

Analysis of Motorcycle-involved Crashes in the Philippines from 2010-2019

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ABSTRACT

Background. This is a 10-Year retrospective study of motorcycle crashes in the Philippines, which are among the top 9 causes of death in the country. Hence, the need to quantify the severity of motorcycle-involved crashes.

Objectives. The objectives of the study are to determine the epidemiology of motorcycle-involved crashes and to investigate the trend of motorcycle-involved crashes, their proportion against other vehicle types, and how it associates with demographic, clinical, and other hospital and crash variables.

Methods. Online National Electronic Injury Surveillance System (ONEISS) was used to analyze trends, proportions, and associations for motorcycle-involved crashes. Descriptive and Inferential Statistics were computed to see how motorcycles relate to the other variables for each dataset.

Results. Motorcycle crashes comprised the largest percentage from 2010 to 2019, increasing to 6,136 cases and 21,580 cases, respectively. The year 2018 recorded the highest number of motorcycle crash cases with 32,543, which decreased in 2019. The average age of victims of motorcycle-related road crashes is 30.03 years (SD = 14.799). The majority are males (78.2%), single (14.7%), and drivers (65.8%). Linear regression shows that alcohol consumption increases odds for sustaining multiple injuries (OR = 1.826, 95% CI [1.746-1.910]) concussion (OR = 1.158, 95% CI [1.068-1.255]), avulsion (OR = 1.589, 95% CI [1.478-1.708]), and abrasion (OR = 1.545, 95% CI [1.480-1.613]) while being male (OR = 1.552, 95% CI [1.280-1.881]) and lack of sleep (OR = 2.980, 95% CI [1.759-5.047]) increases odds of death among motorcycle-related crash patients.

Conclusion. The study showed an increase in motorcycle-related crashes in the Philippines from 2010 to 2019 and the overall impact of motorcycle-involved crashes on drivers and pedestrians. Motorcycles are also the most involved vehicle type in road crashes, and therefore, policies and programs to reduce and prevent motorcycle crashes should be strengthened to prevent motorcycle-related fatalities on the roads.

Keywords: motorcycle crash, length of hospitalization, motorcycle-related injuries, motorcycle fatality



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INTRODUCTION

Road traffic accidents (RTA) are a global problem. In the year 2000, 1.5 million deaths were recorded from road accidents. Around 1.35 million people die of road traffic accidents annually, indicating that the accidents in relation to road traffic are continuously rising.^{1,2} In fact, road traffic accidents are the leading cause of death for children and young adults aged 5 to 29 years of age, and are the 8th leading cause of death for all ages.²

RTAs cause a GDP loss of 3% yearly and pose decreased productivity among victims and increased hospital care costs. Ironically enough, more than 90% of deaths due to road crashes occur in low- to middle-income countries (LMICs),

and even in developed countries, those with low economic status are more prone to RTAs.³ Statistics show that the risk of dying is three times higher in developing countries, with Southeast Asia being placed after Africa for road traffic death risk.⁴ Similar to the global trends, the cases of road traffic deaths in the Philippines – a middle-income country – are continuously rising, with an estimated 12,690 claimed lives in 2016. The vulnerable road users – motorcyclists, pedestrians, and cyclists – account for approximately half of the recorded road traffic statistics.⁵ The focus of this study is on motorcycles, and the study aims to investigate the trend of motorcycle-involved crashes, their proportion against other vehicle types, and how it associates with demographic, clinical, and other hospital and crash variables.

METHODS

The dataset in this study came from the Department of Health's (DOH) Online National Electronic Injury Surveillance System (ONEISS). ONEISS is a web-based system developed by DOH with the facility to electronically capture injury-related data from health facilities, store data in a centralized and secure location, process, consolidate, and transform data into meaningful information. It establishes a common or standard set of injury-related data elements collected for surveillance and standards to facilitate collection, management, transmission, analysis, access, dissemination, and sharing of data. ONEISS was initially implemented in 6 pilot hospitals, but today it has expanded to include more than 80% of all government and private hospitals and infirmaries in the Philippines. Health facilities with training on ONEISS are required to report injuries they managed to

the system. The researchers secured a request to acquire the ONEISS database from 2010 to 2019 (2nd quarter), subject to guidelines approved by DOH-SJREB, which explicitly approved the protocol and study.

