

A REVIEW OF MOTORCYCLE SAFETY SITUATION IN BANGLADESH

Shahrior Pervaz^{*1}, Dr. Md. Mizanur Rahman², Shahnewaz Hasanat-E-Rabbi³, Md. Imran Uddin⁴, Md. Mahbubur Rahman⁵

¹*Lecturer, Accident Research Institute (ARI), BUET, Dhaka-1000, Bangladesh,
e-mail: pervazs.ce.buet@gmail.com*

²*Director, Accident Research Institute (ARI) & Professor, Department of Civil Engineering, BUET,
Dhaka-1000, Bangladesh, e-mail: mizanur@ce.buet.ac.bd*

³*Lecturer, Accident Research Institute (ARI), BUET, Dhaka-1000, Bangladesh,
e-mail: shahnewaz.rabbi@gmail.com*

⁴*Lecturer, Accident Research Institute (ARI), BUET, Dhaka-1000, Bangladesh,
e-mail: mdimran.buet@gmail.com*

⁵*Additional Superintendent of Police, Bangladesh Police, Dhaka-1000, Bangladesh,
e-mail: mahbub_03@yahoo.com*

***Corresponding Author**

ABSTRACT

Like the other Asian countries, the increase in motorcycle crashes and consequent fatalities in Bangladesh is a growing problem resulting from the massive increase of motorcycles. Of over 2.9 million of registered motor vehicles, motorcycles represent almost 65% in the country. This high percentage is the direct result of cheap and availability of the motorcycle and local road characteristics in the country. Crash and fatality data of this huge percentage of motorcycles showed a significant increase over the last decades. This study focuses on the safety situation of this mode in Bangladesh. The study used police reported crash database preserved at the Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET). The analyses revealed that the highest number of motorcycle fatalities occurred in rural locations (74%). Among the road classes national highways contributed to the highest (45%) fatality rate. The majority of the victims were 26 to 30 years old (22%). Of those involved in fatal crashes, 88% of the motorcyclists did not wear helmets. The highest number of fatalities by type of collision was head on (49%) followed by rear end (29%) and sideswipe (12%). The study compared crash data of five national dailies to quantify the underreporting of police reported data. This comparison exposed significant underreporting in the country. In addition, structured self-administered questionnaire survey was conducted at five hospitals in Dhaka city in order to identify motorcyclists' driving behavior along with the predominant injury patterns due to the crashes. The survey results demonstrated that predominant injury patterns were fracture in the right leg (22%) and fracture in the left leg (15%). The survey results also exposed root causes of crashes, daily riding time and operating speed during crashes. Finally, the study recommends few effective strategies and countermeasures in this situation.

Keywords: *Traffic crashes, Motorcycle, Fatalities, Injury patterns, Underreporting.*

1. INTRODUCTION

Road crashes and fatalities are a growing concern in Bangladesh, with more than 2,700 fatalities over 3,100 recorded crashes yearly for the past 19 years. Although the average yearly reported numbers for the last 5 years are around 1,900 and 2,000 respectively, WHO (2013) estimated more than 20,000 deaths occur annually from road crashes in the country. Of these fatalities, around 70% are attributed to Vulnerable Road Users (VRUs)-pedestrians, bicyclists, motorcyclists and users of non-motorized para-transit vehicles. Among the crashes involving VRUs, motorcycle crashes are increasing alarmingly. The share of motorcycle fatalities was 3% in 1998 which have increased up to 22% in 2017. However, the actual number of fatalities should be much higher at least four times the number officially reported (Hoque, Hossain, Rahman & Islam, 2014). The most alarming fact is that Bangladesh is the Asian country with the greatest motorcycle deaths rate, 28.4 per 10,000 motorcycles (Nguyen, 2013). Moreover, there hardly found studies addressing this issue in the country. Therefore, this study intends to provide an insight of motorcycle crashes and fatalities along with injury patterns of the motorcyclists in Bangladesh. It also addresses the underreporting of the crash data throughout the country. The study findings can be used for the evidence-based interventions for policy-making decisions to reverse the adverse motorcycle crash trend and to mitigate motorcycle injuries in Bangladesh.

