occupant-fatality-report-2015/*.

[7] IRCOBI/Safe2wheelers Workshop Malaga, September 2016 *https://safe2wheelers.eu/workshop-held-at-ircobi-2016-on-crash-reconstruction/*

alcohol or drugs and lack of insurance and licences. Other reasons considered are lack of training, sports bike riders taking unnecessary risks and riding at high speeds which has been used as a measure for severe injuries. While this may be true, as this study and other investigative reports indicate, it is not the only reason for crash causation and the problem with this analysis is that analysts may have fallen into the trap of using standardized labels to characterize motorcyclists and crash causation rather than looking at the dynamics of the crashes per se.

Training is an important factor for motorcyclists to learn how to avoid crashing. In this survey, 43% of the respondents indicated that they had taken part in different types of post licence training courses and whether the type of training had any bearing on the skills of the rider in an emergency situation. There is no standardization of post licence training and in many countries, instructors are not registered or licenced to teach advanced training.

Technology has been developed in order to reduce the possibility of riders falling or sliding in an emergency situation, however over a third of the riders did not use their brakes, whether they just did not have time or were unable to because of the circumstances. How this can be addressed is relevant to the fact that in this study a third of the motorcycles were equipped with Advanced Braking Systems while 12% had traction control.

It would appear that some motorcycle accident investigation analysts have not differentiated between a motorcycle and a car. In a crash scenario for a car, there are three impacts: the first is the impact of the car against another vehicle or object, the second is the impact of the car occupant with the inside of the car, the third is the impact of the car occupant's internal organs with the wall of the body[8]. What this means is that both the car and the occupant undergo the same change of velocity in a collision. The body and interior of a car are designed to keep the occupants' change of velocity gradual enough to remain below the injury threshold. By comparison, motorcycles have neither the crushable, energy-absorbing body nor the closed compartment to contain and protect riders. Efforts to create crushable, energy-absorbing structures on motorcycles to protect the rider have not been successful (Rogers & Zellner, 1998, 2001)[9] As a result, riders are vulnerable to injury from every object in their path from the start of a collision sequence until they come to rest[10]. How the motorcyclist separates from the bike and where the motorcyclist ends up, determines whether he/she is injured and to what degree.

What has become apparent from this study is that the mechanism of the crash – i.e. how the rider falls and what he/she hits, trumps the discourse of speed versus injuries. This report opens up a whole new chapter of motorcycle crash causation.

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[8] Ref: Damian Coll, Forensic Science Northern Ireland, Senior Collision Investigator.

[9] Rogers NM and Zellner JW; (1998) An overall evaluation of UKDS motorcyclist leg protectors based on IS0 13232; *Proceedings Of The 16th Conference On Experimental Safety Vehicles*, Windsor, Ontario, Canada; Paper No. 98-S 1 O-O-13; Rogers NM and Zellner JW (2001); Factors and status of motorcycle airbag feasibility research; *Proceedings Of The 19th Conference On Experimental Safety Vehicles* Paper Number 01-S9-O-207.

[10] In physics, Kinetic Energy = Mass/2 x Velocity^2, that is, half the mass times the velocity squared. Car and occupant both have the same Velocity (and same V^2) but different masses. They have different energies simply because of the difference in mass. Also, note that speed and velocity are not quite the same, though many people use the words interchangeably. Velocity has 2 components: speed AND direction. So, 50 mph north is a different velocity than 50 mph west. Same speed but different velocities because the directions are different.

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1 Introduction

This study of motorcycle crashes aims to provide useful information for researchers and for those interested in finding solutions to reduce casualties due to these incidents with the ultimate objective to enhance rider safety.

Accordingly, an online survey was carried out in 2019 and focused on motorcyclists who had been involved in a crash. The survey was disseminated throughout Europe, the USA, Asia, Australia and South America in order to get as much of a global response as possible.

The study extends and expands a 2016-2017 pilot study survey of crash-involved riders whose motorcycles were fitted with the technology of Advanced (anti-lock) Braking Systems (ABS). It was entitled: *Effects of Advanced (Anti-lock) Braking Systems (ABS) On Motorcycle Crashes*[11].

The new research presented in this report, most importantly involves riders bringing their personal experience and their expertise. Riders understand motorcycling in way quite different than that of academia, where statistical analyses of large databases such as police reports and hospital records has displaced research that requires in depth crash scene investigative knowledge. Furthermore, the authors of the report are all motorcyclists and therefore are aware of the dynamics of riding a motorcycle and the potential risks riders face. The riders who replied to the survey came from a varied age range, motorcycling experiences, as well as depths of skills and training.

The motorcycles they were riding when they crashed also included a full range of models, styles and sizes of modern and older motorcycles, fitted or not fitted, with the technology available as standard or as optional from manufacturers. This include ABS, Cornering ABS, Combined Brakes and Traction Control. Forty-three percent (n. 684) of riders who took the survey had taken post licence training courses, which is significantly higher than what would be expected in most countries. The reason is presumably, because the respondents came to the survey through the websites and social media pages of motorcycle organisations and clubs which were mainly from developed countries.

The study includes safety “elements” fitted to the motorcyclists themselves: in simple terms protective clothing. Most countries require both riders and passengers to wear a helmet. (This study also looked specifically at pillion passengers.)

In whatever part of the world, it is a well-known fact that there is little to separate riders from the road and its infrastructure. The circumstances may be different but when riders crash, they can be injured or worse. This study looks at all of this and gives the riders an extra voice to go personally beyond the data, to tell the story of their experiences, including treatment of injuries and the dynamics of their crash.

1.1 Previous international studies

1.1.1 Accident Research In Thailand Vol. I and II

The Thailand study was funded by various subdivisions of Honda Motor Corporation. The Principal Investigator was Dr. Vira Kasantikul, MD of Chulalongkorn University in Bangkok. The study used the same on-scene, in-depth accident investigation methods developed by Hurt and his colleagues, who investigated 900 motorcycle crashes that occurred in 1976-77

[11] http://investigativeresearch.org/documents/Northern_Ireland_Motorcycle_Fatality_Report_2012.pdf

in Los Angeles[12]. The same researchers provided training and quality control oversight of the Thailand team. The actual data collection took place in 1999 (Bangkok – 723 cases) and 2000 (Upcountry – 359 cases), with Final[13] Reports[14] prepared in 2001.

The on-scene, in-depth accident investigation method requires investigators to cooperate with first responders in order to receive immediate notification when a crash occurs, then travel to the accident scene. Once there, a team of investigators typically scours the scene of physical evidence related to the crash, photograph motorcycles and any other vehicles involved in the crash. They interview riders, drivers, eyewitnesses. Injury information may be provided by the rider himself, ambulance personnel, hospital records and personnel and, in fatal cases, the coroner's office. Investigators try to collect accident-involved helmets for later disassembly and damage analysis. Sometimes riders simply hand over their helmet, sometimes they accept payment to purchase a new helmet.

When the evidence from a crash had been collected, it was analysed to identify actions by the various parties, reconstruct speeds and collision motions and identify cause factors. In addition, investigators identified what the rider had contacted to cause each injury and evaluated the relationship between helmet use (or non-use) and head-neck injuries. The data from each case (500 to a thousand questions) were loaded into a computer database and later analysed.

This on-scene, in-depth method was used in the 1970s in Los Angeles for the 1981 Hurt Report, in Thailand and in the MAIDS[15] study in Europe that took place at the same time (2002).

1.1.2 In-depth investigations of accidents involving powered two wheelers: MAIDS

MAIDS was an in-depth accident collection project funded by ACEM (the representative body of European motorcycle manufacturers) with the support of the European Commission. It used an international harmonised methodology for motorised two-wheeler accident analysis that was developed by an OECD technical working group. During the period 1999-2001, five European countries (France, Germany, Netherlands, Spain and Italy) collected in total 921 motorcycle and moped/mofa accidents with an injured rider, as well as a control group of another 923 motorcycles and mopeds/mofas.

The total of 921 accidents were investigated in detail, resulting in approximately 2000 variables being coded for each accident. The investigation included a full reconstruction of the accident; vehicles were inspected; witnesses to the accident were interviewed; and, subject to the applicable privacy laws, with the full cooperation and consent of both the injured person and the local authorities, pertinent medical records for the injured riders and passengers were collected. From the data, all the human, environmental and vehicle factors which contributed to the outcome of the accident were identified.

In order to provide comparative information on riders and Powered Two Wheelers (PTWs = motorcycles, scooters, mopeds and mofas) that were not involved in accidents in the same sample areas, data was collected in a further 923 cases. The collection technique was specifically developed to meet the circumstances of this study and is commonly referred to as an exposure or case-control study. This exposure information on non-accident involved PTW

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[12] Hurt, HH, Jr., Ouellet, JV and Thom, DR, *Motorcycle Accident Cause Factors and Identification of Countermeasures, Final Report*, DOT HS 805 862, 1981.
[13] Kasantikul, V., *Motorcycle Accident Cause Factors and Identification of Counter-measures in Thailand: Volume I: Bangkok,* KP Printing, Bangkok, 2001.
[14] Kasantikul, V., *Motorcycle Accident Cause Factors and Identification of Counter-measures in Thailand: Volume II: Upcountry.* KP Printing, Bangkok, 2001.
[15] Motorcycle Accident In Depth Study

riders was essential for establishing the significance of the data collected from the accident cases and the identification of potential risk factors in PTW accidents.

1.1.3 Powered Two-Wheeler (PTW) and Bicycle Accidents in the European Union (SaferWheels)

The SaferWheels[16] study was conducted to investigate accident causation for traffic accidents involving PTWs and bicycles in the European Union. The project was funded by the European Commission and took place in the period 2014-2018.The objective of the study was to gather accident data from in-depth crash investigations, obtain accident causation and medical data for those crashes, and to store the information according to an appropriate and efficient protocol enabling a causation-oriented analysis. The expected outcomes were:

- Collection of accident data for at least 500 accidents of which approximately 80% would involve PTWs and the remainder bicycles. Equal numbers of cases were to be gathered in six countries; France, Greece, Italy, the Netherlands, Poland and the UK.
- In-depth investigation and reporting for each of the accidents on the basis of the data collected.
- Description of the main accident typologies and accident factors.
- Proposal of most cost-effective measures to prevent PTW and bicycle accidents.

In the selection of the accidents to be included in the sample utmost care was also taken to achieve a selection procedure that was random as far as possible. The reference population was represented by local traffic police records in order to reflect the accident data within the CARE database. Data privacy issues, legal investigation, accident involving police and explicit refusal by involved parties prevented the investigation of some accidents.

Case selection was random in all cases however factors such as traffic jam, team availability, and the presence of the vehicles on the scene all provided practical restrictions to the ideal selection. This is a normal situation and case selection in all in-depth investigations is limited by these practical issues. All partners, when feasible, were able to collect accident data retrospectively and this method was used to counteract other practical restrictions on sampling methods.

1.2 Aims and Objectives

The study aims to identify the dynamics of crashes between motorcycles, scooters, mopeds and another vehicle, object or roadside. The time frame is between January 2010 and March 2019. This time frame allows the researchers to focus on the type of technology of motorcycles developed in recent years which may include Advanced Braking Systems, also known as Automatic Braking Systems (ABS), Cornering ABS and Traction Control to understand the specifics of the impact of the motorcycle with and without this technology and how this affects the rider in terms of the trajectory of the rider post-impact and the type of possible injuries sustained by the rider.

The objectives of the survey was to find out from riders, their experiences which will be used to provide information to improve training and the development of future technology for motorcycles, but also to understand more fully what actually happens from the motorcyclists' perspective through their own comments when they crash and the follow up events i.e. injuries and so forth, as well as the analysis of the data from their responses.

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[16] SaferWheels: Study on Powered Two-Wheeler and Bicycle Accidents in the EU. Final Report, Brussels, 2018.

1.3 Research Questions and Hypotheses

Driver assistance systems for cars have rapidly developed over recent years. Although a date for full deployment, in the sense of implementation of autonomous vehicles remains unclear, we are probably much closer to the realisation of these systems than we are to their beginning. For motorcycles, there is still a much longer way to go. ABS is probably the only widespread assistance system employed, while some of these systems also include brake force distribution, but many still do not. With scooters, at this point in time, ABS is predominantly applied on the front wheel. Many riders install navigation systems on their bikes. Only five years ago (2015), the "motorcycle stability program" entered the market, the first system to cope with any roll angle and provide universal protection against unintended wheel spin caused by braking or accelerating.

Some studies have investigated riders' attitudes with regards to more Advanced Rider Assistance Systems (ARAS). ABS and curve-ABS are the only systems to perform well in these studies, riders are quite sceptical concerning all other systems. There are studies which have investigated riders' braking performance with ABS[17] and the IIHS[18] has found insurance claims to be lower for motorcycles fitted with ABS. It would appear that ABS on motorcycles is increasingly (according to its market penetration) changing and it is "expected" that it will further change the crash records. It is presumed that riders with ABS not only have less accidents, but they also have different accidents. It was the initial concept of this study to investigate, how ABS and other ARAS effect types of crashes and the kind of injuries they sustain.

Beyond that, this survey is also designed to serve as a basis for further research. 40 years after the material for the legendary Hurt Study[19] was collected and 20 years after the MAIDS[20] report was issued, this data collection aims to provide and up-to-date basis to review and find answers to traditional questions as well as aiming to facilitate research regarding actual questions. Among the important findings from this study, is evidence that 1) Speed versus days spent in hospital (equal to seriousness of injuries) is random. 2) Trajectory or post-crash motion, defines the type of injuries - i.e. it is the mechanism (or dynamics) of the crash. There are other issues such as the fact that one third of the riders did not use their brakes prior to crashing as well as training where 43% of the respondents in this survey replied that they had done post licence training.

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[17] Brake performance of experienced and novice motorcycle riders – results of a field study. K. Vavryn, M. Winkelbauer *Austrian Road Safety Board (KfV), Austria. 2004 January

[18] Effects of antilock braking systems on motorcycle fatal crash rates: an update: Teoh, Eric R. Insurance Institute for Highway Safety, 2013 May.

[19] Technical *Report*, *Hurt*, H.H., Ouellet, J.V. and Thom, D.R., Traffic Safety and *injury* causation and characteristics of the *motorcycle* accidents, Traffic Safety Center, University of Southern California, Los Angeles, California 90007. 1981 January

[20] MAIDS In-depth investigations of accidents involving powered two wheelers. Final Report 2.0 ACEM 2004 September

2 Methodology

2.1 Survey

In order to have a more valid understanding of the dynamics of motorcycle crashes, this study extends and expands the previous survey and covers eight different languages: English, French, Swedish, German, Spanish, Italian, Greek and Norwegian.

This survey took place between May and October 2019 and was disseminated through magazines, Facebook, motorcycle forums and web sites. The wealth and depth of information provided by the motorcyclists who participated allowed for a wide range of analysis of the details that resulted from the questionnaire and the responses.

The questionnaire had 39 questions divided into four sections:

1. “About you and your motorcycle” (16 questions)
2. “Background” (11 questions)
3. “Crash Details” (11 questions)
4. “Further Comments” (this allows plenty of space for the rider to comment freely)

2.2 Sample characteristics

The motorcyclists participating in the survey came from n.30 countries throughout the world. In total 1,578 motorcyclists replied to the survey. Due to the dissemination of the survey through organisations, clubs, social media and websites typically frequented by motorcyclists, this suggests that the rider is more inclined to be a “life-style” motorcyclist. However, this is a sample of people who have crashed irrespective of where they came from.

2.3 Data analysis

Data analysis was carried out using Excel and SPSS. Pearson Chi-Square test of independence was used to discover if there was a relationship between two categorical variables in the cross-tabulation tables. Also analysed were the comments left by the respondents, n.832 left further comments detailing the events surrounding their crash. Other comments included detailed information about the types of injuries, rehabilitation, information regarding pillion passengers and the riders’ opinions about crash causation.

3 General accident results

3.1 Day of Crash

Table 1: Day of the week of the crash

On what day did the crash occur?	Frequency	Percent	Valid Percent
Monday	123	7.8	9.5
Tuesday	170	10.8	13.1
Wednesday	180	11.4	13.9
Thursday	181	11.5	13.9
Friday	175	11.1	13.5
Saturday	267	16.9	20.6
Sunday	200	12.7	15.4
Don't know	271	17.2	-
No Answer	11	0.7	-
Total	1578	100.0	100.0

Nearly 30% of crashes occurred over the weekend – Saturday and Sunday, suggesting that the riders in the survey were weekend leisure riders. (Table 1). An Austrian study[21] found that about 75% of riders were predominantly active as leisure riders, about 25% were predominantly commuting, but there were almost no overlaps between the groups. It is also known that motorcycle use strongly varies between different regions of the world and continents (See world map of motorcycle usage compared to cars on page 35). Motorcycles are the most important means of transport in several Asian and African countries. While 60% of the world's motorcycles have less than 250cc engine displacement, in the USA, 85% have more than 1000 cc[22]. All these issues indicate that weekly distribution of PTW crashes is highly dependent on what the vehicle is predominantly used for.

3.2 Time of Day when Crashed

Table 2: Time of day of the crash

What time of day did the crash occur?	Frequency	Percent	Valid Percent
Early morning: From 5 a.m. to 8 a.m.	131	8.3	8.3
Morning: From 8 a.m. to 12 noon	340	21.5	21.6
Early afternoon: From 12 noon to 3 p.m.	368	23.3	23.4
Afternoon: From 3 p.m. to 6 p.m.	460	29.2	29.2
Early evening: From 6 p.m. to 8 p.m.	186	11.8	11.8
Evening: 8 p.m. to 12 (midnight)	76	4.8	4.8
Night: 12 (midnight) to 5 a.m.	13	.8	8.3
Don't know	2	.1	-
No answer	2	.1	-
Total	1578	100.0	100.0

Crashes equal to 74% (n.1168) occurred during the day, from 8 a.m. to 6 p.m. with the highest proportion (29.2%) occurring in the afternoon from 3 p.m. to 6 p.m (Table 2). Overall, the

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[21] Winkelbauer et al : Naturalistic Research on Powered Two Wheelers; https://erticonetwork.com/wp-content/uploads/2017/03/UDRIVE-Webinar_Winkelbauer_20170308_V03.pdf

[22] Buche T (2014): Factors that Increase and Decrease Motorcyclist Crash Risk. IfZ Conference Cologne, Germany.

majority of crashes (n.828, equal to 52.5%), occurred in the afternoon. Austrian crash data[23] shows that the daily distribution of motorcycle crashes has the same peak in the afternoon as is appears with other vehicle categories, but there is no morning peak. There is little information to provide any explanation for this circumstance, however based on studies carried out in France and the UK[24] there is evidence to suggest that leisure riders in particular, as indicated in this study i.e. those that perhaps ride more or only at weekends may be tired (fatigued) which could be that they have been riding most of the day. In Table 17 in this report describing Impairment, n.86 (5.4%) of the respondents indicated that they were tired prior to crashing.

3.3 Lighting Conditions when Crashed

Table 3: Lighting Conditions at the time of the crash

Lighting Conditions	Frequency	Percent	Valid Percent
Dawn - Good Visibility	84	5.3	5.6
Dawn - Poor Visibility	14	0.9	3.7
Daylight - Good Visibility	1245	78.9	82.9
Daylight - Poor Visibility	79	5.0	5.3
Dusk - Good Visibility	63	4.0	4.2
Dusk - Poor Visibility	21	1.3	1.4
Uncertain	72	4.6	-
Total	1578	100.0	100.0

The previous Table 3 indicates that the weather and lighting conditions were predominantly favourable for riding, allowing clear vision which would have been positive for the motorcyclist. However, the majority of the motorcyclists were riding in these (good) conditions, hence the greater proportion of crashes occurred in favourable weather conditions. Earlier research showed a correlation between precipitation and frequency of motorcycle crashes[25]. As indicated above, there are two major groups amongst riders, i.e. leisure riders and commuters, where commuters' exposure appears to be less sensitive to weather conditions.

However as the comparison with the Thailand studies highlighted in Chapter 11, where the majority of motorcyclists are commuters, factors such as weather do not necessarily mean differences in the type of collisions or injuries, though it may exacerbate the conditions.

[23] Source: Statistics Austria, analysis by KFV

[24] Motorcycle Rider Fatigue, A Review. Road Safety Research Review, N. 78. Dept. for Transport. London. https://pdfs.semanticscholar.org/ef9c/614f713f6ef40025497f50f08e36a6077a24.pdf

[25] Winkelbauer et al : How Motorcycle Collisions Depend on Weather. https://www.researchgate.net/publication/225752993_How_Motorcycle_Collisions_Depend_on_Weather

3.4 Month of Crash

Table 4: Frequency of the crash by month

Which month of the year did you crash?	Frequency	Percent	Valid Percent
January	57	3.6	3.8
February	59	3.7	3.9
March	104	6.6	6.9
April	129	8.2	8.6
May	197	12.5	13.1
June	220	13.9	14.6
July	180	11.4	12.0
August	168	10.6	11.2
September	171	10.8	11.4
October	91	5.8	6.1
November	78	4.9	5.2
December	49	3.1	3.3
Don't know	63	4.0	-
No Answer	12	.8	-
Total	1578	100.0	100.0

The months when the majority of respondents crashed were between May and September (59.2%) Typically the warmer months in the Northern Hemisphere (Table 4). As indicated below, climate and weather strongly influence rider habits in terms of exposure. In a representative Austrian opinion study, 9% of the interviewees indicated that they use their motorcycles all year. Given there is a relationship between exposure and crashes, the annual variability might be due to less riders being active in the colder months of the year.

3.5 Weather

Table 5: Weather prior to the crash

What was the weather like prior to the crash	Frequency	Percent	Valid Percent
Sunny	954	60.5	61.7
Overcast (cloudy)	329	20.8	21.3
Light Rain	132	8.8	0.3
Heavy Rain	57	3.6	0.3
Mist	5	.3	8.5
Fog	4	.3	3.7
Ice	15	1.0	0.1
Snow	2	.1	1.0
Other	49	3.1	-
Don't know	13	.8	-
No Answer	18	1.1	-
Total	1578	100.0	100.0

The distribution shown in Table 5 suggests that riding on sunny or overcast days leads to more crashes which may simply be due to the fact that riders ride more in optimal weather.

3.6 Season of crash and Hemisphere

The impact of weather on the crash record is threefold: The weather, or even just the weather forecast appears to effect exposure. Weather conditions may determine the rider's choice of whether to venture out on the road (e.g. through change of road surface friction, sight conditions, physical state of the rider). And finally, riders adopt their behaviour to cope with adverse weather conditions. There are many studies analysing the effects of outside temperature, humidity and precipitation on workload in trauma centres but as table 5 indicates, 81.3% (n.1283) crashed in optimal weather conditions.

Table 6: Season and Hemisphere of the Crash

Month	Northern	Southern	Total
No Answer	12	0	12
	.8%	.0%	.8%
Don't know	53	10	63
	3.7%	6.9%	4.0%
January	43	14	57
	3.0%	9.7%	3.6%
February	50	9	59
	3.5%	6.2%	3.7%
March	94	10	104
	6.6%	6.9%	6.6%
April	120	9	129
	8.4%	6.2%	8.2%
May	185	12	197
	12.9%	8.3%	12.5%
June	210	10	220
	14.6%	6.9%	13.9%
July	168	12	180
	11.7%	8.3%	11.4%
August	151	17	168
	10.5%	11.7%	10.6%
September	162	9	171
	11.3%	6.2%	10.8%
October	82	9	91
	5.7%	6.2%	5.8%
November	65	13	78
	4.5%	9.0%	4.9%
December	38	11	49
	2.7%	7.6%	3.1%
Total	1433	145	1578
	100.0%	100.0%	100.0%

Spring	Summer	Winter	Autumn

In the Southern Hemisphere, 23.5% of the motorcyclists crashed during the summer months, this compared to 36.8% in the Northern Hemisphere (Table 6). In spring 21.4% crashed in the Southern Hemisphere, compared to 27.9% in the Northern Hemisphere. However, 87.5% of the respondents in the Southern Hemisphere were from Australia, which has an annual warmer climate compared to Europe and North America, which may explain the lower percentages of the Southern compared to Northern Hemisphere. Overall, as mentioned previously, table 5 indicates that n.1283 (81.3%) riders crashed on a sunny or overcast day i.e. when the weather conditions should not have had an adverse effect on the ride.

3.7 Country where crashes occurred – left- or right-hand traffic

Table 7: Country where crash occurred

Country of Crash (top 15)	N/A	Left	Right	Total
France			328	328
The Netherlands			240	240
Sweden			206	206
Australia		126		126
Norway			115	115
UK		104		104
Italy			83	83
USA			61	61
Austria			55	55
Germany			55	55
Belgium			48	48
Canada			35	35
Greece			24	24
Spain			22	22
Switzerland			10	10
Other countries		26	34	60
No Answer	6			6

The full list of countries is considerably longer and can be found in Annex IV, Table I

In total, 16.2% (n.256) of the motorcyclists rode on the left-hand side of the road (Table 7). Conversely, 83.4% (n.1316) rode on the right-hand side of the road. The interest that this highlights is the direction of the trajectory and whether riding on a specific side of the road has any bearing to the fall. The authors presume that there is no “right” or “wrong” side of the road.

However by comparing the side of travel to the type of road where the respondents crashed, the comparison between left hand traffic (LHT) and right hand traffic (RHT) indicates that on a rural road, those LHT riders who crashed on a left bend had a slightly higher percentage (8.6%) compared to RHT riders (7.4%). Whereas on urban roads, those RHT riders who crashed on a left hand bend represented 5.5% compared to LHT riders (3.1%) Conversely, those who crashed on a right hand bend on a rural road indicates that 12.9% of LHT riders crashed compared to 5.8% of RHT riders. However, on an urban road the outcome was similar, where 4.7% of LHT riders crashed on a right hand bend compared to 5.1% of RHT riders.

Table 8: Countries by continents

Continent	Number of countries	Number of crashes
Europe	13	1320
South America	6	8
Oceania	2	130
North America	2	96
Asia	5	10
Africa	2	8
No Answer		6
Total	**30**	**1578**

58% of the countries and 84% of the crashes in the study were European (Table 8). Significant contributions also came from Oceania (8.2%) and North America (6.1%).

4 Personal Information

This chapter focuses on personal information of the respondents, in general as well as about personal circumstances at the time of the crash they are reporting.

4.1 Age and Gender

There was a total of 1,578 responses to the survey and of these, 12.2% (n.193) were aged under 24 years, there were 3.4% (n.54) aged from 65 to over 74 years. This follows by 16.2% (n.256) aged between 55 to 64 years, 19.8% (n.313) aged between 24 to 34 years, 21% (n.331) aged between 35 to 44 years and the highest proportion of 27.3% (n.431) were aged between 45 to 54 years. Overall the highest proportion of riders, 64.2% n.1018) were aged between 35 and 64 years. In this survey, of those who responded, n.1429 motorcyclists identified themselves as male (90.6%) and n.133 as female (8.4%).

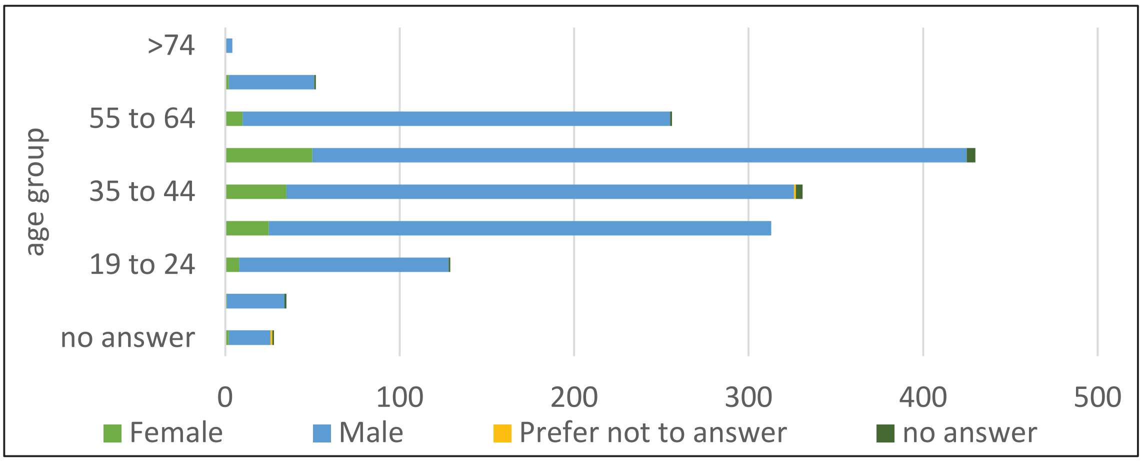

Figure 1: Crashes by age and gender of the rider

Table 9 repeats the Figure 1 above, but provides the frequencies in detail. Of interest is the low number of young female riders (under the age of 25) compared to those aged 25 and over with 13.3% for those aged 45 to 54. Perhaps suggesting that there is no incentive to attract young female riders or they have no interest to ride motorcycles.

Table 9: Crashes by age and gender of the rider

Age Group	Female	Male	Prefer not to answer	no answer	total
14 to 18	1	33		1	35
19 to 24	8	120		1	129
25 to 34	25	288			313
35 to 44	35	291	1	4	331
45 to 54	50	375		5	430
55 to 64	10	245		1	256
65 to 74	2	49		1	52
>74		4			4
no answer	2	24	1	1	28
Total	**133**	**1429**	**2**	**14**	**1578**

In developed countries e.g. Europe, Australia and Northern Europe, a major impact stemmed from certain changes in the system of driver education. Until the 1980s, the youngest age-group (18-24) was by far most at risk, which dramatically changed in many countries by implementing graduated licencing systems. In the European Union this culminated in the Third European Driving Licence Directive in January 2013.

These systems limited young riders' access to motorcycles to models with moderate engine performance. There is no clear evidence, however, the huge impact of graduated licensing might have been due to a change of exposure. Even if the young riders chose not to ride a motorcycle, sales did not suffer much and more or less increased continuously until today in most of the EU countries.

Fatally Injured (at 30 days) by age group															
age group	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
15-19	355,51	483,56	491,84	428,37	438,18	427,34	431,97	345,25	416,49	381,68	359,98	283,63	278,54	252,30	242,34
20-24	818,06	974,28	988,32	902,14	829,15	944,02	943,59	904,19	928,81	871,25	847,07	638,53	669,36	590,10	554,94
25-29	826,72	1051,24	1019,32	1035,03	980,88	982,55	1014,53	894,24	1048,10	888,18	853,57	697,06	673,84	564,22	515,42
30-34	559,50	758,28	815,30	835,47	861,40	819,66	848,03	805,84	886,78	707,28	670,79	621,66	537,32	512,80	431,96
35-39	419,87	605,67	717,43	642,27	726,48	744,69	677,88	713,51	721,82	663,66	675,16	563,64	530,36	408,66	367,76
40-44	260,83	379,94	464,05	506,62	565,16	520,59	533,73	541,69	664,21	581,28	587,94	486,92	506,03	441,56	409,66
45-49	165,85	253,89	306,38	351,33	370,87	370,38	429,20	443,56	517,10	490,28	476,54	459,52	476,61	422,20	412,42
50-54	100,65	171,58	171,04	194,32	196,87	245,81	250,10	258,71	299,64	308,92	322,89	363,73	385,17	346,94	327,13
55-59	60,47	97,71	89,49	139,29	127,04	132,18	163,40	188,16	177,35	171,17	236,70	187,51	225,11	223,60	239,52
60-64	34,82	52,92	74,64	62,71	67,08	73,02	94,80	91,63	104,08	103,19	102,75	112,63	123,60	114,20	129,31
65-69	26,60	54,77	50,58	46,72	53,76	52,55	47,25	63,23	69,69	64,50	51,32	63,72	76,25	65,14	83,07
70-74	33,88	33,54	28,47	51,79	36,53	25,15	41,21	37,37	55,23	40,14	42,42	53,16	47,10	58,06	57,04
75-79	16,41	21,38	22,23	20,64	24,50	23,40	20,12	20,02	25,19	27,23	19,04	26,09	23,06	30,02	25,02

Figure 2: Fatalities in the EU by age group of the rider (Source: CADAS)

The table in Figure 2 above shows motorcycle rider fatalities in the European Union countries, which deliver crash data to the CADAS (Common Accident Dataset) by age group of the riders. Today's target group for preventive measures has extended from 18-24 to 15-59.

4.2 Licence at the time of the crash

Table 10: Licence at time of the crash

Licence at the time of the crash	Frequency	Percent
Don't know	1	0.1
50cc (AM in Europe)	10	0.6
125cc (A1 in Europe)	44	2.8
A2 in Europe	87	5.5
Full licence (A in Europe)	1347	85.4
Other (e.g. learner, provisional, commercial)	72	4.6
No licence	4	0.3
no answer	13	0.8
Total	**1578**	**100.0**

The type of licence held by the riders at the time of the crash (Table 10) indicated that 85.4% (n.1347) held a full licence (A in Europe) while 5.5% (n.87) held an A2 licence (in Europe) and 2.8% (n.44) held an A1 licence (in Europe) these latter two are restricted by engine size. AM in Europe is the typical moped, i.e. typically a 50cc two stroke engine. In Europe, the technical maximum speed of these vehicles must be limited to 45 km/h. A1 includes motorcycles up to 125cc, 11 kW and a minimum of 10 kg of empty weight per kW engine power. Most EU countries issue A1 licences from 16 years. Some countries provide an A1 licence and an extra to a passenger car licence, in some countries only practical training is required for car drivers to get an A1 licence.

4.3 Type of helmet worn at the time of the crash

Of the respondents who did not wear a helmet, two were from the USA, three from Greece, one from Austria, Columbia, the Netherlands respectively. The majority of riders (58.5%) wore a full-face helmet, followed by Modular (flip-up): 27.9% (n.440) then open face: 9.1% (n.143). Riders were not asked if the helmet they were wearing was of an approved standard for their country. There are various standards for helmets across countries from the United States - Europe - Australia - New Zealand. Also for example the Europe standard UNECE Regulation 22.05 is an acceptable standard in various countries outside of Europe. The standard 22.05 is undergoing a revision at present to 22.06. It would be assumed that all riders were wearing a legal helmet for riding in their country.

This graph (Figure 3) provides limited information about riders' preferences on what type of helmet to wear. What it does not provide is information about the protective performance of helmets. Furthermore, the survey did not ask whether the helmet came off at the time of the crash, nor the type of fastener of the chin strap i.e. whether it was a double D lock or seatbelt type lock. Nevertheless, these data can be used to compare head injuries sustained by riders using different types of helmets which can be observed in chapter 9 relating to head injuries in this report.

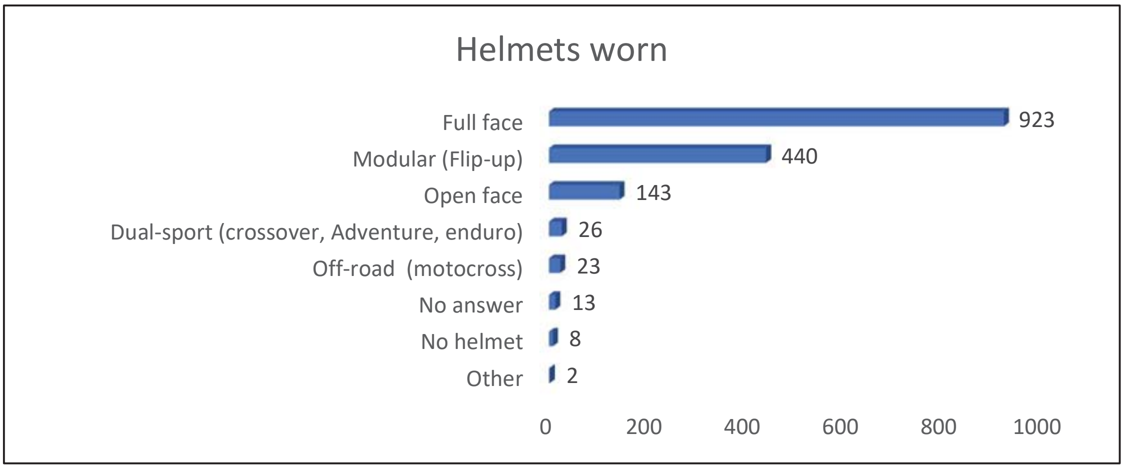

Figure 3: Type of Helmet worn at the crash

4.4 Type of Clothing worn

Table 11: Type of Clothing worn at the crash

Clothing	Frequency	Percent
Gloves	1505	95.4
Jacket with armour	1386	87.8
Boots	1333	84.5
Trousers with armour	1057	67
Trousers without armour	428	27.1
Reflective vest, jacket or stripes	405	25.7
Winter clothes	268	17
Shoes or trainers	194	12.3
Jacket without armour	135	8.6
Light summer clothes	92	5.8
Air vest or jacket	31	2

The vast majority of the respondents indicated that they used protective clothing, most notably gloves (95.4%), jackets with armour (87.8%), boots (84.5%) and trousers with armour (67%). This demonstrates that the majority of motorcyclists are aware of the need for protection in the case of a crash. A quarter of the riders used some form of reflective clothing or stripes for the purpose of conspicuity (Table 11).

Only 2% indicated that they had used an air vest or jacket. Of the n.31 that had air vests or jackets, two riders commented that the airbag vest did not deploy; another rider commented that the air vest was deployed and according to him, helped reduce his injuries (he had seven days medical leave). None of the remaining respondents commented about the deployment of their air vests/jackets. Five of the respondents did not separate from their motorcycle. Overall, n.12 of the riders wearing an air vest or jacket were admitted to hospital for stays from one day to a maximum of n.36 days.

Comments on protective clothing:

- *I tried to avoid the collision and I slowed down progressively when I saw that the driver was not looking to the side where I was coming from, arriving almost stopped at the place where he had an impact on me, so I avoided further injuries, together with the fact that I was wearing an airbag vest that was activated properly avoiding them.*
- *I still don't know what caused the front wheel to lock and tuck under at walking pace approaching a traffic light on a slight downward slope. I landed on my face, hands and knees. Had I not been wearing a full-face helmet I dread to think what the injuries would have been, ditto without stout leather gloves, I gave up all idea of buying an open face lid, replacing the one that saved me, and I now always ride with leg armour.*
- *The accident happened on a stretch of two lanes with 80 km speed limit. I am in the left lane, driving past (about 30-40 km per hour, there was a queue) so a car pulls out. I crash into the car and get thrown over the car. Cracking both ankles, both wrists, back, hearing, shoulder and crushing left shoulder. I got severe hearing loss on both ears. (used good quality flip opening helmet) Also used gloves, denim Kevlar trousers, heavy-duty leather jacket and riding boots.*
- *Drove left turn at 60-80km / h due to gravel on the tarmac. The bike landed off the road, my wife and I slid / rolled and stopped at the asphalt edge. Both my wife and I wore full protection, boots, leather pants, leather jacket with backpack, gloves and helmet. "Only" damage of type, no abrasions. All of the riding equipment was damaged and everything was replaced. Was taken by ambulance to the emergency room, checked and discharged.*
- *I saw the loose gravel and reacted incorrectly - actually I should have just continued on the curve without an accident, instead I tried to stay straight and brake to the edge of the curve. That went wrong. My left leg was straight into the ground and my knee was badly squeezed. Multiple injuries. Important: I was wearing very good motorcycle gloves. Three layers of leather are torn on the inside of the palm. I would have seen my bones without gloves. So, nothing happened to the hand.*
- *The van turned into me without slowing down. I had no time to react. Feet and knees smashed into van causing injuries and then I flew over van causing concussion. Jacket and gloves protected my upper body. Jeans and trainers didn’t protect my legs and feet. I had a good modular helmet that was closed. No injury to face or head but did have a concussion.*

4.5 Annual Mileage

Table 12: Annual Mileage

Annual Mileage	Frequency	Percent	Valid Percent
1 to 1000	72	4.6	4.8
1001 to 3000	138	8.7	9.3
3001 to 6000	276	17.5	18.5
6001 to 10000	428	27.1	28.7
10001 to 15000	258	16.3	17.3
15001 to 20000	171	10.8	11.5
20001 to 30000	90	5.7	6.0
30001 to 40000	29	1.8	2.0
>40000	28	1.8	1.9
No answer	88	5.6	-
Total	**1578**	**100**	**100.0**

NB: countries using miles were recalculated into kilometres for this table

The distance ridden by the respondents indicates that the highest proportion, 27% (n.428) rode between 6001 and 10000 kilometres per year (Table 12). Overall, 44.6% of the motor-cyclists averaged between 3000 and 10000 kilometres per year. The purpose of the question was to learn about the experience of the respondent in terms of length of travel.