The ONEISS houses a wide variety of variables. Demographic variables include age, gender, and civil status. There are also data on pre-admission, such as attendance in the ER and OPD, first aid management, place of injury (POI), time of injury (TOI), nature of injury (NOI), external cause of injury, and intent. ONEISS also keeps track of patients' severity, ER outcome, in-patient outcome, disposition, and transport details. For Transport and Vehicular Crash cases, risk factors such as drug use, alcohol use, mobile phone use, seatbelt and helmet use are included. There are also data on vehicle type, place of crash, and activity for transport and vehicular crash cases. Based on the ONEISS dataset, the total road crashes per year are shown in Figure 1. Due to the large database from hospitals all over the Philippines uploading to the ONEISS of DOH, the results of the descriptive and inferential statistics can be deemed generalizable to the target population.

RESULTS

Motorcycle-related crashes relative to other transport vehicles from 2005 to 2019 are shown in Figure 2. Motorcycle-involved crash patients compose the largest percentage throughout the years, and the highest peak was in the first quarter of 2019. This is followed by pedestrians involved in vehicular crashes.

The trend of motorcycle-related road crashes from 2010 to 2018 is an increasing trend, recording the highest motorcycle crashes and 2010 recording the lowest. There is also an

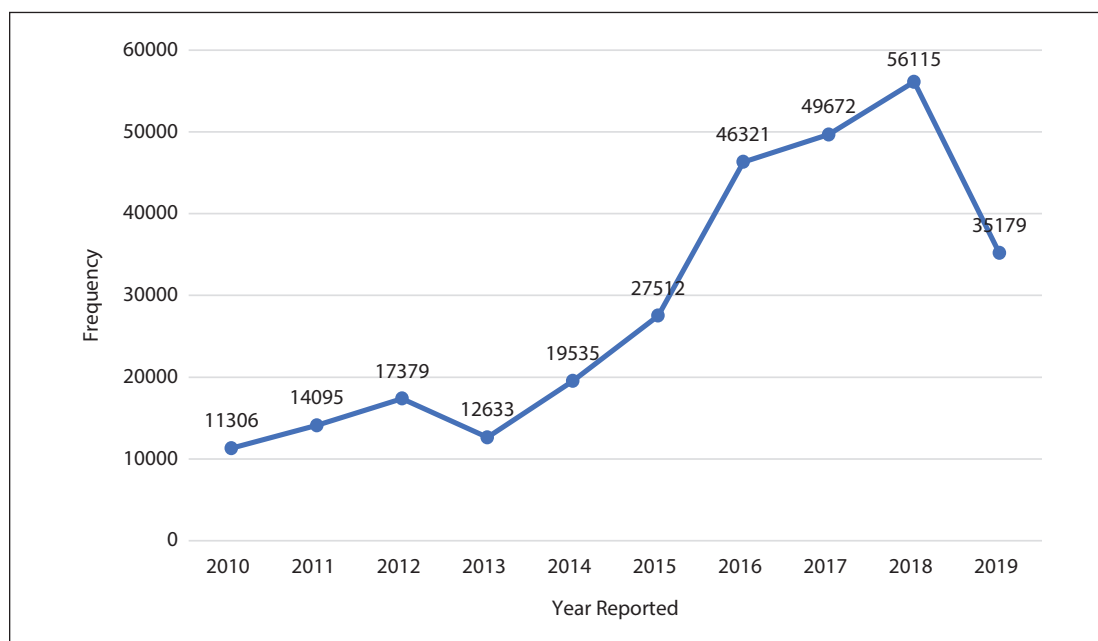


Figure 1. Total road crashes from 2010 to 2019 based on ONEISS from 2010-2019.