2. GLOBAL MOTORCYCLE GROWTH AND SAFETY

Being one of the cheapest modes of transport, motorcycle has dominated recently in the registered vehicles across the world. The increase rate of motorcycle surpassed the rate of car growth during 2002-2010 and the total registered number reached up to 30% of the world's vehicles in 2010. However, this growth created headaches among safety researchers. It is found from the safety point of view that, the motorcyclist's risk of a fatal crash is 26 times greater than a passenger car per vehicle-mile travel (NHTSA, 2013). The situation is more concerning for Asian countries which accommodated most of the world's motorcycles, approximately 79% (Nguyen, 2013). Research identified that suitable tropical and sub-tropical climate, favorable economic and institutional infrastructure and inadequate urban road space for cars were the prime reasons for this higher ownership (Senbil, Zhang & Fujiwara, 2007). This tremendous ownership of motorcycles in the region was responsible for most of the motorcyclist deaths, accounting up to 78% (WHO, 2013). Five Asian countries (Thailand, Lao, Vietnam, Malaysia, and Cambodia) are among the top ten of countries with the greatest motorcyclist deaths per 100,000 populations. Six Asian countries (Bangladesh, Cambodia, Lao, Thailand, India, and Myanmar) have death rates higher than the average rate of Asia, in which the death rate in Bangladesh has found to be about 4 times greater than that in Asia and the world (WHO, 2013). Figure 1 shows the Asian countries with the greatest motorcyclist deaths per 10,000 motorcycles.

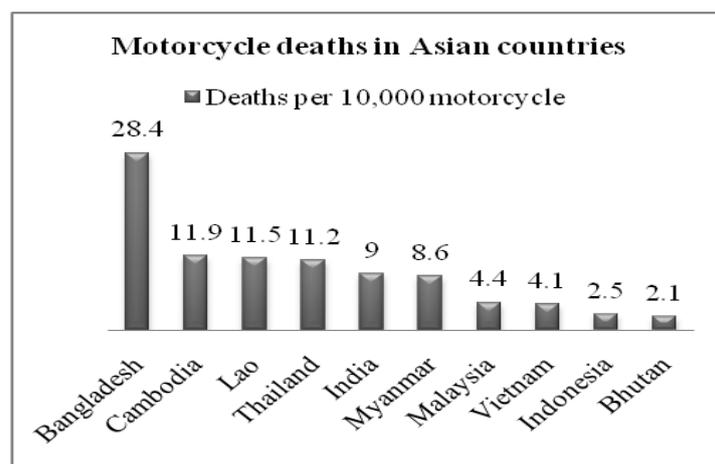


Figure 1: Asian countries with the greatest motorcyclist deaths rate (Nguyen, 2013; WHO, 2013)

Last decade showed a tremendous increase in the usage of motorcycles in Bangladesh. Currently, it occupies a large share (around 65%) in total registered vehicles in the country. The registered motorcycles grew from around 215,670 to 2,050,919 during 1999-2017 (Figure 2). The economic growth of the country, increase in per-capita income, cheaper cost and availability of national and international brands played an important role behind this growth. A growing number of city-dwellers are also going now for motorcycles to get around the heavy traffic jams. Moreover, it is the most convenient mode of transport in rural areas, particularly in the narrow village roads.