4.6 Year of Crash

Table 13: Year of crash

Year of Crash	Frequency	Percent
1963 to 1999	27	1.7
2000 to 2009	69	4.4
2010	91	5.8
2011	76	4.8
2012	88	5.6
2013	76	4.8
2014	120	7.6
2015	145	9.2
2016	179	11.3
2017	228	14.4
2018	283	17.9
2019	169	10.7
No answer	27	1.7
Total	**1578**	**100**

Although the survey requested information from riders who crashed between 2010 and 2019, there were n.96 (6.1%) who indicated that they had crashed prior to this period, n.27 did not answer the question. Over half the respondents (54.4%) crashed between 2016 and 2019 (Table 13). The significance of this proportion is relevant in that legislation for mandatory Advanced Braking Systems was introduced in the European Union in 2016. Of the n.1578 respondents, n.1309 (83%) resided in the European Union at the time of the crash.

4.7 Consecutive Years Riding

Table 14: Consecutive years riding

Years Riding	Frequency	Percent	Valid Percent
1 to 2	327	20.7	21.8
3 to 5	307	19.5	20.4
6 to 10	285	18.1	19.0
11 to 20	248	15.7	16.5
21 to 30	148	9.4	9.9
31 to 40	115	7.3	7.7
>40	73	4.6	4.9
No Answer	75	4.8	-
Total	**1578**	**100**	**100.0**

Table 14 above identifies the length of time the motorcyclist rode his/her motorcycle without a lapse prior to the crash. The highest proportion 20.7% (n.327) rode between one to two years consecutively, while 19.5% (n.307) rode consecutively between three to five years prior to the crash.

4.8 How Many Months Riding (if less than one year)

Table 15: Number of months riding

Months Riding	Frequency	Percent
1	6	14.3
2	2	4.8
3	8	19
4	6	14.3
5	3	7.1
6	8	19
7	1	2.4
8	1	2.4
9	2	4.8
10	2	4.8
11	1	2.4
No answer	2	4.8
Total	**42**	**100**

Table 15 identifies novice motorcyclists who had commenced riding within the year of the crash, which represent 2.6% (n.42) of the total respondents.

4.9 Overall Years Riding

Table 16: Overall years riding

Overall Years Riding	Frequency	Percent
1 to 2	127	8
3 to 5	203	12.9
6 to 10	298	18.9
11 to 20	323	20.5
21 to 30	247	15.7
31 to 40	197	12.5
> 40	140	8.9
No Answer	43	2.7
Total	**1578**	**100**

The above Table 16 highlights the total number of years riding a motorcycle from the time the motorcyclist received his/her licence. It does not identify whether the rider had taken a break from riding and started riding again, although the information from table 14 indicates the length of time the motorcyclists had ridden consecutively prior to crashing. Based on the data available, of the riders from the age of 40 years up to the age of 66 years, who crashed during the first year of consecutive riding, were n.47 (3%) while those of this age (40 years to 69 years) riding up to two years consecutively numbered n.105 (6.6%).

4.10 Impairment

Table 17: Impairment of riders

Impairment	Frequency	Percent
Consumed Alcohol	10	0.6
Prescribed Drugs	43	2.7
Non Prescribed drugs	19	1.2
Tired	86	5.4
Other	27	1.7

NB: Blood alcohol content levels (BAC) allowed while in control of a vehicle are generally 50 mg per 100 ml in most European countries, with exceptions such as Sweden, Norway, Poland which are 20 mg per 100ml and 80 mg per 100 ml in England and Wales. Czech Republic and Hungary have a zero allowance for alcohol while driving. Some countries have different BAC levels between - Commercial drivers, Novice drivers, Standard drivers.

Of the ten who indicated that they had consumed alcohol (Table 17), two were from Austria, two from the U.K. and one was from India, Greece, Canada, France and Italy respectively. There were four other respondents who were uncertain if they had consumed alcohol. Overall, the proportion of riders who indicated that they had consumed alcohol was very low – 0.6%. There was speculation that the respondents may not have been completely honest regarding alcohol, but as there is no prohibition to consuming alcohol in the countries where the riders resided and as the survey was anonymous, they had no reason to hide that information, though perhaps they may have underestimated how much they may have drank.

While the effects of alcohol are important to highlight, especially compared to the Thailand studies, other studies such as the Northern Ireland Motorcycle Fatality study (2012) indicates that 4% of riders had over the limit BAC levels and/or drugs when they crashed. That is much the same elsewhere in Europe (see MAIDS 2002) where the proportion of riders with who had consumed alcohol was 4%.

There were n.86 respondents (5.4%) who indicated that they were tired at the time of the crash and this can be compared to table 2 (Time of day when crashed) which suggests that fatigue can be an important factor as a contribution to crashing.

However impairment is not necessarily restricted to physical impairment, it can also mean technological impairment such as the case where the motorcyclist crashed because he was trying to answer his Bluetooth phone:

"I was attempting to pull over quickly due to repeated phone calls via my Bluetooth headset which caused distraction especially as I was entering an area with no mobile reception and felt whoever was attempting to call me repeatedly had an important reason, however they hung up when I crashed. I have ignored all phone calls since whilst riding and just listen to music with no further incidents".

Technological impairment is not just an issue for motorcyclists, the following comments highlight how drivers of other vehicles can and do cause crashes by not giving their complete attention to the road:

Comments from respondents regarding mobile phone use:

- *The driver of the car did not stop at the junction, on the telephone, device in hand. I was saved because I was thrown over the vehicle.*
- *Taxi, 12 seater people carrier, went through stop sign, driver looking at phone, hit my arm/upper body and side of bike.*
- *Rear collision on the Paris ring road. The traffic slowed down a bit abruptly and the lady behind me, who was consulting her phone did not see the stop and rammed into the 4x4 which preceded me, thus sending me to fly over the 4x4.*
- *Stopped at a yield to the entrance to a roundabout due to the density of traffic. Hit in the back by a car whose driver was phoning, I projected into the crossroads. Stuck under the motorcycle.*
- *Motorist on the phone entering a parking lot without indication.*
- *The driver of the car said he was distracted at the time of the accident. It seems that he had just sent an SMS, without seeing that my motorcycle came from his right. Then he accelerated and hit me, with the impression that my bike was coming out of nowhere.*
- *Inattention of the driver who just changed lanes without checking my presence just because she was checking her phone.*
- *Stop at a red light, car arriving behind did not brake and I was thrown by the impact against the stationary vehicle in front of me. Potential use of the telephone while driving by the motorist.*

4.11 Country of Residence and Hemisphere of riders

Table 18 indicates the residence of the respondents according to hemisphere, however the table relating to the country where the riders crashed is in Annex IV Table II. Table 18 also demonstrates that overall, the respondents came from developed countries. Chapter 11 focuses on motorcycle crashes in Thailand which is considered a "developing" country. The comparisons are extremely useful to identify similarities and differences between different economic situations and cultures.

Table 18: Residence and Hemisphere of riders

Country of residence	Northern	Southern	Total
France	323	0	323
The Netherlands	292	0	292
Sweden	223	0	223
Australia	0	127	127
Norway	120	0	120
UK	106	0	106
Italy	74	0	74
Austria	61	0	61
USA	58	0	58
Belgium	46	0	46
Canada	37	0	37
Germany	25	0	25
Greece	22	0	22
Spain	17	0	17
Finland	6	0	6
South Africa	0	6	6
Ireland	5	0	5
Switzerland	5	0	5
Hong Kong	4	0	4
New Zealand	0	4	4
Romania	4	0	4
Argentina	0	2	2
Colombia	2	0	2
Denmark	2	0	2
Chile	0	1	1
Guadeloupe	1	0	1
Guyane Française	1	0	1
India	1	0	1
New Caledonia	0	1	1
Thailand	1	0	1
No Answer	0	0	1
Total	**1432**	**145**	**1578**

4.12 Voluntary Post Licence Training or Assessment

The high proportion of riders who indicated that they had done post licence training (43%), is possibly a reflection on the fact that the respondents came to the survey through rider organizations' websites or social media, motorcycle clubs and magazines which focus on motorcycle issues including focus on riding safety, therefore would be more inclined to take part in organised training (Table 19).

Table 19: Post Licence Training

Voluntary Post Licence Training	Frequency	Percent	Valid Percent
No	850	53.9	55.4
Yes	684	43.3	44.6
No Answer	44	2.8	-
Total	**1578**	**100**	**100.0**

4.12.1 Type of Training

Table 20: Type of post licence training

Post Licence Training	Frequency	Percent
Emergency braking	573	36.3
Cornering (Counter steering)	540	34.2
Slow Riding	476	30.2
Hazard Awareness	467	29.6
Assessment of skills	409	25.9
Riding in a group	334	21.2
Braking with ABS	314	19.9
Filtering/Lane splitting	163	10.3

What the survey does not show is the year when the respondent took part in the courses indicated above, this question was not asked. Therefore, it is not possible to understand whether recent training as opposed to training done years before has any bearing on the crash. The assessment of skills is not a training course, rather it is carried out by either an instructor, or in the case of the United Kingdom, by experienced motorcycle police officers – this scheme is called "Bikesafe" which is where the rider is followed in order to provide an assessment of his/her abilities (Table 20).

4.12.2 Emergency Braking (Training) with or without ABS when crashed

Table 21: Emergency braking training with or without ABS

Emergency Braking	Did your motorcycle have Antilock brakes (ABS)?				Total
	N/a	No	Uncertain	Yes	
No	23	650	11	321	1005
	79.3%	67.8%	64.7%	56%	63.7%
Yes	6	309	6	252	573
	20.7%	32.2%	35.3%	44%	36.3%
Total	29	959	17	573	1578
	100%	**100%**	**100%**	**100%**	**100%**

The highest proportion of motorcyclists who had took part in post licence training, had training for emergency braking (n.573, 36.3%). Of those, 44% (n.252) had motorcycles equipped with Advanced (Antilock) brakes at the time of the crash.

Those riders who took part in specific training for braking with ABS represented 19.9% (n.314) – see Table 21. Of these, 65% (n.204) indicated that they were riding motorcycles with ABS brakes at the time of the crash. Of the n.553 riders who did not use their brakes prior to crashing 46.8% (n.259) had motorcycles with ABS brakes.

4.12.3 Post Licence Test Training Country of Residence

The figures in red in Table 22 represent the countries where a higher proportion of motorcyclists who replied to the survey had taken post licence training courses than those that had not. There were nine countries, all European. The highest number of riders (n.195) representing 30% of the total who had done post licence training, were those from Sweden and Norway, as the respondents came through the Swedish SMC which does post-test training courses and Norwegian NMCU motorcycle organisation, it was expected that a higher proportion of riders who answered, had done post licence training. However the proportion of riders who have done post licence training overall, in all 30 countries is not recorded (for example in Austria the proportion is believed to be c.2%) but as 43.3% of the riders had done post licence training and still crashed needs to be examined more closely.

Table 22: Post licence training by country of residence

Country Of Residence	Voluntary Training			Total
	N/A	No	Yes	
Argentina	0	0	2	2
Australia	6	63	58	127
Austria	2	22	**37**	**61**
Belgium	4	20	**22**	**46**
Canada	1	21	15	37
Chile	0	1	0	1
Colombia	0	2	0	2
Denmark	0	2	0	2
Finland	0	2	4	6
France	5	234	84	323
Germany	0	9	**16**	**25**
Greece	0	9	**13**	**22**
Guadeloupe	0	1	0	1
Guyane Française	0	1	0	1
Hong Kong	0	4	0	4
India	0	1	0	1
Ireland		03	2	5
Italy		055	19	74
New Caledonia		01	0	1
New Zealand		02	2	4
Norway	2	51	**67**	**120**
Romania		03	1	4
South Africa	1	2	3	6
Spain	1	9	7	17
Sweden	6	89	**128**	**223**
Switzerland		1	**4**	**5**
Thailand		0	1	1
The Netherlands	8	146	138	292
UK	5	64	37	106
USA	3	31	24	58
No answer	0	1	0	1
Total	44	850	684	1578
	2.8%	**53.9%**	**43.3%**	**100%**

5 Pillion (Passenger) Riders

This chapter provides information regarding the passenger or pillion rider. Although the data are limited, they offer details relating to the profile of the pillion rider and further details about the severity of injuries which resulted from the crash. In terms of protective equipment, the pillion riders had very similar proportions as the riders with 82.5% and 94.3% wearing helmets.

Further details were given regarding injuries and treatment for pillion riders in the comments, as can be seen in the table 70, where there are two instances of riders with pillions who collided with a roadside barrier.

The description from the comments and responses indicates that 60% (n.49) of the crashes where a pillion (passenger) was on the motorcycle, were with a car. While in seven cases the crash was caused by gravel on the road, in six cases the cause was a slippery surface with oil. In seven cases there was water on the road, but in four of these cases the motorcyclist collided with a car.

5.1 Age and Gender of Pillion

Table 23: Age and Gender of Pillion

Age	Frequency	Percent	Gender	Frequency	Percent
Minor (<16 years)	6	5.7	Male	20	18.9
Adult (>16 years)	99	94.3	Female	86	81.1
Total	**105**	**100**	**Total**	**106**	**100**

As highlighted above 94.3% of pillions were adults and 81.1% were female, which suggests that the typical pillion would be the wife or partner of the rider. (Table 23)

5.2 Protective Equipment

Table 24: Protective Equipment for Pillion

Protective clothing	Frequency	Percent	Helmet	Frequency	Percent
No	18	17.5	No	6	5.7
Yes	85	82.5	Yes	99	94.3
Total	**103**	**100**	**Total**	**105**	**100**

While helmet wearing is mandatory in many countries, the authors did not find a country in the survey, where wearing protective equipment is required by law. With this background, it suggests that the respondents are aware of their vulnerability thus wear protective clothing. Also the survey was circulated through rider websites and forum, which may reflect the reason.

5.3 Injuries and Treatment

There were n.54 pillions injured (56.8%) however as the questions were not mandatory, this figure does not tally with following answers regarding severity. In fact in table 26, the responses indicate that there were n.51 slightly injured and n.20 seriously injured.

Table 25: Injured Pillion

Injured	Frequency	Percent
No	40	42.1
Yes	54	56.8
Uncertain	1	1.1
Total	**95**	**100**

The responses effectively replied to, are based on the interpretation of the respondent (Table 25). While not perfect, they do offer a window into the dynamics of what happened. The responses suggest that the pillion is vulnerable to the skills and ability of the rider to stay in control. Pillion riders can and do act as a support in cases such as fatigue whereby, they can prod the motorcyclist if he/she goes to sleep while riding. Or simply by indicating a potentially dangerous situation to avoid. Becoming more and more popular are Bluetooth and Wi-Fi networking communication technology - intercom systems between rider and pillion.

5.4 Severity of Injuries

Table 26: Type of injuries of Pillion

Slightly Injured	Frequency	Percent	Seriously Injured	Frequency	Percent
No	38	42.2	No	66	77.6
Yes	51	56.7	Yes	17	20.0
Uncertain	1	1.1	Uncertain	2	2.4
Total	**90**	**100**	**Total**	**85**	**100**

Table 26 displays the injuries sustained by the pillion passengers. The vast majority of pillion passenger was injured, but three of four injuries were slight.

5.5 Treatment

As Table 27 highlights, 40.9% of pillion riders were treated at the scene of the crash while 54.5% were taken to hospital to be treated. There was one case in which the pillion rider died at the scene of the crash where she fell off the motorcycle into the path of an oncoming car.

Table 27: Treatment of pillion

Treated at Scene	Frequency	Percent	Taken to Hospital	Frequency	Percent
No	54	58.1	No	44	44.4
Yes	38	40.9	Yes	54	54.5
Uncertain	1	1.1	Uncertain	1	1.0

6 Information about the Motorcycle

6.1 Make of Motorcycles

The four major Japanese manufacturers Honda (21.6%), Yamaha (15.8%), Suzuki (12%) and Kawasaki (10%), made up the bulk of the makes of motorcycles of the riders, with n.938 (59.4%) followed by BMW the German manufacturer, with n.197 (12.5%). The British manufacturer Triumph represented n.97 (6.1%). The US manufacturer Harley Davidson represented 5% and scooters and mopeds of various makes represented 4.3% (67) of the total (Table 28). There was one electric motorcycle. The table of all the makes of motorcycles can be found in Annex IV Table III.

Table 28: Make of motorcycles

Make	Frequency	Percent
Honda	341	21.6
Yamaha	249	15.8
BMW	197	12.5
Suzuki	190	12
Kawasaki	158	10
Triumph	97	6.1
Harley Davidson	79	5
Ducati	59	3.7
KTM	42	2.7
Aprilia	34	2.2
Moto Guzzi	28	1.8
Others	104	6.6
Total	**1578**	**100**

6.2 Style of Motorcycle

Table 29: Style of motorcycle

Style	Frequency	Percent
Naked (Streetbike)	484	30.7
Adventure	251	15.9
Supersport	232	14.7
Sports Tourer	168	10.6
Touring	118	7.5
Cruiser	87	5.5
Custom	84	5.3
Trail/Enduro (Off road)	53	3.4
Scooter	52	3.3
Supermoto	25	1.6
Moped	15	1.0
Other	4	0.3
No Answer	5	0.3
Total	**1578**	**100.0**

Supersports and Sports Tourers combined make up 25.3% (n.300) of the motorcycles involved in crashes in this survey. The Adventure motorcycles represented 15.9% (n.251) of those ridden, while touring bikes made up 7.5% (n.118). Cruiser and custom bikes combined made up 10.8% (n.173) while scooters and mopeds only represented 4.3% (n.67) of all powered two wheelers in the survey (Table 29).

Naked Street bikes make up the biggest percentage of style in this survey with 30.7% (n.484).

6.3 Year of Manufacture

Table 30: Year of manufacture of motorcycle

Year made	Frequency	Percent	Valid Percent
Up to 1980	33	2.1	2.2
1981 to 1990	76	4.8	5.0
1991 to 2000	256	16.2	16.8
2001 to 2015	989	62.7	64.9
From 2016	170	10.8	11.2
No Answer	54	3.4	-
Total	**1578**	**100**	100.0

The biggest proportion of motorcycles (62.7%) in this survey were manufactured between 2001 and 2015 (Table 30). The introduction of mandatory advanced braking systems (ABS) did not come into force until 2016 in Europe and in this survey those motorcycles made up 10.8% (n.170) of the respondents' motorcycles. However, manufacturers introduced voluntary AHO (Automatic Headlights On) in 2003.

6.4 Engine Size (cc)

Table 31: Size of engine

Engine size	Frequency	Percent	Valid Percent
Up to 50cc	16	1	1.0
51cc to 125cc	66	4.2	4.2
126cc to 250cc	59	3.7	3.8
251cc to 500cc	91	5.8	5.8
501cc to 750cc	499	31.6	31.8
751cc to 1000cc	389	24.7	24.8
>1000cc	448	28.4	28.6
No Answer	10	0.6	-
Total	**1578**	**100**	**100.0**

The engine sizes from 501 cc to >1000 cc represented n.1336 (84.8%) of all motorcycles, scooters and mopeds in the survey (Table 31). As previously mentioned, the type of licence held by the riders at the time of the crash indicated that 85.4% (n.1347) held a full licence (A in Europe), while 5.5% (n.87) held an A2 licence (in Europe) and 2.8% (n.44) held an A1 licence (in Europe) these latter two are restricted by engine size. A2 restricts the rider to a motorcycle up to 600 cc and cannot have more than 35 kW – that's 47 bhp – and it cannot have a power-to-weight ratio of more than 0.2 kW-per-kg. AM in Europe is the typical moped, i.e. a 50 cc two stroke engine. In Europe, the technical maximum speed of these vehicles must be limited to 45 km/h. A1 includes motorcycles up to 125 cc, 11 kW and a minimum of 10 kg of empty weight per kW engine power.

Europe has seen a dramatic change in terms of motorcycle mobility in the recent years. There are some reasons for that. The change of market offer is an important issue. Manufacturers started to market "large scooters", with the Suzuki Burgman being the first and the Piaggio Vespa GTS300 being among the most prominent ones. In the old millennium, scooters were typically powered by 125 cc two stroke engines, has small wheels, poor brakes and three to four gear manual shift transmission. A powerful scooter currently on the market is the SVR 850 by Aprilia with a 78 hp engine, continuous variable transmission, disc brakes and ABS.

These vehicles are much more attractive and change urban mobility. In addition, many of these vehicles are also popular for leisure rides on the weekend as well as holiday trips.

There is no common explanation for the increase of motorcycle sales in the early 1990s, though a possible answer is that the there was more financial stability in developed countries which allowed extra cash to spend on motorcycles. Or it was just a matter of fashion to buy a motorcycle as soon as the kids left the house, or it was it a change of generations or all of these reasons combined. Motorcycles in Europe and other developed countries used to be the poor man's vehicle shortly after World War Two. They were quickly replaced by very small cars (bubble cars), as soon as the user could afford one. Whatever the reason, riding a motorcycle stayed at a low level for about three decades.

Of interest however is the worldwide use of two wheeled vehicles i.e. motorcycles compared to cars (Figure 4). As the map below indicates[26], less developed countries have a higher usage of motorcycles. The comparison with the crash investigation studies in Thailand (Chapter 11) highlights the diversity of the type of PTW and the economic conditions for two wheeled transport.

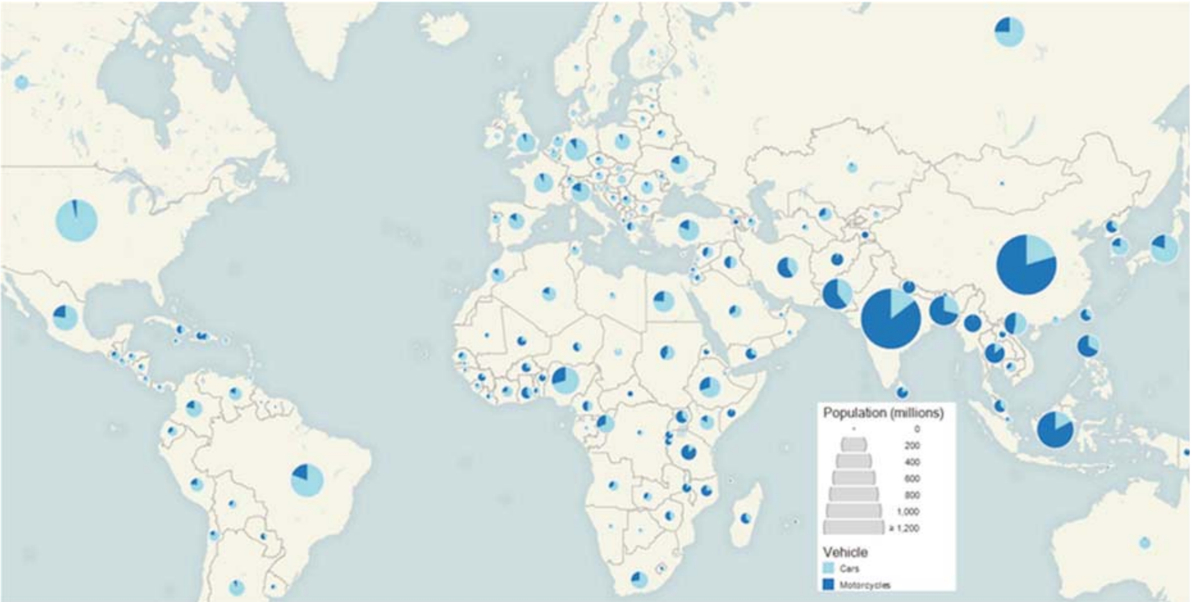

Figure 4: World Map

6.5 Technology on motorcycle

Table 32: Technology on motorcycle

Technology	Frequency	Percent
Antilock brakes (ABS)	573	36.3
Traction Control	190	12
Cornering ABS	101	6.4

As the Table 32 indicates, over a third (36.3%) of the respondents had ABS brakes fitted to their motorcycles while 12% (n.190) had traction control fitted with 6.4% having cornering ABS fitted. What is not known is the proportion of motorcycles on the road that have this technology i.e. the overall population and whether this sample is representative or not.

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[26] https://commons.wikimedia.org/wiki/File:Map_Motorcycles_vs_cars_by_population_millions_2002.png

6.6 If not ABS brakes, what type of brakes did your motorcycle have?

Table 33: Type of brakes

Type of Brakes	Frequency	Percent
Disc Brakes	911	57.7
Combined braking system (CBS)	103	6.5
Drum brakes	20	1.3
Uncertain	20	1.3
No Answer	524	33.2
Total	**1578**	**100**

Disc brakes represented the highest proportion of brakes (57.7%) of those motorcycles that did not have ABS brakes, while CBS represented 6.5% of brakes used (Table 33).

6.7 Was the Motorcycle Insured at the time of the crash

Table 34: Insurance at time of crash

Insurance	Frequency	Percent
No	44	2.8
Yes	1526	96.7
No Answer	8	0.5
Total	**1578**	**100.0**

Six of the motorcycles were "off road" styles and may not have required insurance for riding (Table 34). Although the question did not specify the type of insurance, it is assumed that basic road cover insurance is taken out by motorcyclists as it is mandatory in most countries throughout the world. Of those that had no insurance, n.16 were from Australia; four from Sweden; three from the Netherlands and the USA respectively; two from Austria, Columbia, Germany, South Africa, Hong Kong respectively and one each from Belgium, Denmark, Canada, France, Greece, India, New Zealand and Romania.

7 Road infrastructure

7.1 Type of Road Where Crashed

Table 35 and Table 36 indicate that a straight road was where the majority of crashes occurred. In 74.4% of cases the crashes on a straight road occurred on a highway/motorway, followed by 55.6% on a main road and 51.9% on a dual carriageway. Overall, 41.6% (n.657) crashes occurred on a straight road. While 13.5% (n.213) crashed on a left-hand bend and 13.1% (n.207) crashed on a right hand bend. Special mention of roundabouts highlights that 12.8% (n.82) of crashes on an urban road and 7.6% (n.120) occurred at a roundabout.

Table 35: Road type where crash occurred (Frequency)

Type of Road	N/A	Dual	High way	Main road	Off road	Car park	Rural road	Tun-nel	Urban road	Total
Straight Road		111	87	40	11	9	126	7	266	657
LH Bend		26	8	3	4	2	103	1	66	213
RH Bend		29	9	3	3	2	95	1	65	207
Junction (Lights)		10	4	10			5	1	65	95
Junction		9	3	5			8		36	61
T-Junction		9		3		3	12		39	66
Crossroads		2	1	2	1	1	4		9	20
Not on Public Road		1	1		3	1	2		4	12
Railway Crossing							1		2	3
Pedestrian Crossing									4	4
Roundabout		16	3	6		1	12		82	120
Staggered Junction		1	1				2		4	8
Don't Know		1	1			1	3	2	9	17
No Answer	95									95
Total	**95**	**215**	**118**	**72**	**22**	**20**	**373**	**12**	**651**	**1578**

Highway/Motorway/Freeway (3+ lanes); Dual carriageway; Main road (2+1 = 2 lanes one way and 1 the other way); Petrol station, car park, private entrance.

Table 36: Road type where crash occurred (Percentage)

Type of Road	Dual	Highway	Main Road	Off road	Car park	Rural road	Tunnel	Urban road	Total
Straight Road	51.9	74.4	55.6	50.0	47.4	34.1	70.0	41.4	41.6
LH Bend	12.1	6.8	4.2	18.2	10.5	27.8	10.0	10.3	13.5
RH Bend	13.6	7.7	4.2	13.6	10.5	25.7	10.0	10.1	13.1
Junction (Lights)	4.7	3.4	13.9	0.0	0.0	1.4	10.0	10.1	6.0
Junction	4.2	2.6	6.9	0.0	0.0	2.2	0.0	5.6	3.9
T-Junction	4.2	0.0	4.2	0.0	15.8	3.2	0.0	6.1	4.2
Cross Roads	0.9	0.9	2.8	4.5	5.3	1.1	0.0	1.4	1.3
Not on Public Road	0.5	0.9	0.0	13.6	5.3	0.5	0.0	0.6	0.8
Railway Crossing	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.2
Pedestrian Crossing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.3
Roundabout	7.5	2.6	8.3	0.0	5.3	3.2	0.0	12.8	7.6
Staggered Junction	0.5	0.9	0.0	0.0	0.0	0.5	0.0	0.6	0.5
Don't Know	0.5	0.9	0.0	0.0	5.3	0.8	20.0	1.4	1.1
No Answer									6.0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

7.2 Road Conditions

Table 37: Road Conditions at the time of the crash

Road Conditions	Frequency	Percent
Good condition - sealed with tarmac or cement	1024	64.9
Gravel or loose dirt	117	7.4
Water on road	114	7.2
Slippery surface (oil)	74	4.7
Potholes	41	2.6
Icy surface	23	1.5
Rough terrain (dirt track or road)	16	1.0
Manhole cover/s	8	.5
Other	102	6.5
Don't know	4	.3
No Answer	55	3.5
Total	**1578**	**100.0**

Overall, the road conditions as indicated by the respondents (64.9%) were "good" – i.e. there were no obvious road defects (Table 37). This was followed by problems with gravel or loose dirt as indicated by 7.4% of the respondents, then water on the road (7.2%). In terms of how the road effected the propensity to crash, in the case of "Single Vehicle" crashes, there were n.321 (22.5%) of riders who indicated that they lost control and there was no contact with other vehicles or infrastructure which may have been in part due to the conditions of the road as indicated in the comments from the respondents.

Comments on road conditions:

- *Big oil spill in the curve. The spilled oil stretched along 800 meters of road.*
- *Road In poor condition with sand mixed with gravel in a curve which was dropped by a poorly closed door of a dump truck and I simply skidded I did not fall but my foot had the fracture and a sprain I managed to keep my motorcycle on two wheels.*
- *The vehicles in both lanes in front of me slow down due to cardboard on the roadway. I couldn't stop and drove into the car in front of me.*
- *I believe very poor traffic management contributed. The material soaking up the oil also had stones in it, no warning of the hazard, no signage or workman before the hazard. All the workmen were about 100 metres up past the spill having lunch*
- *In the middle of the turn I hit a spot of oil or diesel Fuel. The tarmac was dry until I hit this spot. It took me by surprise. There was no warning. Suddenly no traction.*
- *The accident occurred on the daily route of my home - work commute. I fell because of gravel used to repair the road. The gravel started halfway around the turn and was therefore invisible before being in the turn and no sign had been installed to indicate the gravel.*
- *Road patching where loose gravel was not removed, no warning sign!*
- *The fall occurred at low speed due to a hole covered with water that was not there the day before (I ride this road every day).*
- *Cause was water filled deep pot holes near the centre of the road. Front wheel kicked violently left right and left again in a row of deep almost invisible potholes on a wet surface with the potholes filled with water.*
- *Pulled away to go through roundabout, rear wheel picked up piece of disregarded NBN cable which lodged in the drive chain getting caught in the front sprocket and jamming rear wheel causing me to high side at 40 kph. Broke my right leg in three places and have metal rods.*
- *Poor grip on steel tram rails contaminated with building site dust, unseen at night.*

8 Accident scenarios - dynamics

8.1 Speed prior to crashing (before applying the brakes)

Table 38: Speed prior to Crash

Kilometres	Frequency	Percent	Miles	Fre-quency	Percent
1 to 10 kph	72	5.0	1 to 10 mph	10	6.7
11 to 20 kph	117	8.2	11 to 20 mph	20	13.3
21 to 30 kph	180	12.6	21 to 30 mph	30	20.0
31 to 40 kph	176	12.3	31 to 40 mph	28	18.7
41 to 50 kph	212	14.8	41 to 50 mph	19	12.7
51 to 60 kph	149	10.4	51 to 60 mph	22	14.7
61 to 70 kph	121	8.5	61 to 70 mph	6	4.0
71 to 80 kph	112	7.8	71 to 80 mph	5	3.3
81 to 90 kph	59	4.1	81 to 90 mph	3	2.0
91 to 100 kph	42	2.9	91 to 100 mph	4	2.7
101 to 110 kph	33	2.3	111 to 120 mph	2	1.3
111 to 120 kph	21	1.5	121 to 130 mph	1	0.7
121 to 130 kph	9	0.6	**Total**	**150**	**100**
>130 kph	15	1.1			
Stationary: App. I	95	6.7			
Don't know	9	0.6			
No Answer	6	0.4			
Total	**1428**	**100**			

9.5% of riders replied that their speed was measured in miles per hour (Table 38). The two countries that use miles per hour are the United Kingdom and the USA.

A common hypothesis suggests that younger riders though less experienced, take greater risks in terms of speed. However, the responses indicate that the correlation between age and speed is random. Respondents who were travelling at a low speed of one to 10 kph prior to crashing, varied from 18 to 74 years with an average age of 46 years. Respondents who were travelling at speeds of between 91 to 100 kph varied from 17 years to 71 years with an average age of 42 years. Of the n.95 riders who were hit by another vehicle while stationary, the age varied from 17 years to 69 years, with an average age of 44 years. Of the n.15 respondents who indicated that they were travelling at >130 kph prior to crashing, the age varied from 22 years to 53 years and the average age was 39 years.

8.2 Braking prior to crash

Table 39: Braking prior to crash

Braking Action	Frequency	Percent
No	553	35.0
Yes	890	56.4
Uncertain	108	6.8
No Answer	27	1.7
Total	**1578**	**100**

Table 39 highlights that over a third (35%) of the respondents did not use their brakes prior to crashing.

8.3 Prior to crashing, did you apply the brakes?

Table 40: Number of riders applying brakes prior to crash with ABS

MC had ABS	N/a	No	Uncertain	Yes	Total
No	15	282	57	605	959
	55.6%	51.0%	52.8%	68.0%	60.8%
Yes	11	259	45	258	573
	40.7%	46.8%	41.7%	29.0%	36.3%
Uncertain	0	3	2	12	17
	0.0%	0.5%	1.9%	1.3%	1.1%
No Answer	1	9	4	15	29
	3.7%	1.6%	3.7%	1.7%	1.8%
Total	**27**	**553**	**108**	**890**	**1578**
	100%	**100%**	**100%**	**100%**	**100%**

Possibly more of interest is that of the n.553 who did not use their brakes prior to crashing, n.259 (46.8%) had ABS brakes fitted to their motorcycles which raises the issue of perception/reaction time for the rider which is indicated at between 0.75 to 1.5 seconds by crash scene investigators (Table 40). In other words, the rider may not have had time to react[27].

8.4 Separation from Motorcycle on Impact

Table 41: Separation from motorcycle on impact

Separation from MC	Frequency	Percent
No	393	24.9
Yes	1135	71.9
No Answer	50	3.2
Total	**1578**	**100.0**

A quarter of the respondents (n.393) did not separate from their motorcycles on impact. Consider that n.95 of the riders were stationary when the crash occurred (Table 41).

8.5 Speed and Separation

This Table 42 excludes those who measured their speed in miles per hour. The proportion of respondents who crashed using kilometres as a measurement of speed, from stationary to 60 kph was 79.4% (n.281) this is compared to 31.6% (n.320) of those riders who separated from their motorcycles at the point of impact. This suggests that the respondents who did not separate were riding at a lower speed (compared to those that were separated) which is to be expected.

[27] Forensic Aspects of Driver Perception and Response, Paul Olsen, Lawyers and Judges Publishing Company Inc. 1996. ISBN 0-913875-22-8

Table 42: Separation from motorcycle on impact and speed

Speed (Kilometres)	Separated						
	N/a	No	%	Yes	%	Total	%
1 to 10 kph	2	30	8.5	40	4.0	72	5.1
11 to 20 kph	5	48	13.6	64	6.3	117	8.3
21 to 30 kph	6	46	13.0	128	12.6	180	12.7
31 to 40 kph	1	52	14.7	123	12.2	176	12.5
41 to 50 kph	6	47	13.3	159	15.7	212	15.0
51 to 60 kph	6	29	8.2	114	11.3	149	10.5
61 to 70 kph	3	23	6.5	95	9.4	121	8.6
71 to 80 kph	3	22	6.2	87	8.6	112	7.9
81 to 90 kph	4	6	1.7	49	4.8	59	4.2
91 to 100 kph	4	9	2.5	29	2.9	42	3.0
101 to 110 kph	2	5	1.4	26	2.6	33	2.3
111 to 120 kph	3	3	0.8	15	1.5	21	1.5
121 to 130 kph	0	2	0.6	7	0.7	9	0.6
More than 130 kph	0	3	0.8	12	1.2	15	1.1
Stationary	2	29	8.2	64	6.3	95	6.7
Total	47	354	100.0	1012	100.0	1413	100.0

8.6 Separation and Days in Hospital

Table 43: Separation and Days in Hospital

Days in Hospital	Separated			
	No	Percent	Yes	Percent
1	8	21.6	36	18.0
2	7	18.9	17	8.5
3	0	0.0	44	22.0
4	6	16.2	12	6.0
5	4	10.8	27	13.5
6	0	0.0	9	4.5
7	3	8.1	16	8.0
8	1	2.7	5	2.5
9	0	0.0	4	2.0
10	2	5.4	11	5.5
11	0	0.0	5	2.5
12	1	2.7	3	1.5
13	1	2.7	0	0.0
14	4	10.8	11	5.5
up to 14 days	37	100.0	200	100.0
Total	45	82.2	251	79.7

However, of the n.45 (15.2%) respondents who did not separate from their motorcycles at the time of the crash, n.37 indicated that they spent time in hospital compared to n.200 who separated from their motorcycles (Table 43). The proportion of those who spent up to 14 days in hospital whether they separated from their motorcycles or not – was similar i.e. not separated 82.2% compared to separated 79.7%.

8.7 Trajectory

Table 44: Trajectory of riders

Trajectory	Frequency	Percent
Fell backwards	37	2.3
Highside and fell left	75	4.8
Highside and fell right	88	5.6
Left lowside - fell over to the left	313	19.8
Right lowside - fell over to the right	244	15.5
Topside, over the front of the handlebars	288	18.3
Other – Annex II	106	6.7
Don't know	48	3.0
No Answer	379	24.0
Total	**1578**	**100**

The trajectory or post-crash motion of the riders (Table 44) indicate that the Left lowside with n.313 (19.8%) was the direction of the highest proportion of riders, followed by Topside, over the front of the handlebars, with n.288 (18.3%) and Right lowside with n.244 (15.5%). The interest in determining the post-crash motion is an important point of discussion with regards to advanced (anti-lock) braking systems. The purpose of ABS is to limit the opportunity of sliding and to bring the motorcycle to a safe and controlled stop. However, if the function of ABS is to keep the motorcycle upright, then in a crash scenario (a collision) it is assumed that the propensity would be for the rider to travel topside – i.e. over the front of the handlebars. As indicated in table 46, the highest percentage where the motorcycle was impacted, was frontal (15.4%).