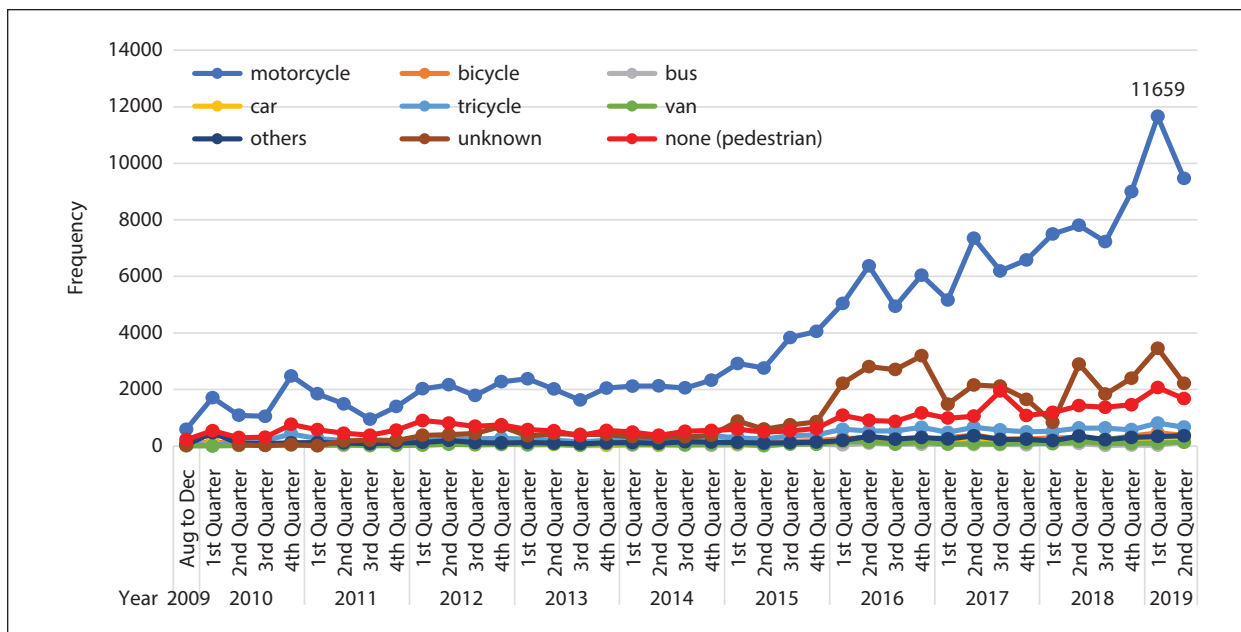


Figure 2. Trend of motorcycle-involved crash patients from 2010-2019.

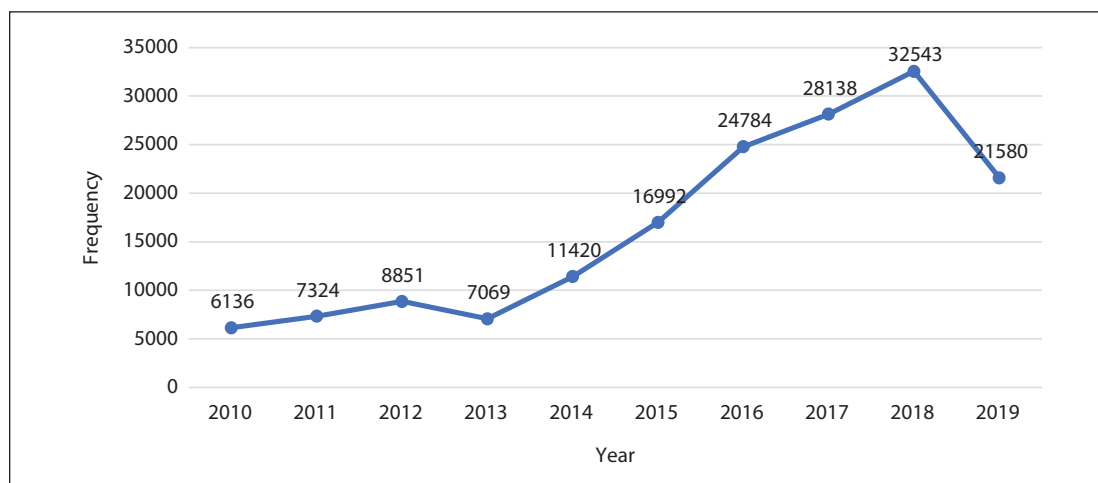


Figure 3. Trend of motorcycle-related road crashes from 2010 to 2019 (N = 168,934).

observable decline from 2018 to 2019; however, this could be due to the incomplete data gathered for 2019 (Figure 3).

The majority of the road crash patients were within the productive age group. The average age of the admitted patients is 30.03 years (SD = 14.799). With an age range of 26 to 29 years accounting for the majority of the victims, followed by 17 to 25 years old, road crash victims are in their productive age (Table 1).