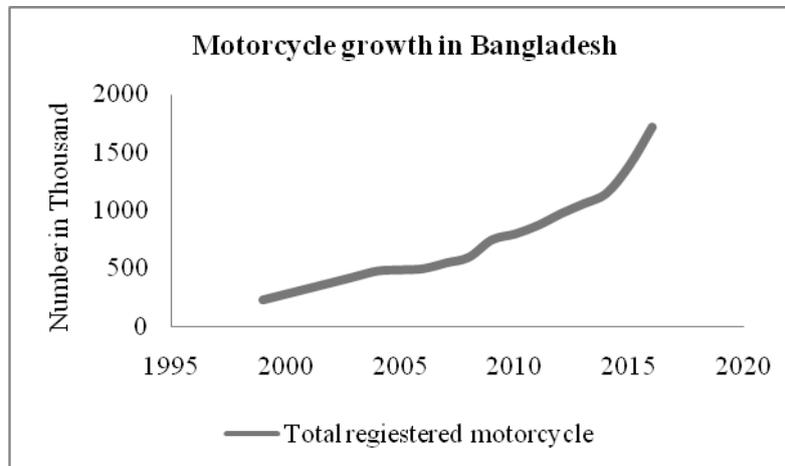


Figure 2: Trend of motorcycle growth in Bangladesh (BRTA, 2018)

3. METHODOLOGY

This study analyzed motorcycle crash and fatality data in terms of frequency and pattern by location type, road class, road geometry, age, time, lighting condition, collision type, uses of the helmet and contributing factors. These data were collected from the Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET) that maintains police reported crash database. Microcomputer Accident Analysis Package 5 (MAAP5) software was used to analyze these data. The study assessed the injury patterns by a structured self-administered questionnaire survey of hospitalized motorcyclists. The survey was conducted among 100 patients at five specialized hospitals which were Dhaka Medical College Hospital, Sir Salimullah Medical College Mitford Hospital, Shahid Suhrawardi Medical College Hospital, National Institute of Traumatology and Orthopedic Rehabilitation Hospital (NITOR) and Trauma Centre. These are the leading hospitals in the country where patients from all areas of the country are taken for better treatment. Thus, these patients can be considered as a representative sample for the survey. The survey included questions regarding injury patterns (e.g. head injury, bone fracture, spinal cord, etc.), driving attitude and behavior of hospitalized motorcyclists. Furthermore, underreporting of crash data were quantified by comparing the police reported and the newspaper reported data.

4. TRENDS OF MOTORCYCLE CRASHES AND FATALITIES IN BANGLADESH

Analysis by MAAP5 showed that the motorcycle crashes and fatalities increased from 4% to 20% and 2% to 22% respectively from 1998 to 2017 (Figure 3). Both the crash and fatality rates (per 10,000 motorcycles) have shown alarmingly upward trend very recently (Figure 3). Further analysis of crash and fatality data by different road attributes is discussed in the following sections.

4.1 Motorcycle Fatalities by Location, Road Class and Road Geometry

Analysis revealed that motorcycle crashes are predominant in rural areas of Bangladesh. The major portion of the national and regional roads is situated in these areas where 69% of motorcycle crashes occurred, whereas 31% occurred in urban areas, resulted 74% and 26% fatalities respectively. Among

the road classes, national highways were responsible for 45% of the motorcycle fatalities and were followed by regional (19%) and feeder roads (17%), Figure 4. Research emphasized that greater speeds made possible by lower traffic volumes and less traffic control might be responsible for this higher rate (Silva, 1978). Further analysis revealed that fatalities per crash were higher on national (1.33) and regional roads (1.08) compared to that on city roads (0.60).