8.8 Trajectory (left or right) of rider after separation – LHT and RHT

Table 45: Trajectory after separation (left or right)

Right Hand Traffic	Frequency	Percent
Highside and fell left	61	10.3
Highside and fell right	76	12.8
Left lowside - fell to the left	251	42.3
Right lowside - fell to the right	206	34.7
Total	**594**	**100**
Left Hand Traffic	**Frequency**	**Percent**
Highside and fell left	14	11.3
Highside and fell right	12	9.7
Left lowside - fell to the left	61	49.2
Right lowside - fell to the right	37	29.8
Total	**124**	**100**

LHT Countries Where Crash occurred: Australia, Guyane Française, Hong Kong, India, Nepal, New Zealand, South Africa, Thailand, UK

RHT Countries Where Crash occurred:: Austria, Belgium, Canada, Croatia, Denmark, Finland, France, Germany, Greece, Italy, Lithuania, Luxembourg, New Caledonia, Norway, Poland, Romania, Romania, Spain, Sweden, The Netherlands, USA

The comparison with left hand traffic and right hand traffic in terms of trajectory is useful to understand whether riding on the left or the right side of the road has any bearing on the type of crash. The accepted view is that when crashes occur at bends in countries that drive on the left side of the road, the propensity to crash at a bend would be that the rider would go wide towards the right side of the road and head into oncoming traffic, conversely where a crash occurs in countries that drive on the right, the rider would go wide towards the left side of the road and head into oncoming traffic. However, as Table 45 indicates, there appears to be little difference in the outcome of the trajectory whether riding in left hand traffic or right hand traffic in this survey when the rider fell Left lowside. Of those travelling on the right of the road n.251 (42.3%) indicated that their trajectory was Left lowside while n.61 (49.2%) of those travelling in left hand traffic indicated that their trajectory was also Left lowside – i.e. both groups indicated that they fell to the left.

8.9 Where was the impact on the Motorcycle?

Table 46: Impact on motorcycle

Impact	Frequency	Percent
Frontal	243	15.4
Lateral - left side	160	10.1
Lateral - right side	195	12.4
Rear end	142	9.0
Other	50	3.2
Don't know	3	0.2
No Answer	785	49.7
Total	1578	100.0

The biggest proportion of the position of impact on the motorcycle was frontal (15.4%) with 10.1% lateral left side and 12.4% lateral right side (Table 46). This is followed by those motorcycles that were rear-ended (9%).

The area of impact can be confirmed by the type of damage that the motorcycles sustained e.g. with the highest proportion on the handlebars (61.6%) and mirrors (66.2%), indicators (61.5%), front lights (38.3%) and front mudguard (36.6%). Other indicators are damage to the fairing, Screen, front forks and front wheel (Table 47).

8.10 What Damage Did the Motorcycle Sustain?

Table 47: Damage to motorcycle

Damage	Frequency	Percent
Mirrors	1045	66.2
Handlebars	972	61.6
Indicators	971	61.5
Fairing	927	58.7
Front Lights	605	38.3
Front Mudguard	578	36.6
Screen	562	35.6
Front Forks	552	35
Front Wheel	538	34.1
Tank	510	32.3
Gear Lever	508	32.2
Engine and Casing	468	29.7
Rear Brake Lever	437	27.7
Frame	399	25.3
Top Box & Panniers	386	24.5
Instruments	346	21.9
Other	332	21

Sub Frame	281	17.8
Brake Reservoir	219	13.9
Tail (Rear) Lights	207	13.1
Clutch Reservoir	197	12.5
Swing Arm	160	10.1
Back Wheel	155	9.8

Table 48 identifies the trajectory of the motorcyclist when separated from the motorcycle. The respondents whose trajectory was Left lowside indicated that a third (33.5%) had motorcycles with ABS brakes did not use their brakes, while 26.2% (n.64) fell to the right (Right lowside) in both cases, just over half did not use their brakes prior to crashing. Of particular interest is that 37.1% (n.107) of the n.288 respondents with ABS brakes on their motorcycles went Topside – i.e. over the front of the handlebars, which could be perhaps partially due to the mechanism of ABS brakes which are intended to stop the wheels of the motorcycle from locking and prevent uncontrolled skidding and therefore come to a stop in an upright position and thus keep the motorcycle upright. However, 40% of the n.107 that had ABS brakes did not use them before crashing.

Table 48: Trajectory after separation from motorcycle

Trajectory	Did your motorcycle have ABS brakes				
	N/a	Uncertain	Yes	No	Total
Fell backwards	1	0	21	15	37
	3.4%	0.0%	3.7%	1.6%	2.3%
Highside and fell left	1	2	28	44	75
	3.4%	11.8%	4.9%	4.6%	4.8%
Highside and fell right	1	1	33	53	88
	3.4%	5.9%	5.8%	5.5%	5.6%
Left lowside - fell over to the left	3	2	105	203	313
	10.3%	11.8%	18.3%	21.2%	19.8%
Right lowside - fell over to the right	6	3	64	171	244
	20.7%	17.6%	11.2%	17.8%	15.5%
Topside, over the front of the handlebars	8	3	107	170	288
	27.6%	17.6%	18.7%	17.7%	18.3%
Other See Annex II	0	0	40	66	106
	0.0%	0.0%	7.0%	6.9%	6.7%
Don't know	1	3	15	29	48
	3.4%	17.6%	2.6%	3.0%	3.0%
No Answer	8	3	160	208	379
	27.6%	17.6%	27.9%	21.7%	24.0%
Total	**29**	**17**	**573**	**959**	**1578**
	100%	**100%**	**100%**	**100%**	**100%**

Common sense suggests that the direction the body travels after a collision is closely linked the type of crash. As an example, a rear end collision with the motorcycle rear-ending a car will usually cause the rider to go over the front of the handlebars.

The information from Table 48 identifies the trajectory of the motorcyclist when separated from the motorcycle. The respondents whose trajectory was Left lowside indicated that a third (33.5%) had motorcycles with ABS brakes did not use their brakes, while 26.2% (n.64) fell to the right (Right lowside) in both cases, just over half did not use their brakes prior to crashing. Of particular interest is that 37.1% (n.107) of the n.288 respondents with ABS brakes on their motorcycles went Topside – i.e. over the front of the handlebars, which could be perhaps partially due to the mechanism of ABS brakes which are intended to stop the wheels of the motorcycle from locking and prevent uncontrolled skidding and therefore come to a stop in

an upright position and thus keep the motorcycle upright. However, 40% of the n.107 that had ABS brakes did not use them before crashing.

Table 48 Table 49 and Table 50 is the comparison between motorcycles with and without ABS.

Table 49: Braking, ABS Trajectory, did not brake

Prior to crashing, did you apply the brakes?		Did your motorcycle have ABS brakes				Total
		N/a	Uncertain	No	Yes	
Uncertain		4	2	57	45	108
No	Fell backwards	0	0	7	8	15
		0%	0%	2%	3%	3%
	Highside and fell left	0	0	14	11	25
		0%	0%	5%	4%	5%
	Highside and fell right	0	0	24	17	41
		0%	0%	9%	7%	7%
	Left lowside - fell over to the left	2	1	75	55	133
		22%	33%	27%	21%	24%
	Right lowside - fell over to the right	2	2	47	34	85
		22%	67%	17%	13%	15%
	Topside, over the front of the handlebars	3	0	38	43	84
		33%	0%	13%	17%	15%
	Other see Annex II	0	0	21	18	39
		0%	0%	7%	7%	7%
	Don't know	0	0	5	9	14
		0%	0%	2%	3%	3%
	No Answer	2	0	51	64	117
		22%	0%	18%	25%	21%
	Total	**9**	**3**	**282**	**259**	**553**
		100%	**100%**	**100%**	**100%**	**100%**

Table 50: Riders who applied brakes

Prior to crashing, did you apply the brakes?		Did your motorcycle have Antilock brakes (ABS)				Total
		N/a	Uncertain	No	Yes	
Yes	Fell backwards	0	0	8	11	19
		0%	0%	1%	4%	2%
	Highside and fell left	1	2	26	10	39
		7%	17%	4%	4%	4%
	Highside and fell right	1	1	23	13	38
		7%	8%	4%	5%	4%
	Left lowside - fell over to the left	1	1	115	44	161
		7%	8%	19%	17%	18%
	Right lowside - fell over to the right	4	1	113	27	145
		27%	8%	19%	10%	16%
	Topside, over the front of the handlebars	4	1	118	47	170
		27%	8%	20%	18%	19%
	Other see Annex II	0	0	39	16	55
		0%	0%	6%	6%	6%
	Don't know	0	3	18	3	24
		0%	25%	3%	1%	3%
	No Answer	4	3	145	87	239
		27%	25%	24%	34%	27%
	Total	**15**	**12**	**605**	**258**	**890**
		100%	**100%**	**100%**	**100%**	**100%**

Of particular interest is the comparison of riders whose motorcycles were equipped with ABS brakes and did not apply their brakes with those that did. There were n.259 whose motorcycle had ABS brakes but did not use them and there were n.258 who had ABS brakes and used them prior to crashing. Of those that fell Left lowside, 21% did not use their brakes compared to 17% who did use them. Of those that fell Right lowside, 13% did not use their brakes, while 10% did use them. Finally, 17% who did not use their ABS brakes, fell topside (over the front of the handlebars) while 18% did use their brakes.

In the case where the riders used their brakes prior to crashing, the proportion of those that fell Left lowside and did not have ABS brakes (19%), was similar to those that did (17%). While there was a notable difference for those that fell Right lowside – 10% with ABS and 19% without. The outcome for those who fell topside is similar – 18% with ABS and 20% without.

8.11 Were the headlights of your motorcycle switched on when you crashed

Table 51: Headlights on at crash?

Headlights On	Frequency	Percent
No	41	2.6
Yes	1520	96.3
No Answer	17	1.1
Total	**1578**	**100**

It must be noted that since 2016 motorcycles sold into the European Union must have their headlights switched on permanently - AHO (Automatic Headlights On). India introduced the same regulation from early 2017 with some manufacturers also installing in addition to AHO, DRL (Daytime Running Lights). Prior to 2016 AHO was fitted in increasing numbers voluntarily by motorcycle manufacturers from 2003 which thus explains the high proportion of motorcycles (96.3%) that had the headlights switched on (Table 51). Further, many countries obliged their riders to use low beam or dedicated daytime running lights.

Comments on braking:

- *Forgot that I did not ride my usual motorcycle which has ABS, so when I braked, I locked the rear tire, thumped into the curb and further into the lamppost and then down on a field. The bike was scrap but I miraculously managed without injuries, nothing more than bruises and light concussion.*
- *Car in front suddenly stopped without warning or reason. Motorcycle went down sideways on tarmac after front brake lock, where engine-guard took the blunt force but did not hit the car. Guard was scrapped and replaced after. Road was in bad condition, didn't have enough space in front for braking. ABS would probably have saved the situation.*
- *The ABS has saved me from other accidents but in this case the road was so slippery and the taxi so abruptly changed direction that I failed to avoid the collision.*
- *My accident was caused because I braked for the changing traffic lights and I was on a wet white arrow on the road at the traffic lights. The front wheel locked and kicked me off. The handlebar flicked and cracked my right wrist and ultimately, I ended up with a hairline fracture. No one else was involved.*
- *This accident was mainly due to inexperience as a rider at the time. I was leaning to go around a right-hand bend whilst a van veered onto my side of the road. I grabbed my front brake whilst leaned over, rookie mistake and thankfully at a low speed too. Have since participated in numerous instructional track training days and open track days to gain more experience. In the same circumstances now, I would not have binned my bike. :)*
- *It was a typical brake error in an emergency situation accident that might have been avoided if I had a new bike with ABS.*
- *A vehicle changed lanes without indicating, he did not see me, I braked by reflex and due to the lack of experience, I slipped (front wheel locked).*

9 Injuries

9.1 Type of injuries

Table 52: Type of injuries

Injuries	Frequency	Percent
Lower limbs, including knees, feet and/or ankles	672	42.6
Upper limbs, arms, elbows, wrists, hands	525	33.3
Shoulders	350	22.2
Chest internal	150	9.5
Neck	134	8.5
Chest external	89	5.6
Back see Annex III	87	5.5
Pelvic external	86	5.4
Head	78	4.9
Pelvic internal	73	4.6
Brain	59	3.7
Abdomen internal	57	3.6
Abdomen external	50	3.2
Face	49	3.1
Don't know	1	0.1

9.2 Post Crash Treatment

Table 53: Treatment after crash

Treatment	Frequency	Percent
Declined Treatment	83	5.3
Self-Treated	250	15.8
Went to own doctor later	267	16.9
First aid at scene	268	17.0
Transported to emergency room, treated and released	392	24.8
Admitted to hospital	311	19.7
Stayed in hospital	302	19.1
Rehabilitation	177	11.2
Don't know	9	0.6

NB: n.481 indicated that they declined treatment, self-treated, or received first aid at scene and/or then went to their own doctor later. In the case where n.311 (19.7%) respondents were admitted to hospital, n.302 (19.1%) remained for one or more days. 24.8% of the respondents indicated that they were transported to the emergency room, treated and then released (Table 53). Overall 76% of the riders did not have injuries severe enough to require a stay in hospital. The Thailand and Hurt study data both showed that roughly 30% of riders did not go directly from the scene to a hospital, about one-third were treated in the ER and released, about one-fourth were admitted to the hospital and about 5-6% were fatal.

9.3 Time Spent in Hospital

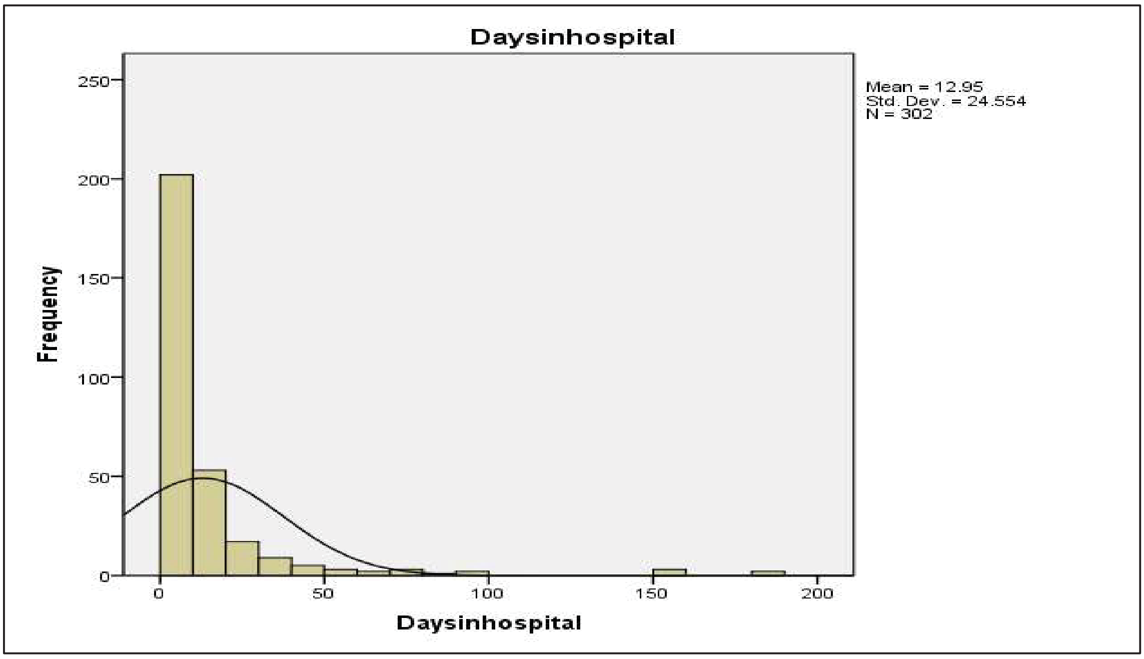

Figure 5: Time at hospital

The histogram (Figure 5) indicates the time spent in hospital which varies from one day to a maximum of 183 days. The average time spent in hospital was 13 days.

9.4 Time Spent in Rehabilitation

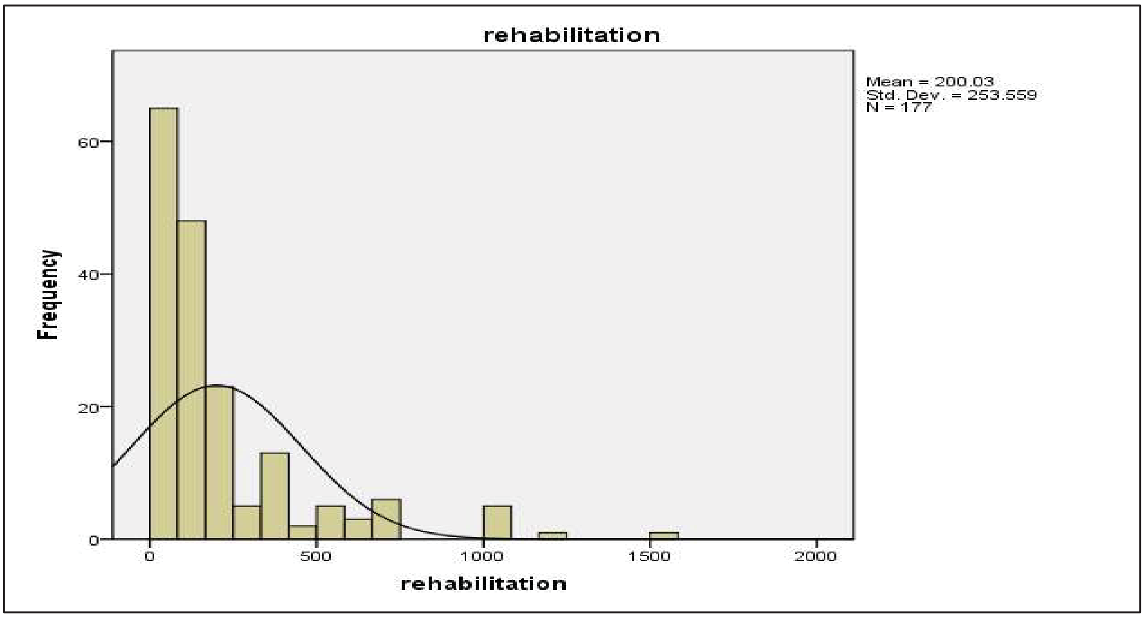

Figure 6: Time in rehabilitation

Rehabilitation as highlighted in Figure 6 of the n.177 respondents varies from one day to over four years with an average rehabilitation period of 200 days.

9.5 Protective Armour and Injuries

Table 54: Injuries: Upper limbs - Jacket with armour

Clothing Jacket with armour	Injuries: Upper limbs - arms, elbows, wrists, hands		Total
	No	Yes	
Yes	929	457	1386
No	93	45	138
Uncertain	1	3	4
No answer	30	20	50
Total	**1053**	**525**	**1578**

Table 54 indicates that 49% of those who wore a jacket with armour at the time of the crash received injuries to the upper limbs. There were n.350 who had injuries to their shoulders of which n.309 (88.2%) were wearing a jacket with armour. The obvious question of why riders who wore armoured jackets still suffered injuries to their upper arms.

Table 55: Injuries: Lower limbs - trousers with armour

Clothing Trousers with armour	Injuries: Lower limbs, including knees, feet and/or ankles		Total
	No	Yes	
Yes	633	424	1057
No	211	214	425
Uncertain	6	0	6
No answer	56	34	90
Total	**906**	**672**	**1578**

The respondents who were wearing armoured trousers and were injured to their lower limbs were n.424 or 63%. There were n.73 respondents whose internal pelvic area was injured of whom 63% were wearing armoured trousers. Whereas there were n.86 respondents who had external pelvic injuries when 60% were wearing armoured trousers (Table 55).

What perhaps need to be considered is the caveat required in relation to motorcyclists' clothing[28] which is that hazards against which this garment cannot provide protection are: 1) Severe bending, crushing and torsional forces which occur when the body and arms become trapped between the motorcycle and another vehicle or the road. 2) Massive penetrating injuries on any part of the body. 3) High energy impacts on the chest or abdomen, and severe bending forces such as when the torso strikes an upright post. Whilst certain types and levels of accident protection can be provided by clothing, protection against some hazards is impossible.

9.6 Helmet and Injuries

The information in Table 56 indicates the type of injuries according to the style of helmet. The most popular helmet used was the full face worn by n.923 (58.5%) of the respondents, next most popular was the Modular or flip-up style worn by 27.9% of the riders responding. Open face helmets were worn by 9.1%. Neck injuries were indicated as the most common with

[28] Ref: Paul Varnsverry www.pva-ppe.org.uk

56.7% (full face) 33.6% Modular and 7.5% open face. Next most common injury was to the head, followed by brain and then face with similar proportions for the three types of helmet.

Table 56: Style of helmet and type of injuries

Helmet Type	Type of Injuries								Total	
	Neck		Face		Head		Brain			
	Fr	%	Fr	%	Fr	%	Fr	%	Fr	%
Dual-sport	2	1.5	3	6.1	2	2.6	1	1.7	26	1.6
Full face	76	56.7	19	38.8	43	55.1	34	57.6	923	58.5
Modular (Flip-up)	45	33.6	14	28.6	22	28.2	16	27.1	440	27.9
No helmet	0	0.0	1	2.0	1	1.3	0	0.0	8	0.5
Off-road (motocross)	1	0.7	0	0.0	1	1.3	1	1.7	23	1.5
Open face	10	7.5	12	24.5	7	9.0	7	11.9	143	9.1
Other	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
No Answer	0	0.0	0	0.0	2	2.6	0	0.0	13	0.8
Total	**134**	**100.0**	**49**	**100.0**	**78**	**100.0**	**59**	**100.0**	**1578**	**100.0**

9.7 Speed versus Injuries

Table 57: Speed and injury (kph)

Speed	Injured					Total
	N/A	No	%	Yes	%	
1 to 10 kph	2	32	7.6	38	4.0	72
11 to 20 kph	5	51	12.1	61	6.4	117
21 to 30 kph	5	60	14.2	115	12.0	180
31 to 40 kph	0	52	12.3	124	12.9	176
41 to 50 kph	8	52	12.3	152	15.8	212
51 to 60 kph	2	43	10.2	104	10.8	149
61 to 70 kph	1	30	7.1	90	9.4	121
71 to 80 kph	1	22	5.2	89	9.3	112
81 to 90 kph	3	11	2.6	45	4.7	59
91 to 100 kph	3	9	2.1	30	3.1	42
101 to 110 kph	1	7	1.7	25	2.6	33
111 to 120 kph	3	7	1.7	11	1.1	21
121 to 130 kph	0	3	0.7	6	0.6	9
More than 130 kph	0	4	0.9	11	1.1	15
Stationary see Annex I	4	37	8.7	54	5.6	95
Don't know	1	3	0.7	5	0.5	9
Total	**39**	**423**	**100.0**	**960**	**100.0**	**1422**

Table 58: Speed and injury (mph)

Speed	Injured				Total
	No	%	Yes	%	
1 to 10 mph	2	7.7	8	6.3	10
11 to 20 mph	1	3.8	18	14.1	19
21 to 30 mph	6	23.1	24	18.8	30
31 to 40 mph	6	23.1	21	16.4	27
41 to 50 mph	2	7.7	17	13.3	19
51 to 60 mph	3	11.5	19	14.8	22
61 to 70 mph	1	3.8	5	3.9	6
61 to 70 mph	1	3.8	5	3.9	6
71 to 80 mph	2	7.7	3	2.3	5
81 to 90 mph	1	3.8	2	1.6	3
91 to 100 mph	0	0.0	4	3.1	4
111 to 120 mph	1	3.8	1	0.8	2
121 to 130 mph	0	0.0	1	0.8	1
Total	**26**	100.0	**128**	100.0	**154**

Ten motorcyclists who were stationary when they were hit by another vehicle were admitted to hospital and stayed for periods of one day (four), two days (three), three days (one), five days (one) and 90 days (one). Overall, 65.7% of the respondents who used kilometres as a measure, were travelling at speeds below 60 kph.

Table 59: Speed and hospital admission (kph)

Speed Kilometres	Admitted to hospital				Total
	No	%	Yes	%	
1 to 10 kph	59	5.1	13	4.7	72
11 to 20 kph	109	9.5	8	2.9	117
21 to 30 kph	161	14.0	19	6.9	180
31 to 40 kph	147	12.7	29	10.5	176
41 to 50 kph	170	14.7	42	15.3	212
51 to 60 kph	112	9.7	37	13.5	149
61 to 70 kph	89	7.7	32	11.6	121
71 to 80 kph	85	7.4	27	9.8	112
81 to 90 kph	36	3.1	23	8.4	59
91 to 100 kph	33	2.9	9	3.3	42
101 to 110 kph	25	2.2	8	2.9	33
111 to 120 kph	17	1.5	4	1.5	21
121 to 130 kph	8	0.7	1	0.4	9
More than 130 kph	9	0.8	6	2.2	15
Stationary : Annex I	85	7.4	10	3.6	95
Don't know	6	0.5	3	1.1	9
No Answer	2	0.2	4	1.5	6
Total	1153	100.0	275	100.0	1428

Based on the data in Table 57, Table 58 and Table 59, the following Figure 7 and Figure 8 highlight the correlation between speed in kilometres and time spent in hospital. Figure 7 shows the variation of speed of n.39 riders who only spent one day in hospital (14.1%) whereas figure 8 demonstrates the correlation between speed and over 20 days of n.20 riders who spent time in hospital. Overall there were n.275 riders who registered their speed in kilometres of which 7.2% spent more than 20 days in hospital.

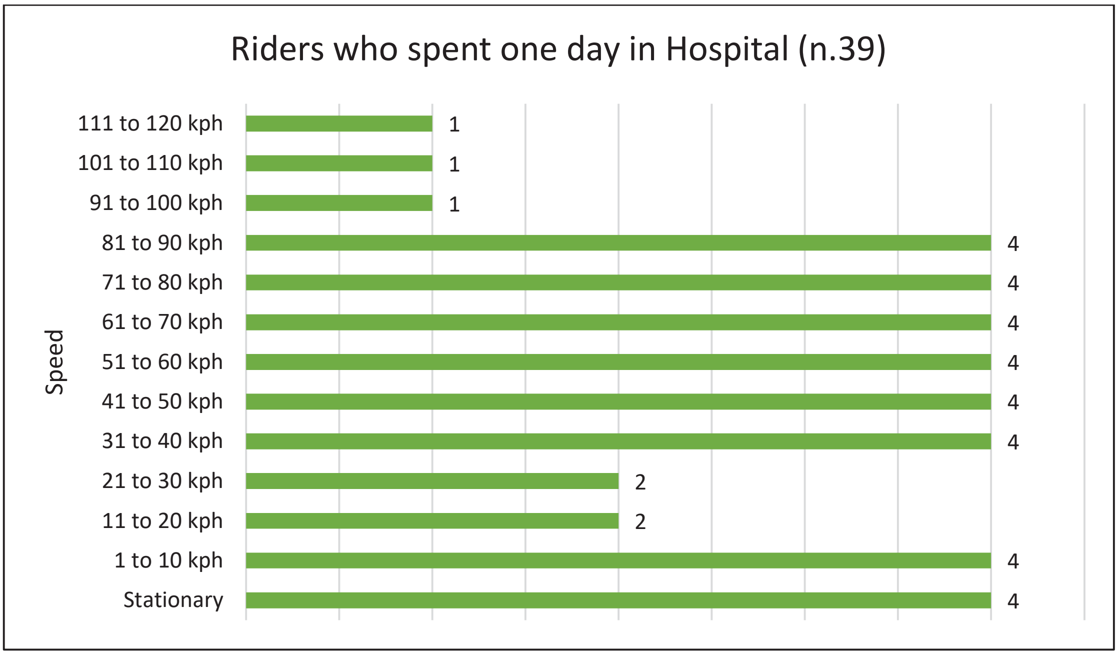

Figure 7: Speed (kph) prior crash and one day hospital stay

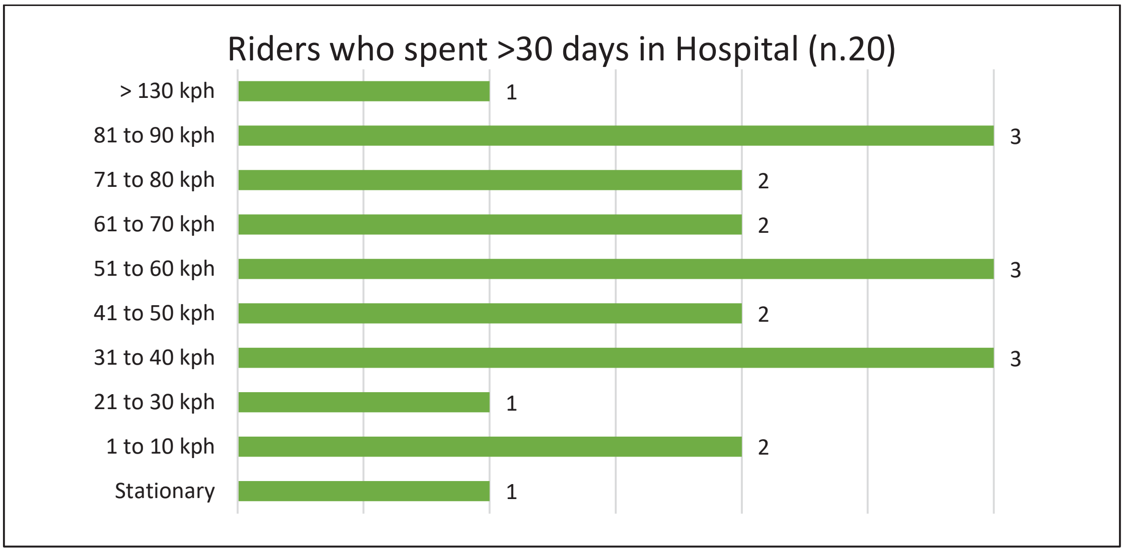

Figure 8: Speed (kph) prior crash and hospital stay (>30 days)

Figure 9 highlights the total number of riders who were admitted to hospital with speeds of 111 kilometres or more. Of the total n.275 admitted to hospital (see table 59), 4% (n.11) represented those respondents travelling at the speeds (in kilometres indicated in graph below). The graph demonstrates that the correlation between speed and days spent in hospital is random – which suggests that the severity of the injuries is not due to the speed per se.

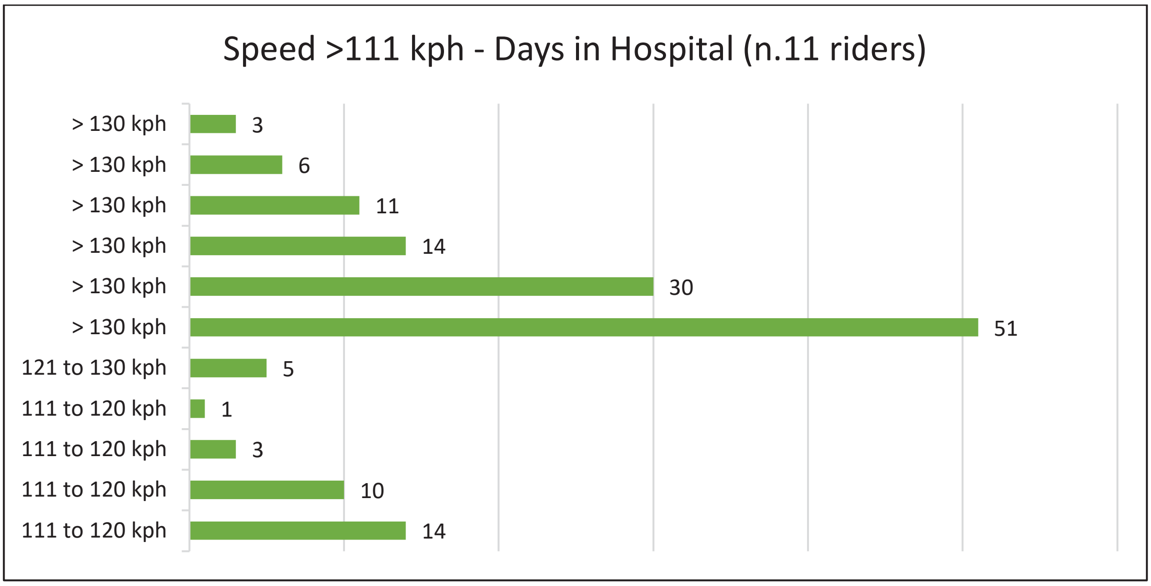

Figure 9: Speed (kph) prior crash and hospital stay (days)

Table 60 and Figure 10 both highlight the speed in miles of those respondents who were admitted to hospital and spent time in hospital. Overall, 77.7% of the respondents who used miles as a measure indicate speeds of between 11mph to a maximum of 60 mph.

Table 60: Speed / Admitted to hospital (miles)

Speed Miles	Admitted to hospital				Total
	No	%	Yes	%	
1 to 10 mph	9	7.9	1	2.8	10
11 to 20 mph	16	14.0	4	11.1	20
21 to 30 mph	26	22.8	4	11.1	30
31 to 40 mph	22	19.3	6	16.7	28
41 to 50 mph	11	9.6	8	22.2	19
51 to 60 mph	16	14.0	6	16.7	22
61 to 70 mph	3	2.6	3	8.3	6
71 to 80 mph	5	4.4	0	0.0	5
81 to 90 mph	2	1.8	1	2.8	3
91 to 100 mph	1	0.9	3	8.3	4
111 to 120 mph	2	1.8	0	0.0	2
121 to 130 mph	1	0.9	0	0.0	1
Total	**114**	**100.0**	**36**	**100.0**	**150**

Figure 10 below shows the number of days spent in hospital, compared to the pre-crash speed indicated by the riders in miles per hour. The rider who indicated the lowest speed – 1 to 10 mph, spent 14 days in hospital, while those who indicated a pre-crash speed of between 91 to 100 mph spent between one day to five days in hospital. The rider that spent the most time in hospital (n.75 days) was travelling at a pre-crash speed of between 51 to 60 mph.

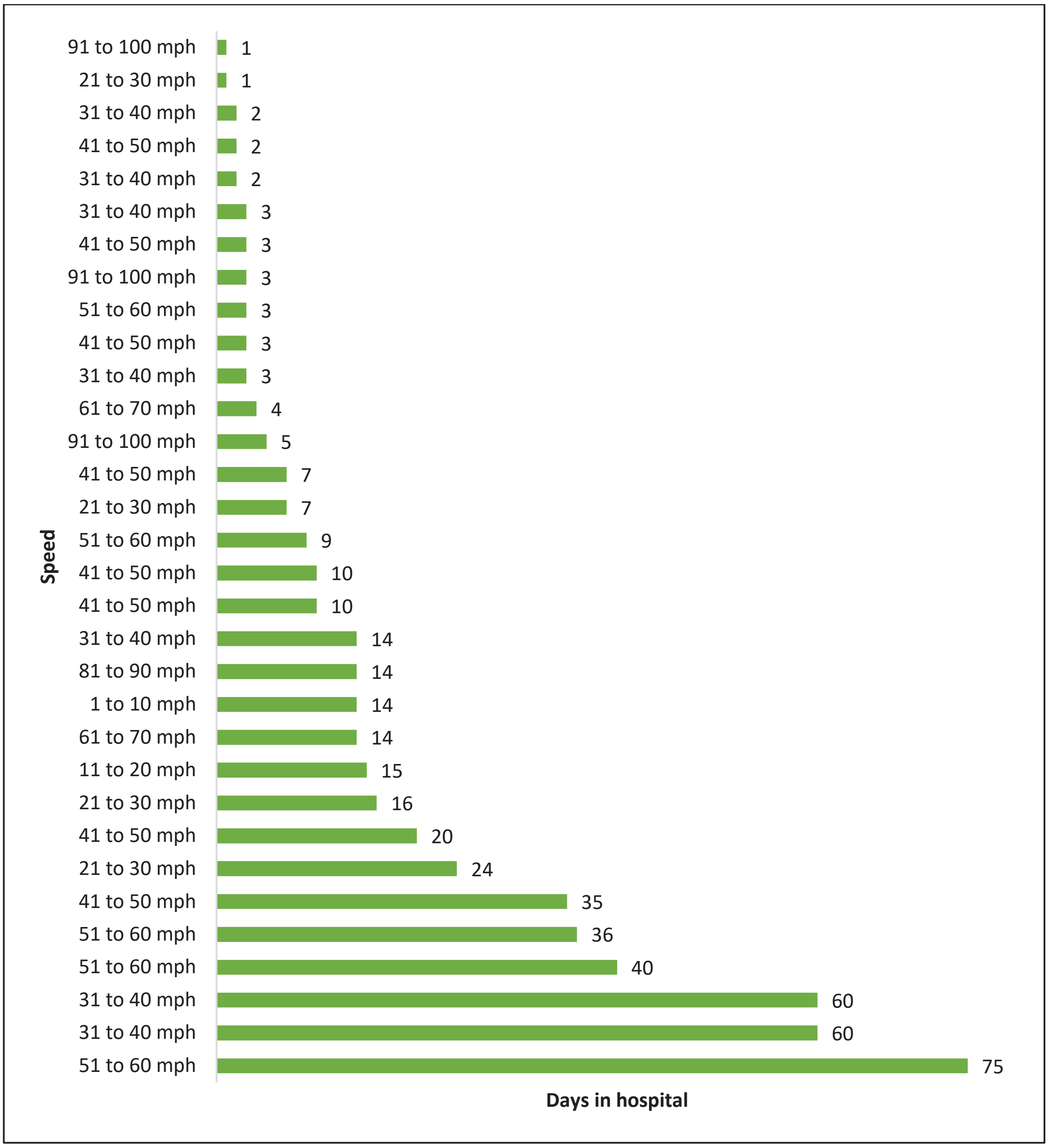

Figure 10: Speed (mph) prior crash and hospital stay

9.8 Speed, days in hospital and rehabilitation - comments by riders

Table 61 reinforces the notion highlighted in the previous tables that speed does not necessarily correlate to the severity of injuries. Of the n.45 respondents who spent more than n.20 days in hospital, there were n.33 who gave details of their injuries. The following table identifies speed, days in hospital, days in rehabilitation and the type of injuries that the n.33 respondent received from the crash.

The information is compelling in demonstrating that speed and the correlation with the severity of injuries is random. From one end of the spectrum, the rider who was stationary when hit, spent 90 days in hospital (possibly due to the speed of the vehicle who crashed into the rider) and 120 days in rehabilitation to the other end where the rider whose speed was above 130 kph spent 51 days in hospital and further 120 days in rehabilitation. Throughout the table, the type of injuries vary as do the speeds and time spent in hospital and rehabilitation.