More than half were non-collision. On the other hand, the most involved in road crashes are drivers, and the most common place of crashes is on the roads (Table 2).

More than half of the motorcycle-related road crash patients sustained multiple injuries, specifically, abrasions, wounds, contusions, closed fractures, and avulsions.

The majority (92.2%) of the road crash victims are brought to the Emergency Room, and most are conscious and alive, while patients who are dead or dead-on-arrival only comprised a small part (Table 3).

For safety measures, the majority do not have safety measures in their respective vehicles. The majority reported alcohol use (n = 21,560) as the most common risk factor.

Figure 4 shows the motorcycle proportion over total vehicular crash cases from the ONEISS. The year 2015 recorded the highest proportion, while 2012 recorded the lowest. The trend in motorcycle-involved crashes is constantly increasing over the years (Figure 5).

Table 1. Socio-demographic Characteristics of Motorcycle Road Crash Patients from 2010 to 2019 (N = 168,934)

Variable	Frequency	Percent
Age (years)		
16 and below	23,074	13.7
17 to 25	52,929	31.3
26 to 39	53,041	31.4
40 to 64	35,639	21.1
65 to 74	2,975	1.8
75 and above	997	0.6
Total (Valid)	168,655	99.8
Missing	279	0.2
Total	168,934	100.0
Sex		
Female	33,260	19.688
Male	119,455	70.711
Total	152,715	90.399
Missing	16,219	9.601
Civil Status		
Single	24,876	14.725
Married	15,792	9.348
Widowed	493	0.292
Live-in	136	0.081
Separated	70	0.041
Total	41,367	24.487
Missing	127,567	75.513

Logistic Regression Models

Logistic Regression was done within the motorcycle crash victim subset of the ONEISS database. Dependent variables considered are Patient Death and injury types. Independent variables used were socio-demographics (Sex, Consult type, victim type) and risk factors (alcohol intake, drug intake, smoking, sleep, helmet use).

In each of the models, the variables entered are selected through Forward Selection with a criterion for entry set

Table 2. Frequency Distribution of Motorcycle Road Crash Patients' Collision Type, Victim Type, Place of Crash, Activity, and Consult Type (N = 168,934)

Variable	Frequency	Percent
Collision Type		
Non-Collision	108,239	64.1
Collision	60,532	35.8
Total	168,771	99.9
Missing	163	0.1
Total	168,934	100.0
Victim Type		
Driver	111,132	65.8
Front Passenger	4,865	2.9
Rear Passenger	41,992	24.9
Pedestrian	2,535	1.5
Others	133	0.1
Unknown	7,595	4.5
Total (Valid)	168,252	99.6
Missing	682	0.4
Total	168,934	100.0
Place of Crash		
Road	166,695	98.675
Home	252	0.149
School	203	0.120
Workplace	128	0.076
Videoke Bars	27	0.016
Others	219	0.130
Unknown	1,409	0.834
Total	168,933	99.999
Missing	1	0.001
Activity		
Leisure	58,479	34.616
Work Related	8,513	5.039
Sports	638	0.378
Others	9,419	5.576
Unknown	82,291	48.712
Total	159,601	94.475
Missing	9,594	5.679

