

Characteristics of Motorcycle Crashes

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Abstract— Motorcycles are popular in Asian countries including Sri Lanka and it is becoming an important part of transportation in the country. Despite its popularity, little research has been conducted to study the impact of motorcycles on road safety in Sri Lanka. The objective of this study was to investigate the risk factors of crashes involving motorcycles. Data was obtained from Police crash records which contain details of police-reported crashes, at all severity levels that occurred in Sri Lanka. Various characteristics such as environment, roadway, driver, and vehicle are analysed investigating the Odds-ratios so that potential countermeasures can be developed to improve roadside safety. Motorcycle crashes are rapidly increased in Sri Lanka last five years. More frequent crash conditions for motorcycle crashes occurred while driving on rural roadways, driving during week days in heavy traffic, and driving newer motorcycles. Dry road surfaces, clear weather conditions predominantly characterized motorcycle-crashes. This study adds detailed information about characteristics of motorcycle crashes and measures to improve motorcycle safety in Sri Lanka to the transportation safety literature.

Keywords— Motorcycle crashes, road safety, Crash data analysis

I. INTRODUCTION

Compared to other vehicle drivers, motorcycle riders vulnerable road users as they have lack of protection in the case of a crash. Therefore, motorcycle riders are often associated with high injury risks in the case of crashes. In order to improve the safety of these vulnerable road users, a number of studies have thus investigated the factors affecting motorcycle crash severity. Different factors affecting the motorcycle crashes consisting environmental, road, vehicle, and human elements. However, literature produced mixed results on the importance of different factors (Rifaat et al., 2012). These inconsistencies may be because differences in traffic composition at the road, driver behaviour, vehicle, and road factors in different geographical areas studied. Other reasons may be difference methodologies for data collection or different statistical methods for data analysis. Hence, it is important to conducted more studies using different estimation techniques and data from different

geographical areas to provide a more complete picture on the safety effects of these factors. The present research investigates the risk factors of crashes involving motorcycles and contributory causes using data from Sri Lanka.

The number of registered motorcycles in Sri Lanka is 2,546,447 in 2012, which is 52.2% of the total vehicle population [Department of Motor Traffic, 2015]. From 2008 to 2012, the number of registered motorcycles in Sri Lanka increased by 44.6%, with a corresponding 0.6% increase in model share. As the number of motorcycles increase, so does the probability of their being involved in motor vehicle crashes. In 2013, about 4,047 fatal motorcycle crashes occurred on Sri Lankan roads.

II. DATA AND METHODOLOGY

Data was obtained from Traffic Police Head Quarters' crash records which contains details of police-reported crashes, at all severity levels that occurred in Sri Lanka. The dataset contains information related to every police reported motorcycle crash in Sri Lanka integrating various driver-, vehicle-, environment-, and road-related characteristics that prevailed at the time of the crash. The severity of injury was determined and categorized as fatal, grievous injury, and non-grievous injury based on the level of injury sustained by the vehicle occupants. Crash severity was a variable used for analysis in this study, and was identified based on the highest level of injury severity sustained by the occupants involved in a crash.

The characteristics of crashes involving motorcycles in Sri Lanka were investigated, utilizing five years of data from 2009-2013. The number of motorcycle-involved crashes has increased during the last five years with the highest being observed in 2012. In this study the number of motorcycle-involved crashes were analysed. There could be more causalities due to motorcycle-crashes than the number of motorcycle-involved crashes.

To measure the association between crash severity and characteristics of crashes involving motor cycles, Odds-Ratios (ORs) and 95% Confidence Intervals (CIs) were calculated using binary logit analysis (Long, 1997). The OR is a widely used statistic in traffic safety studies for comparing whether the probability of a certain event is

the same for two groups. The "odds" of an event is defined as the probability of the outcome event occurring divided by the probability of the event not occurring (Long, 1997).

$$Odds = \frac{P(y = 1 / x_1, x_2, \dots, x_p)}{P(y = 0 / x_1, x_2, \dots, x_p)} \quad (1)$$

The ratio of odds of one variable (odds₁) and odds of other variable (odds₀):

$$odds\ ratio = \frac{odds_1}{odds_0} \quad (2)$$

is called Odds Ratio (OR). It gives the relative amount by which the odds a variable (odds₁) increase (OR > 1.0) or decrease (OR < 1.0) when the value of one of the predictor variables (odds₀) is increased by 1.0 unit. The dependent variable in these analyses was "high-risk", which was binary-variable based on whether the motorcycle crash was a fatal/ grievous injury crash or not.