Table 61: Speed, days in hospital and rehabilitation with comments

Speed	Comments injuries	Days in hospital	Days rehab.
1 to 10 kph	Lost consciousness – severe lower limb injuries	45	300
1 to 10 kph	The rear footrest bore into the calf above the boot and slit the calf open.	20	
21 to 30 kph	Left leg	20	180
31 to 40 kph	Lost a lot of hearing on both ears. Almost deaf on the left. Wearing hearing aids today	90	30
31 to 40 kph	Broken humerus left side. Muscle pains in shoulder and lowerback	38	
31 to 40 kph	Leg amputated (Right leg was cut off in the middle of the thigh on a sharp-edged guardrail post.	28	120
31 to 40 kph	Complicated fracture ankle, shin and fibula	20	90
31 to 40 mph	Damage to Lungs and Spleen.	60	150
41 to 50 kph	Spinal cord infarction leading to lower paralysis and three years in a wheelchair.	72	110
41 to 50 kph	The bone was twisted, doctors said it was the most severe knee injury they had seen in 15 years. They were thinking of amputating first, could not walk again. Prosthesis was surgical after MANY trips for 3.5 years. Wheelchair bound for 2.5 years.	30	720
41 to 50 mph	There were indications of spine damage on the initial CT scan, however I have not had any back problems since then.	35	365
41 to 50 mph	Collapsed lung , haemothorax, pneumothorax, bruised kidneys, broken & bruised thumb & fingers	20	
51 to 60 kph	Fracture of the right internal malleolus, open fracture of the right femur, three cracked ribs on the right, a pneumothorax. Fracture of the right clavicle, open fracture of the radius and ulna and slight head trauma.	158	1000
51 to 60 kph	Fracture of the right tibial plateau dislocation of the left shoulder	150	180
51 to 60 kph	Ribs, vertebra and teeth	40	
51 to 60 kph	Explosion of the acetabulum and lesion of the right sciatic nerve	25	60
51 to 60 kph	Lost most of my upper teeth, leg amputated after 25 operations over a 2 year period.	21	1500
51 to 60 kph	Punctured lung from broken ribs, fractures: 2 in neck, 1 in back, collarbone, shoulder, both shoulder blades, breastbone cracked, 22 rib fractures, minor nerve damage left leg (from slide)	20	90
51 to 60 kph	Fractured left leg and ankle broken in 7 pieces , Shoulder injuries split and separated main muscle. Still bad bloodflow and pain.	20	1000
51 to 60 mph	Fractured jaw	75	1000
51 to 60 mph	Spinal injuries	36	1200
61 to 70 kph	Pelvic fractures	60	180
61 to 70 kph	Small brain bleed. Broken wrist requiring surgery. Broken pelvis--no walking for eight weeks, three cuts to face.	39	39
71 to 80 kph	Wounds to the scrotum, Wounds to the knees, Detachment of the pleura, Fracture vertebra D2	150	600
71 to 80 kph	life threatening septicemia	56	200
71 to 80 kph	Broken collar bone, three broken ribs, broken pelvis front and back on both sides and a pneumothorax.	30	30
81 to 90 kph	Mental trauma which affects me for several years.	38	550
81 to 90 kph	Plexus brachial	22	600
81 to 90 kph	Held in coma for 5 days, 16 rib fractures, fractured vertebra, 2 folding lungs, torn lung, 8 litres of blood drained in, broken knee	21	365
81 to 90 kph	Fracture in the right hand and L5 vertebra	20	30
>130 kph	Hip fracture	51	120
> 130 kph	Broken Clavical (right) and 7 ribs (right)	30	
Stationary	Damage to left lung	90	120

9.9 Style of Motorcycle, Injuries

Three styles of motorcycles dominate the table 62 regarding the proportion of respondents injured (Table 62). Adventure (15.9%), Naked (30%) and Supersport (14.6%).

Table 62: Style of motorcycle and Injury

Style	Were you injured?						
	N/A	%	No	%	Yes	%	Total
Adventure	2	4.9	76	**17.0**	173	**15.9**	251
Cruiser	3	7.3	20	4.5	64	5.9	87
Custom	2	4.9	25	5.6	57	5.2	84
Moped	1	2.4	7	1.6	7	0.6	15
Naked (Streetbike)	14	34.1	143	**31.9**	327	**30.0**	484
Scooter	4	9.8	12	2.7	36	3.3	52
Sports Tourer	0	0.0	46	10.3	122	11.2	168
Supermoto	0	0.0	5	1.1	20	1.8	25
Supersport	8	19.5	65	**14.5**	159	**14.6**	232
Touring	5	12.2	31	6.9	82	7.5	118
Trail/Enduro (Off road)	1	2.4	16	3.6	36	3.3	53
Other	0	0.0	1	0.2	3	0.3	4
No Answer	1	2.4	1	0.2	3	0.3	5
Total	**41**	**100.0**	**448**	**100.0**	**1089**	**100.0**	**1578**

In Annex IV, Table IV lists the style of motorcycle and the post-crash motion of each style. The outcome of the trajectory of the style of motorcycle is similar in proportion to Table 48 identifies the trajectory of the motorcyclist when separated from the motorcycle. The respondents whose trajectory was Left lowside indicated that a third (33.5%) had motorcycles with ABS brakes did not use their brakes, while 26.2% (n.64) fell to the right (Right lowside) in both cases, just over half did not use their brakes prior to crashing. Of particular interest is that 37.1% (n.107) of the n.288 respondents with ABS brakes on their motorcycles went Topside – i.e. over the front of the handlebars, which could be perhaps partially due to the mechanism of ABS brakes which are intended to stop the wheels of the motorcycle from locking and prevent uncontrolled skidding and therefore come to a stop in an upright position and thus keep the motorcycle upright. However, 40% of the n.107 that had ABS brakes did not use them before crashing.

Table 48, Table 49 and Table 50. Left lowside, Right lowside and Topside are the most predominant trajectories by Adventure bikes (n.251), Naked Streetbike (n.484) Supersport (n.232) and Touring (n.118). These styles represent 69% of the motorcycles in this survey. While both Topside and Left lowside has the highest proportion overall of those who crashed with c.19% each.

9.10 Trajectory and type of injuries

The following tables indicate the type of injuries identified, depending on the trajectory (post-crash motion) of the respondents. What these responses do not indicate is the severity of the injuries or whether the injuries resulted in time spent in hospital. Table 63 focuses on lower limb and pelvic injuries as well as upper limbs and indicates that the two trajectories Left lowside and Topside dominate the type of injuries. Left lowside averaging 20% excluding pelvic internal and Topside averaging 25%. Note however that the pelvic internal injuries for Topside was 37%.

Table 63: Trajectory and type of injury

Trajectory	Lower limbs, including knees, feet and/or ankles		Upper limbs - arms, elbows, wrists, hands		Pelvic internal		Pelvic external	
	Fr	%	Fr	%	Fr	%	Fr	%
Fell backwards	16	2.4	10	1.9	1	1.4	0	0.0
Highside and fell left	37	5.5	30	5.7	2	2.7	5	5.8
Highside and fell right	47	7.0	41	7.8	5	6.8	5	5.8
Left lowside - fell over to the left	129	**19.2**	108	**20.6**	5	6.8	17	**19.8**
Other see Annex II	56	8.3	32	6.1	9	12.3	10	11.6
Right lowside - fell over to the right	97	14.4	75	14.3	8	11.0	10	11.6
Topside, over the front of the handlebars	130	**19.3**	123	**23.4**	27	**37.0**	18	**20.9**
Don't know	28	4.2	21	4.0	7	9.6	5	5.8
No answer	132	19.6	85	16.2	9	12.3	16	18.6
Total	**672**	**100.0**	**525**	**100.0**	**73**	**100.0**	**86**	**100.0**

Once again Table 64 highlights the two dominating post-crash motions with the highest proportion of injuries as Left lowside and Topside. However, across the range of types of injuries, Topside dominates with an average of 30% for abdomen and chest injuries, while Left lowside has an average of 20% for chest injuries.

Table 64: Trajectory and type of injury (cont.)

Trajectory	Abdomen internal		Abdomen external		Chest internal		Chest external	
	Fr	%	Fr	%	Fr	%	Fr	%
Fell backwards	3	5.3	1	2.0	4	2.7	3	3.4
Highside and fell left	3	5.3	0	0.0	10	6.7	3	3.4
Highside and fell right	2	3.5	4	8.0	13	8.7	11	12.4
Left lowside - fell over to the left	3	5.3	7	14.0	26	**17.3**	20	**22.5**
Other see Annex II	6	10.5	4	8.0	16	10.7	6	6.7
Right lowside - fell over to the right	8	14.0	7	14.0	23	15.3	11	12.4
Topside, over the front of the handlebars	23	**40.4**	17	**34.0**	40	**26.7**	19	**21.3**
Don't know	2	3.5	2	4.0	7	4.7	2	2.2
No answer	7	12.3	8	16.0	11	7.3	14	15.7
Total	**57**	**100.0**	**50**	**100.0**	**150**	**100.0**	**89**	**100.0**

Table 65 refers to back and shoulder injuries. In this case, the post-crash motion, Topside overwhelmingly dominates with 29% compared to the remaining trajectory types. The question relating to back injuries was not asked, this is a shortfall in the survey, however the respondents who replied to the question about trajectory, were then asked to comment on "other injuries" and n.87 replied with details that they had received back injuries of varied severity. These comments are included in Annex III.

Table 65: Trajectory and type of injury (cont.)

Trajectory	Back - see Annex III		Shoulders	
	Fr	%	Fr	%
Fell backwards	5	5.7	9	2.6
Highside and fell left	9	10.3	25	7.1
Highside and fell right	9	10.3	35	10.0
Left lowside - fell over to the left	5	5.7	53	15.1
Other see Annex II	11	12.6	22	6.3
Right lowside - fell over to the right	10	11.5	52	14.9
Topside, over the front of the handlebars	27	**31.0**	95	**27.1**
Don't know	5	5.7	17	4.9
No answer	6	6.9	42	12.0
Total	**87**	**100.0**	**350**	**100.0**

Table 66 provides details of neck, face, head and brain injuries and the Topside post-crash motion dominates with an average of 38.5% for all these types of injuries. Table 56 (page 50) considers these types of injuries and compares them to the style of helmet used by the respondent.

Table 66: Trajectory and type of injury (cont.)

Trajectory	Neck		Face		Head		Brain	
	Fr	%	Fr	%	Fr	%	Fr	%
Fell backwards	4	3.0	1	2.0	3	3.8	1	1.7
Highside and fell left	6	4.5	4	8.2	4	5.1	2	3.4
Highside and fell right	9	6.7	0	0.0	8	10.3	0	0.0
Left lowside - fell over to the left	19	14.2	8	**16.3**	4	5.1	4	6.8
Other see Annex II	9	6.7	6	12.2	3	3.8	5	8.5
Right lowside - fell over to the right	15	11.2	6	12.2	6	7.7	9	15.3
Topside, over the front of the handlebars	48	**35.8**	16	**32.7**	35	**44.9**	24	**40.7**
Don't know	8	6.0	5	10.2	8	10.3	8	13.6
No answer	16	11.9	3	6.1	7	9.0	6	10.2
Total	**134**	**100.0**	**49**	**100.0**	**78**	**100.0**	**59**	**100.0**

What the tables highlight is that the trajectory is significant in establishing the percentages of injuries. Overwhelmingly, the Topside motion has the highest proportion of declared injuries for all types, with the exception of “external chest”. The Left lowside motion had the second highest proportion of type of injuries. As mentioned above, the type of injuries highlighted do not determine the severity of the injuries. However, as highlighted in Table 61, the severity of injuries detailed by n.33 respondents compares them with speed and days spent in hospital and rehabilitation.

9.11 Topside – Over the front of the handlebars

A total of n.288 riders stated that their trajectory was Topside (compared to n.313 Left lowside) while, n.232 whose post-crash motion was “Topside” stated that they were injured (compared to n.206 Left lowside). Overall, n.95 “Topside” were admitted to hospital (compared to n.25 Left lowside), whereas when the Trajectory was topside, n.59 stayed in hospital between one to seven days; n.20 between eight to 20 days (Figure 11).

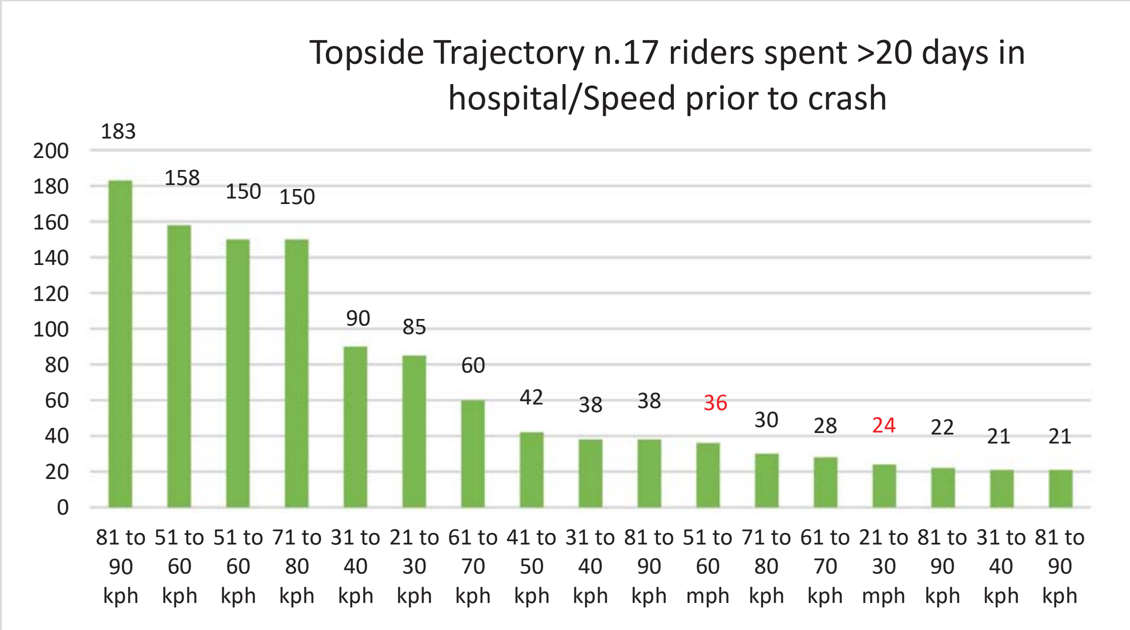

Figure 11: Speed prior crash/Topside trajectory/ hospital stay > 20 days

9.12 Days in Hospital – Riders whose motorcycles had ABS

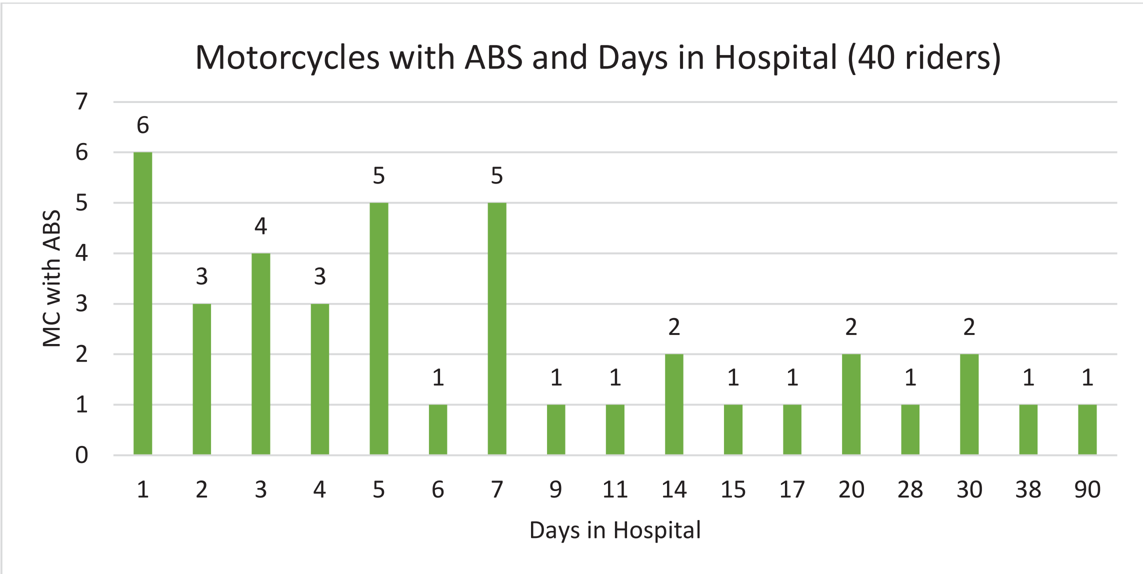

Figure 12: Motorcycles with ABS where brakes were used and days spent in hospital by the riders

Figure 12 refers only to the n.40 riders who applied their brakes prior to crashing. Time spent in hospital varied from one day (six riders) to n.90 days for one rider.

10 Type of Crashes

10.1 What the Motorcycle Crashed with

Table 67: Type of motorcycle collision

Collided With	Frequency	Percent
Car	695	48.7
Single vehicle	321	22.5
Motorcycle/Scooter/Moped	83	5.8
Van (incl. 3 motorhomes)	73	5.1
Road side Barrier	50	3.5
Large animal*	36	2.5
Other	59	4.1
Road hump	19	1.3
Truck	17	1.2
Bicycle	16	1.1
Small animal (dog, fox etc)	8	0.6
Truck with trailer	9	0.6
Don't know	7	0.5
Flying objects including birds	7	0.5
Pedestrian	7	0.5
Road side Barrier with MC protection	7	0.5
Bus	6	0.4
Tractor	5	0.4
Tuk Tuk (Rickshaw)	1	0.1
Bridge	1	0.1
Total	**1427**	100.0
No Answer	151	

** Large animals include a bear, moose a herd of cows, kangaroos, deer, sheep and wild boars.*

There were n.27 riders who responded "other" and commented, avoided a car and then crashed. These figures are included in this Table 67 as “other”. Although crashes with road-side barriers and other road infrastructure are considered “single vehicle crashes”, for the purpose of identifying the specific type of road infrastructure, the table identifies these separately. In the case of “Single Vehicle”, there were n.321 (22.5%) riders who indicated that they lost control and there was no contact with other vehicles or infrastructure.

Table 68 compares the post-crash motion to what the motorcycle crashed with and demonstrates that of the n.696 motorcycles that crashed with a car, 63.5% (n.183) of the motorcyclists’ trajectory was Topside (n.288). Of the single vehicle crashes (n.191) where the rider lost control and did not crash against an object or vehicle, the predominant trajectories were Left lowside (18.8%) and Right lowside (19.3%).

10.2 Crashed with and Trajectory of motorcycle post-crash

Table 68: Collision with and trajectory after crash

Crashed with	If you were separated from your motorcycle, which way did you go?									Total
	N/a	**Don't know**	**Fell back wards**	**High-side and fell left**	**High-side and fell right**	**Left lowside - fell over to the left**	**Other, See Annex II**	**Right low side - fell over to the right**	**Topside, over the front of the handle bars**	
Bicycle	6	0	0	0	1	2	2	0	4	15
	1.6%	0.0%	0.0%	0.0%	1.1%	0.6%	1.9%	0.0%	1.4%	1.0%
Bridge	0	0	0	0	0	0	0	0	1	1
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.1%
Bus	1	1	0	0	1	0	0	0	1	4
	0.3%	2.1%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.3%	0.3%
Car	179	19	18	27	35	102	45	88	183	696
	47.2%	39.6%	48.6%	36.0%	39.8%	32.6%	42.5%	36.1%	63.5%	44.1%
Flying objects (e.g.birds or insects)	1	0	0	0	0	2	2	0	1	6
	0.3%	0.0%	0.0%	0.0%	0.0%	0.6%	1.9%	0.0%	0.3%	0.4%
Large animal (e.g. moose, horse, deer)	8	2	4	1	2	3	4	6	5	35
	2.1%	4.2%	10.8%	1.3%	2.3%	1.0%	3.8%	2.5%	1.7%	2.2%
Motorcycle/scooter, moped	16	6	4	6	7	15	4	14	10	82
	4.2%	12.5%	10.8%	8.0%	8.0%	4.8%	3.8%	5.7%	3.5%	5.2%
Other	24	2	3	9	10	30	9	12	9	108
	6.3%	4.2%	8.1%	12.0%	11.4%	9.6%	8.5%	4.9%	3.1%	6.8%
Pedestrian	3	0	0	0	0	2	0	1	0	6
	0.8%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.4%	0.0%	0.4%
Road hump	3	1	1	0	3	3	0	5	3	19
	0.8%	2.1%	2.7%	0.0%	3.4%	1.0%	0.0%	2.0%	1.0%	1.2%
Road side (crash) barrier	11	2	1	5	3	11	6	6	5	50
	2.9%	4.2%	2.7%	6.7%	3.4%	3.5%	5.7%	2.5%	1.7%	3.2%
Road side (crash) barrier with motorcycle guard rail	2	1	0	0	0	3	0	0	1	7
	0.5%	2.1%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.3%	0.4%
Single vehicle	31	4	1	4	8	59	15	47	22	191
	8.2%	8.3%	2.7%	5.3%	9.1%	18.8%	14.2%	19.3%	7.6%	12.1%
Small animal dog, fox	2	0	0	1	0	1	1	1	2	8
	0.5%	0.0%	0.0%	1.3%	0.0%	0.3%	0.9%	0.4%	0.7%	0.5%
Tractor (agricultural vehicle)	2	0	0	0	0	0	1	1	0	4
	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.4%	0.0%	0.3%
Truck	3	1	0	1	1	1	4	2	3	16
	0.8%	2.1%	0.0%	1.3%	1.1%	0.3%	3.8%	0.8%	1.0%	1.0%
Truck with trailer/s	3	1	0	0	2	1	0	0	2	9
	0.8%	2.1%	0.0%	0.0%	2.3%	0.3%	0.0%	0.0%	0.7%	0.6%
Tuk tuk (rickshaw)	1	0	0	0	0	0	0	0	0	1
	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Van	14	4	2	3	2	12	5	8	21	71
	3.7%	8.3%	5.4%	4.0%	2.3%	3.8%	4.7%	2.9%	7.3%	4.4%
Don't know	0	1	0	2	0	2	0	0	2	7
	0.0%	2.1%	0.0%	2.7%	0.0%	0.6%	0.0%	0.0%	0.7%	0.4%
No Answer	69	3	3	16	13	64	8	53	13	242
	18.2%	6.3%	8.1%	21.3%	14.8%	20.4%	7.5%	21.7%	4.5%	15.3%
Total	**379**	**48**	**37**	**75**	**88**	**313**	**106**	**244**	**288**	**1578**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Comments on collision with animals and insects:

- *The kangaroo came out from a gap between two buildings at approximately 40km/h perpendicular to my direction of travel, from just outside the arc of my headlights. First, I saw of it was when it impacted me. Two vehicles behind stopped to render assistance, along with a pedestrian and a resident of one of the buildings.*
- *Hit a herd of escaped cattle in the road at night, poor headlamps on bike contributed. Owner of cattle not found. Police not bothered.*
- *Accident on a one lane country road in a wood at 1 a.m. A boar crossing in front of me, I had no time to react, I hit him in the face. Loss of consciousness at the time of the collision, waking up 5 meters from the motorcycle in the road. Emergency services called.*
- *I hit a big insect and got distracted for a second and looked down, and when I looked up I got into a very sharp corner and didn't have the time to break enough. I low sided into the ditch and injured my right index finger. I had a cold, and I might have been a little bit drowsy from that.*
- *Deer ran over on the road so abruptly then I started slowing down but when deer refused to jump over the middle wires instead turn deer and ran back then bang. Had deer jumping over cables then I had managed to get away with an accident.*
- *My hitting the Bear was completely unavoidable as unseen he leapt from the ditch so close in front, I never touched the brakes. There was no traffic on this quiet forested road*

10.3 Trajectory of Motorcycle crashed with a car

Table 69: Trajectory of motorcycle crashed with a car

Trajectory	Frequency	Percent
Fell back wards	18	2.6
Highside and fell left	27	3.9
Highside and fell right	35	5.0
Left lowside - fell over to the left	102	14.7
Other See Annex II	45	6.5
Right lowside - fell over to the right	88	12.6
Topside, over the front of the handle bars	183	26.3
Don't know	19	2.7
No answer	179	25.7
Total	**696**	**100.0**

Table 69 identifies the trajectory of the motorcycle on impact with a car. The most prevalent post-crash motion (26.3%) was indicated as Topside, followed by Left lowside (14.7%), then Right lowside with 12.6% of the riders who collided with a car. Topside is also prevalent in table 68 where 63.5% of Topside cases crashed with a car compared to other vehicles, road infrastructure, animals or objects.

10.4 Road side crash barriers (* indicates motorcycle friendly barriers)

Table 70 includes comments from respondents who crashed against a road side barrier. Further n.26 cases without comments are included in Annex IV Table III. Overall there were n.58 cases where riders crashed against a road side barrier and includes a case where the rider collided with a car and then hit a crash barrier. Of these n.47 had a full A licence. Table 70 highlights n.31 cases with comments from the riders about the incident. Represented by country are seven from Australia, one from Canada, six from France, five from Germany, one from Italy, four from Norway, two from Spain, one from South Africa, three from Sweden, one from the Netherlands.

There were six instances where the road side barriers were identified as "motorcycle friendly" (*) that is where the barriers include an under guard rail in order to protect the motorcycle from sliding underneath the gap in the fence and covers the posts to prevent impact and exposure to the motorcyclists. There were eight cases where the motorcycle was equipped with ABS brakes and four with ABS where the rider did not use the brakes. n.17 riders indicated that the conditions of the road were good while n.11 indicated that there were road defects, including gravel, ice, oil and in one case, potholes. Speeds prior to the crash highlight that there was a variation from 11 to 20 kph up to >130 kph.

With regards to the post-crash motion, this has been a focus of interest for motorcyclist organisations and roadside barrier manufacturers. Typically testing for motorcycle friendly crash barriers, assumes that the motorcyclist slides into the barrier with either a Left lowside or Right lowside post-crash motion. However as this table demonstrates, while there were ten instances where that occurred, there were five other instances where the rider's post-crash motion was Highside either left or right and a further three whose trajectory was Topside (over the front of the motorcycle). The remaining n.12 answered "other", "don't know" or did not reply to the question.

Of the n.26 respondents in the table III in Annex IV, all crashed in European countries. Information whether the rider used their brakes, showed that were n.9 that did not use their brakes, seven fell either Left or Right lowside (two did not answer the question) and of those, five had motorcycles equipped with ABS brakes.

Table 70: Collisions with road side barriers (with comments)

	road conditions	country crashed	licence	ABS	speed	Brake prior to crash	Trajectory	Comments
1	Other	Spain	Full licence (A in Europe	No	61 to 70 kph	Yes	Left lowside - fell over to the left	Accident caused by poor curve cleaning in truck accident and lack of traffic information regarding the accident. Great physical damage caused by rails, guillotines for us. With another system, damages and expenses of my recovery and that of my wife would have been avoided.
2	Good condition	Norway	Full licence (A in Europe	No	71 to 80 kph	Yes	Right lowside - fell over to the right	The reason for the accident was that I was inattentive and looked to the side too long. Braked sharply to avoid hitting a car that had stopped in front of me.
3	Good condition	Sweden	A2 in Europe	No	31 to 40 kph	Yes		Before the crash I was too tight in a tight corner on a half narrow round, misjudged the corner and at that point I straightened up the motorcycle applied full brake for 4-5 meters (maybe more) and went down a 1m ditch. I got the bike over me and was not able to get bike up so I was stuck for a short period of time before I managed to get the bike up. No direct injuries but was very close to twisting my ankle.
4	Gravel or loose dirt	Norway	Full licence (A in Europe	No	31 to 40 kph	Yes		Car did not comply with rules when I was to turn off the main road at the junction. Had to take big turns to avoid collision. This meant that I came out in loose gravel and collided with barrier protection

5	Icy surface	France	Full licence (A in Europe	No	21 to 30 kph	No	Left lowside - fell over to the left	Falling due to cold tyre and motorcycle that slipped on a pedestrian crossing at the time of acceleration.
6	Other	Australia	Other	Yes	11 to 20 kph	Yes		Coming around a downhill hair pin slowly. Tyres caught tree debris. Low sided at very slow speed with tyres into the guard rail, me under bike. Prior to crash i was upset which was why I was riding slow. Road has nowhere to pull off so was waiting to reach bottom to stop.
7	Gravel or loose dirt	Australia*	Full licence (A in Europe	Yes	61 to 70 kph	No	Don't know	Construction vehicles that drop masses of gravel on the road and don't place warning signage or clear it up should be prosecuted.
8	Good condition	Germany*	Full licence (A in Europe	No	51 to 60 kph	No	Left lowside – fell to the left	Due to the underrun protection and decent motorcycle clothing nothing happened to me, I slid about 8 meters on the butt over the road until I arrived with the feet in front of the guardrail and stopped. Without the underride guard, my trip off the road might have gone further, with which injuries would be put there.
9	Good condition	Canada*	Other	Yes	11 to 20 kph	Yes		Driver behind me following too close as I was riding slowly on an inclined turn. Moved my bike to the side to let him pass, but was too slow on the inclined embanked turn, when I turned the throttle to increase speed, the bike became more erect (as bikes do) and my "turn on a curve" became a "straight line on a curve". I managed to regain control and missing the driver as he passed, just before hopping the curb and scraping my bike against the guard rail. :/ First ride of the season (July, Sad I know) and was riding in the hot sun for about 12 hours. I was exhausted and made a poor choice. This one is on me. I haven't fixed the scrape yet.
10	Water on road	France	Full licence (A in Europe	No	91 to 100 kph	Yes	Right lowside - fell to the right	It was a mistake of judgement, I didn't realise that the asphalt was wet.
11	Slippery surface (oil)	Norway	Full licence (A in Europe	No	101 to 110 kph	Yes	Other	Filled gas 2 minutes before where there was oil residue, and crashed where a lot of heavy transport drives.
12	Good condition	Norway*	Full licence (A in Europe	No	71 to 80 kph	Yes		Driver error was the cause. Stiffened with fear and reduced speed without sufficient control. Had been on a refresher course a month earlier. A little too high speed according to conditions.
13	Water on road	Australia	Full licence (A in Europe	No	41 to 50 kph	Yes	Highside and fell left	Hit guard rail head on with helmet around chin area, low speed impact; initial rear brake lock into corner, corrected, was off line for corner, brakes again, tracked onto grass verge, front brake grabbed and back went and flipped me off, bike slid but fence and spun to stop.

14	Good condition	Aus-tralia	Other	No	81 to 90 kph	No	Highside and fell left	I was following another rider who failed to negotiate a right hand bend. He crashed and went under the guard rail. I think I fixated on him and more or less followed him in and crashed myself. My lower back came in contact with the guard rail. It was an 80kph bend that he should have negotiated easily at the speed we were travelling, me too, but I was distracted for too long, got into some loose gravel at the edge of the road and lost control. Riding conditions were perfect.
15	Slippery surface (oil)	Ger-many*	Full li-cence (A in Europe	No	41 to 50 kph	Yes	Left lowside – fell to the left	I was riding at legal speed, taking the bend just as I was through, when my bike suddenly slipped away (rear wheel). We stood in the grass for a while and couldn't find any oil, but a lot of the motorcycles that took the same bend, had their rear wheel brake out of line
16	Good condition	Ger-many	Full li-cence (A in Europe	No	101 to 110 kph	No	Other	I had good luck then because I reacted correctly and pushed my motorcycle in the guardrail and I flew ON the guard-rail.
17	Slippery surface (oil)	France	Full li-cence (A in Europe	No	31 to 40 kph	No		I slipped on oil on a highway slip road
18	Good condition	Aus-tralia*	Other	n/a	101 to 110 kph	Yes	Topside, over the front of the han-dle bars	My deceased husband was not able to avoid a dead kangaroo laying on road. He ran into it on the road. He was cata-pulted from his bike into the air and landed in the wire rope barriers lining the freeway where he died of resulting injuries. If the wire rope barriers were not in place my husband may have sur-vived. They took any chance he had. It was a centre median barrier which had been placed lining 2 way roadsides separated by large grassed area with not one hazard to be seen until they put up the barrier thereby becoming the hazard which killed my husband. He was doing everything to be safe. Full protective clothing, safe riding and no il-licit drugs.
19	Other	Spain	A2 in Eu-rope	Yes	71 to 80 kph	No	Left lowside - fell to the left	I was not aware of how the fall oc-curred, I lost traction without expecting it at all. I was not speeding.
20	Good condition	Sweden	Full li-cence (A in Europe	No	71 to 80 kph	Yes	Highside and fell left	The accident was because I slowed down when the car in front of me changed file too tight in front of me. If I had had ABS brakes I don't think I would have crashed.

21	Good condition	Sweden	Full licence (A in Europe	No	81 to 90 kph	Uncertain	Don't know	Passenger injuries, Passenger probably squeezed the left lower leg between the MC and the road rails, was thrown over the rails to the left and down a road bank consisting of rough crushed stone, landed in a bush. Left lower leg crushed, amputated under the knee in February 2010. Infection in the wound did not heal. Both shoulders badly injured, operated on in turns Left hand, a number of small bones broken that were simply removed! The hand works perfectly satisfactorily today. Infected wound left thigh, caused by keys, stored in closed key case penetrated through the case and into the leg. Hospital time + accommodation at rehab facility 8.5 months
22	Good condition	Australia	Full licence (A in Europe	No	91 to 100 kph	Yes	Highside and fell right	Ran off road by another bike rider travelling in opposite direction. He was on my side of the road and had to avoid. Dropped bike on grass and impacted crash barrier.
23	Good condition	France	Full licence (A in Europe	No	101 to 110 kph	Yes	Topside, over the front of the handle bars	Riding too fast.
24	Gravel or loose dirt	South Africa	Full licence (A in Europe	Yes	61 to 70 kph	No		Road was extremely slippery. Bike started slipping off the surface and despite managing to get it out of the snaking twice the front slipped out on the third go.
25	Gravel or loose dirt	France	Full licence (A in Europe	Yes	51 to 60 kph	No		Alone on the road, slip on a strip of gravel present on the curved road. My bike was very loaded with luggage, so the behaviour was different.
25	Potholes	Australia	Full licence (A in Europe	No	61 to 70 kph	Yes	Right lowside – fell to the right	Shit road caused the crash, hidden bump in the road
27	Good condition	Italy	Full licence (A in Europe	Yes	111 to 120 kph	Yes	Highside and fell right	Straight road, vibrations on the front that have turned into real tank slapper that threw me off. I don't think I had a puncture, Ducati excluded a defect in the bike or the tyre...
28	Good condition	The Netherlands	Full licence (A in Europe	No	111 to 120 kph	Yes	Topside, over the front of the handlebars	Target fixation, was looking at the side of the road and so I went there. Front wheel slipped in the grass and I got launched down the hill. No injuries just Bruises.
29	Good condition	Germany	Full licence (A in Europe	No	91 to 100 kph	No	Left lowside - fel to the left	Accident was on a motorway exit on another highway. I could have easily put the machine into the bend, I was distracted (had looked at the cockpit during the approach. When I looked up again the guardrail was there.) After falling I slip under the guardrail and down the slope (hedges) I was able to get up by myself and then walked back to where we met two helpers who had watched it, one stayed with me and the other put up the warning triangle We stood at the guardrail and waited for help.

30	Good condition	France	Full licence (A in Europe	No	More than 130 kph	Yes	Right lowside - fell to the right	Decelerated too fast and bad position on the road.
31	Good condition	Germany	Full licence (A in Europe	Yes	61 to 70 kph	Yes		Before the bend, there was a little sand on the road.

NB: Comments in blue are translations from the original language

Not included in the comments above is where another rider collided with another vehicle and then crashed into a roadside barrier. The rider spent 28 days in hospital and needed 120 days rehabilitation.

Rider's comment: *"Course of the accident: I was traveling on an open road in column traffic at about 30km / h. On a straight piece I started to overtake in accordance with the regulations (indicators, overtaking vision, safety view). When I was at the same height with the vehicle that was in front of me, the driver (24 years) wanted to overtake myself and swerved without blinking and looking. He rammed me sideways (from the right), pressed me against the left guardrail and I braked. My front wheel got under the guardrail, caught and overturned with me. The fork was pulled out. I landed on my back and slid under the guardrail. My right leg was cut off in the middle of the thigh on a sharp-edged guardrail post. The car driver has continued for the time being. From a legal (and also subjective) perspective, the car driver is 100% to blame for the accident. He obviously didn't look over his shoulder".*

11 Previous International studies

11.1 Motorcycle Accident Research in Thailand, Vol. I and II

In 1998, two on-scene, in-depth motorcycle crash studies began. One was the MAIDS study in Europe that involved accident investigation and reconstruction teams in five European countries: France, the Netherlands, Spain, Italy and Germany, with funding from the European Motorcycle Manufacturers' Association (ACEM)[29]. The second study, in Thailand, was funded by various subdivisions of Honda Motor Corporation. Both studies used the OECD Common International Methodology, which was modelled on the Hurt study methods and was developed by Professor Harry Hurt Jr. of the University of Southern California.

This section of the report describes some of the findings of the Thailand study for comparison to the Dynamics survey. It provides an interesting comparison to other studies that have all taken place in wealthy, developed nations.

The Thailand study began in late 1997 with three months of classroom and on-the-street training for the crash investigators, all of whom were motorcycle riders and recent university graduates. In 1998, all data collection took place in Bangkok, where 723 cases were investigated[30]. In 1999, the team investigated another 359 crashes in five "upcountry" provinces outside Bangkok, as far north as Chiang Rai and as far south as Trang province on the west coast of the Malay Peninsula[31]. In all, the team investigated 959 crashes involving 1,082 riders. There were more riders than crashes because about one-fourth of multiple vehicle crashes involved two motorcycles.

100% of the Thailand investigations took place immediately at the scene of the crash, while police, car drivers, eyewitnesses, etc. were still present. The handful that were not investigated at scene were typically investigated and completed the same day. This immediate on-scene investigation method has the highest "capture rate" of evidence critical for accident reconstruction and analysis. Investigations begun after the scene has cleared can miss physical evidence such as skid or scrape marks, rider clothing marks, points of impact or rest. Accident-involved cars quickly become unavailable, which complicates reconstruction of vehicle-to-vehicle and rider-to-vehicle injury contacts; drivers and even riders may refuse to cooperate; when a rider won't cooperate, his helmet will probably never be examined and injury information may be limited to the imprecise descriptions in a police report.

In all, the more missing evidence, the more the internal quality of crash reconstruction and accident cause analysis suffers. In fact, the percentage of crashes investigated on-scene (as compared to follow-up days or weeks later) provides a simple but reasonably reliable way to judge the internal quality of data in on-scene, in-depth investigations[32]. It's much simpler than trying to judge whether crash reconstruction and cause analysis is competent and reliable.

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[29] ACEM (Association des Constructeurs Europeens de Motocycles); 2009; *MAIDS: In-depth Investigations of Accidents Involving Powered Two-Wheelers*; Brussels, Belgium.
[30] Kasantikul, V., *Motorcycle Accident Cause Factors and Identification of Countermeasures in Thailand: Volume I: Bangkok,* KP Printing, Bangkok, 2002.
[31] Kasantikul, V., *Motorcycle Accident Cause Factors and Identification of Countermeasures in Thailand: Volume II: Upcountry.* KP Printing, Bangkok, 2002.
[32] Ouellet JV, How the timing of motorcycle accident investigation affects sampling and data outcome; *Proceedings, International Motorcycle Safety Conference,* Motorcycle Safety Foundation, Irvine, CA, 2006.

The information, evidence and analysis collected during the Thailand crash investigations were coded on data forms. The 1981 Hurt study had over 500 questions that had to be answered for each case; the Thailand and MAIDS study data forms had more than a thousand questions per case. Some of the entries involved simple issues, such as the motorcycle manufacturer, weather or roadway type. Some required complicated, expert analysis such as speeds, loss of control mode, injury contacts or helmet performance.

11.1.1 Thailand

Thailand is moving beyond being a developing nation but not yet a fully developed nation. At the time of the research, 1998-2000, the government imposed a 100% tariff on motorcycles with an engine larger than 150 cc. As a result, all but 12 motorcycles (1.1%) were in the 80-150cc range of engine displacements. Motorcycle ownership is also class- and income-related. For many Thais, the first motorized transportation they could afford was a motorcycle, which often served as transportation for the entire family, especially on weekends. (In spite of the frequency of seeing entire families on a single motorcycle, not one of the 959 crashes involved a family, though a handful of crashes involved more than one passenger.)