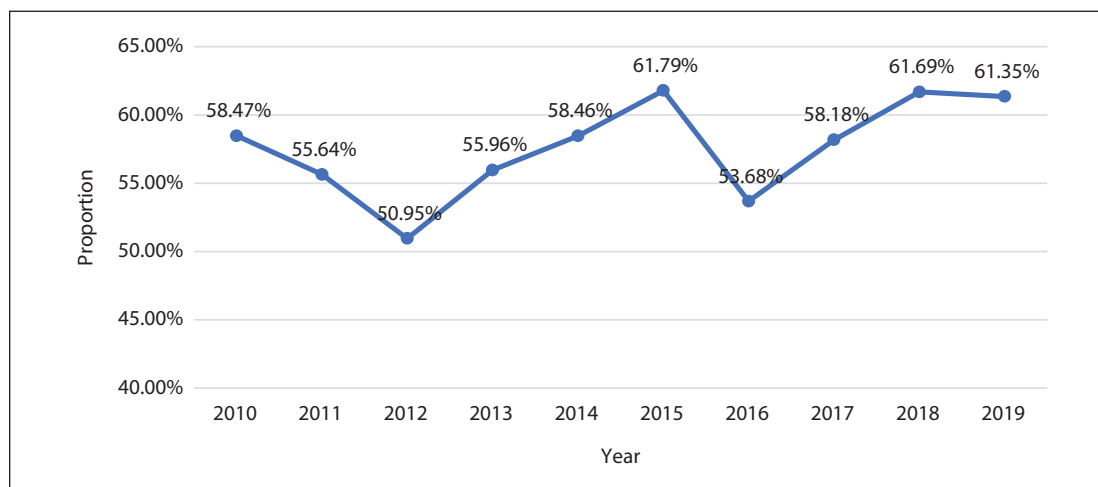


Figure 4. Proportion of motorcycles in total crash cases from 2010 to 2019.

at 0.05. For the linear regression on patient death, 92,655 cases are considered. Nagelkerke R-square suggests that the model explains up to 1.3% of the variance in the dependent

Table 3. Frequency Distribution of Motorcycle Road Crash Patients' Consult Type, Status, and Outcomes

Variable	Frequency	Percent
Consult Type		
Emergency Room	155,774	92.210
OPD - New Case	8,614	5.099
OPD Revisit	571	0.338
OPD	3,738	2.213
In Patient	237	0.140
Total	168,934	100.000
Status		
Alive	22,636	13.4
Alive (Conscious)	141,669	83.9
Alive (Unconscious)	2,669	1.6
Dead/Dead on Arrival	507	0.3
Total (Valid)	167,481	99.1
Missing	1,453	0.9
Total	168,934	100
Outcome		
	Emergency Room	In-Patient
Died	790	651
Improved	127,468	22,689
Unimproved	8,764	3,696
Total (Valid)	137,022	27,036
Missing	31,912	141,898
Total	168,934	168,934

variable. Results show that motorcycle crash patients who are intoxicated with alcohol have an increased odds ratio of patient death by 98.5%. On the other hand, motorcycle crash patients who are sleepy have an increased odds ratio of patient death by 198%. Motorcycle crash patients who are using mobile phones have an increased odds ratio of patient death by 91.5%. Motorcycle crash patients who use helmets have a decreased odds ratio of patient death by a factor of 0.675. Male motorcycle crash patients have an increased odds ratio of patient death by 43.9%. Smoking is not a significant risk factor for patient death.

The same number of cases was considered for linear regression on multiple injuries among road crashes involving motorcycles. Results show that motorcycle crash patients who are intoxicated with alcohol have an increased odds ratio of suffering multiple injuries by 60.2%, and those who smoke have an increased odds ratio of suffering multiple injuries by 31%. Non-helmet use is associated with multiple injuries, increasing the odds ratio by 27.9% (Table 4).

Table 5 shows the odds ratio of sustaining specific injuries such as abrasion, concussion, and contusion with specific risk factors such as alcohol use, non-use of a helmet, among others, and certain types of road users, either driver, passenger, or pedestrian. For instance, motorcycle victims who are intoxicated with alcohol have an increased odds ratio of suffering abrasion by 54.5%, and those who do not use a helmet are more likely to sustain multiple injuries by 65.2%. Table 6 also shows the increased risk of certain types of injuries such as closed fracture, open fracture, and open wounds with alcohol use and smoking, and that drivers are more affected than passengers or pedestrians.

Table 4. Linear Regression on Patient Death and Multiple Injuries among Road Crashes Involving Motorcycles

Independent Variables	Parameter Estimate	Standard Error	p-value	Odds Ratio	95% CI for OR	
					Lower	Upper
Patient Death						
Alcohol	0.686	0.082	<0.001	1.985	1.692	2.329
Sleep	1.092	0.269	<0.001	2.980	1.759	5.047
Smoke	-1.335	0.715	0.062	0.263	0.065	1.069
Mobile Phone	1.915	0.609	0.002	6.787	2.057	22.396
Helmet	-0.675	0.292	0.021	0.509	0.288	0.902
Sex (Male)	0.439	0.098	<0.001	1.552	1.280	1.881
Constant	-5.548	0.184	<0.001	0.004		
Multiple Injuries						
Alcohol	0.602	0.023	<0.001	1.826	1.746	1.910
Smoke	0.270	0.124	0.030	1.310	1.027	1.671
Helmet	0.246	0.046	<0.001	1.279	1.169	1.400
Driver	0.387	0.029	<0.001	1.473	1.392	1.557
Front Passenger	0.311	0.047	<0.001	1.365	1.245	1.496
Rear Passenger	0.342	0.031	<0.001	1.408	1.325	1.496
Pedestrian	0.606	0.050	<0.001	1.834	1.661	2.024
Sex (Male)	0.168	0.017	<0.001	1.182	1.143	1.223
Constant	-0.259	0.040	<0.001	0.772		