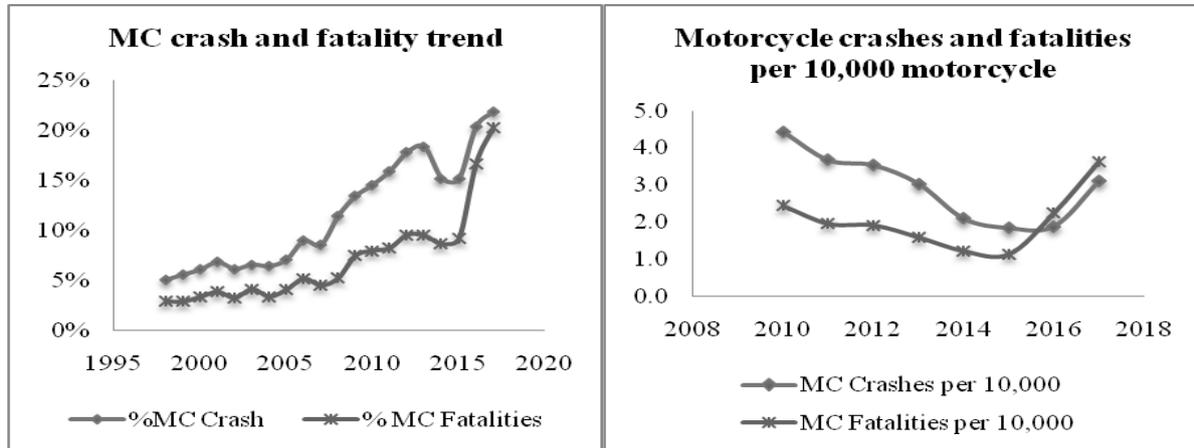


Figure 3: Motorcycle crash and fatality trends in Bangladesh (1998-2017)

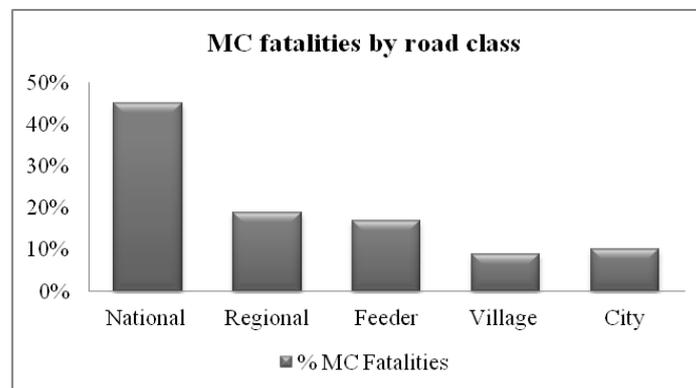


Figure 4: Motorcycle fatalities by road class (1998-2017)

Distribution of motorcycle fatality data by road geometry showed that most of the fatalities occurred at straight segments of roads (87%). The curve sections also contributed to a significant portion of motorcycle fatalities (11%). Other sections experienced only 2% of motorcycle fatalities.

4.2 Motorcycle Fatalities by Gender and Age

The reported data showed that the age group of 26 to 30 years was mostly involved in motorcycle fatalities during 1998-2017 (Figure 5). More alarmingly, the majority of the victims were working class people of age 21 to 35 (56% fatalities). It was also found that male shared 96% of motorcycle fatalities in the country.

4.3 Motorcycle Fatalities by Time, Day, Month and Weather Condition

The distribution of fatalities for motorcyclists was highest (78%) from 8.00 am to 7.00 pm. The fatalities peaked during the period of 10.00 am to 1.00 pm and later 4.00 pm to 5.00 pm in the day time coinciding with the higher level of motorcycle flow. Motorcycle fatalities by time of the day are shown in Figure 6.

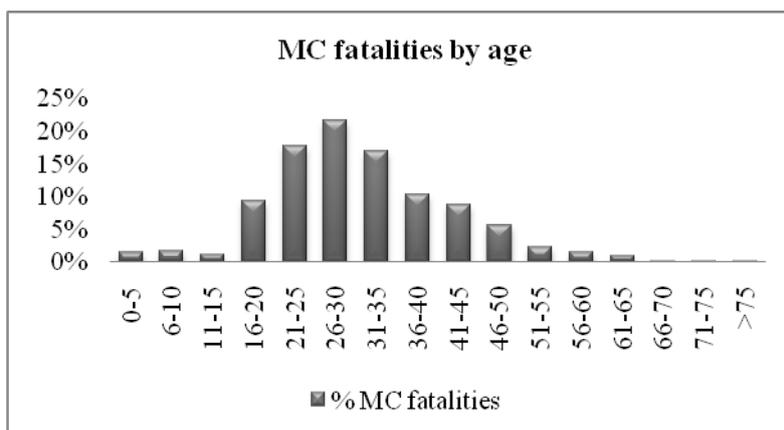


Figure 5: Motorcycle fatalities by age (1998- 2017)