In Bangkok, 29% of the vehicles in traffic were motorcycles; upcountry it was about 50%. Motorcycles were everywhere – splitting lanes, riding immediately next to curbs and, during rush hours, sometimes using the sidewalk to get around traffic. But because of this saturation of motorcycles in the traffic mix, car drivers rarely said they hadn't seen a motorcycle that was in plain view (an extremely common crash cause in developed nations). Instead, they sometimes insisted the motorcycle should have yielded to their car. This may reflect social class expectations, or it may be because expectations about who has the right-of-way seem to be much less rigid in Thailand than in OECD countries. Driving in Thailand may be more cooperative and less obsessed with right-of-way.

Another thing was exceptional about the Thailand motorcycle accident study: the very high level of alcohol involvement in crashes. Table 71 summarizes the percentage of riders in several studies who had any amount of alcohol in their system.

Table 71: Percent of riders who had been drinking before they crashed in various on-scene, in-depth and this survey

Study	Percent drinking riders
Hurt, Los Angeles, 1981	11.4%
Hurt Fatal Study, 1978-81	50.2%
MAIDS, 2002	4.1%
Thailand, 2002	35.6%
Dynamics survey	0.6%

Crashes in which the rider has been drinking tend to differ markedly from no-alcohol crashes[33]. Alcohol crashes are more likely to occur from late afternoon to about 3 a.m.; they are more likely to be single-vehicle loss-of-control crashes (often simply running off the road), with lower levels of helmet use and, unsurprisingly, higher fatality rates. Other researchers[34] (e.g., Kim and Boski, 2001) have noted similar differences between alcohol and non-alcohol crashes. As a result, the proportion of alcohol-involved crashes in any study affects the

[33] Kasantikul V, Ouellet JV, Smith TA, Sirathranont J and Panichabhongse V; (2005); The role of alcohol in Thailand motorcycle crashes; *Accident Analysis and Prevention; 7,* (2): 357-366.

[34] Kim K and Boski J (2001); Motorcycling and Impaired Motorcycling in Hawaii: Rider Characteristics, Environmental Factors and Spatial Patterns; *International Motorcycle Safety Conference "The Human Element."* Orlando, Florida. Available from Motorcycle Safety Foundation, www.msf-usa.org.

"shape" of the data that comes out of the study. In Thailand, that proportion was remarkably high.

The review that follows is a summary of the principal findings from the Thailand study and comparisons to the results of the Dynamics survey.

11.1.2 General Characteristics of Thailand Crashes

11.1.2.1 Time of day

Figure 13 shows the frequency distribution of accident hour for drinking and non-drinking riders in Thailand. Note the very different time distributions. The survey questionnaire asked about the general time of day of the respondent's crash but not the specific hour as in the Thailand study, so direct comparisons are difficult.

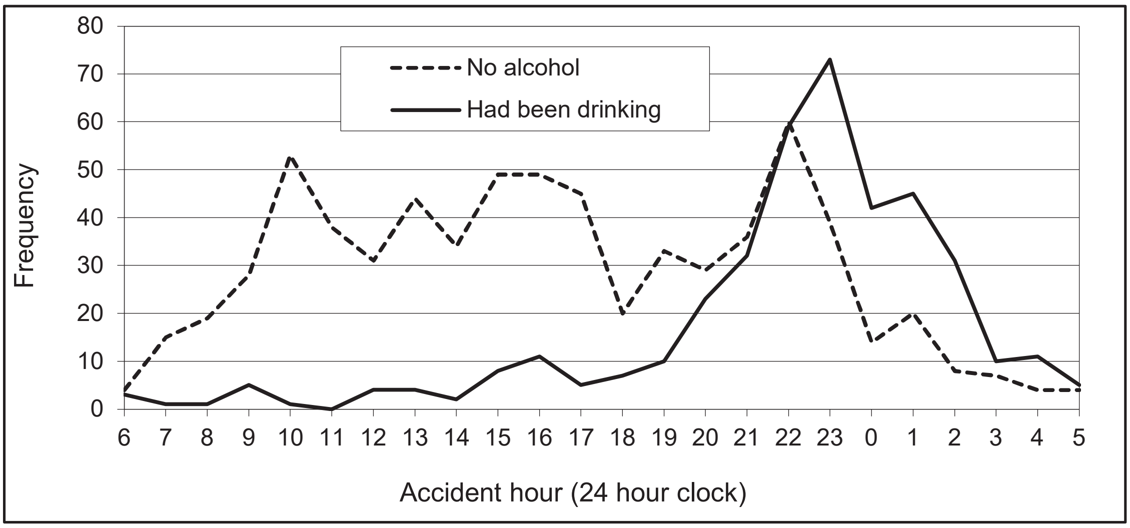

Figure 13: Accident hour for drinking and non-drinking riders differed in the Thailand motorcycle accident research study

11.1.2.2 Day of the Week

Motorcycle crashes in Thailand were generally steady over the course of the week. By comparison, of the 1,296 survey respondents who identified the day of the week they crashed, Saturday showed an increase and Monday a decrease compared to the other days of the week. Weekends—Saturday and Sunday—accounted for over one-third of the crashes (Table 72).

To some extent this difference in day-of-week distribution could reflect riders who are unusually careless on Saturday and unusually careful on Mondays. However, it more likely reflects economic conditions in the Thailand compared to the OECD countries that dominate this survey. In Thailand, motorcycles are usually a rider's or family's basic transportation, maybe even a source of income by acting as taxis (particularly in Bangkok rush hour traffic) or transporting goods. By contrast, in wealthier nations, the majority of riders have an automobile as their primary transportation and a motorcycle as a second vehicle for fair weather transportation or recreation.

Table 72: Percent distribution of accident day of week in Thailand and the 1,296 riders who identified the day of the week they crashed in this Dynamics survey

Day	Thailand	Dynamics Survey
Monday	12.0	9.5
Tuesday	13.0	13.1
Wednesday	11.7	13.9
Thursday	15.9	14.0
Friday	16.6	13.5
Saturday	16.0	20.6
Sunday	14.7	15.4

11.1.2.3 Weather Conditions

Despite being a tropical country with a rainy season that has daily rain from about June through October, only about one in 30 Thailand motorcycle crashes occurred while it was raining and only five in heavy rain. Two-thirds of Thailand crashes occurred when the sky was clear and another 24% when it was cloudy, five percent when it was overcast. By comparison, 62% of 1,547 survey respondents who identified weather conditions said it was sunny, 21% said it was cloudy or overcast, and nearly one in eight crashed while it was raining (usually lightly).

11.1.2.4 Ambient Lighting Conditions

Over half (55%) of the Thailand crashes occurred at night (Table 73), compared to 17.4% of the survey respondents who indicated that they had crashed from early evening (6 p.m.) through the night (until 5 a.m.) The survey did not ask respondents to indicate whether any artificial lighting was present if they crashed at night, so the 17.4% figure for night crashes includes both lighted and no-light conditions. The remarkable number of night crashes in Thailand probably reflects a combination of the influence of alcohol on crash time distribution) and the relatively unvarying 12 hours of darkness in Thailand – seasonal variations in the length of the day are minimal compared to temperate climates outside the tropics. Another contributing factor may be the fact that motorcycles so often serve as the sole source of personal transportation in Thailand, as opposed to their optional or recreational uses in wealthier countries.

Table 73: Percent distribution of ambient lighting conditions reported at time of crash

Ambient Lighting	Thailand	Dynamics Survey	Hurt Report*
Daylight, bright	35.0	82.7	75.1
Daylight, not bright	4.0	5.3	0.8
Dusk, sundown	4.6	5.6	6.6
Night, lighted	24.2	-	25.9
Night, unlighted	31.1	-	3.1
Dawn, Sunrise	1.1	6.5	-

* *The data above are taken from 3,600 police reported crashes in Los Angeles, which provides a more accurate representation of time distribution of Los Angeles crashes*[35]

Motorcycles in Thailand struck a variety of objects — three-fourths of the time it was another vehicle in traffic. While the overall fatality rate was about 5%, five of 35 collisions with a parked vehicle (15%) killed the rider. Most of those involved a drunk rider at night colliding with the rear of an illegally parked heavy truck that was so dirty as to be nearly invisible. One

[35] Hurt, HH, Jr., Ouellet, JV and Thom, DR, *Motorcycle Accident Cause Factors and Identification of Countermeasures, Final Report*, DOT-HS-F-01160, 1981, p.49.

could see exactly where the rider hit the back of the truck because the dirt was cleaned off where he struck (Table 74).

Table 74: Objects struck by motorcycle

Object Struck by Motorcycle	Frequency	Percent
Other vehicle in traffic	812	75.0
Parked vehicle	35	3.2
Roadway	147	13.6
Roadside, fixed object	31	2.9
Pedestrian, bicyclist	37	3.4
Animal	10	0.9
Other	10	0.9
Total	1082	100.0

Figure 14 shows how a Bangkok taxi driver succeeded in causing two motorcycles approaching from his right to crash when he exited a side street onto a larger roadway. The riders collided with each other while trying to take evasive action, then both fell and slid. One motorcycle hit the taxi right rear door, the other slid to a stop in front of the taxi. Bangkok post-crash accident scenes were often a little chaotic.

Figure 14: Crash in Bangkok, Taxi vs. PTW

11.1.3 Rider Characteristics

11.1.3.1 Age and Gender

Accident involved riders in the Thailand study tended to be much younger than riders who responded to the Dynamics survey (Median 26 vs. 43; Interquartile range of 20-33 in Thailand, 30-52 in survey.) The Thailand data are shown in Figure 3. However, the validity of age comparisons suffers because the data in the two studies were collected 20 years apart. The riders in the Thailand study would be twenty years older now and the combination of sufficient economic development and the availability of low cost, lightweight motorcycles, is more recent in Thailand than in more developed nations (Figure 15).

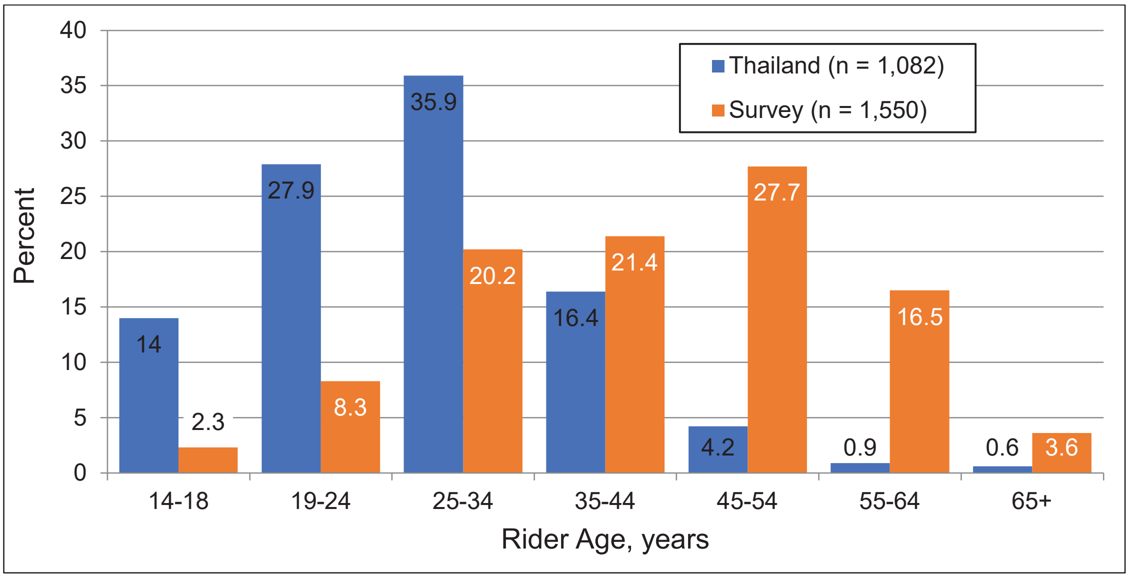

Figure 15: Age distribution of accident involved riders in the Thailand study and the survey

In Thailand, 90% of the riders were male, compared to 91% of the riders who responded to the survey. However, females were only 4% of the Bangkok riders in the 723 accidents and those observed on the streets. Upcountry, females were 21% of the 359 accident-involved riders but 26% of those observed riding on the streets Gender related risk acceptance and risk avoidance know no boundaries, geographically or across time.

11.1.3.2 Licence and Training

Licence requirements in Thailand was less rigorous than in many other nations, as shown in Table 75. About two-thirds of the Thailand riders (68%) reported having a licence to operate a motorcycle. However, licensing varied by location. In Bangkok, nearly 70% of riders who crashed had a motorcycle licence, compared to 50% upcountry. The risk of encountering police enforcement may have played a role in this difference.

Table 75: Licence held by accident-involved riders in the Thailand study

Licence type	Frequency	Percent
No Licence	305	28.2
Learner's Permit	20	1.9
Motorcycle Licence	738	68.2
Automobile Licence	7	0.7
Licence to Transport People	1	0.0
Unknown	11	1.0

At the time of the Thailand study (1998-2001), no rider training was available or required in order to get a motorcycle licence. The only motorcycle training that was available in Thailand at that time was at a Honda facility near Bangkok where training was provided for police motorcycle operators.

11.1.3.3 Riding Experience

In Thailand, riders in accidents were asked about their overall riding experience and experience on the accident motorcycle. Figure 16 shows that slightly over half the riders said they had been riding motorcycles for longer than eight years but nearly 40% said they had one year of less of experience on the accident motorcycle. The 1981 Hurt study[36] reported that experience on the accident-involved motorcycle had a stronger effect on crash risk than over-all riding experience.

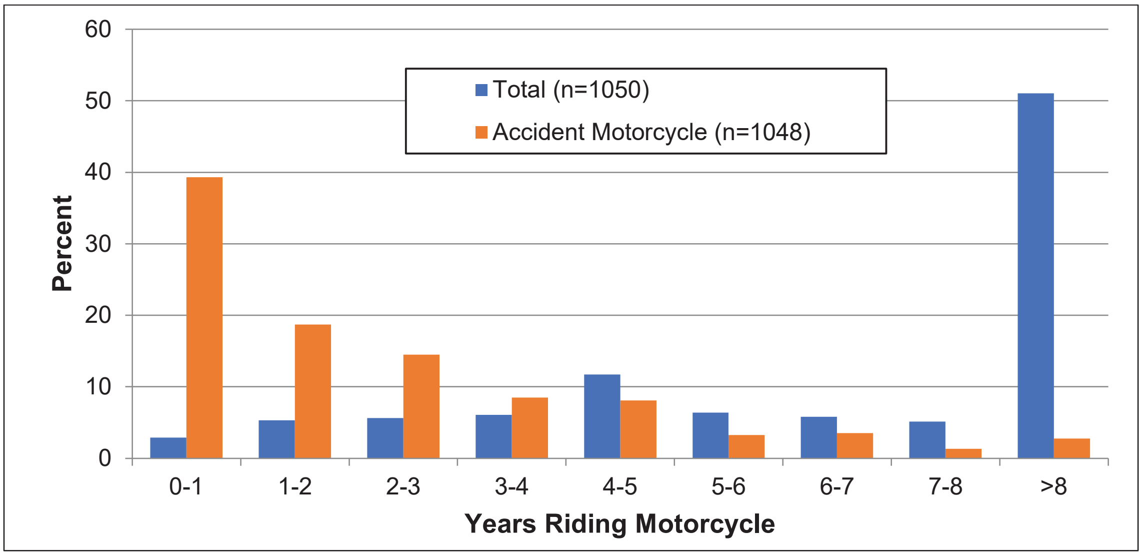

Figure 16: Total motorcycle riding experience and riding experience on the accident involved motorcycle in Thailand

Riders in Thailand were also asked how many days per year they ride a motorcycle. Eighty-six percent (86%!) said they ride every day. Only about 10% said they ride less than five day per week.

11.1.4 Thailand motorcycles

Motorcycles in the Thailand study were nearly all 150cc or smaller; ten were in the 160-500 cc range, two more were larger than 500 cc. Table 76 shows the motorcycle type for the 1,082 accident involved motorcycles compared to the type of motorcycles in the Dynamics survey.

Table 76: Motorcycle types in Thailand and Dynamics Survey crashes

Motorcycle Type	Frequency	Percent	Survey %
Standard Street model	109	10.1	30.7
Standard Street model, modified	23	1.5	-
Sport bike[a]	272	25.1	25.4
Step-through frame	651	60.2	0
Scooter	17	1.6	3.3
Cruiser	6	0.6	5.5
Dual Sport[b]	4	0.4	19.3
Other	0		15.8
Total	**1082**	**100.0**	**100.0**

a. Dynamics survey data combines Supersport & Sport Tourers.

b. Dynamics survey data combines Adventure and Enduro models

[36] Hurt, HH, Jr., Ouellet, JV and Thom, DR, *Motorcycle Accident Cause Factors and Identification of Countermeasures, Final Report*, DOT-HS-F-01160, 1981, p.391.

The brakes on accident involved motorcycles in Thailand were all simple, independently operated front and rear brakes. Table 77 shows that three different front + rear combinations dominated: 1) single leading shoe drum brakes front and rear (33%), 2) a single disc brake at both front and rear (36%) and 3) a front disc brake with a single leading shoe rear brake at the rear (14%).

None of the accident-involved motorcycles in Thailand had ABS or any sort of combined braking system. This should be no surprise: at the turn of the century when the Thailand study took place, ABS or combined braking were similarly rare in the U.S. By comparison, of the 1,034 riders in the Dynamics survey who described their brakes, 88% said they had disc brakes, 10% had a combined braking system and 2% had drum brakes.

Table 77: Crosstabulation of front and rear brake types on Thailand motorcycles

Front Brake Type	**Rear Brake Type**				**Total**
	None	Drum, Single leading shoe	Drum, Double leading shoe	Single disc, multi-piston	
None, no brake	0	26	2	3	31
Drum, single leading shoe	1	352	0	0	353
Single disc, single piston	1	83	55	0	139
Single disc, multi-piston	1	150	18	385	554
Double disc, multi-piston	0	1	1	3	5
Total	**3**	**612**	**76**	**391**	**1082**

One of the noticeable differences between the Hurt and Thailand studies involved loss of control during collision avoidance just before the crash. About 70% of Hurt study riders took some sort of pre-crash evasive action but about 40% of those riders lost control of their motorcycle. In Thailand, only about half the riders took a pre-crash evasive action but only 20% of those who took action lost control—half as often as the Americans[37]. The data are shown in Figure 17.

In this survey of crash dynamics 1,443 riders stated whether they either did or did not apply their brakes before they crashed. Of those, 553 (38%) said they failed to apply their brakes before the crash. Curiously, of the 517 survey riders who reported having ABS almost exactly half reported using their brakes—far less than the 807 riders (68%) without ABS who said they braked before the crash. This chi square comparison was statistically significant: χ^2 = 46.2, p << .01, df =1.

Another unexpected finding in Thailand was that the better the brakes on the motorcycle, the more likely the rider was to suffer a loss of control. This is illustrated in Figure 18.

[37] Ouellet JV and Kasantikul V; (2006); Rider training and collision avoidance in Thailand and Los Angeles motorcycle crashes; *Proceedings, International Motorcycle Safety Conference,* Motorcycle Safety Foundation, Irvine, CA, 2006

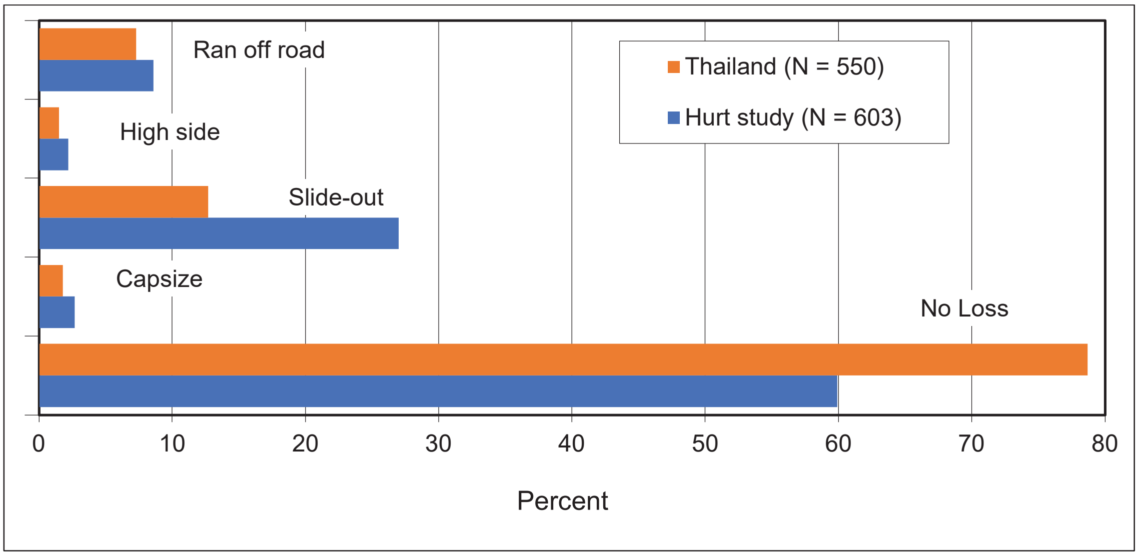

Figure 17: Loss of control mode for riders in the Thailand and Hurt studies who took evasive action before they crashed[4]. "Capsize" is a simple low-speed fall over without any skidding

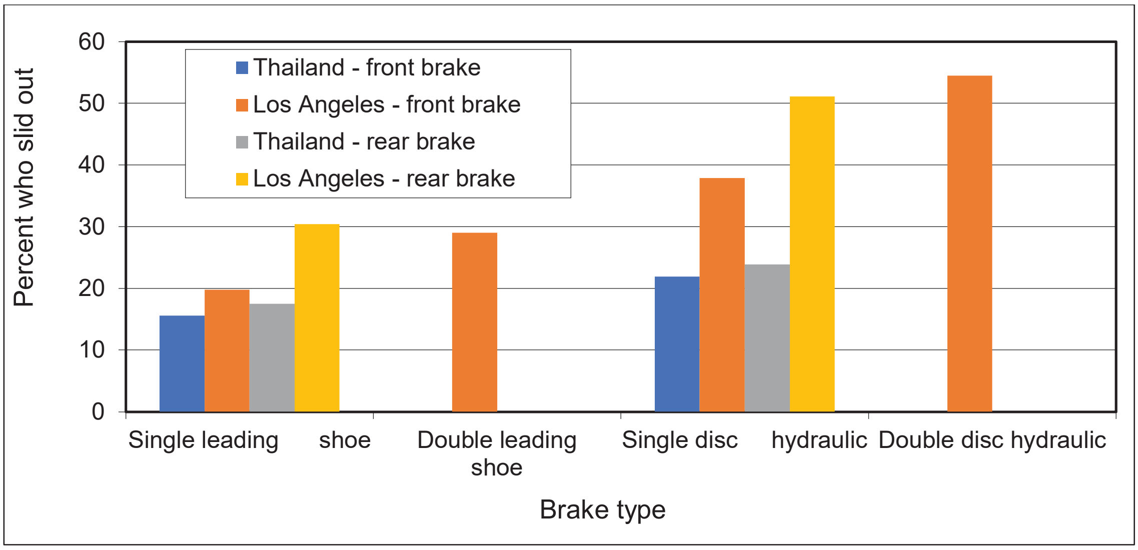

Figure 18: Frequency of slide-out loss of control as a function of the type of brake in Thailand and the Hurt study (Ouellet & Kasantikul, 2006)

11.1.5 Motorcycle Roadway

Nearly 90% of Thailand crashes occurred on a straight section of roadway, nine percent on curves, while 15 crashes (1.4%) occurred on other some other alignment. By comparison, the Dynamics survey data shows that about two-thirds of respondents crashed on a road that was either straight or curved to right or left.

Similarly, three roadway types accounted for about 90% of crashes: Major arterials (44%), minor arterials (12%) and local streets (34%). Table 78 shows a crosstabulation of the major roadway type by horizontal alignment.

Table 78: Roadway type and horizontal alignment in Thailand motorcycle crashes. Only cases where both were known are included

Motorcycle Roadway Type	**Motorcycle Roadway Horizontal Curvature**			
	Straight	Curve right	Curve left	Total
Motorway on-ramp	3	1	0	4
Motorway off-ramp	1	0	1	2
Major arterial	437	18	17	472
Minor arterial	109	10	10	129
Local street	338	18	12	368
Construction, detour	5	0	0	5
Alley	40	1	2	43
Driveway	13	0	0	13
Other	21	6	2	29
Total	**967**	**54**	**44**	**1065**

For comparative purposes with to the Dynamics survey, Major arterial could be defined as a Highway, Motorway or Freeway, whereas Minor arterial could be a Dual carriageway, Local street = Urban road, Alley = Urban road/not on a public road and Driveway = Private Entrance. Curve right = Right hand bend and Curve left = Left hand bend. Although possibly not exact, the comparison of definitions helps to understand better the road types.

Roadway surface defects such as potholes, ruts and bumps sometimes cause a motorcycle to crash. The same is true of roadway surface contamination such as water, oil, wet leaves and debris that falls from other vehicles. Table 79 and Table 80 tally the frequency of such defects in Thailand. Roadway maintenance defects such as those in Table 79 and Table 80 precipitated or caused a crash in 13 cases (1.2%) and were a contributing factor in another 16 cases (1.5%). Roadway maintenance defects – either surface defects noted in Table 79 or contamination noted in Table 80 – were present on the motorcycle roadway at 120 crash scenes but did not cause or contribute to causing those crashes. Figure 19 shows one exception.

Table 79: Roadway surface defects at the scene in Thailand motorcycle crashes. The presence of a defect does not mean it caused or contributed to a crash. ("Spalling" is flaking off of the roadway surface, a common occurrence after a fire.)

Motorcycle Roadway Surface Defects	**Frequency**	**Percent**
None	980	90.6
Cracking	17	1.6
Spalling	5	0.5
Holes	9	0.8
Bumps	6	0.6
Surface repairs	35	3.2
Tram, train rails	6	0.6
Other	24	2.0
Total	**1082**	**100.0**

Table 80: Roadway surface contamination at the scene in Thailand motorcycle crashes. The presence of contamination does not mean it caused or contributed to a crash

Motorcycle Roadway Contamination	Frequency	Percent
None	972	89.8
Water	48	4.4
Petroleum, oil, gas, etc.	2	0.2
Temporary sign board	1	0.0
Other	12	1.1
Total	**1082**	**100.0**

Figure 19: Thailand investigators at the scene of an upcountry crash. The rider hit a huge unmarked pile of dirt that covered half the roadway. Adequate warnings of roadway hazards were not always a strong point of Thailand work projects.

11.1.6 Crash information

In Thailand, the median speed before the rider took any evasive action was 39 kph with an interquartile range of 28 to 53 kph. Figure 20 compares the distribution of pre-crash speeds in Thailand with the speed estimates provided by riders in the Dynamics survey.

A comparison of pre-crash speeds (before any collision avoidance actions) in Thailand and the Dynamics survey respondents. The numbers along the x-axis represent the mid-point of a speed range. For example, "35" is the midpoint for riders who said their speed was between 31 and 40 kph. Missing values of "no answer" and "unknown" were excluded. The Dynamics survey data also leaves out the 10% of riders who gave a speed in miles per hour

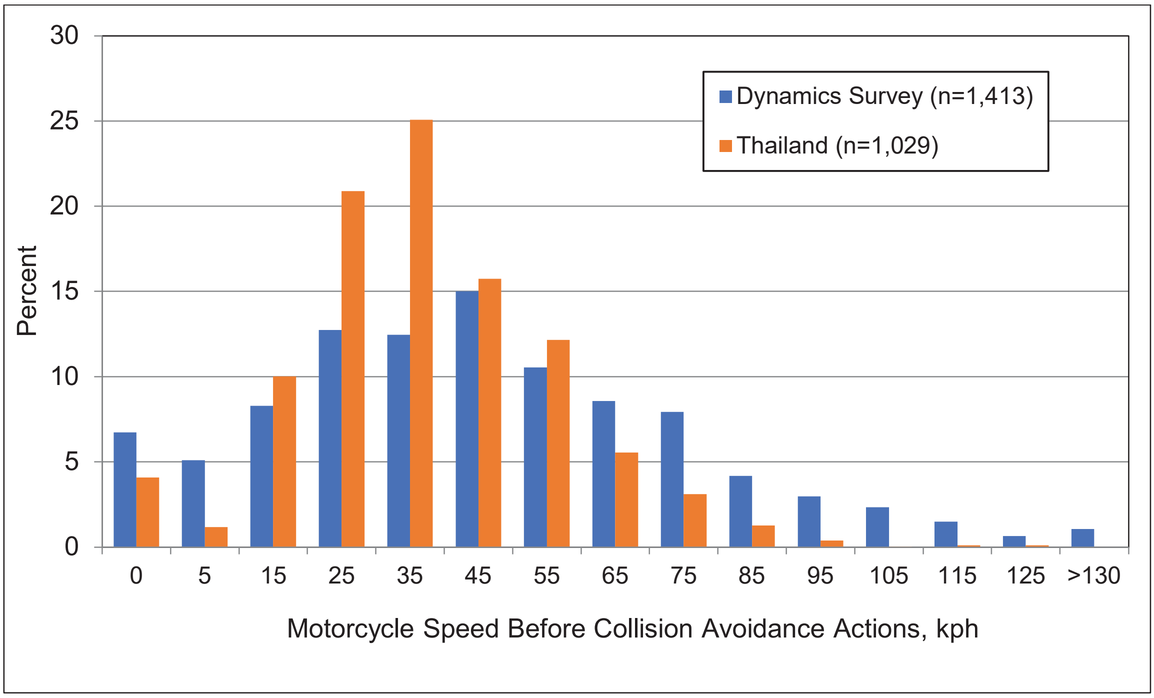

Figure 20: Comparison of pre-crash speeds

11.1.6.1 Collision configuration

Table 81: Collision configuration of 1,082 Thailand cases

Collision Configuration	Percent
1. Head-on	3.8
2. Perpendicular i/s impact, both going straight, OV* strikes MC	4.1
3. Perpendicular i/s impact, both going straight, MC strikes OV	4.6
4. OV perpendicular to MC path at start, turns left	1.2
5. OV perpendicular to MC path at start, turns R	5.0
6. OV l/t in front of approaching MC, OV hits MC	1.0
7. OV l/t in front of approaching MC, MC hits OV	5.5
8. MC l/t, OV perpendicular to MC initial path	0.7
9. MC r/t, OV perpendicular to MC initial path	2.1
10. MC overtaking OV on L, OV makes l/t	1.9
11. MC overtaking OV on R, OV makes r/t	3.7
12. OV rear-ends MC	4.5
13. MC rear-ends OV	12.7
14. Sideswipe, MC & OV going opposite directions	4.1
15. Sideswipe, MC & OV going same directions	7.1
16. OV U-turn or Y-turn in front of MC	6.9
17. Other MC to OV impacts	8.9
18. MC fall on roadway, no OV involved	4.4
19. MC ran off roadway, no OV involved	6.5
20. MC fall on roadway trying to avoid OV	3.9
21. MC ran off roadway trying to avoid OV	0.7
22. MC impacts pedestrian or animal in road	4.1
23. MC impacts environmental object	1.6
98. Other	0.9
Total	**100.0**

** OV = Other vehicle, MC = Motorcycle, l/t = left turn, r/t = right turn*

Table 81 shows the collision configuration of the Thailand crashes. The most common configuration involved the motorcycle hitting another vehicle from the rear, which accounted for about one in eight crashes. Note that configurations 2 and 3 are roughly equivalent – both are perpendicular intersection collisions that differ only by which vehicle was the striking vehicle and which was struck. The same is true for configurations 6 and 7, which are the classic OV turn across the path of a motorcycle approaching from the opposite direction.

Figure 21 illustrates the portion of the motorcycle where the primary impact occurred. Two-thirds of the impacts occurred and the front, right front or left front of the motorcycle. "Left center" (10.4%) or right center (10.3%) could include impacts in which another vehicle struck the motorcycle in the side or crashes in which the motorcycle simply fell on its side at any speed—that could include low-side and high-side crashes.

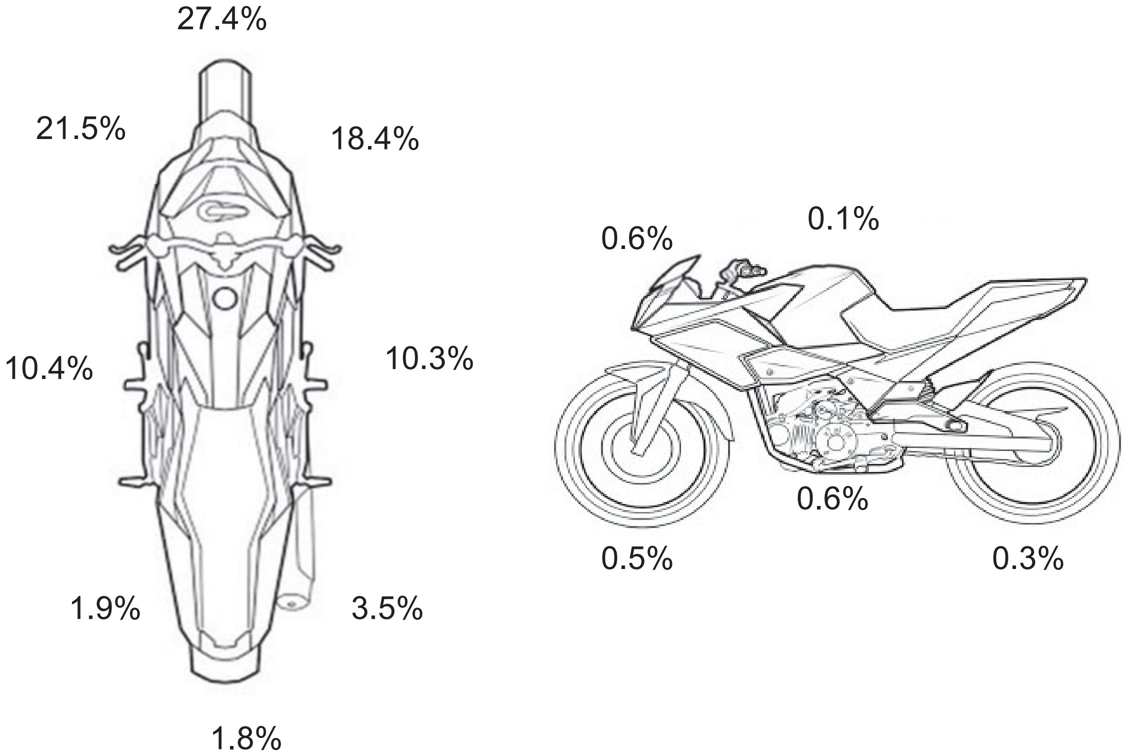

Figure 21: Location of impact to the motorcycle

Figure 21 also shows locations of impact to the motorcycle in 1,077 Thailand cases. Five cases were coded "Other." The image on the right represents impacts primarily to the top or bottom of the motorcycle (24 cases), mostly impacts the motorcycle was down sliding.

11.1.6.2 Crash Factors in Injury Severity

On average, about 25% of accident-involved riders in Thailand needed only first aid at the crash scene. Roughly 50% were transported to a hospital, treated in the emergency room and released within 24 hours. However, about 20% were admitted to the hospital for more serious injuries and 54 (5.3%) were killed (nine passengers were also killed). Post-crash medical treatment is used here as a rough measure of rider injury severity.

Table 82 provides a comparison of rider post-crash medical treatment across the various crash configurations.

Highlighted cells in Table 82 have an unusually high injury rate and enough crashes in that configuration to suggest that the high percentage is not just the result of a very low frequency used as a denominator.

Table 82: Collision configuration of 1,082 Thailand cases and percent distribution of post-crash medical status for each row

Collision Configuration	n	First Aid	Emergency Room, Released	Hospitalized	Fatal
1. Head-on	41	14.6%	46.3%	26.8%	12.2%
2. Perpendicular i/s impact, both going straight, OV* strikes MC	44	27.3%	43.2%	27.3%	2.3%
3. Perpendicular i/s impact, both going straight, MC strikes OV	50	26.0%	40.0%	30.0%	4.0%
4. OV perpendicular to MC path at start, turns left	13	46.2%	38.5%	15.4%	
5. OV perpendicular to MC path at start, turns R	54	22.2%	53.7%	22.2%	1.9%
6. OV l/t in front of approaching MC, OV hits MC	11	18.2%	63.6%	9.1%	9.1%
7. OV l/t in front of approaching MC, MC hits OV	60	16.7%	48.3%	25.0%	10.0%
8. MC l/t, OV perpendicular to MC initial path	8	50.0%	50.0%		
9. MC r/t, OV perpendicular to MC initial path	23	21.7%	47.8%	21.7%	8.7%
10. MC overtaking OV on L, OV makes l/t	21	42.9%	47.6%	9.5%	
11. MC overtaking OV on R, OV makes r/t	40	20.0%	55.0%	25.0%	
12. OV rear-ends MC	49	36.7%	44.9%	14.3%	4.1%
13. MC rear-ends OV	137	28.5%	40.1%	22.6%	8.8%
14. Sideswipe, MC & OV going opposite directions	44	25.0%	47.7%	22.7%	4.5%
15. Sideswipe, MC & OV going same directions	77	32.5%	45.5%	14.3%	7.8%
16. OV U-turn or Y-turn in front of MC	75	20.0%	61.3%	16.0%	2.7%
17. Other MC to OV impacts	96	34.4%	39.6%	21.9%	4.2%
18. MC fall on roadway, no OV involved	48	20.8%	58.3%	16.7%	4.2%
19. MC ran off roadway, no OV involved	70	10.0%	51.4%	28.6%	10.0%
20. MC fall on roadway trying to avoid OV	42	31.0%	45.2%	16.7%	7.1%
21. MC ran off roadway trying to avoid OV	8	25.0%	62.5%	12.5%	
22. MC impacts pedestrian or animal in road	44	34.1%	56.8%	6.8%	2.3%
23. MC impacts environmental object	17	11.8%	52.9%	23.5%	11.8%
98. Other	9	11.1%	33.3%	44.4%	11.1%
Total	**1081**	**25.7%**	**47.8%**	**20.7%**	**5.7%**

** MC = Motorcycle, OV = Other Vehicle, r/t = right turn, l/t = left turn, i/s = intersection*

Table 82 suggests that a few collision configurations may have a higher risk of hospitalization or death: head-on collisions, perpendicular intersection collisions with another vehicle, the motorcycle striking a vehicle coming from the opposite direction that turns across the motorcycle's path, running off the road, perhaps collisions with an object in the environment.

11.1.6.3 Rider Post-Crash Motion and Medical Treatment

Table 83 combines a frequency count of the different rider post-crash motions recorded in the 1,082 Thailand cases (Frequency and Column Percent Columns) with a cross-tabulation of injury severity by post-crash motion (the two columns on the right.) The two most common post-crash motions – "6 – skidded and slid from POI to POR" and "15 – did not separate from motorcycle" together accounted for nearly 60% of post-crash motions but only 13% of fatalities and 104 of 224 hospitalizations (46%). The post-crash motions with the highest risk of death – a nearly 100% fatality risk -- involved being run over by another vehicle. The risk of hospitalization after an accident was about one in five overall, but the post-crash motions with a higher risk of hospitalization tended to occur when the rider vaulted over the handlebars or struck a second object after the initial impact.