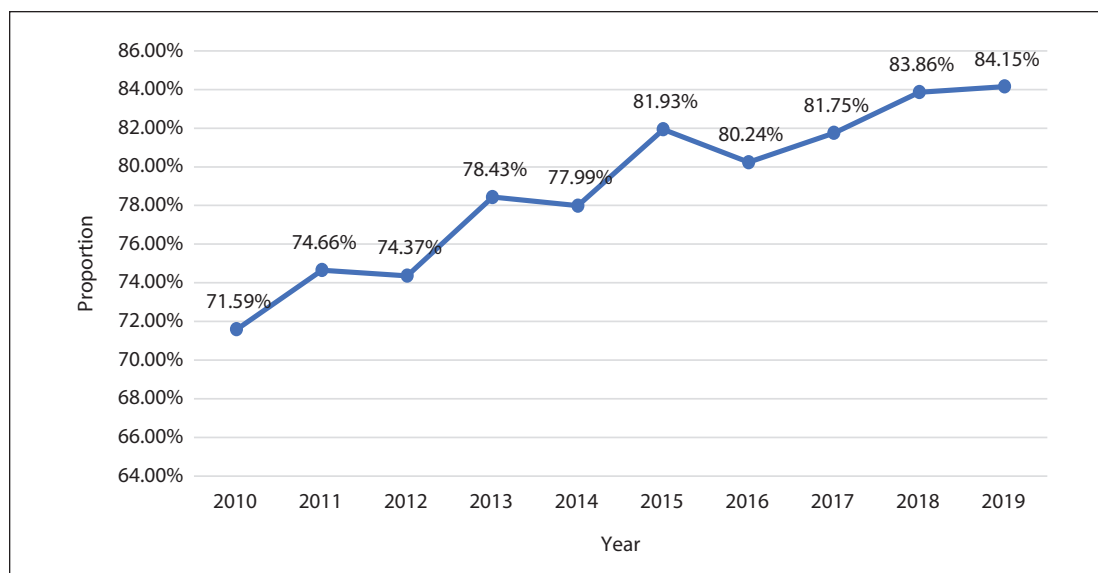


Figure 5. Proportion of motorcycles among total vehicles reported from 2010 to 2019.

DISCUSSION

This study focused primarily on motorcycle accidents in the Philippines. The results of this study showed that the trend of motorcycle accidents and admissions to hospitals is generally increasing throughout the years from 2010 to 2018. In comparison to the total vehicles involved in crashes, motorcycles are the majority throughout the years. This may be attributed to the large proportion of 2-wheeled vehicles (57.6%) in the Philippines.²

The productive age groups of 17 to 39 years old were the most involved in motorcycle accidents, and most were males. This is consistent with several studies in LMICs that showed that young males were the most mobile and the most widespread motorcycle users on the road.⁶ They are also more prone to engaging in risky behaviors such as speeding, drifting, one-wheeling competitions, rash driving, reckless and aggressive driving, impulsivity, and drunk driving as compared to older adults who are generally more experienced on the road and thus are more cautious.^{7,8} In this study, male motorcycle crash patients have increased odds of death due to motorcycle crashes by 43.9%, which is consistent with other studies exploring motorcycle accidents.⁹ Single people, although representing a small proportion among road crash victims, were also observed to be engaging in risky behaviors, as they have no children or spouses to support.¹⁰