This analysis, also called univariate analysis, is based on the assumption that the dependent variable is influenced by only one independent variable, while keeping all other variables constant. Independent variables included driver-, environmental-, road-, and vehicle-related characteristics.

III. RESULTS

Table 1 shows the characteristics of the motorcycle crashes occurred in Sri Lankan roadways during the years 2009 and 2013. The total number of motorcycle crashes during the five year period was 209,382 including 21,996 fatal crashes and 63,228 grievous injury crashes. The driver-, environmental-, road-, and vehicle-related characteristics were defined as binary variables and tabulated in the Table 1. More frequent crash conditions for motorcycle crashes were crashes occurred while driving on rural roadways, driving during week days, and driving newer motorcycles. Dry road surfaces, clear weather conditions predominantly characterized motorcycle-crashes.

Table 1: Odds Ratios for Motorcycle Crashes Occurred from 2009-2013 in Sri Lanka

Characteristics	Crashes		Odds Ratio	Univariate Analysis	
	Number of crashes	%		95 % Confidence Interval	
				Lower Bound	Upper Bound
<i>Driver-Related Characteristics</i>					
Male	189,122	90	1.134	1.101	1.168
Valid licensed	116,348	56	1.248	1.226	1.270
Safety helmet used	69,968	33	0.953	0.918	0.952
<i>Environmental-Related Characteristics</i>					
Not daylight	75,832	36	0.814	0.800	0.829
Clear weather	193,144	92	1.208	1.170	1.247
Week days	147,290	70	1.039	1.019	1,059
<i>Road-Related Characteristics</i>					
Urban roads	88,586	42	1.308	1.285	1.322
Location: intersection-related	56,684	27	1.153	1.130	1.176
Dry road surface condition	197,970	95	0.842	0.811	0.875
<i>Vehicle-Related Characteristics</i>					
Vehicle Age: Less than 5 years	135,668	65	0.997	0.979	1.016
5-10 years old	38,039	18	1.067	1.043	1.091
More than 10 years	35,675	17	0.939	0.917	0.961

An odds ratio greater than 1.000 indicates the concerned characteristic leads to a higher crash risk, and vice versa. For example, traveling on dry surface condition, or safety helmet used showed a lower crash risk as odds ratios and the 95% confidence intervals are less than 1.000.

When investigating odds of driver-related variables, safety helmet used showed a significantly lower risk than unused. The odds ratio of male drivers was higher than 1.000, which indicated male drivers had increased crash risk compared to female drivers. Also, it is interesting to note that valid licensed did not grantee to have lower crash risk. The odds ratios of environmental-related variables showed that daylight, clear weather condition, and weekday independently increased the motorcycle crash risk. Motorcycle crash risk on urban roads was higher than that of rural roads. As one can expect, motorcycle crash risk under dry road conditions was lower than wet roads and motorcycle crash risk at intersections was higher than non-intersection locations. Vehicle age less than five years was not statistically significant at the 95% confidence interval. Vehicle age between 5-10 years showed increased crash risk while age more than 10 years showed lower crash risk.

IV. CONCLUSIONS

A significant increase in number of motorcycle crashes in recent years has been observed. This study identified characteristics of motorcycle-crashes relating to vehicle, driver, environment, road, and other related factors. The majority of motorcycle-crashes were found to have occurred during dry surface and clear weather conditions.

More frequent crash conditions for motorcycle crashes were the crashes occurred while driving on rural roadways, driving during week days, and driving newer motorcycles. Dry road surfaces, clear weather conditions predominantly characterized motorcycle-crashes. Majority of all three motorcycle-crashes which occurred during the relevant study period happened on weekdays. A large number of three wheeler-crashes occurred when the motorcycles were driven by male drivers. The odds

ratio showed that helmet use was much safer. Also, it showed that riding motorcycle on urban roads, intersection locations, during clear weather, and during weekends were less safe.

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Niranga Amarasingha is a senior lecturer of Civil Engineering at the Sri Lanka Institute of Information Technology, Sri Lanka. Her research focuses on traffic safety and human factors, traffic engineering, modeling of transportation systems, railroad engineering, and multi-criteria decision making and has had training and experience in Sri Lanka, India, Thailand, and the U.S.A. She completed her Ph.D. at the Kansas State University, U.S.A. and worked there as a post-doctoral research associate before joining the Sri Lanka Institute of Information Technology.