Table 83: Rider post-crash motion and post-crash medical hospitalization or fatality

Rider post-crash motion	Frequency	Column Percent	Hospitalized (Row %)	Fatal (Row %)
1. Stopped at POI	58	5.4	15.52	3.45
2 Stopped within 2 m of POI	102	9.4	25.49	8.82
3 Tumbled and rolled from POI to POR*	103	9.5	30.10	4.85
4 Tumbled from POI, hit other object at POR	10	.9	30.00	10.0
5 Slid with MC to POR	1	.1	0.00	-
6 Skidded then slid POI to POR	214	19.8	25.70	1.40
7 Skidded and slid, hit another object at POR	23	2.1	34.78	-
8 Vaulted above ride height, the rolled to POR	22	2.0	40.91	-
9 Vaulted above ride height from POI,slid to POR	46	4.3	45.65	15.22
10 Vaulted from POI, hit another object at POR	16	1.5	25.00	18.75
11 Run over at POR	4	.4	0.00	100.00
12 Run over, dragged from POI to POR	7	.6	14.29	85.71
13 Carried by OV to POR different from OV POR	33	3.0	39.39	3.03
14 Entangled with OV, same POR as OV, not run over	5	.5	20.00	40.00
15 Did not separate from MC, same POR as MC	412	38.1	11.89	1.21
19 Hit-and-run, MC departed scene	2	.2	0.00	0
98 Other	23	2.1	17.39	43.75
99 Unknown	1	.1	0.00	0
All Crashes	1082	100.0	20.70	5.73

** POI = Point of Impact, POR = Point of Rest. MC = Motorcycle OV = Other Vehicle*

11.1.6.4 Rider Post-Crash Medical Treatment

The various categories of rider post-crash medical treatment in Thailand were simplified into four groups as illustrated in Figure 22. Roughly one-fourth needed no treatment or only first aid at the scene, about half were treated at an emergency room and released, one in five were admitted to the hospital for treatment and about 6% were fatal.

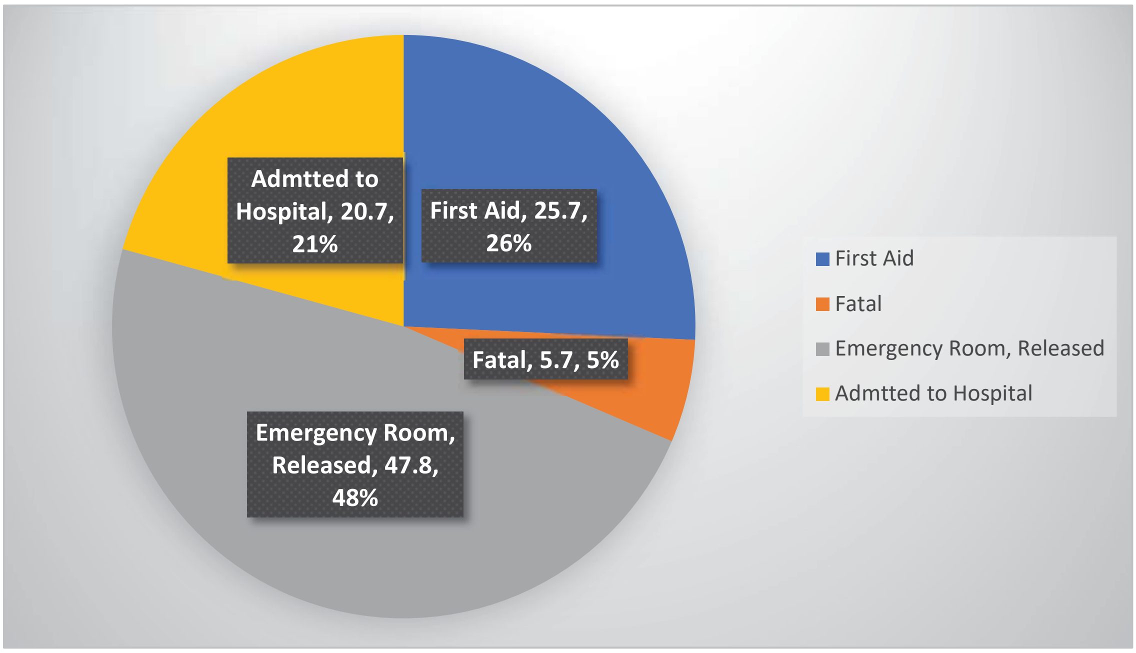

Figure 22: A summary of rider post-crash medical treatment in Thailand motorcycle crashes

The categories are hard to compare to responses in the Dynamics survey. That is, the 1,567 riders in the Dynamics survey who made a response other than "not sure" gave of total of 2,050 responses for their post-crash medical treatment—and average of 1.3 responses per survey respondent. There is plenty of room for overlap among the various categories: a single rider could say he was treated at the scene, treated in the ER, admitted to the hospital and received rehabilitation treatment. Another rider could say he declined treatment at the scene, saw his own doctor later and eventually sought rehabilitation for, perhaps, a shoulder or knee sprain injury.

11.1.6.5 Motorcycle Speed and Rider Injury Severity

Normally, one would expect that the faster the rider is going at the start of a crash, the more severe his injuries will be. But does data from on-scene, in-depth crash investigation studies actually support that common intuitive expectation? (A "spoiler alert" is when somebody warns you, they're about to reveal something crucial in the plot of a movie or book. So, here's a spoiler alert: The linear correlation of motorcycle crash speed or crash speed squared (as a measure of kinetic energy) runs in the neighbourhood of .25 to .35 for common measures of injury severity such as ISS or MAIS.)

In the Thailand data reported here, motorcycle pre-crash speed (before any rider collision avoidance action) is used as the measure of motorcycle speed that probably best corresponds to the speeds riders reported in the online survey. Rider injury severity is not reported directly, as measured by such common tools as the Abbreviated Injury Scale (AAAM, 1976 – 2018), the Injury Severity Score (ISS) or New Injury Severity Score (NISS; Reference). Instead we will use the rider's post-crash medical treatment as a yardstick for injury severity.

In Figure 23, "First aid" can mean that the rider had no injury or received only first aid at the scene before going on his way or the rider declined treatment and said he would see a doctor later. "ER" means the rider was transported to a hospital emergency room, treated and released within 24 hours of the crash. "Hospitalized" means the rider was admitted to the hospital for further treatment. In four cases the rider was expected to be hospitalized indefinitely. "Fatal" should be obvious: the rider died within 30 days of the crash.

Figure 23 shows that, overall, about one-fourth of the Thailand riders needed only first aid at the crash scene. Half were transported to an emergency room, treated and released. About one in five riders required admission to the hospital and about one in twenty died. If there is a strong correlation between speed and injury severity, it should show that the percentage of riders who need only first aid or treatment in the emergency room should decline as speeds go up while the percentage of fatals and hospitalized riders increases. However, even among the 111 riders who crashed at speeds above 60 kph (37 mph), 27% were hospitalized and 7% were killed. This is not exactly strong support for the notion that speed is a crucial factor in rider injury severity.

The relationship between motorcycle speed and rider injury severity appears to be real but not particularly strong. As astronauts and Mars surface exploration vehicles show, the crucial factor is not how fast you go, it's how you come to a stop.

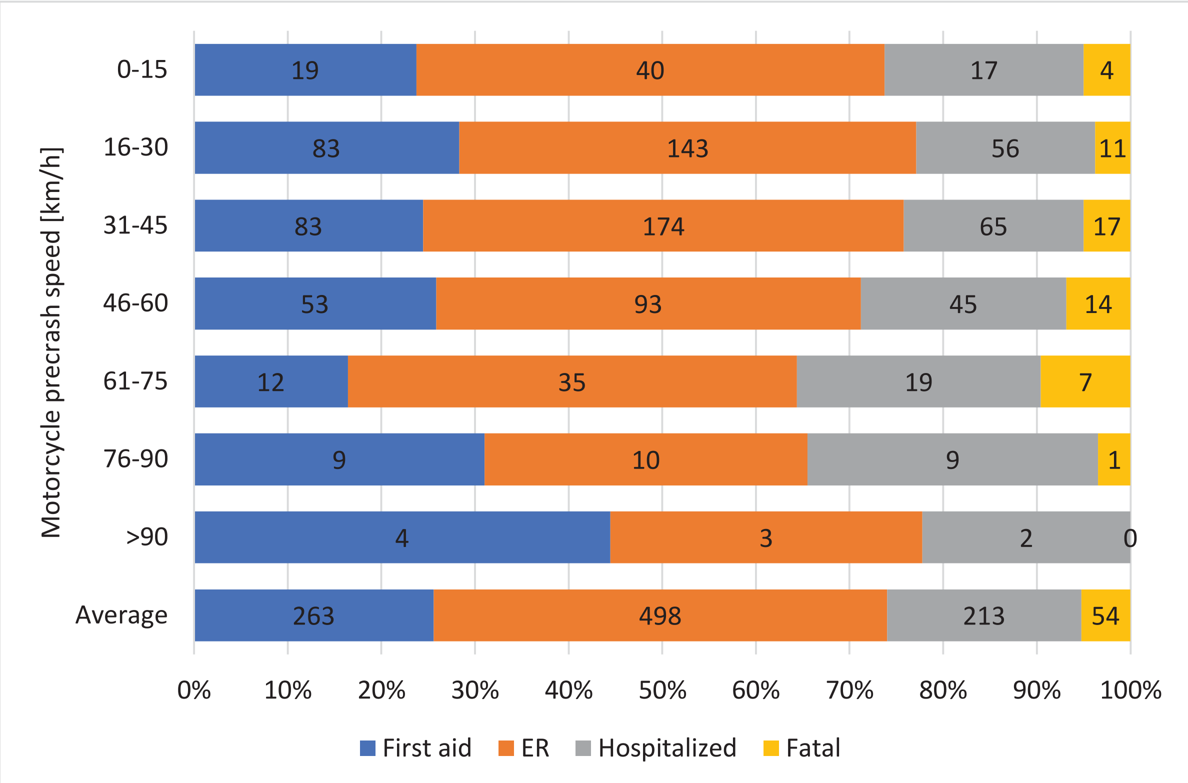

Figure 23: Motorcycle pre-crash speed and rider post-crash medical treatment

11.1.6.6 Protective Equipment

Despite a nationwide mandatory helmet use law, only about half (51%) the riders in Thailand were wearing a helmet when they crashed. Motorcycle helmets in Thailand at the time of the study generally cost less than US$40; most cost much less. Most were rudimentary, lacking in the carefully designed padding, bells and whistles that make helmets then and now so comfortable. Only four helmets came from a well-known manufacturer of high-quality helmets. Nonetheless, high prices for comfort, bells and whistles and certification for compliance with multiple performance standards do little to make a helmet better at preventing injuries. A low-cost helmet can be made with the basic components—a hard, flexible shell, a crushable, energy-absorbing liner (usually expanded polystyrene in a density of about 30-50 g/l) and a competent retention system—and it can perform nearly as well as helmets that cost ten to a hundred times as much.

Only about three-fourths of the helmeted riders in Thailand had their helmet properly fastened before the crash. The helmet came off the rider's head in about one-fourth of the crashes. It should be no surprise that unfastened helmets accounted for the great majority of helmets loss cases but a few fastened helmets came off as well, and about one-fourth of unfastened helmets remained on. Table 84 shows a cross tabulation of the data on helmet fastening and ejection.

Table 84: Helmet fastening and retention in Thailand motorcycle crashes

	Helmet remained on head	Helmet came off	Total
Helmet fastened	383	14	397
Helmet not fastened	35	113	148
Total	418	127	545

11.1.6.7 Helmet Performance

Among Thailand riders who survived their crash, unhelmeted riders had a much higher brain injury rate than helmeted riders—nearly 12% versus 2%. But riders whose helmet came off in the crash fared worst of all—roughly 30% suffered some kind of brain injury and nearly a third of those riders suffered a brain injury in the serious-severe-critical range that is likely to lead to some level of permanent disability. The data are shown in Figure 24.

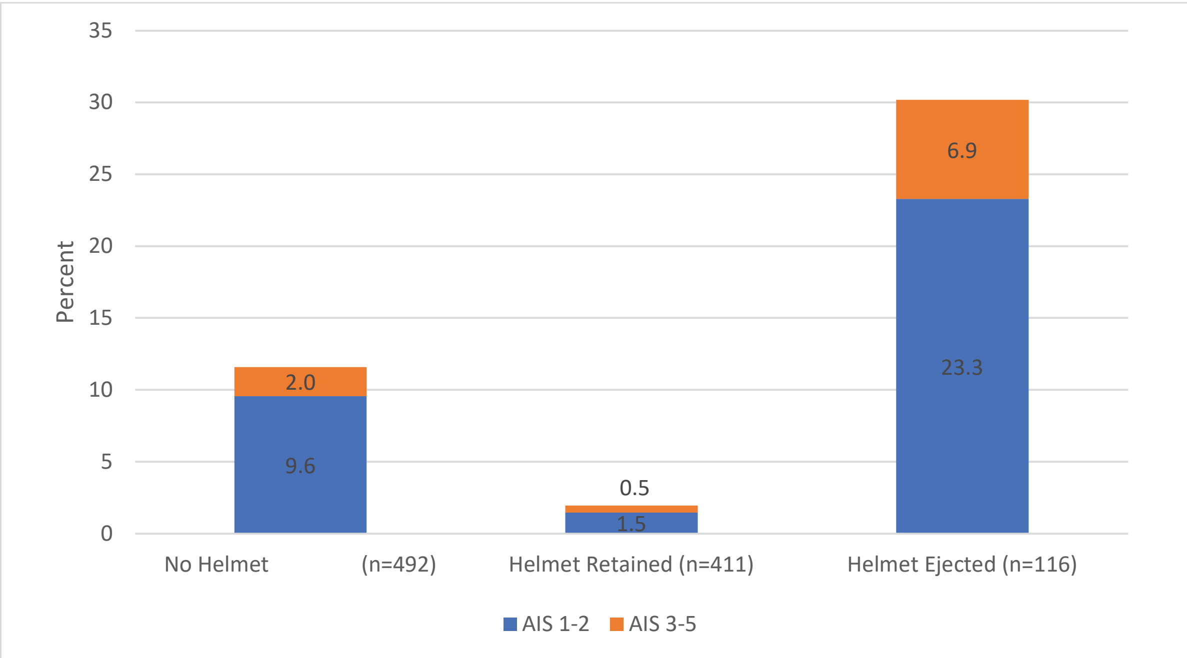

Figure 24: Percentage of Thailand riders who survived their crash but with brain injuries. AIS 3-5 injuries are likely to cause mild to severe permanent disabilities

The difference among the three groups in Figure 24 was statistically significant (χ^2 = 25.05, p < .001, df = 2) and all three pair-wise comparisons were significantly different (χ^2 > 5, p < .02, df = 1).

A "disastrous outcome," was defined as either death or surviving with an AIS≥3 brain injury. Figure 25 shows the percentage of helmeted, unhelmeted and helmet-ejected riders who suffered a "disastrous outcome." The overall comparison between the three groups was statistically significant (□^{2} = 29.22, $p < .0001$, df = 2), as were all three pair-wise comparisons (□^{2} > 4.7, $p < .03$, df = 1).

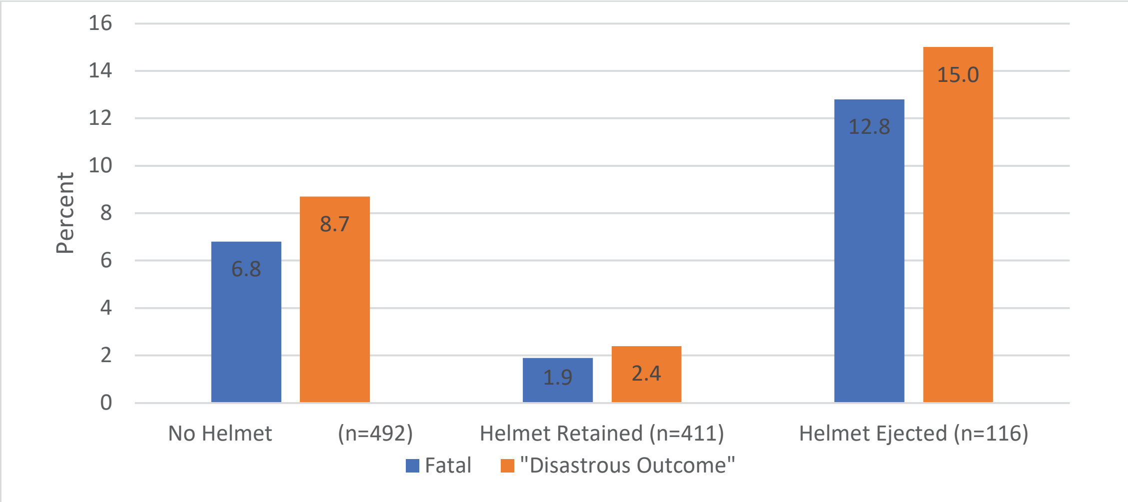

Figure 25: Percentage of Thailand riders who suffered a "disastrous outcome," defined as either death or surviving with an AIS 3-5 brain injury

11.1.6.8 Thailand riders

The amount of helmet coverage — the type of helmet the rider wore — had some effect on Thailand brain injury and fatality rates but that effect was overwhelmed by the simpler effect of whether the rider wore a helmet or not. Table 85 compares the 948 riders in Thailand who were either unhelmeted or whose helmet remained on to the end of the crash events. Riders whose helmet came off were left out of this comparison because of the ambiguity of when in the crash and why the helmet came off. In Table 85, keep in mind that fatally injured riders may have died due to injuries below the neck on which a helmet can have no effect.

Table 85: Brain injury and fatality rates in Thailand. This table includes only unhelmeted riders and helmeted riders whose helmet remained on throughout the crash

Type of Head Protection	N	Brain Injured %	Fatal %
No helmet	528	17.1	6.8
Not motorcycle helmet	12	0	0
Partial coverage MC helmet	141	5.0	3.6
Full coverage open face MC helmet	90	2.2	1.1
Full face coverage MC helmet	177	2.8	1.1
Total	948	11.0	4.6

Table 86 compares rider brain injury severity depending on the type of coverage provided by the rider's helmet. As in Table 85, the effect of wearing a helmet overwhelmed the effect of helmet coverage. While there was little difference between full facial coverage helmets and open face-full coverage helmets, both types had fewer brain injuries than partial coverage helmets.

Table 86: A comparison of the severity of the most severe brain injury by the type of coverage the rider's helmet provided. The cells show the row percent, the percent of riders in each row

Type of Head Coverage	N	No Injury	Minor	Moderate	Serious	Severe	Critical	Fatal
No helmet	528	83.0	8.5	0.8	2.8	3.2	1.1	0.6
Not a motorcycle helmet	12	100.0	0	0	0	0	0	0
Partial coverage helmet	141	95.0	0.7	2.8	2.8	2.8	0	0
Full, open face MC helmet	90	97.8	1.1	0	1.1	0	0	0
Full face MC helmet	177	97.2	0.6	1.1	0	1.1	0	0
Total	948	89.0	5.1	0.8	1.9	2.2	0.6	0.3

For decades, rumors and "old wives' tales" have circulated among riders that helmets cause neck injuries. These rumors may have their origins in a 1969 paper that evaluated the effect of New York's new mandatory helmet law[38]. The study reported a steep decline in fatalities after the law passed. Head injuries rates declined from 116 to 69 per 1,000 crashes while serious neck injuries increased from 3 to 6 per 1,000 crashes. (It may be worth noting that in the nearly 2,000 crashes of the Hurt study and the Thailand study combined, not one single rider was paralyzed by a cervical spinal cord injury, though a few had vertebral fractures, with or without a helmet.)

A really poorly done 1986 paper reanalyzed Hurt study data and alleged that the risk of neck injuries increases at speeds over 13 mph. Unfortunately, the author of that paper used the wrong variable for speed and therefore had to "impute" a speed value for 100% of the unhelmeted riders and about 90% of the helmeted riders. (The paper mentions "imputing" missing values but fails to admit the vast extent of such imputing.) Rice et al., (2016) exposed the failings of the 1986 paper and reanalyzed the same Hurt study database correctly.[39] Rice et al. found what the Hurt report found: a very mild reduction of neck injuries among riders who were wearing a helmet when they crashed.

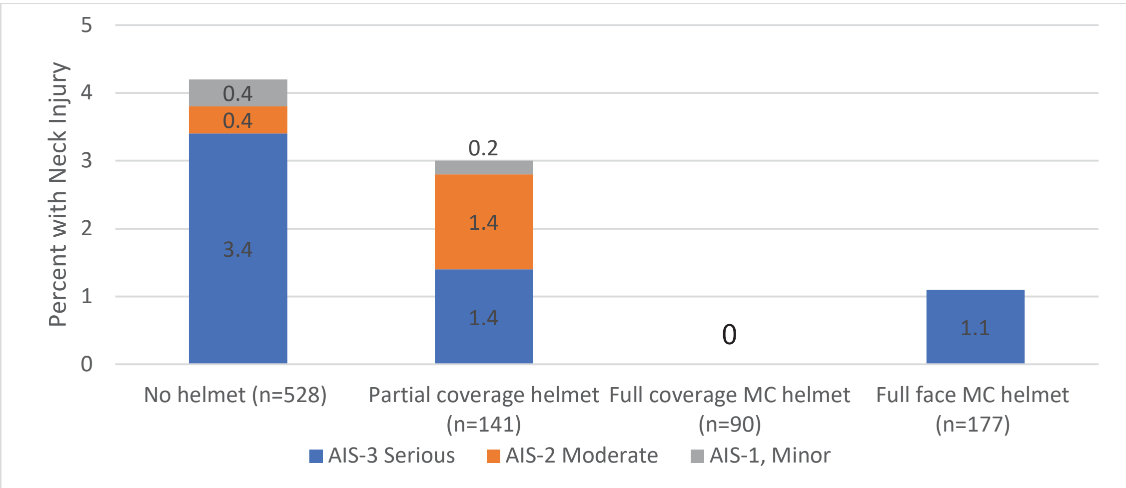

Figure 26: Neck injury severity as a function of the amount of head coverage provided by the rider's helmet

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[38] Negri, B (1969) *The Effect of the New York State Helmet Law on Injuries Sustained by Motorcycle Occupants*, New York Department of Motor Vehicles.
[39] Rice TM, Troszak L, Ouellet JV, Erhardt T, Smith GS and Tsai BW; (2016) Motorcycle helmet use and the risk of head, neck, and fatal injury: Revisiting the Hurt Study; Accident Analysis and Prevention; 91, 200–207

Figure 26 shows the distribution of neck injury severity among Thailand riders. The graph excludes riders whose helmet came off during the crash as well as twelve riders who were wearing a non-motorcycle helmet (military, athletic, etc.) The differences between helmets in neck injury risk are small compared to the fact that over 95% of riders had no neck injury at all no matter what type of helmet they wore—or no helmet at all. Figure 26 suggests that unhelmeted riders are at somewhat greater risk of serious neck injury and neck injury overall.

11.1.6.9 Protective Clothing

Protective clothing was almost unheard of in Thailand, for a variety of reasons: the hot, humid tropical climate discourages it, as does the expense and the inconvenience of dressing up for a short trip—the median intended trip length was 4 km and the 80th percentile was 10 km. It was very common to see riders wearing only short pants, flip-flop footwear and a T-shirt. A well-dressed rider would wear a helmet, long pants, leather shoes and maybe a lightweight jacket in cool season (November – February) when temperatures would drop to 20C (68 F). Figure 27and Figure 28 illustrate fairly typical apparel for Thailand riders.

Figure 27 shows two photos of practical accident research. Thailand Principal Investigator, Dr. Vira Kasantikul, MD and a Hurt study co-author hold a scooter that had struck the rear end of a stopped car. The top of the front fender and the "fairing" were collapsed by the impact. Other members of the Thailand investigation team are visible behind the scooter.

Typical rider apparel for cool season in Bangkok: blue denim pants, flip-flop footwear and lightweight upper torso coverage. In hot season, upper torso coverage would probably be T-shirt only. Dr Vira checking the rider's injuries: No fractures or dislocation but a badly bruised knee.

Figure 27: Practical research in Thailand

More photos of the same crash can be found in Figure 28: Scooter front fender and front end damaged by impact with car rear end. The load of boxes was common for delivery riders. Rear end of the car struck by the scooter. The helmet resting on the rear of the car was typical of those worn in Thailand.

Figure 28: PTW and the rear end of the car

A total of three (3) riders wore upper torso coverage heavier than "medium cloth" (such as a shirt over an undershirt). One wore heavy cloth or Kevlar, two wore a leather jacket. Lower extremity coverage was essentially similar: about half the riders (53%) wore short pants or very lightweight pants; the other half (47%) wore medium-weight pants such as denim jeans. None wore protective pants made of leather, Kevlar or other synthetics. Only 18 riders (1.7%) were wearing any sort of gloves when they crashed. Of those 18, twelve were some kind of lightweight cloth better suited to keeping hands warm than to abrasion resistance. Foot protection was only slightly better, as shown in Figure 29: about 65% of riders were wearing sandals or flip-flops while only about 4% were wearing any kind of heavy boot or shoe.

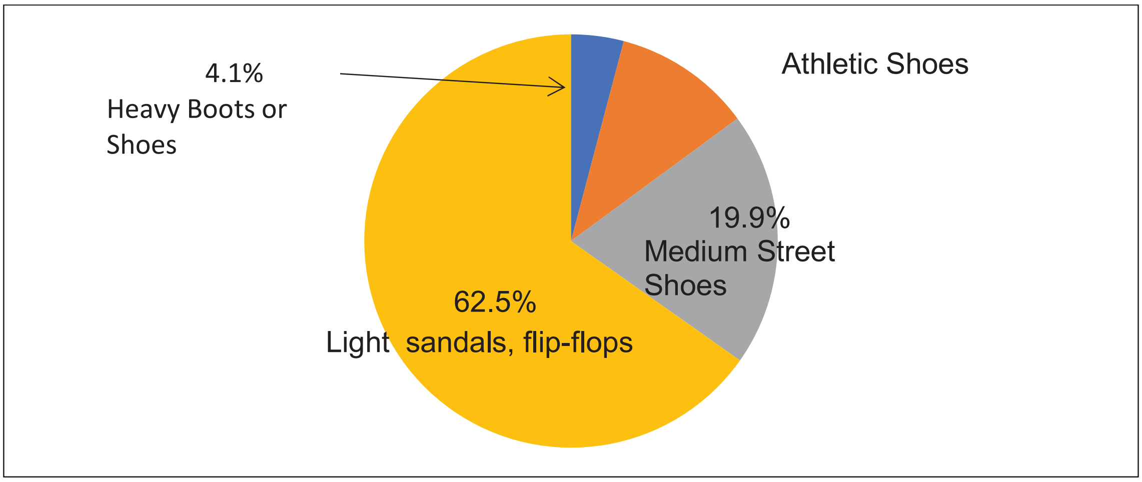

Figure 29: Distribution of different types of foot coverage worn by accident-involved riders in Thailand

A growing body of research suggests that good protective clothing is associated with reduced risk of hospitalization, time spent in the hospital and a rider's quicker return to work and normal activities. The Thailand data did not record all of those variables but it did record days in hospital.

Of the 1,082 riders in Thailand crashes, 224 were admitted to the hospital for one or more days. However, the Thailand data for jackets and upper torso cover does not appear to support other studies suggesting that better coverage and protection reduces the length of hospital stays for riders who are admitted to the hospital. Figure 30 is a cumulative percent distribution that compares the length of hospital stays for Thailand riders (poor upper torso protection) and Dynamics Survey riders who said they were wearing an armoured jacket. If armour were effective at reducing hospital stays, the graph line for riders wearing armour would be noticeably to the left of the graph line for the unprotected Thailand riders.

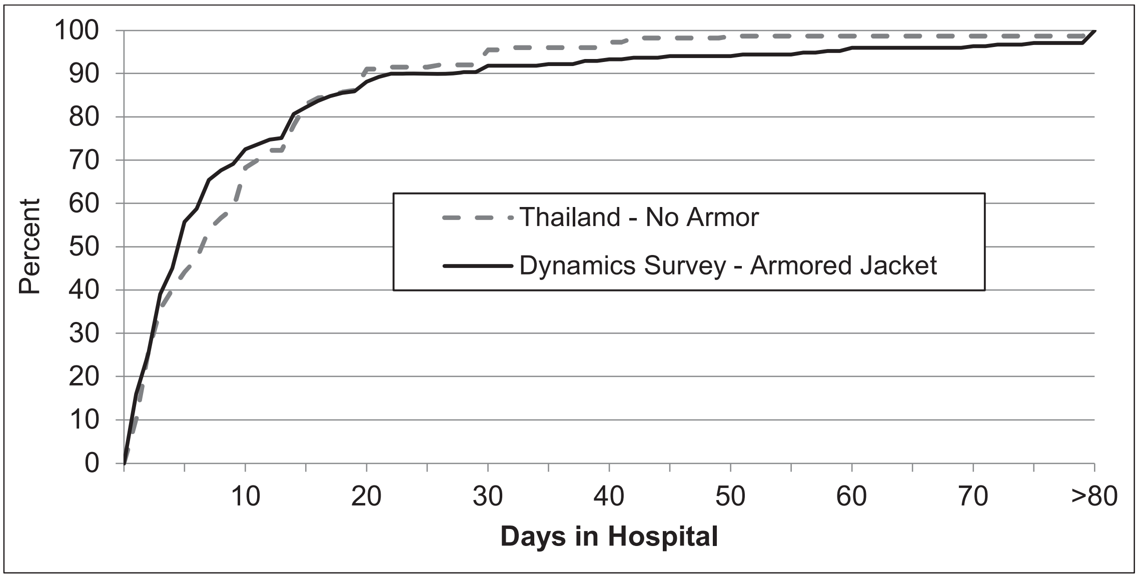

Figure 30: Cumulative percent distribution of days in hospital for riders who were admitted to the hospital

Generally, about 20-25% of crash-involved riders. Riders in the Dynamics Survey were wearing heavy jackets with armour. Thailand riders were mostly wearing a lightweight shirt.

11.1.7 Thailand Summary

The Thailand study remains the only on-scene, in-depth study in a developing nation. It differs in important ways from the 1981 Hurt study in Los Angeles and the MAIDS study in Europe. Nearly all motorcycles in Thailand had small two-stroke engines in the 80-150 cc range. They were much more likely to be used daily as the rider's primary transportation, rather than as a second or leisure use vehicle as in developed nations. In Thailand, motorcycles were everywhere: 29% of vehicles in traffic in Bangkok and 50% in upcountry regions. This may be Thailand car drivers were much less likely than drivers in other studies to say they hadn't seen the motorcycle before the crash. Instead, motorcycles in Thailand were much more likely to strike the rear of a car. Alcohol use in crashes was far higher in Thailand than in the Hurt or MAIDS studies or this Dynamics Survey.

Training was completely absent and licensing was haphazard yet Thailand riders were much less likely to lose control during collision avoidance than Dynamics Survey respondents (20% vs. 46%). Riders in Thailand suffered a serious leg injury about two-thirds as often as Hurt study riders[40]. About one-fourth of that difference may be because of the much higher number of motorcycle-motorcycle crashes, in which leg injury severity is about as low as loss of control crashes. The cause of the rest of the difference remains unclear but it may be due to the small size and step-through frames of so many motorcycles in Thailand. Protective clothing

[40] Ouellet JV and Kasantikul V, (2004); Comparing lower extremity orthopedic injury cause factors in Thailand and U.S. motorcycle crashes; *Tagunsband der 5. Internationalen Motorradkonferez 2004, (Proceedings of 5th International Motorcycle Conference)*, Institut fur Zweiradsicherheit e.V., Essen, Germany 45329.

was almost totally absent in Thailand. Oddly, this did not seem to affect the risk of hospitalization (19% survey vs. 21% in Thailand[41]), nor did it have much effect on the number of days riders were hospitalized.

Along with the differences between Thailand and findings of similar research in developed nations, there are many similarities. Alcohol use and its effect on riding does not seem to differ from one country to another. Drinking riders are far more likely to cause their own crash, often due to inattention. They are more likely to be in a motorcycle-solo crash, to run off the road and into rigid fixed objects that kill them. As in other countries, injury severity in Thailand appears to be mildly related to speed and human error, by the rider or another vehicle driver, accounted for about 90% of crashes. In Thailand, as in other studies, about two thirds of impacts were to the front, right-front or left-front of the motorcycle. Neck injuries of any type were infrequent in Thailand and seemed to be somewhat more common among unhelmeted riders, as in other studies. Even the serious neck injuries did not involve spinal cord damage.

11.2 MAIDS and SaferWheels

In some ways, the findings of the Dynamics Survey are very similar to previous research in the MAIDS and SaferWheels (SW) studies, while in other ways the Dynamics Survey is very different. Some of this is likely due to the way in which data were collected in the three studies. MAIDS and SW were classic crash investigation studies in which investigators inspected vehicles, crash scenes, interviewed riders and collected injury information very soon after the crash. After collecting the evidence, investigators reconstructed crashes and made decisions about how and why the crash happened and injuries occurred. The MAIDS data were collected in 1999-2000 and published in 2002[42]. The SW data were collected between 2014 and 2018 and published in 2018[43].

By contrast, the Dynamics Survey was a questionnaire disseminated online in 2019, largely through rider clubs or organisations and enthusiast websites, where riders told us what happened. By fishing in a different pond than on-scene accident investigation studies, this survey was bound to catch a different group of riders.

Some comparisons that are explored in more depth later:

- Survey respondents were far more likely to be riding a large displacement motorcycle (85% vs. ~40%) and on a weekend (36% vs. ~20%) when they crashed. This suggests that survey respondents were more likely to be on a weekend recreational ride when they crashed than riders in MAIDS or SW.
- Despite the difference in motorcycle size and day of crash, speeds were very similar between the MAIDS and Dynamics Survey cohorts.
- Survey respondents generally had many more years of riding experience than riders in MAIDS or SW and a sizable minority (43%) had considerable post-licence training.

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[41] Kasantikul V, Ouellet JV, Smith TA, Sirathranont J & Panichabhongse V; The role of alcohol in Thailand motorcycle crashes; *Accident Analysis & Prevention;7,* (2): 357-366, March 2005.

[42] ACEM (European Association of Motorcycle Manufacturers); 2009; *MAIDS: In-depth Investigations of Accidents Involving Powered Two-Wheelers*; Brussels, Belgium.

[43] Morris AP, Brown LA, Thomas P, Davidse RJ, Phan V, Margaritis D, Usami D, Robibaro M, Krupińska A, Sicińska K, Ziakopoulos A, Theofilatos A and YannisG (2018); SAFERWHEELS - Study on Powered Two-Wheeler and Bicycle Accidents in the EU: *Final Report*; Luxembourg, Publication Office of the European Union.

- Helmet use was much higher among survey riders, possibly because in the countries surveyed, helmet usage is mandatory (with the exception of some states of the USA).
- Finally, the percentages reported in these comparisons are the percent of known cases. "Missing data" entries such as "Unknown" or "Not applicable" or "no answer" are excluded. As a result, the percentages reported here are likely to differ somewhat from those in the original MAIDS and SW reports.

11.2.1 Accident day of week

Figure 31 shows the distribution of accident day of week for the previous and current study. The most notable difference is the large percentage of weekend accidents among survey respondents—36%-- compared to roughly 20% weekend crashes in the MAIDS and SW studies. This suggests that many of the crashes reported in this survey involved recreational riding trips.

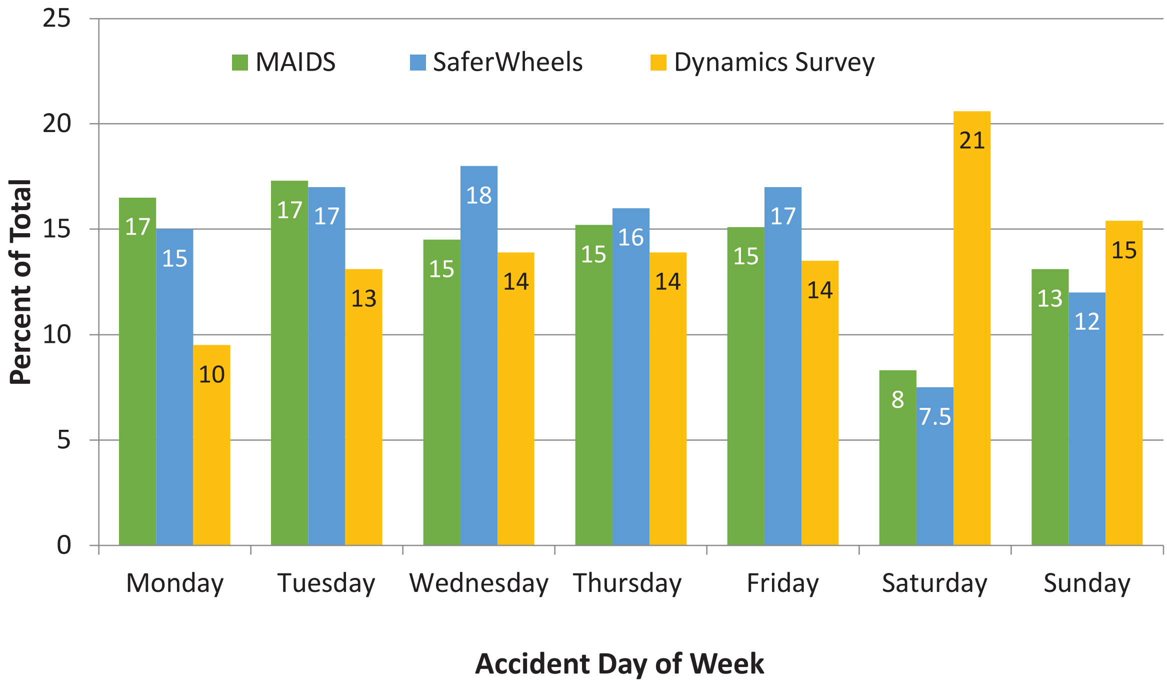

Figure 31: Accident day of week

Accident time of day seems to be distributed about the same within all three studies. That is, roughly 20% of crashes occurred overnight, between about 8 pm in the evening and about 7 a.m. in the morning.

11.2.2 Accident month of year

It is no surprise that the MAIDS and SW study recorded few crashes in the winter months and more in the riding season from May to September. For comparison, the Dynamics Survey data reported in Figure 32 are for only the northern hemisphere. The data for the Dynamics Survey show a similar pattern, though the crashes in the survey are somewhat more tightly clustered in the May-to-September riding season—59% versus 54.6%.