Based on the study, more than half of the motorcycle accidents in the Philippines were non-collisions (a pedestrian is involved in the collision), and the rest were caused by collisions. Pedestrians are among the vulnerable road users. Elsewhere, pedestrians were found to be significantly involved in motorcycle crashes.^{2,11} Pedestrian accident cases can be compounded by a lack of safety measures, poor road infrastructure, and the absence of designated

and lighted crosswalks, road safety design, and traffic management.^{12,13} In some instances, pedestrians share paths with vehicles. In Metro Manila, sidewalks are narrow and could get congested during peak hours, which forces pedestrians to walk on roads opposite vehicles.¹³ It is also important to note that pedestrians are vulnerable to road crash collisions, that these accidents often result in fatal injuries and bodily harm, which was also found in this study, and that pedestrians have increased odds of suffering from multiple injuries by 83.4%.¹²

Aside from pedestrians, drivers are also common victims. Motorcycle drivers are deemed vulnerable because motorcycles are less safe, and are smaller, and lighter than cars, and lack structural support like an enclosure.^{14,15} The drivers are at risk of injuries because only helmets and clothing gear are their protection.¹⁶ Despite these risks, motorcycles are still favored in LMICs because it is cheaper, more mobile, easier to maneuver in heavy traffic, and require low maintenance.¹⁷

This study in the Philippines shows that the majority of motorcycle-related crash patients are engaged in unsafe and risky behaviors, which is generally alarming because the majority of the cases do not have safety measures in their vehicles. The helmet law in the Philippines was only signed in 2018, and the provisions for helmets were only made stricter thereafter. In Pakistan, of the 109,210 riders sampled, only 6% wore helmets, and in Lebanon, only 42% of the motorcycle riders wear helmets.^{18,19}

Wearing helmets is important to decrease the likelihood of deaths and cervical injuries, which is consistent with the findings of this study that helmet use decreases the chance of suffering a concussion, which is potentially fatal, especially if it leads to bleeding or swelling of the brain.^{18,20} In another study, head injuries are the most common injury sustained by motorcyclists.²¹ Full-face helmets were shown

Table 5. Linear Regression on Abrasion, Avulsion, Concussion, and Contusion among Road Crashes Involving Motorcycles

Independent Variables	Parameter Estimate	Standard Error	p-value	Odds Ratio	95% CI for OR	
					Lower	Upper
Abrasion						
Alcohol	0.435	0.022	<0.001	1.545	1.480	1.613
Sleep	0.317	0.106	0.003	1.373	1.115	1.689
Smoke	0.324	0.120	0.007	1.383	1.094	1.749
Helmet	0.502	0.047	<0.001	1.652	1.506	1.812
Driver	0.899	0.030	<0.001	2.458	2.320	2.605
Front Passenger	1.148	0.048	<0.001	3.150	2.866	3.463
Rear Passenger	1.146	0.032	<0.001	3.146	2.955	3.349
Pedestrian	1.043	0.050	<0.001	2.837	2.572	3.129
Sex (Male)	0.079	0.017	<0.001	1.082	1.046	1.119
Constant	-0.727	0.041	<0.001	0.483		
Avulsion						
Alcohol	0.463	0.037	<0.001	1.589	1.478	1.708
Smoke	0.793	0.139	<0.001	2.210	1.683	2.901
Driver	0.584	0.080	<0.001	1.793	1.532	2.098
Front Passenger	0.500	0.115	<0.001	1.648	1.315	2.066
Rear Passenger	0.495	0.085	<0.001	1.640	1.389	1.937
Pedestrian	0.639	0.114	<0.001	1.895	1.516	2.368
Sex (Male)	0.509	0.043	<0.001	1.664	1.529	1.811
Constant	-4.340	0.109	<0.001	0.013		
Concussion						
Alcohol	0.146	0.041	<0.001	1.158	1.068	1.255
Helmet	-0.491	0.112	<0.001	0.612	0.492	0.762
Driver	-0.131	0.048	0.006	0.877	0.798	0.964
Front Passenger	-0.355	0.097	<0.001	0.701	0.579	0.848
Rear Passenger	-0.194	0.054	<0.001	0.824	0.741	0.915
Sex (Male)	-0.203	0.035	<0.001	0.816	0.763	0.873
Constant	-2.271	0.073	<0.001	0.103		
Contusion						
Smoke	-0.719	0.200	0.001	0.487	0.329	0.721
Front Passenger	-0.125	0.055	0.024	0.883	0.792	0.984
Pedestrian	0.257	0.053	<0.001	1.294	1.166	1.435
Sex (Male)	-0.542	0.021	<0.001	0.582	0.559	0.606
Constant	-0.822	0.037	<0.001	0.440		

to decrease fatalities as they are more protective than open or half-coverage helmets.²² Despite this, there is evident low compliance with the wearing of helmets by Filipinos, which may be due to the climate in the Philippines and other subtropical countries that are hot and humid, and wearing helmets is perceived as uncomfortable.^{7,22}