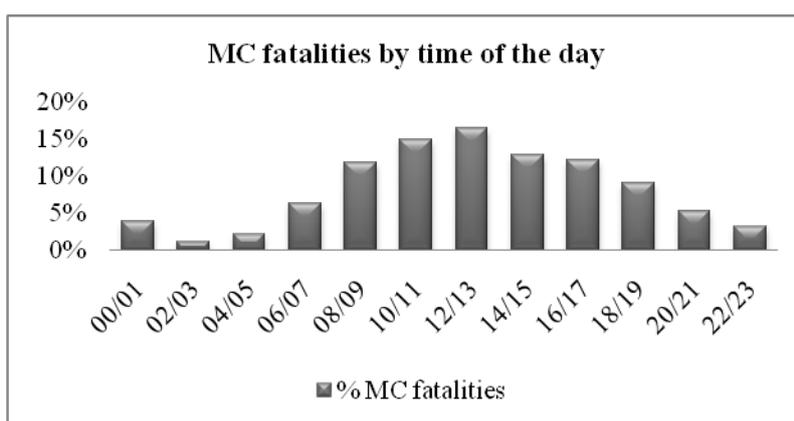


Figure 6: Motorcycle fatalities by time of the day (1998-2017)

Table 1: MC fatalities by day of the week (1998-2017)

Day of Week	% MC fatalities
Monday	14%
Tuesday	14%
Wednesday	13%
Thursday	15%
Friday	15%
Saturday	16%
Sunday	12%

From 1998 to 2017, motorcycle fatality data were almost evenly distributed over the days of the week with slight higher records from Thursday to Saturday (Table 1). Distribution of fatality data by months showed fluctuations throughout the year. The records were highest from December to May of the year, as seen in Figure 7. The fatalities occurred more during fair weather condition (92%) followed by rainy condition (5%). Records also showed that fatalities occurred more during the day time (76%) followed by dawn/dusk time (12%) and night (12%).

4.4 Motorcycle Fatalities by Collision Type

The most frequent fatalities by collision type were head on (49%) and rear end (29%). Sideswipe (12%) collisions with motorcycles were also significant (Table 2). Motorcycle crashes were splitted as 35% single-vehicle and 65% multi-vehicle crashes. The share of fatal motorcycle crashes was 5.6% and 11% for single-vehicle and multi-vehicle crashes respectively.

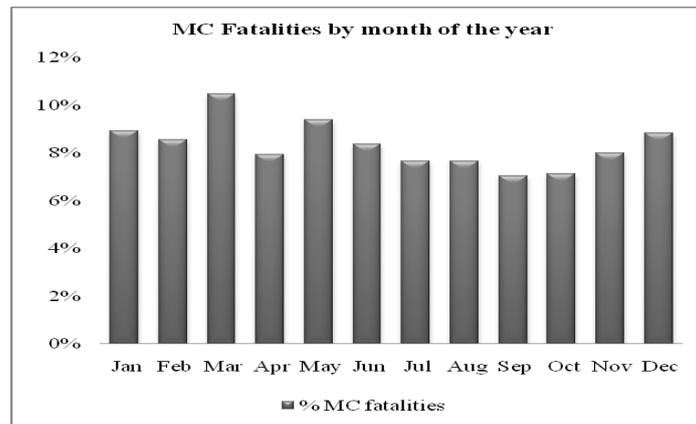


Figure 7: MC fatalities by month of the year (1998-2017)

Table 2: Motorcycle fatalities by collision type

Collision Type	% MC Fatalities
Head on	49%
Rear end	29%
Right angle	2%
Sideswipe	12%
Over turn	2%
Hit object	2%
Hit parked vehicle	2%
Hit pedestrian	0%
Other	3%

4.5 Motorcycle Fatalities by Helmet Use

According to the database, 88% of those involved in motorcycle fatalities did not wear helmet and 12% worn helmet during the ride. The reasons behind not wearing helmet came out from the questionnaire survey. The result showed that 43% of respondents did not wear helmet due to feeling hot inside helmets, 25% used to feel uncomfortable using helmet, 11% did not use while in the short distance trip and 5% did not have any helmet.