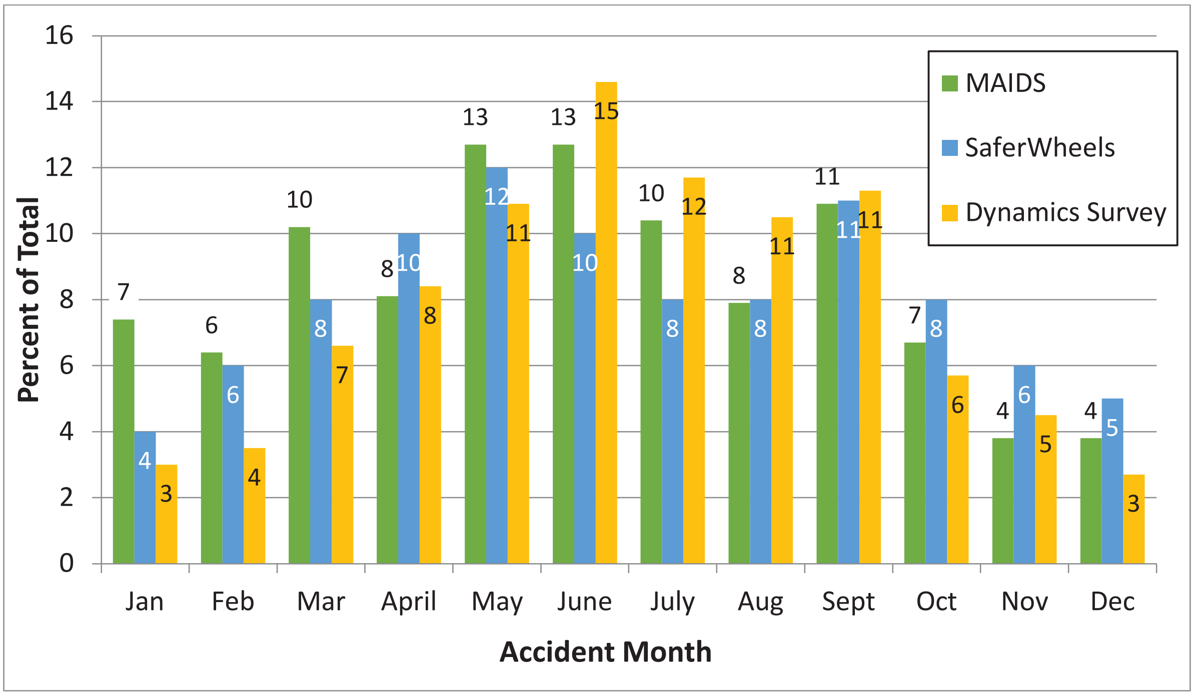

Figure 32: Accident month

11.2.3 Ambient lighting

With regards ambient lighting, the overwhelming majority of motorcycle crashes in all three studies occurred during daylight. However, in MAIDS and SW, about 20% of crashes occurred at night and around 5% at dusk-dawn. By comparison, riders in the survey reported no crushes at dusk or dawn and only 12% at night. Again, this may be consistent with a higher level of recreational riding among the Dynamics Survey riders than those in the MAIDS or SW studies (Figure 33).

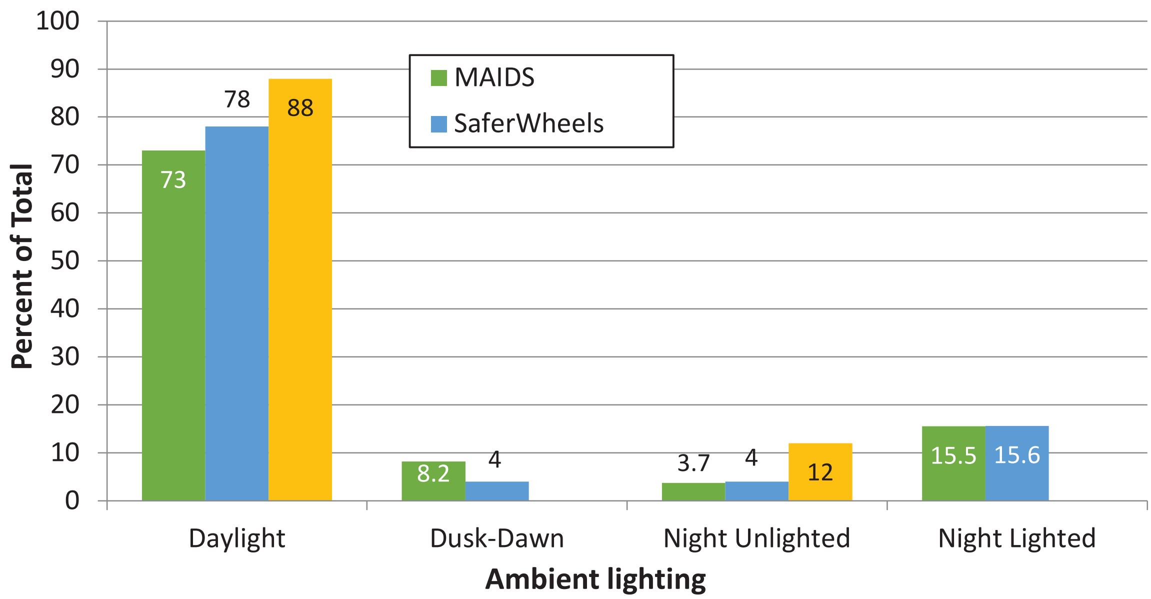

Figure 33: Ambient lighting

11.2.4 Weather

The great majority of crashes occurred in the MAIDS study and the Dynamics Survey occurred during sunny or overcast weather conditions (92% and 83%, respectively). Eight percent of MAIDS crashes occurred in the rain compared to 12% in the survey. Fog/mist or ice/snow were less than 1% in the MAIDS study and about 4% in the survey.

The SW report classifies weather conditions in a curious binary, non-exclusive way. For example, "rain," "fog" and "high wind" are answered yes or no. But saying that it's not raining doesn't mean the weather is fine; it could still be adverse conditions such as fog or high winds.

11.2.5 Road conditions

Overall, the road conditions were only slightly influenced by ice or snow which is highlighted in MAIDS as 0.5% for icy surfaces compared to 1.5% in the Dynamics survey. Overall, the road conditions were good in the MAIDS study the percentage is 84.7% compared to 64.9% in the Dynamics survey. Water on the road was very similar in both studies – 7.9% MAIDS and 7.2% Dynamics. Poor road conditions were far higher in the survey (gravel 7.4% and oil 4.7%) compared to the MAIDS study (gravel 2.5% and oil 0.8%).

11.2.6 Headlights

The MAIDS and SW studies reported headlamp use of 74% and 72% respectively, while 97.4% of riders in this survey reported having their headlamp on at the time they crashed.

11.2.7 Style of motorcycle

The MAIDS and SW studies are very similar in the predominance of small displacement PTWs, usually mopeds (MAIDS) and scooters (SW): roughly 45% in each study (Table 87). The motorcycles in the Dynamics Survey are very different from the other two, with scooters and mopeds making up only 4% of the sample and large displacement street bikes making up the majority. "Naked," sport and dual purpose models made up 75% of motorcycles in the Dynamics Survey compared to 43% of the MAIDS study and 28% in the SW study.

Table 87: Style of motorcycle

Study	Motorcycle Type						
	Naked	Scooter/ Moped	Sport/ Sport Tour	Cruiser Custom	Dual Purpose	Touring	Other
MAIDS	17.0	44.2	19.0	3.4	7.1		
Safer Wheels	21.1	47	3		3.7	4.4	
Dynamics Survey	30.7	4.0	25.4	10.8	19.3	7.1	

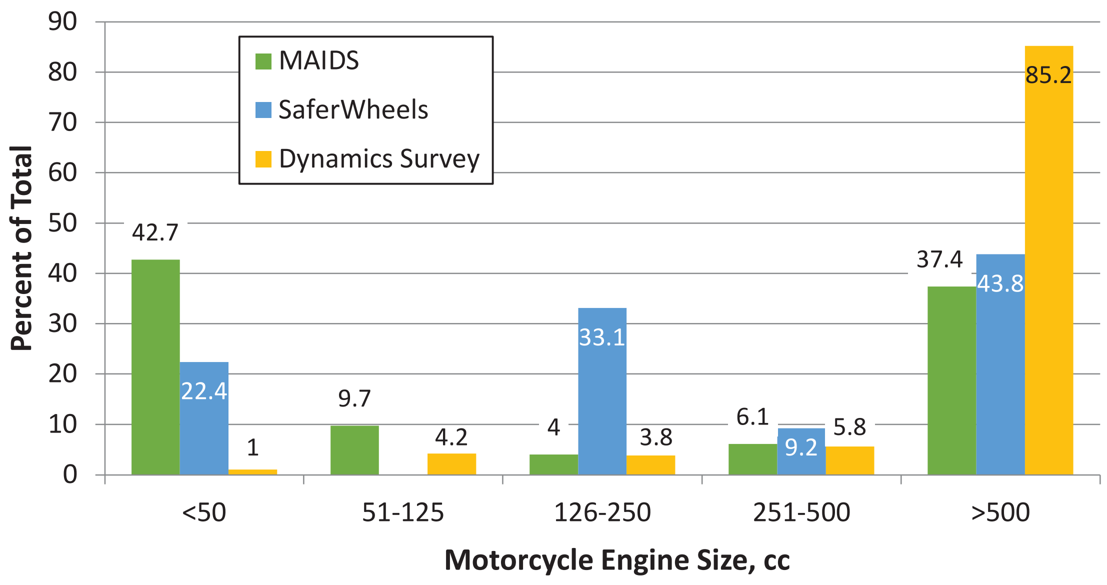

Figure 34: Motorcycle engine size

Only 15% of the motorcycles in the Dynamics Survey had an engine size less than 500 cc, compared to 59% in the MAIDS study and 75% in SW. However, in the under-500 cc group, the MAIDS study was dominated by PTWs with a displacement under 50 cc, while the most common under-500 cc size in SW was in the 100-250 cc range (Figure 34).

11.2.8 Motorcycle Braking Systems

Comparing brake systems in the different studies presents a problem. The SW study (2014-2018) mentions anti-lock braking systems (ABS), particularly as a way to reduce the toll of single vehicle run-off-road crashes but does not mention how many motorcycles in the study had some sort of advanced braking system. When the MAIDS data were collected (1999-2001), ABS was just beginning to be applied to motorcycles. As a result, only four motorcycles had ABS, 20 had a combined front-and-rear braking system (CBS) and two had both ABS and CBS. In the Dynamics Survey, riders could provide more than one answer (or no answer) to two different questions, while it was possible to determine if a bike had ABS-only versus ABS + traction control, this analysis was not done. Nonetheless, it is clear that technologically advanced braking systems have come much into much more widespread use. Among riders who responded to this survey, advanced braking / traction control systems were reported by over one third who had ABS and 12% who had traction control.

11.2.9 Age of Rider

It is possible to compare, approximately, the age ranges of riders in the three studies. None of them use exactly the same "split" between different age groups. For example, MAIDS group riders aged 26-40 and 41-55 in two groups whereas the SW and Dynamics Survey split those years into three different groups. (This is the reason why the graph shows an excessive number of riders in the 26-35 age group and none in the 36-45 age group.

Despite these differences in grouping, Figure 35 shows a stronger similarity between the SW and Dynamics Survey rider ages than to the MAIDS data. Generally, riders in the MAIDS study seem to have been noticeably younger than riders in the more recent studies. In part, this reflects the trend of increasing age among motorcyclists in developed countries. It's also possible that the same age cohort that showed up in the MAIDS study has continued riding 15 years later.

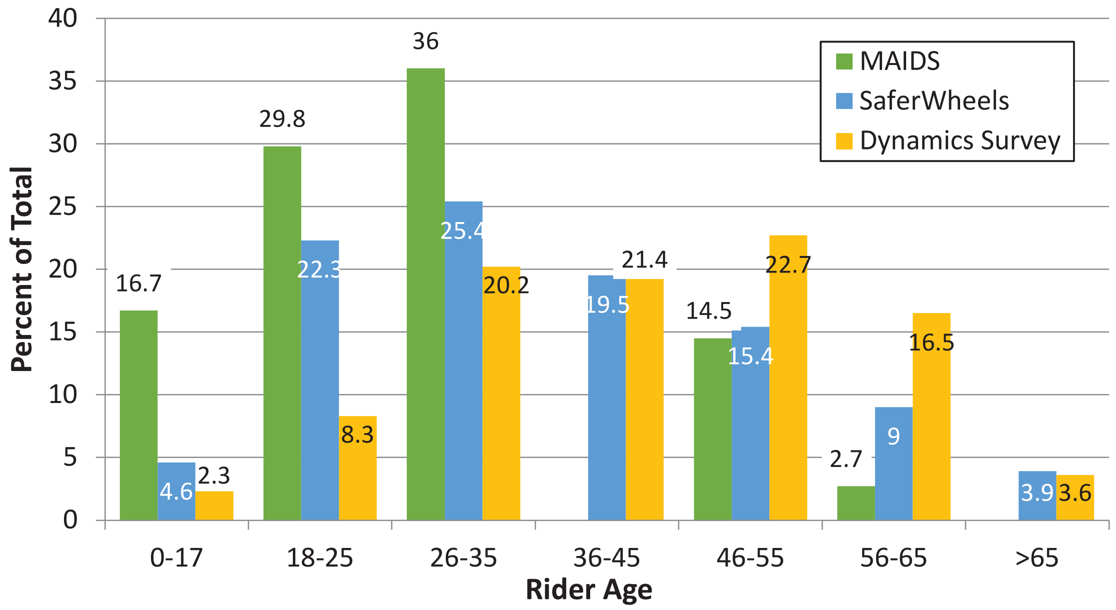

Figure 35: Age of rider

11.2.10 Training

Forty-three percent of respondents in the Dynamics Survey took at least one post-licence training course. (Overall, those 684 riders reported taking 3,276 courses: and average of nearly five courses per rider.)

In the MAIDS study, 55% of riders had taken compulsory training; only four (4) riders took training beyond the minimum required. Forty-five percent had no training at all.

The SW study report does not provide any tabulation of rider training.

11.2.11 Licence

In the MAIDS study, 81.5% of riders held a licence that qualified them to operate the motorcycle they were on when they crashed. Another 17.2% were operating a PTW for which they were not required to have a specialized licence. Only 1% were riding a motorcycle for which they did not have the proper licence. The SW report provides no data on licencing.

The Dynamics Survey found that only four riders (0.2%) admitted to having no licence. The survey did not ask riders if the licence they held qualified them to ride the motorcycle they were riding when they crashed. However, 85% of survey respondents held a full licence so the frequency of riding out-of-qualification is limited.

11.2.12 Experience

In the MAIDS study, 21.6% of accident-involved riders had less than one year of riding experience on any PTW. One-third had one to three years of total riding experience and another one-third had over eight years. The SW report notes that inexperience was linked to speeding and increased crash risk but does not tabulate riding experience.

By comparison to riders in the MAIDS study, Dynamics Survey respondents were an experienced lot. Only 2.5% reported having less than one year of riding experience, while 59% reported having more than 10 years of riding experience. If half the 298 riders who reported 6-10 years of riding experience had more than eight years on motorcycles, that would make 69% with over eight years riding, compared to one-third of those in the MAIDS study.

11.2.13 Helmets and Clothing

All three studies reported high levels of helmet use: 74% in MAIDS, 84% in SW and about 99% of survey respondents. Part of the explanation for the difference may lie in the different PTWs in the earlier studies compared to the Dynamics Survey. The earlier studies reported lower levels of helmet use among riders on mopeds, which made up roughly 45% of their samples, compared to only 4% in this survey. Only the Dynamics Survey reported on the type of helmet riders wore, so no direct comparison of helmet style is possible.

The SW study reported that about 13% of riders were wearing some kind of retroreflective clothing compared to 25.7% of survey respondents. The MAIDS study did not report any information about reflective clothing.

11.2.14 Injury Severity

Comparing injury severity among the three studies is not easy because the three provide different measures of severity. The data form used for coding injuries was essentially identical in the Hurt, Thailand and MAIDS studies. It allowed investigators to encode up to 30 individual injuries (including severity) and to match each injury to contact with surfaces on motorcycles, vehicles and the environment. Ideally, this allows a spectacular amount of comparison of injuries, injury severity and injury mechanisms The data forms also allowed coding a sort of general outcome such as first aid only, emergency room treatment, hospital admission, days in hospital or fatality. The Dynamics Survey had no way of coding injury information in as much detail as MAIDS or SW but it did allow riders to provide information about medical treatment, hospital stay, disability, etc.

Of course, "fatal" is a simple binary yardstick common to both the MAIDS and SW studies. However, no fatally injured rider could respond to the survey questionnaire, though one female respondent reported that her husband had been killed when he hit a wire rope barrier and one rider reported that his pillion was thrown from the motorcycle into on-coming traffic and died at the scene. In addition, it is unlikely any rider with severe or critical brain injuries could respond to the survey because of amnesia for events surrounding the crash that seems to universal with severe blunt force brain injuries[44]. Despite these limits on comparing one study to another, let's do what we can.

11.2.15 Fatalities

MAIDS reported a fatality rate of nearly 11% while SW reported a rate of nearly 18% (Table 88). These rates are higher than typical fatality rates. Two factors could explain the difference. One is if both riders and passengers are included in the count. In the 1981 Hurt study, 54 of 900 riders were killed for a fatality rate of 6%. If the five (of 132) passengers are included, the fatality rate would go up to 6.6%. In Thailand, adding the 11 passenger fatalities would increase the fatality rate from 5.8% to 6.7%. In the United States, the National Highway Traffic Safety Administration reported nationwide fatal and injury crashes with a fatality rate around 6%.

The second reason the fatality rates may be higher in MAIDS and SW is that fatal and serious injury crashes are usually easier to get access to the evidence and information necessary to complete investigation and reconstruction, especially for crashes that are started after the accident scene has cleared[45].

Table 88: Fatalities

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[44] Levin HS, Benton AL and Grossman RG (1982); *Neurobehavioral Consequences of Closed Head Injury;* Oxford University Press.

[45] Ouellet JV, How the timing of motorcycle accident investigation affects sampling and data outcome; *Proceedings, International Motorcycle Safety Conference,* Motorcycle Safety Foundation, Irvine, CA, 2006.

Study	Percent Fatal	Fatalities / Crashes
MAIDS	10.9	100 / 921
SaferWheels	17.9	57 / 385
Thailand	5.8	62 / 1,082
Hurt et al., 1981	6.0	54 / 900
United States, 2015[46]	5.7	4,918 / 86,182

11.2.15.1 Medical treatment after nonfatal crashes

Again, direct comparisons between studies are difficult because rider post-crash treatment was categorized differently in each study.

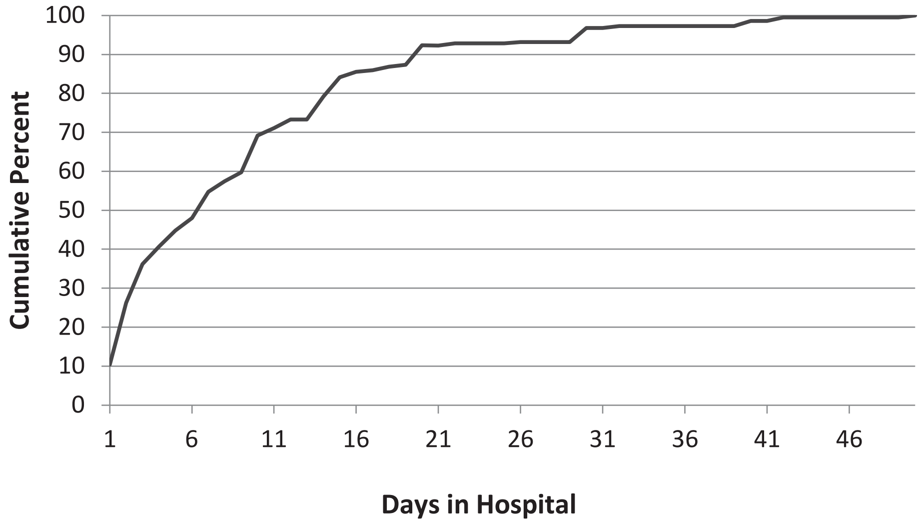

Figure 36: Cumulative percent distribution of hospital stay duration for Thailand riders who survived their crash

The Thailand study shows this distribution of post-crash medical treatment of riders[47]: No injury: 1.8%, First aid at scene only: 23.9%, Emergency room treatment, or <24 hours in hospital: 47.8%, more than 24 hours in hospital: 20.7%. Thailand riders who survived their crash and were hospitalized had median duration of seven hospital days; 75% were out within 14 days and 90% stayed fewer than 20 days. Figure 36 shows a cumulative percent distribution of hospital stay duration before discharge.

The MAIDS study, using the same data form as Thailand, combined riders who were treated in the emergency room and released with those who spent up to eight days in the hospital. The MAIDS data show this distribution (Table 89):

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[46] National Center for Statistics and Analysis. (2018, May). *Lives and costs saved by motorcycle helmets, 2016* (Traffic Safety Facts Crash•Stats Report No. DOT HS 812 518). Washington, DC: National Highway Traffic Safety Administration.

[47] Kasantikul V, Ouellet JV, Smith TA, Sirathranont J & Panichabhongse V; The role of alcohol in Thailand motorcycle crashes; *Accident Analysis & Prevention; 7,* (2): 357-366, March 2005.

Table 89: Post crash treatment MAIDS

Post-crash Treatment MAIDS	Percent of 921 Total
No Injury	0.3
First aid on Scene	2.4
Hospital up to 8 days	56.8
Hospital over 8 days	13.1
Hospital unknown days	15.4
Disabled	0.4

For comparison, if the Thailand data is sorted to include both riders treated and released from the emergency room (n=449) with those who spent up to eight days in the hospital (n=127), the combined total comes to 53.2% of the 1,082 riders—very similar to the MAIDS data.

SW reported that 31% of crashes were "serious" (presumably requiring hospitalization) 41% were "non-serious" (probably not hospitalized) and 6.7% with no injury.

11.2.16 Speed before evasive action

Though the two studies differ in how the number was reached, both MAIDS and the Survey report motorcycle speed before any evasive action. These estimates were remarkably similar as shown in Figure 37. SW did not report motorcycle speed at impact or before any evasive action. A graph line further to the right indicates higher speeds for riders in that group. Numbers on the horizontal axis represent the mid-point of a 10 kph speed range.

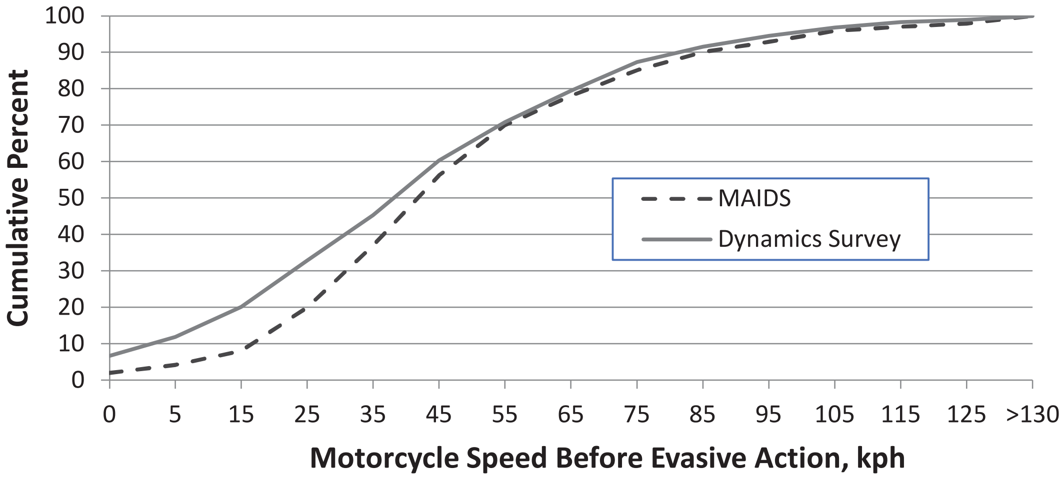

Figure 37: Cumulative percent distribution of motorcycle speed before evasive action in MAIDS study and the Dynamics Survey.

11.2.17 Speed

The MAIDS study (2.0, 2009) produced a graph comparing motorcycle crash speed to the severity of the rider's most severe injury. It shows clearly that, as speeds increase the percentage of riders with minor and moderate injuries declines while the percentage of riders more severe injuries increases. On the other hand, injuries at all levels of severity turn up in every speed range. Even in the highest crash speed range, over 60 kph, nearly half the riders had no more than a minor or moderate injury (compared to over 80% with a crash speed in the 0-30 kph range). Although the MAIDS study provides information on rider post-crash medical treatment, it does not provide any comparison of treatment to motorcycle speed.

The SW study provides no data that might demonstrate a link or lack of between speed and rider injury severity.

The Dynamics Survey did not ask respondents to use the Abbreviated Injury Scale to rank the severity of their injuries. Instead, it uses the less precise but probably more reliable measure of rider post-crash medical treatment as a way to estimate injury severity.

Readers should be aware of an important difference in reported speed in the MAIDS and Dynamics Survey. In the MAIDS study, crash speed was the speed at impact as determined by crash reconstruction. In the Dynamics Survey how fast they were going before the crash. While it is likely riders know their speed before their situation turns into an imminent crash, it's unlikely for a rider to know his speed at the moment of impact. Therefore, the speeds reported here should be considered an approximation of the rider's precrash speed. The 1981 Hurt study reported a median *precrash* speed of about 30 mph (48 kph) and a median speed at impact of about 20 mph (32 km//hr). It would be fair interpret the speed data reported here in a similar manner – that actual speed at impact is probably lower than the speed reported in the tables and graphs.

About two-thirds of the riders (67.6%) in the survey reported that they were injured in their crash. Overall, this is a much lower percentage reporting injury than in most on-scene, in-depth studies such as MAIDS or the Hurt Report, where about 95% of riders report some sort of injury. Figure 38 shows the percentage of riders in the different speed ranges who said they were injured. The horizontal axis shows the midpoint of the different speed ranges. For example, the 51-60 kph speed range would be listed as "55." Perhaps there is a trend here for about half of riders to suffer some kind of injury in crashes at speeds below 20 kph but a 70-80% likelihood of some kind of injury at speeds over 30 kph.

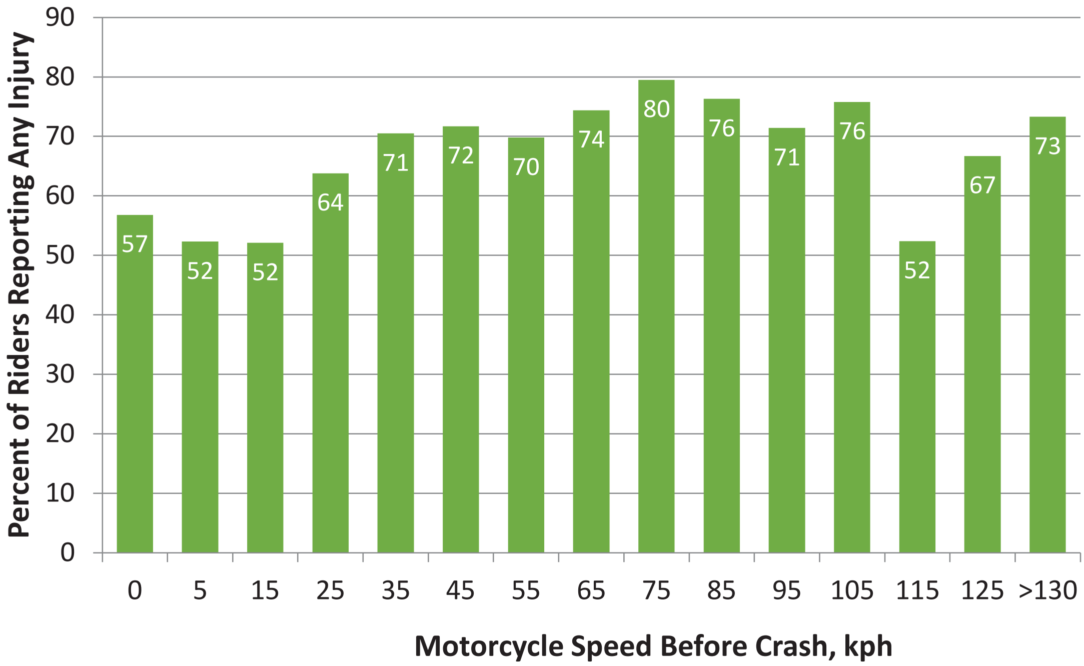

Figure 38: Percent of riders in each speed range who said they sustained an injury in their crash.

Not every rider who crashes goes to the hospital for treatment. Figure 39 reports the percentage of riders who reported being admitted to the hospital for treatment after a crash. Overall, 19% of survey riders said they were hospitalized, which is consistent with the percentage of hospitalized riders in the Hurt and Thailand studies.

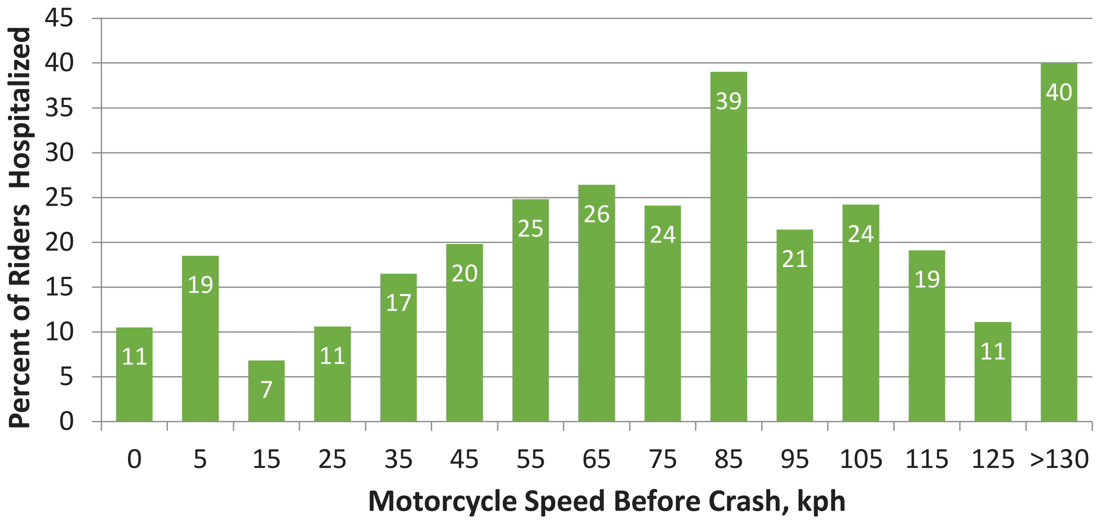

Figure 39: Percentage of riders hospitalized in each speed range. Dynamics Survey data.

Perhaps Figure 39 suggests a trend in which riders going faster than about 30-40 kph have a risk of hospitalization in the 20-30% range. However there seems to be no consistent trend of hospitalization risk increasing as speed goes up.

Table 90: Rider post-crash medical treatment in MAIDS, Thailand and Dynamics Survey studies.

Post-crash Treatment	MAIDS (n=914)	Thailand (n=1,082)	Dynamics Survey (n=1,521)*
	Percent	**Percent**	**Percent**
No Injury, Declined treatment	0.3	6.8	38.2
First Aid on Scene	2.4	23.9	17.1
Treated in ER and released	-	47.8	25.0
ER and Hospital up to 8 days	56.8		
Hospital over 8 days	13.1	20.7	19.8
Hospital unknown days	15.4		
Disabled	0.4	0.4	Not reported

In order to compare MAIDS and Thailand data, the Thailand data can be sorted to include both riders treated and released from the emergency room (n=449) with those who spent up to eight days in the hospital (n=127), the combined total comes to 53.2% of the 1,082 riders—very similar to the 56.8% of MAIDS riders who were treated in the ER and spent up to eight days in the hospital (Table 90).

Neither MAIDS nor SW reports on the number of days riders were hospitalized. SW reported that 31% of crashes were "serious" (presumably requiring hospitalization) 41% were "non-serious" (probably not hospitalized) and 6.7% with no injury.

11.2.18 Collision partner

The "collision partner" is simply whatever vehicle or object the motorcycle happened to collide with. The SW study does not tabulate collision partners but MAIDS did. The categories between MAIDS and the Dynamics Survey have much in common but do not match exactly. The most notable exception is that MAIDS lists "roadway" while the survey lists "single vehicle." Presumably the two are essentially similar. Figure 40 compares the collision partners in the MAIDS and Dynamics Survey. They show considerable similarity, with cars dominating.

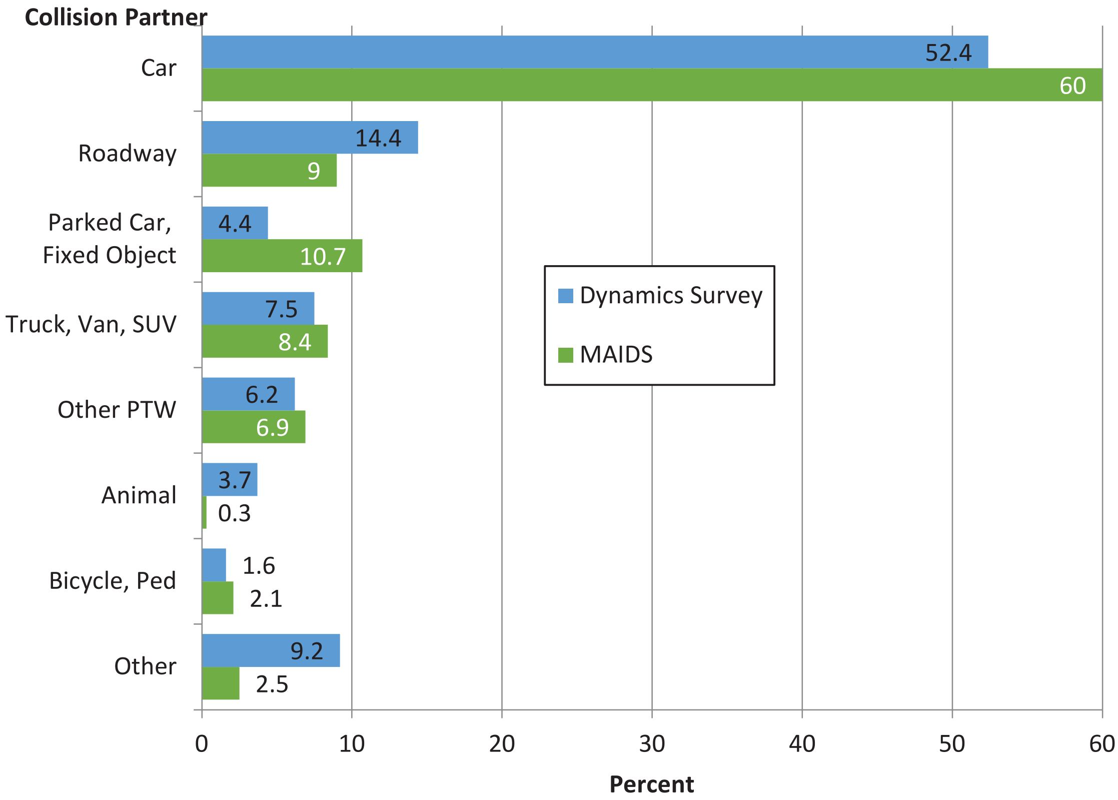

Figure 40: Object the motorcycle collided with in the MAIDS study and the Dynamics Survey

11.2.19 MAIDS and SaferWheels Summary

Compared to the riders in the MAIDS and SW studies, respondents to the Dynamics Survey were:

- More likely to be in a crash on a weekend
- Less likely to be in a crash at night
- Highly likely to crash during acceptable weather conditions
- Very similar in their choice of collision partners
- Far less likely to be riding a moped or a scooter
- Riding larger displacement motorcycles
- Far more likely to have ABS or some advanced braking and stability system
- Traveling at about the same or slightly lower speeds just before they crashed
- Older and with far more riding experience
- Far more likely to hold a full license
- Far more likely to have training, particularly post-licence training
- Much less likely to go to an emergency room for treatment

12 Conclusion

The findings from this study have identified a factor that is possibly contentious, which is evidence that indicates that the correlation between speed and the seriousness of injuries is random. In other words, the speed of the motorcycle when it crashes with another vehicle, road infrastructure or an object or animal does not necessarily determine the severity of the injuries of the motorcyclist. This finding is important because it allows analysts and researchers to focus their attention on what the evidence in this study provides, which is the mechanism of the crash (the trajectory of the rider and what he/she hits) has far more importance than speed in terms of the severity of injuries. However, that does not diminish the fact that high speed can lead to crashes.

The difference between avoiding a crash or not is determined by the ability to be able to stop in time. As an example[48], if the indicated speed (using miles as a measurement) is 60 mph, the braking distance is calculated at 31 metres, if the indicated speed is 100 mph then the braking distance would be 97 metres and at the higher speed of 148 mph, the required braking distance would be 181 metres. Simply, the lower the speed, the shorter the braking distance and the greater the possibility of avoiding a crash.

In simple terms, the speed limits are there for a reason. It is important to recognise that speed does have an effect in terms of control. Riding on a public road requires riders and indeed drivers to acknowledge that the road is to share and therefore preparation, awareness and riding within the legal speed limits is relevant in terms of crash avoidance. Speed limits should not, however, be a target for riders and there are many examples of crashes occurring because the speed was inappropriate for the conditions of the road and the surroundings.

Technology on motorcycles has the purpose of aiding the rider to control the motorcycle in order to be able to accelerate, ride, lean and stop. As the findings of this report demonstrate, over a third of the respondents (35%) did not use their brakes prior to crashing and of these, n.259 (46.8%) had ABS brakes fitted. Those riders who took part in specific training for braking with ABS represented 19.9% (n.314). Of these, 65% (n.204) indicated that they were riding motorcycles with ABS brakes at the time of the crash.

49% of those who wore a jacket with armour at the time of the crash received injuries to the upper limbs. There were n.350 who had injuries to their shoulders of which n.309 (88.2%) were wearing a jacket with armour. The obvious question is why riders who wore armoured jackets still suffered injuries to their upper arms. Were the components in conformity with EN 1621-1? If so, are the impact energy attenuation requirements specified in the standard suitable and sufficient? Do EN 1621-1-conforming protectors offer sufficient protective coverage, and, if not, were injuries sustained to areas which should have been covered, but were not? Were the protectors adequately restrained in position, or did they move out of position and thereby fail to protect the intended part(s) of the body?

The findings relating to post licence training is important in order to understand whether the courses that the riders participate in have any effect on their ability to avoid crashing. Of the respondents, 43% indicated that they had done some form of post licence training, but still crashed. The type of licence held by the riders at the time of the crash indicated that 85.4% (n.1347) held a full licence (A in Europe) while 5.5% (n.87) held an A2 licence (in Europe) or provisional licence and 2.8% (n.44) held an A1 licence (in Europe). Overall, post licence training seemed to have a limited effect on the type of crashes that occurred.

What is possibly the most important discovery of this study was that the mechanism of each crash, in particular, the trajectory of the rider post-crash, determines not only the type and range of injuries but also the severity of the injuries. The post-crash motion "Topside" occurred in 63% of those cases where the rider collided with a car. In terms of injuries this type

[48] Source: Motorcycle Fatalities in Northern Ireland report (2012) Part two

of trajectory dominates both the range of type of injuries and the severity. The following types of trajectories, Left Low-side and Right Low-side also have high levels of injuries by type. But compared to the Topside trajectory, less time was spent in hospital. This is an area of research that needs further attention. If, as this study suggests, Topside: over the front of the motorcycle, is the trajectory that causes the highest level of injuries, this needs to be a focus of attention, by industry and analysts who wish to reduce motorcyclist injuries and crashes.