More so, the major risk factor in the study is alcohol consumption. In Brazil, 32.9% of the sampled motorcyclists consumed alcoholic drinks prior to accidents. Consumption of alcoholic beverages has been linked to risky behaviors on the road, such as speeding, not using a helmet, and not having a motorcycle license.¹⁷ This is because consuming alcohol impairs the normal function of the brain and central nervous system, which essentially results in a decline in alertness, decision-making, and motor skill coordination.^{23,24}

This study also found that alcohol consumption increases the odds of sustaining fatal and non-fatal injuries such as multiple injuries (concussion, avulsion, and abrasion which is consistent with other motorcycle crash studies.^{25,26}

Lack of sleep was also found to increase odds for fatal and non-fatal accidents such as death and abrasions, which is in line with the study of Tefft that found that drivers with less than 7 hours of sleep have increased odds of being involved in road crashes.²⁷ This is because sleep deprivation also affects reaction time, response accuracy, and attention, which are critical in road safety. A study by Tefft et al. showed that drivers who were awake for 21 hours continuously had impaired driving performance in speed and lane position, as they were at a blood alcohol concentration of 0.08 g/dL.²⁷

Table 6. Linear Regression on Closed Fracture, Open Fracture, and Open Wounds among Road Crashes Involving Motorcycles

Independent Variables	Parameter Estimate	Standard Error	p-value	Odds Ratio	95% CI for OR	
					Lower	Upper
Closed Fracture						
Alcohol	-0.469	0.036	<0.001	0.626	0.583	0.672
Sleep	0.432	0.135	0.001	1.540	1.182	2.005
Driver	0.092	0.038	0.015	1.096	1.018	1.181
Front Passenger	-0.166	0.073	0.023	0.847	0.733	0.978
Rear Passenger	-0.256	0.044	<0.001	0.774	0.710	0.844
Sex (Male)	0.166	0.028	<0.001	1.181	1.117	1.248
Constant	-2.344	0.060	<0.001	0.096		
Open Fracture						
Sleep	0.696	0.225	0.002	2.005	1.291	3.116
Rear Passenger	-0.276	0.062	<0.001	0.759	0.672	0.857
Sex (Male)	0.512	0.065	<0.001	1.668	1.468	1.896
Constant	-4.623	0.126	<0.001	0.010		
Sleep	0.696	0.225	0.002	2.005	1.291	3.116
Open Wound						
Alcohol	0.354	0.171	0.038	1.425	1.020	1.990
Sex (Male)	0.742	0.210	<0.001	2.101	1.392	3.170
Constant	-7.408	0.399	<0.001	0.001		

The most common injuries in the Philippine data were abrasions, wounds, and contusions. Sustaining multiple injuries in motorcycle crashes was also evident. In a study in Guinea among victims of motorcycle crashes, this contributed to poor patient prognosis.²⁸

The majority of the motorcycle-related road crash patients in both emergency and inpatient consultations improved. This could be attributed to motorcycle-to-motorcycle collisions as the most common vehicle collision type. In Pakistan, motorcycle-to-motorcycle collisions result in less fatal injuries because motorcycle riders can visibly see approaching motorcycles and have lower momentum than the impact brought by heavy vehicles, which often result in fatal injuries.^{7,12}

CONCLUSION

This study, coming from several hospitals in the Philippines, showed that among the transport/vehicular crash patients brought to hospitals in the Philippines from 2010 to 2019, approximately 58.21% were motorcycle-related. With respect to other vehicles only, motorcycles accounted for 71.59% in 2010, increasing to 84.15% during the first quarter of 2019. The trend of the involvement of motorcycles

in vehicular crashes is continuously increasing. Among the limitations and biases are the missing data due to incomplete uploading by hospitals in the online system; however, with the large dataset, this can be generalized, and the results are as good as the data that is available.

The study reveals that motorcycle accidents are the most involved in road crashes all over the Philippines. This calls for strict implementation of policies and programs in relation to motorcycles on the road, and a corollary efficient and effective post-crash response for this type of road accident.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

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