13 Recommendations for future research

- The identification of post-crash motion is used in motorcycle racing circuits to explain the trajectory of the motorcyclists when they separate from the motorcycle after impact with an object, roadside furniture or infrastructure or because the rider has lost control of the motorcycle. These definitions are to understand how the rider falls and what the potential type of injuries may occur from the mechanism of the fall. These definitions are not universally used and it would be helpful to decide amongst analysts that a guide should be adopted to facilitate comparative research. Furthermore, based on the findings in this study, the mechanism or post-crash motion appears to determine the type and severity of injuries. This is an area of research which needs to be investigated fully.
- Training is an important factor for motorcyclists to learn how to avoid crashing. In this survey, 43% of the respondents indicated that they had taken part in different types of post licence training courses. A short fall of this study was that the question of when the rider did the course, was not asked and this meant that it was not possible to analyse whether time was a factor in the ability to avoid crashing. However, what is possibly more evident is the high number of participants in the survey who crashed and whether the type of training had any bearing on the skills of the rider in an emergency situation. There is no standardization of post licence training instructors, many who are not registered or licenced to teach advanced training. This is an aspect to consider.
- In 2013, the Third European Driving Licence Directive was introduced throughout Europe. The Member States (MS) were given the option of either testing or training (or both) for novice motorcyclists and for those moving up through the categories A1 and A2 licences. Most MS chose testing between the categories presumably for financial reasons. However, the limitations of testing has been observed, because the focus is effectively to teach the rider to pass the test and not necessarily to learn how to survive, which could be included in a training regime.
- Educating the public could easily be achieved by starting with the young through teaching road awareness in schools - including how to drive cars, ride mopeds, scooters or motorcycles – which could become part of a curriculum. Clearly, this is a medium, long term solution, but one which would ensure that when the time comes, the young people of our countries would be capable of joining the rest of society as responsible road-wise drivers and riders rather than restricting them and praising them just for surviving.
- Technology has been developed in order to reduce the possibility of riders falling or sliding in an emergency situation, however, what has been highlighted in this study is that over a third of the riders did not use their brakes, whether they just did not have time or were unable to because of the circumstances. How this can be addressed is relevant to the fact that in this study a third of the motorcycles were equipped with Advanced Braking Systems while 12% had traction control. Does technology matter in a crash scenario? Consider that the perception/reaction time of the rider/driver is between 0.75 and 1.5 seconds. What solution could there be to address this problem? The assumption that technology will save the day, may miss the obvious fact that what matters in an emergency situation, is the rider him/herself and his/her ability to control the technology.
- Protective clothing can play a part in mitigating injury. Future research could focus on the increasing availability of clothing tested to European Standards (and the Australasian MotoCAP requirements), and what the relative benefits might be of the various performance classifications in the clothing, glove and footwear standards (with a big enough sampling, the chaotic and random nature of real

world accidents might be filtered to a sufficient extent to at least make a start on making sense of the outcomes).

- Questions that need answers are: how effective was the clothing they were wearing? Riders may have invested in dedicated motorcycling apparel, but was it sufficiently protective? They *felt* protected, but did it deliver? This is where a future study, where clothing meeting the requirements of EN 17092 should feature, might prove interesting. There will be a need to identify which performance class the clothing being worn had passed. This might highlight that anything passing “A/B” for abrasion resistance and tear and seam strength as effectively being no better than casual clothing.
- Riders were not asked if the helmet they were wearing was of an approved standard for their country. There are various standards for helmets across countries from the United States - Europe - Australia - New Zealand. Also for example, the European standard UNECE Regulation 22.05 is an acceptable standard in various countries outside of Europe. The standard 22.05 is undergoing a revision at present to 22.06. It would be assumed that all riders were wearing a legal helmet for riding in their country.
- The survey findings provide limited information about riders’ preferences on what type of helmet to wear. What it does not provide is information about the protective performance of helmets. Furthermore, the survey did not ask whether the helmet came off at the time of the crash, nor the type of fastener of the chin strap i.e. whether it was a double D lock or seatbelt type lock or other fasteners. This is an area of interest for future research.
- The development of autonomous vehicles suggest that these vehicles will be in wider use in the coming years, however it has been observed that motorcycles are not a priority in the existing detection systems. This is because technical difficulties such as the small frontal surface combined with travelling speeds similar to this of the surrounding traffic make motorcyclists a road user group difficult to identify by autonomous vehicles. It would be useful to analyse the survey data in order to highlight certain collision scenarios of motorcycles with other vehicles (and their accident details), so that the automotive industry could benefit and propose appropriate improvements for the detection of motorcycles.

Annex I: Comments from riders who were hit while stationary

NB: Comments in blue are translated from the original language

Rear ended at a stop sign by a buddy that was checking out girls instead of concentrating.
Stationary waiting to turn right in a car park t junction, car approaching from the left turned into junction cutting corner and hitting my stationary bike. main cause was age and confidence of the driver who panicked and accelerated into bike
Driver was distracted, changed lanes without looking and accelerated before finally looking to see I was in the lane.
In Australia we are taught to turn corners tight but I think this attributed to the SMIDSY accident at the stop sign. I always keep looking at my mirrors when I'm stopped now & always wear hi Vis. Haven't encountered any other main incidents or near misses since that day.
It was a situation where i was stopped in traffic and the car driver was not aware of me and the situation they were coming up to
Untypical accident in group. Driver could not control his vehicle on the steep driveway. We stopped. Driver rolled back uncontrollably and pushed us with the vehicle to the right rear, where we both crashed onto the national road.
Hit from behind while waiting for green light.
The van that collided with me reversed into me on the road even though I had been clear in his mirror just prior.
I was travelling home in my hometown, which is a big market day in the town and it brings a lot of tourists. I pulled on to my street behind a car and travelled towards my house, as I arrived outside my house I was indicating to turn right to go down my drive as there was a car coming in the opposite direction, I was stationary and waiting for the car approaching to pass, the car in front had stopped to let the approaching car pass. On my left-hand side there was an empty space from which a parked car had left. The car in front of me then put his car in reverse and came back at me, I sounded my horn, but he still reversed. He hit my bike on the front wheel and pushed the bike and me over and still kept reversing as the car ran up the bike and trapping my right leg between his car and the carburator of the bike, the bike ended up on the floor trapping me and dislocating my shoulder. The driver got out the car and came to the back and said "sorry I never saw you" I said "get your fucking car off my legs you absolute Cockwomble! He then proceeded to turn on his hearing aid! and asked me to repeat what I said. The bike is one of the biggest bikes on the road and had one headlight and two daytime riding lights on, my size of 18 stone makes it difficult to hide behind broom handles, so you have to ask yourself, should not using all hearing and visual aids that are required to make you a safe driver be a punishable offence?
Manoeuvring the automobile that pulled me back to the lights
Stopped at a yield the passage at the entrance of a roundabout because of the density of the traffic. Hit at the back by a car whose driver was on his phone. Projected in the crossroads. Stuck under the bike.
It was an accident while I was waiting to get on the roundabout, when a lady came by car and hit me from behind. After the shock, as small as it is, and after having recovered my spirits, this lady explained to me that she had not seen me.
I'm behind a van on a one-way road. After missing an intersection, it stopped abruptly, me too. Then quickly started backing up and hit me while I was standing behind him.
Hit in the back while stopped waiting to turn left. Inattentive motorist misjudged distances
My accident was caused by someone who was distracted while driving (phone).
Hit from behind by a car while stopped at a red light. The bike was propelled on 5 / 6m, on my side I found myself sitting on the hood of the car.
Just to clarify. I was hit in the back by a car that went off track. I was at the moment of impact at the stop while waiting for the road to emerge and that I could pass, I saw absolutely nothing happen and nothing could do since I was stationary
I had stopped; I let a pedestrian cross and the bike, following the collision (from the rear by a car launched at 50 km / h) almost crashed into the pedestrian (then in the middle of the road).
Driver who did not look at his rear-view mirror before reversing, he saw me before getting into his car
The driver of the car ran away and was never found
The speed of the car was very low and my bike was stationary. I honked when I saw the car back two meters away from my bike, because I did not have time to back off myself (no reverse on a motorcycle). She continued to reverse and slowly but surely pushed the bike. I wanted to prevent it from falling, in vain, which caused me tendon damage to the arm. Once the bike on the ground and I straightened, the car to continue to back on my bike. The driver did not even realize the collision had happened, since it was more of a "push".
Hit by a truck while I was in front of him. He did not see me.
The weather was perfect, the road was perfect, the visibility was good, the driver of the car following me did not look in front of him at the time of the accident. He did not give an explanation since he did not stop.
At the traffic lights, the van pulled back to change lanes and hit me while backing up because no visibility through the rear windows because of security grills.

The other driver had assumed I had moved and already focused on the place in the traffic, did not notice that I had to stop.
The driver of the vehicle that hit me was working for Uber and was carrying a customer.
Rear ended by distracted driver making a “stoptional” (was never going to stop). Older lady who said she never saw me yet followed me closely for 2km.
The van driver was using his cell phone, distracted me at very low speed (thankfully) while I was stopped at the traffic lights.
I was cut off by a moped who zig-zagging across the road.
The van driver was distracted with his cell phone in his hand. He left me the insurance details, but they were fake :-(
The driver who hit me was 75 years old
the lady driving the Smart who hit me was distracted by her son (about 4 years old) who was traveling without being secured to the special safety seat provided, so she didn't notice the red light.
Hit in the back at the stop at the entrance to the roundabout
I was at a red traffic light in front of a crosswalk (lights had not yet changed to green for the crosswalk). This traffic light was at the exit of a "+" junction, with another traffic light at the exit of the same road. The car that hit me from the rear, skipped the traffic light at the junction (or passed it in amber, prior to the change to red), and when he reached the exit of the crossing he "found" me stationary (correctly). He made a sharp braking but failed to stop the car in time, hitting luckily at not very high speed, but enough to go forward for the blow. My motorcycle was "embedded" in the front of the car, and I ended up lying on the ground at the end of the cross-walk (for having a reference of the distance that the impact moved me) I was immediately attended by a doctor (but not on duty) who took control of the situation, helping me to sit in a safer place outside the roadway, calling the ambulance, etc. In a few minutes the ambulance arrived, the health workers repeated the process to make sure it was not serious. They transferred me to a medical centre, and they assessed me and my injuries, which were limited to small back and shoulder pains, and a sprain from whiplash.
I was stationary waiting to pull onto a roundabout when I was hit from behind. I was shunted forward and fell onto my left hand side. My bike was damaged and recovered for repair. I visited the emergency room later after developing pain in my left shoulder where I was diagnosed with a subluxion of the left shoulder joint, advised to rest and referred for physio.
She didn’t see me, I was stopped, waiting for the car in front of me move, and the woman hit me from the back
Turning off side road onto busy highway, new rider and a bit nervous, popped the clutch while on the throttle, front end came up and the next thing I remember, I was being walked off the shoulder of the highway. Missed being hit by anything.
Driver admitted to wanting to run a stop light as no police or traffic enforcement devices were at the intersection
I was on a roundabout with 5 entry and exits. As I rode past the last entry, I made eye contact with a male in a large 4 wheel drive ute as he was stopping to enter the roundabout. He looked straight at me then drove into the left- hand side of my bike. I was wearing a white armoured motorcycle jacket on a white scooter, yet he claimed that he never saw me.
I was stationary waiting to turn with blinkers on, foot down, brake engaged. Driver of SUV changed lanes without looking, accelerated and then applied brake when he turned to look. Couldn’t stop and hit me from behind. My bike ended up stuck in the front of his car which caused his car to stop as I landed just in front of his front passenger wheel.
Was stationary on the road in the direction of travel. Had to wait for a friend who has traveled farther to turn. Just release the clutch and left. The last thing I remember is that she is 25-30 meters away. Then she and one more are with me in the ditch. She saw how me and a motorcycle flew away. I was unconscious. fire brigade two ambulances and police came. So do not know why it happened.
The collision happened to me in 3 occasions, two of them had no consequences but every time the driver of the car hitting me had other interests then watching what she was doing. Yes three times the lady was toying with her cellphone.
Just forgot the jiffy and moped fell during mounting
Car (van) suddenly stops and backs in, hitting me in the progress. Have had 3 similar events up til now.
I braked hard for a yellow traffic light, The Volvo behind me assumed I was not going to stop. He was so close I did not see him in my mirrors. The car driver accelerated to pass the yellow traffic light, But I was already stationary. The passenger told me she never saw a person flying that high. The major damage on my motorcycle was due to hitting a lamppost on the other side of the junction. The rear impact bent the swingarm.
This was just a case of idiot car driver, he stated that he didn't want to wait."he had to be somewhere ",so while i picked up my bike he drove off: hit and run. Got the licence plate, cops immediately started a search, he’s now waiting his trial.
While stationary at a red traffic light, I was hit by another motorcycle (Yamaha R1 sports bike), whose driver did not notice the red traffic light. At impact, my motorcycle was lifted of the ground and I was thrown off.
I was in a row of cars that was hit from behind by a lorry. 4 cars were behind me.
I stood still at a T junction in a Belgium village. Giving priority to 2 upcoming cars which got in each other’s way. The left upcoming car left his lane and therefore crashed 90° sharp in the left of my bike. I was a bystander who got involved.

Brain concussion
The van did drive backwards to start with a u turn. He could not see me because I was behind the van in the middle of the road. Now I be more aware of my position on the road when I stop...can everybody see me...
The car that drove into to me was not speeding.
Standing still before the stop line of a roundabout. I was hit from behind. The driver did not see me at all
Rear ended while waiting for a red traffic light. In broad daylight while wearing a reflective backpack. He just did not see me (nor the red traffic light)
Was hit from the back with 70km/h while standing still in traffic jam. Motor (and cars) total-loss and I was launched over 2 cars. Broke my back at 2 places, revalidated at home for 1 year and had 2 years problems with pinched nerves.
Van driver was busy with his cellphone and thought he had a green light and hit me on the back
Hit from behind by a car while standing still at a red light. Car nearly didn't slow down before crashing into me, hit my bike with me and my pillion rider with roughly 30km/h. Driver was a delivery driver, probably checking his route on the phone.

Annex II: Comments on Trajectory (Other)

The lowside ....when verge hit caused a roll and spin
I was knocked off the bike to the left side.
Car impacted with the right-hand side of the vehicle at which point the bike went slightly to the left and on its side down the road, and I carried on in the direction of travel and slid down the road
Forward to the right
Fell left but trapped under bike initially then when hit by car thrown up and onto bonnet and roof.
The car present was dropping cargo (a barrel) from the trailer. The motorcycle runs obliquely on/over the barrel, whereupon the rear of the motorcycle is thrown upwards, like a topside, but not due to heavy braking.
Stopped, pressed against the driver's door. Did not fall
Able to step off prior to impact
Slid under moose with bike and let go once passed. Slid on left leg.
Left motorcycle "voluntarily" to the right
Bike was shunted right and I fell to the left
The rear wheel spun, I let go of the throttle and the engine brake did all the work. The rear end slid out and when the bike is at about 45 degrees across the road, the ice ended. The rear wheel gripped and sent me forwards in the direction I was travelling.
Left the bike before collision with ditch. Jumped off.
There was oncoming traffic, so I was deliberately leaning slightly towards the car I struck while braking hard, to avoid going under the wheels of oncoming car. The bike and I toppled left after coming to rest.
Locked front tyre and the bike disappeared from me
Forward to the left.
To the right of the motorcycle
The motorcycle was falling toward a tree, I threw myself off to the right and landed 50m vertically below my bike.
Bike tipped to the right in loose shoulder material adjacent to the bitumen, I fell with it.
I don't remember but was told that I 'flew' for some distance before hitting the ground.
Laterally to the right
When I was hit, I jumped off the stationary motorcycle to the right.
Was hit and thrown off the bike
Hit by car from right side , flew into the air striking car bonnet and windscreen
Hit from the rear, stationary. Up in the air, down on the hood, across the front wheel.
I jumped off the bike when I realized that I was not able to stop in time. The bike went down on the left side. I was traveling in the left lane with wire rail om my left side. I choose to jump of and tried to slide on the side of the tarmac close to the rail.
Backwards, sliding with the bike
Hit the mountain and both me and the bike were thrown into the road again.
I slid on the ground after the bike
The is crash is not very important I held the bike at the time of the fall, and once the bike was down I went ahead and caught me on the hands (thank you gloves)
I abandoned the vehicle when it went down on the left when the van pulled back abruptly and hit the bike
The front wheel of the scooter slid away and I crashed next to it.
I fell on the right side the bike on top of me
Due to impact with sheep and swerving to right, front wheel climbed the sheep losing traction resulting in a low side style of crash.
The “topside” crash: The motorcycle suddenly decelerates relative to the rider, who is propelled over the handlebars.
The car reversed while I was behind the female driver. She did not see me. I let the bike fall as soon as the rear bumper began to touch the front wheel of my bike to get clear and not be crushed.
Hit on the side and propelled onto the handlebars
Fell into the ditch with multiple rollover. Since I was able to break away from the bike I was only slightly injured.
When I regained consciousness, the bike was lying on me.
Passed by a stationary car, which was indicating to turn at the traffic divider. Inattentive that the bus stop had been rebuilt-drove on the curb (which would not have existed before!)
The rear wheel broke away in the roundabout, motorcycle c swung around 180 degrees.
I went topside but in a way that look more like a lowside. The bike went "slowly" on the right then slid pretty smoothly. As it did, I was still crouching a bit on the left peg and holding the left handlebar but the bike lost inertia faster than me so I went above the front. I was pretty low already and started rolling and sliding. So the bike did a Kind of lowside but going straight and I went in front only when it was fully on the side. Also, I was really lucky not to be pushed by the bike as it passed me on my left.
Motorcycle dropped attachment, sliding along the roadway, I slid down the ditch

I jumped over motorcycle and road barrier
Bike went down on right side, I stayed on bike. It slid about 50 meters then flipped on other side and I was thrown over the bike
Separated about 1/2 second after impact as right leg was trapped between car and bike. Once energy was transferred to bike from car (also traveling in a 60 kph zone but speed unknown) the bike spiralled about 20 meters in a direction of 10 o-clock from my original direction of travel and I bounced off the hood and wind-shield and travelled 60-70 meters in a direction of about 11:40 o'clock according to police
I was thrown to a height of about 3 meters and I hit the traffic lights with my back falling on the edge of the sidewalk
I managed to "slip away" from the bike and it fell and I avoided it ending up on me. I ended up on the road.
I hit a pole and fell off the bike
I was hit from behind by another vehicle
I didn't fall.
I hit on the left side and overturned motorcycle on its right side. My fall was first on the hood of the vehicle from behind and then rolling towards the asphalt.
I was dragged for about thirty meters but remaining attached to the car with the bike and then once the car was stopped I fell to the right with the bike too
The low speed didn't throw me of the bike, but implode on myself
Slipped on the right fell to the front
Did not leave bike at point of impact but a distance after going down on left side.
Slid down the back of a car
The motorcycle hit paving stones about 0.5 meters before the guard rail , which threw me right into the guard rail
Impact from the rear, leaving fired from the front of the motorcycle.
Tee boned
Threw sideways
Fell on top of the Motorcycle which was sliding on its left side
The bike rolls on the right side down a slope with me on it
Off to the side of the motorcycle; rolled on the ground.
I was thrown towards the guardrail.
Highside on the green strip of the oncoming lane and I was thrown off to the left
Turned left, motorbike went straight
Driving instructor said, if it happens, let go and relax. I let go.
Highside on the green strip of the oncoming lane.
Flew over the handlebars in the collision with the car in front
I was thrown off to the left side of the road from the impact
Launched from the motorcycle into a ditch
I fell off my bike. My bike went straight ahead, and I followed
Car impacted my left of the bike, flung me to the right next to the road
Was thrown off of the motorcycle due to the impact. I was 5m away from the bike,...
When braking, I fell off the motorcycle. Motorcycle hit the barrier where the street narrowed, I hit the car.
First got caught between bike and truck, crushed my right side and leg stuck. Then was thrown off to the left of the bike.
Jumped off to the side
Jumped away from falling moped
Right side sliding into the ditch
Hit the car in front of me, motor then turned 180 degrees, fell off motor after motor fell on ground.
I made an emergency brake and stood still with my bike between my legs.
Tossed to the right from the bike over the hood of a car.
The bike slipped and fell during emergency braking, then i was separated from the bike, then after that the bike slid into the front of the car.
After I was side-swiped the motorcycle went left, and my body went right as my left leg was still slung over the motorcycle
Made some air straight up and landed 2 meters to the left on the other side of the road.
Front wheel got stuck between raised tram track and speed bump. I was propelled sideways and landed on the concrete tramway
Impact from the right hand side. Car over bike, me over car.
Jumped off on top of my bike
I pressed rear brake so I could slide down to get under a fence. But then there was a height difference of about 2 meters, zo de motorcycle fell in water and I flew over on land.
Fell to right
Flew a 7 meters and 3 high, landed on the footpath
I held on to the bike, crashed with it and flipped over to the verge in the roadside still together with the bike, only let go when we landed.

Not completely sure but I think I fell to the right after being punched by the right handlebar, then separated from the bike
On my first crash a car slammed into my right hand side on a roundabout with about 50 kph. On my second crash a van did not see me and didn't give me the right of way. Slid off the bike on second crash and flew on the first crash
I drive over the top of a small Hill and suddenly see the Bend going more left then I anticipated. I brake, the front wheel blocks, I fall off and the bike hits the Barrier with front wheel.
Fell off on right side. Bike stayed upright for another 10m.
My son jumped away
I got stuck with my right foot between the front fender and bodywork of the car. Due to impact of speed and momentum I hit the hood too. Somehow I crashed the headlight too
bike went to the left, I was thrown of moving straight ahead
I managed to stay on the bike
Motorcycle hit a curb, slowed down and fell over. I remained upright and standing over motorcycle.
I hit the trailer. When i hit it, the bike and i fell to the left.
Over bonnet of taxi
A car opened its door into me while lane sharing, I collided with the car next to me after the initial impact and went over the front handle bars

Annex III: Comments on Trajectory and Back Injuries

Trajectory	Details of Back Injuries
Fell backwards	back injuries level of coccyx
Fell backwards	I sustained 5 broken vertebrae, # 3 through 7. Fractured right scapular, nine right side broken ribs and a jammed left index finger.
Fell backwards	Lower back
Fell backwards	Lower back, bruising. Done after few weeks rest and therapy.
Fell backwards	Backache
Highside and fell left	Back pain lower, finger pain
Highside and fell left	Fractured 4 vertebrae in lower back in contact with guard rail
Highside and fell left	Back
Highside and fell left	Back, hips, legs
Highside and fell left	Shoulder AC joint dislocation and severe hematoma on my lower back where the skin ripped off the muscle flesh underneath. No cuts, grazes or bleeding externally, only internal on lower back.
Highside and fell left	Spine at T12
Highside and fell left	Bruised big toe (probably overkill) and large superficial bleeding in the lumbar spine and buttocks.
Highside and fell left	broken wrist, ribs, sternum, vertebral fracture
Highside and fell left	Compression of the thoracic vertebrae
Highside and fell right	Broken back, broken ribs
Highside and fell right	Infarction of the spinal cord resulting in paralysis inferior and three years of wheelchair.
Highside and fell right	Lesions vertebra L
Highside and fell right	Low back injury
Highside and fell right	Minor muscle and nerve damage to lower back
Highside and fell right	Paraparesis severe in the lower and upper limbs causes spinal cervical area shock
Highside and fell right	Three fractures in back
Highside and fell right	vertèbre de c1ssee et un compression sur 2 autres vertèbres
Highside and fell right	vertebra fractured - two
Left lowside - fell over to the left	Back
Left lowside - fell over to the left	Cracks in the spine/neck vertebrae
Left lowside - fell over to the left	Explosion of the acetabula and lesion of the sciatic nerve (right)
Left lowside - fell over to the left	Back
Left lowside - fell over to the left	Spiral fractures to Tibia and Fibula
Other	a knee and the lower back
Other	Back
Other	Burns on the buttocks
Other	Broke a bone in my back
Other	cracked vertebra
Other	Fracture and bursting of the vertebra D5.
Other	Had 6 months of physio for my back, neck and shoulders every muscle was sore from impact.
Other	Back, Shoulder blade
Other	There were indications of spine damage on the initial CT scan, however I have not had any back problems since then.
Other	Two fractures in my back , two broken ribs
Other	Backache
Right lowside - fell over to the right	Back
Right lowside - fell over to the right	Fracture Iliac bone
Right lowside - fell over to the right	Fracture of the right scapula + fracture of the 3rd lumbar sprain and sprain of the left ankle plus dermabrasion on both hands and forearm
Right lowside - fell over to the right	Fractures cervical and lumbar vertebrae
Right lowside - fell over to the right	Fractures right hand and vertebra L5
Right lowside - fell over to the right	Right clavicle fracture. Right humorous fracture. Spinal vertebrae burst with synthesis of bars and vines, lesion of the right deltoid. Subdural spillage.
Right lowside - fell over to the right	Sacral area

Right lowside - fell over to the right	Spinal
Right lowside - fell over to the right	Spine
Right lowside - fell over to the right	Three broken vertebrae, two punctured lungs, eight broken ribs, broken left shoulder blade and concussion.
Topside, over the front of the handlebars	Back Broken. Ribs Broken. Brain bleeding. Hand broken
Topside, over the front of the handlebars	Back injury
Topside, over the front of the handlebars	back pain
Topside, over the front of the handlebars	Broke my back
Topside, over the front of the handlebars	Broke my spinal cord and breast bone
Topside, over the front of the handlebars	Broke two vertebrae's (spine/back)
Topside, over the front of the handlebars	Broken collar bone, three broken ribs, broken pelvis front and back on both sides and a pneumothorax.
Topside, over the front of the handlebars	Broken humorous left side. Muscle pains in shoulder and lower back
Topside, over the front of the handlebars	Bruising on back
Topside, over the front of the handlebars	Compression fracture of L2 and L3
Topside, over the front of the handlebars	Compression fractures i T2 and T3
Topside, over the front of the handlebars	A vertebra was broken
Topside, over the front of the handlebars	Fractured in upper and lower back
Topside, over the front of the handlebars	fractured vertebra, fractured ribs
Topside, over the front of the handlebars	Hip, lungs, backbone
Topside, over the front of the handlebars	Crushed a vertebra in the lumbar spine. Despite approved back protection.
Topside, over the front of the handlebars	Massive spinal injury
Topside, over the front of the handlebars	"Scrotal wounds, knee wounds, pleural detachment, vertebral fracture D2"
Topside, over the front of the handlebars	Spine falls flat on the back, 2 fractured vertebrae, may be by the dorsal reinforcement of the jacket ...
Topside, over the front of the handlebars	Spine L2 had a fracture and tail (trauma) traumatized.
Topside, over the front of the handlebars	Back injury, compressed disks
Topside, over the front of the handlebars	Wound damage, friction. Butt, low back
Topside, over the front of the handlebars	Spinal fracture
Topside, over the front of the handlebars	Spinal injuries
Topside, over the front of the handlebars	T8 fracture
Topside, over the front of the handlebars	Two fractures in back - T6 and S1
Topside, over the front of the handlebars	Vertebrae with fractures

Annex IV: Additional Tables

Table I

Country of Crash	N/A	LEFT	RIGHT	Total
No Answer	6			6
Åland			1	1
Argentina			2	2
Australia		126		126
Austria			55	55
Belgium			48	48
Canada			35	35
Chile			1	1
Colombia			2	2
Croatia			2	2
Denmark			2	2
Finland			8	8
France			328	328
Germany			55	55
Greece			24	24
Guyane Française		1		1
Hong Kong		3		3
Hungary			2	2
India		2		2
Ireland		5		5
Italy			83	83
Lithuania			1	1
Luxemburg			3	3
Marocco			1	1
Martinique			1	1
Montenegro			1	1
Nepal		1		1
New Caledonia			1	1
New Zealand		4		4
Norway			115	115
P.R. of China			1	1
Poland			1	1
Romania			4	4
South Africa		7		7
Spain			22	22
Sweden			206	206
Switzerland			10	10
Thailand		3		3
The Netherlands			240	240
UK		104		104
USA			61	61
Total	6	256	1316	1578

Table II

Make	Frequency	Percent
Honda	341	21.6
Yamaha	249	15.8
BMW	197	12.5
Suzuki	190	12
Kawasaki	158	10
Triumph	97	6.1
Harley Davidson	79	5
Ducati	59	3.7
KTM	42	2.7
Aprilia	34	2.2
Moto Guzzi	28	1.8
No Answer	14	0.9
Piaggio	11	0.7
Vespa	9	0.6
Victory	8	0.5
Buell	5	0.3
Mv Agusta	4	0.3
Sym	4	0.3
Cagiva	3	0.2
Derbi	3	0.2
Husqvarna	3	0.2
Hyosung	3	0.2
Royal Enfield	3	0.2
Bajaj	2	0.1
Beta	1	0.1
Brixton	1	0.1
Can Am Spyder	1	0.1
Chopper	1	0.1
CZ	1	0.1
Fantic	1	0.1
GasGas	2	0.1
Gilera	1	0.1
Husaberg	2	0.1
Indian	2	0.1
Jingcheng	1	0.1
Keeway	1	0.1
Kymco	2	0.1
Lifan	1	0.1
LML	1	0.1
Mash	1	0.1
Matchless	1	0.1
MBK	1	0.1
Ovetto	1	0.1
Peugeot	1	0.1
Rieju	2	0.1
Shineray	1	0.1
Superlight	1	0.1
Voxan	1	0.1
Yosung	1	0.1
Zero (Electric)	1	0.1
Zongshen	1	0.1
Total	**1578**	**100**

Table III continues from Chapter 10 (10.4) and identifies n.26 riders who collided with a road side crash barrier but who did not leave any comment about the circumstances of the crash. * indicates motorcycle friendly crash barriers.

Table III

	Road Conditions	Country of Crash	Licence	ABS	Speed	Brake prior to crash	Trajectory
1	Icy surface	The Netherlands*	Full licence (A in Europe)	Yes	51 to 60 kph	No	Left lowside - fell over to the left
2	Water on road	Sweden	Full licence (A in Europe)	Yes	31 to 40 kph	No	Left lowside - fell over to the left
3	Good condition	Sweden	Full licence (A in Europe)	No	71 to 80 kph	Yes	Highside and fell left
4	Good condition	Sweden	Full licence (A in Europe)	Yes	21 to 30 kph	No	Right lowside - fell over to the right
5	Good condition	Austria	Full licence (A in Europe)	No	21 to 30 kph	No	
6	Gravel or loose dirt	Norway	Full licence (A in Europe)		81 to 90 kph	Yes	Highside and fell left
7	Good condition	Austria	Full licence (A in Europe)	No	81 to 90 kph	Yes	Topside, over the front of the handle Bars
8	Water on road	Greece	Full licence (A in Europe)	No	More than 130 kph	Yes	Don't know
9	Other	UK	Full licence (A in Europe)	Yes	31 to 40 kph	No	
10	Gravel or loose dirt	Norway	Full licence (A in Europe)	No	31 to 40 kph	Yes	
11	Gravel or loose dirt	France	125cc (A1 in Europe	No	31 to 40 kph	Yes	Fell back wards
12	Slippery surface (oil)	France	Full licence (A in Europe)	No	41 to 50 kph	Yes	Highside and fell right
13	Good condition	France	A2 in Europe	Yes	61 to 70 kph	Yes	
14	Gravel or loose dirt	Italy	Full licence (A in Europe)	No	11 to 20 kph	Yes	Topside, over the front of the handle bars
15	Gravel or loose dirt	Sweden	Full licence (A in Europe)	Yes	51 to 60 kph	Yes	Other
16	Other	Sweden	Full licence (A in Europe)	No	91 to 100 kph	No	Left lowside - fell over to the left
17	Good condition	Germany	Full licence (A in Europe)	No	81 to 90 kph	Yes	Other
18	Good condition	Norway	Full licence (A in Europe)	No	111 to 120 kph	No	Left lowside - fell over to the left
19	Slippery surface (oil)	Norway	Full licence (A in Europe)	No	1 to 10 kph	Yes	Left lowside - fell over to the left
20	Good condition	The Netherlands	Full licence (A in Europe)	No	More than 130 kph	Yes	Topside, over the front of the handle bars
21	Icy surface	The Netherlands	A2 in Europe	Yes	51 to 60 kph	No	Left lowside - fell over to the left
22	Good condition	The Netherlands	Full licence (A in Europe)	No	61 to 70 kph	Yes	Other
23	Good condition	The Netherlands	Full licence (A in Europe)	No	21 to 30 kph	Yes	Left lowside - fell over to the left
24	Water on road	Germany	Full licence (A in Europe)	No	51 to 60 kph	Yes	Other
25	Slippery surface (oil)	The Netherlands	Full licence (A in Europe)	No	71 to 80 kph	Yes	Left lowside - fell over to the left
26	Water on road	The Netherlands	125cc (A1 in Europe)	No	1 to 10 kph	No	Right lowside - fell over to the right

Table IV

Style	If you were separated from your motorcycle, which way did you go?									Total
	N/a	**Don't know**	**Fell back wards**	**High side and fell left**	**High side and fell right**	**Left low side - fell over to the left**	**Other: Annex II**	**Right low side - fell over to the right**	**Topside, over the front of the han-dle bars**	
N/a	2	0	0	0	0	0	0	1	2	5
	40%	0%	0%	0%	0%	0%	0%	20%	40%	100%
Adventure	70	7	7	8	10	44	17	43	45	251
	28%	3%	3%	3%	4%	18%	7%	17%	18%	100%
Cruiser	26	2	0	6	5	15	4	16	13	87
	30%	2%	0%	7%	6%	17%	5%	18%	15%	100%
Custom	29	3	2	4	3	18	3	15	7	84
	35%	4%	2%	5%	4%	21%	4%	18%	8%	100%
Moped	1	2	0	0	3	5	1	1	2	15
	7%	13%	0%	0%	20%	33%	7%	7%	13%	100%
Naked - Streetbike	111	11	12	27	24	107	24	69	99	484
	23%	2%	2%	6%	5%	22%	5%	14%	20%	100%
Scooter	10	3	1	2	3	17	5	4	7	52
	19%	6%	2%	4%	6%	33%	10%	8%	13%	100%
Sports Tourer	43	7	7	9	9	26	13	27	27	168
	26%	4%	4%	5%	5%	15%	8%	16%	16%	100%
Supermoto	4	0	1	0	2	5	5	2	6	25
	16%	0%	4%	0%	8%	20%	20%	8%	24%	100%
Supersport	41	7	5	12	14	47	18	42	46	232
	18%	3%	2%	5%	6%	20%	8%	18%	20%	100%
Touring	29	6	1	5	10	21	10	14	22	118
	25%	5%	1%	4%	8%	18%	8%	12%	19%	100%
Trail/ Enduro (Off road)	13	0	1	2	5	6	5	10	11	53
	25%	0%	2%	4%	9%	11%	9%	19%	21%	100%
Other	0	0	0	0	0	2	1	0	1	4
	0%	0%	0%	0%	0%	50%	25%	0%	25%	100%
Total	**379**	**48**	**37**	**75**	**88**	**313**	**106**	**244**	**288**	**1578**
	24%	**3%**	**2%**	**5%**	**6%**	**20%**	**7%**	**15%**	**18%**	**100%**

Annex V: Short CV of Authors

Elaine Hardy

Elaine has a Bachelor of Arts degree in Economics and a doctorate in Social Research from the University of Warwick, United Kingdom. As a research analyst and project manager, Elaine has carried out numerous studies. From 1995 to 2003 her research focussed on the automotive sector, specifically, she specialized in vehicle crime and wrote reports on the topic for organisations including the OECD/ITF, UK Home Office and National Crime Intelligence Service UK. She presented her findings at Interpol Conferences and regularly attended Europol Meetings. Her PhD thesis “Fear of Crime and Vested Interests: A Case study of Motorcyclists” brought her to the world of motorcycling. From 2004, she became actively involved in research on motorcycles and road safety. She was Research Officer for the Federation of European Motorcyclists Association between 2004 and 2009 where she represented this organisation in four EU funded projects on Motorcycle Safety. Between 2010 and 2015, she analysed the reports of the Forensic Science Northern Ireland Crash Investigation Team and wrote in depth reports on n.150 road traffic fatalities in that region.

Dimitris Margaritis

Dimitris Margaritis, BSc in Automotive Eng, MSc in Environment Protection, and graduate of the Pedagogical and Technological Education institute in Greece. He is also PhD and Dipl.-Eng. Mechanical Engineer candidate, both at AUTh, Greece.

He is a Research Associate primarily in the area of Traffic Safety and Transport Greening. Since 2006 he works at CERTH/HIT. He has been responsible for the “Clean Vehicle” Lab (2008-2010), the “Environmental and Energy Impact of Transport Systems” Lab (2006-2017) and he is responsible for the "Institute data analysis, Impact Factors and success Indicators Assessment" Lab, as well as for the ISO 9001-2015 process quality system of I.MET. He is the creator and coordinator of the “Mobile Lab for Environmental and Traffic Measurements” and of the clean vehicle infrastructure. Since 2011, he has also been teaching at the ATEI Vehicle Technology department as a part-time lecturer. From 1999-2006 he worked for the Crash Safety department at TNO Automotive in The Netherlands. He contributed to the establishment of the first in-depth accident research team in The Netherlands. Among his accident analysis activities, he participated in EuroNCAP crash tests.He has been involved in more than 40 national (Greek and Dutch) and EU research projects. He actively contributed to all accident analysis studies in Europe since 1999 (including the relevant with this study MAIDS and SaferWheels). He jointed networks such as EEVC WG21, APSN, ECTRI TWG-B. He was the national representative in ITF/OECD Working Group on Motorcyclists Safety and co-author of the “Improving Safety for Motorcycle, Scooter and Moped Riders” report. He is the chairman of FIM Europe Public Affairs Committee and member of the same Committee in FIM Global. He has authored and co-authored about 50 journal and refereed conference articles.

James V Ouellet

Jim Ouellet lucked into a career in motorcycle accident analysis by responding to a classified advertisement in the Sunday newspaper. Professor Harry Hurt Jr. of the University of Southern California hired him in 1975 to work on the landmark Hurt study. Over the next six years he investigated hundreds of motorcycle accidents at the crash scene, while riders, police and vehicles were still present. He disassembled and analyzed damage to hundreds of crashed helmets and reconstructed crashes to determine speeds, evasive actions, crash cause and helmet performance. He is a co-author the so-called 1981 Hurt Report. In addition, he has authored or co-authored papers with his Hurt study colleagues, Professor Harry Hurt and David Thom. Over the decades he also consulted with attorneys as an expert on thousands of motorcycle accidents, where issues that arose in court cases sometimes led eventually to papers published in conferences and journals.

Mr. Ouellet helped train the accident investigation team at Chulalongkorn University in Bangkok, later oversaw the accident reconstruction and analysis from those cases and contributed to writing the final reports. He has co-authored a number of papers with the Thailand principal investigator, Dr. Vira Kasantikul. In addition he has written papers on collision avoidance, accident investigation, environmental hazards, leg injuries, groin injuries, accident causation, research methods, alcohol effects, comparisons of Hurt and Thailand study data, helmet ejection, helmet effects on head and neck injuries.

Martin Winkelbauer

Martin Winkelbauer graduated in Mechanical Engineering at the Vienna Technical University in 1991. He joined the Austrian Road Safety Board in 1993. He spent the first years working on the fields of driver education and vehicle technology. Later, he extended his working field towards efficiency assessment of road safety measures. Today, he holds the position of a senior researcher managing and participating in research projects on national and international level on various fields of road safety. His focus is still on vehicle-related safety issues and driver education, but also cargo securing, motorcycle safety, efficiency assessment and general issues of international cooperation.

He was co-ordinator of the SUPREME project, work package leader in “Powered two-wheeler behaviour and safety”, responsible for dissemination in “PROLOGUE” and for motorcycle safety in “UDRIVE”. Just recently he took part in the work package on the impact of the New Union Model Licence in the evaluation of the 3rd Driving Licences Directive. His current main occupation is a project on renewal of the Austrian AM driving test.

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