4.6 Motorcycle Fatalities by Contributing Factor

Analyzing police reported data it was found that driver factors were contributing to almost 92% of motorcycle fatalities. Among the driver factors, over speeding was the primary cause of 51% fatalities which was immediately followed by careless driving (40% fatalities). Motorcycle fatalities by contributory factors are shown in Table 3.

Table 3: Motorcycle fatalities by contributory factors

Contributory factor	% MC Fatalities
Over speed	51%
Careless driving	40%
Close Driving and wrong Signal	2%
Overtaking	2%
Overturning	1%
Road features	1%
Other	3%

4.7 Injury Patterns

Which parts of the body were injured due to motorcycle crashes were initially identified through physical observation of hospitalized motorcyclists and later confirmed by asking them regarding their injury. The fracture in the right leg had the largest share comprising 22% of total injury patterns. It was followed by fracture in the left leg (15%). Of the others, injury in the right lower leg and fracture in the right hand were 10% and 9% respectively. Head injury, fracture in the left hand and fracture in the right knee equally shared (7% each) in the injuries (Table 4).

Table 4: Injury patterns of hospitalized motorcyclists

Injury Pattern	% of Motorcyclists
Head injury	7%
Fracture in left hand	7%
Fracture in right hand	9%
Fracture in left elbow	2%
Fracture in left wrist	3%
Chest	1%
Backbone	2%
Fracture in waist	1%
Fracture in left leg	15%
Fracture in right leg	22%
Fracture in left knee	5%
Fracture in right knee	7%
Fracture in left ankle	2%
Fracture in right ankle	4%
Injury in right lower leg	10%
Right knee cut-off	3%

It is clear that about half of total injury was in the right leg and more than one-fifth was in the left leg. This finding implies that the lower part of the body is mostly prone to injury for motorcycle crashes.

4.8 Riding Time and Operating Speed

The questionnaire survey revealed that around 50% of the motorcyclists used to ride between 1 and 2 hours daily and 32% of the motorcyclists used to ride daily less than 1 hour. Almost 12% of respondents told that they daily travel on motorcycle between 2 and 4 hours. Only 6% used to ride more than 4 hours daily (Figure 8). Thus, the survey found a notable percentage of the motorcyclists with higher daily riding time.

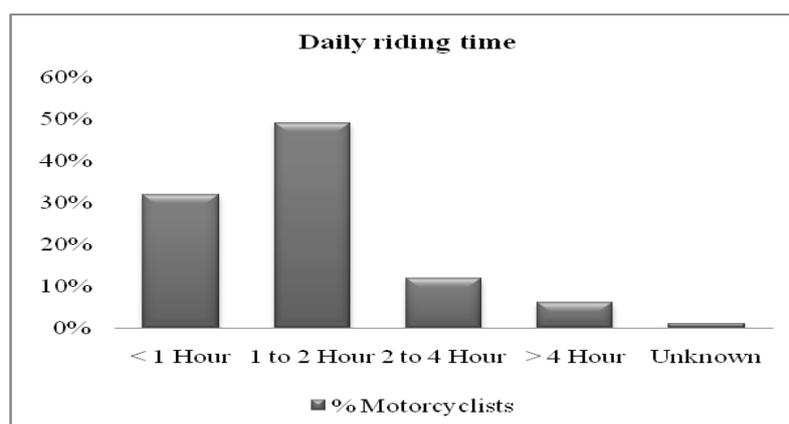


Figure 8: Daily riding time of motorcyclists

The majority of the respondents were riding with a little higher speed during crashes. It is very clear from Figure 9 that about 67% were riding with speed greater than 50 km/h that is higher than the posted speed limit (30-40 km/h) in the survey area. About 51% were with speed ranges from 60 km/h to 80 km/h. Only 8% motorcyclists rode with speed (<40 km/h.) lower than the posted speed limit.

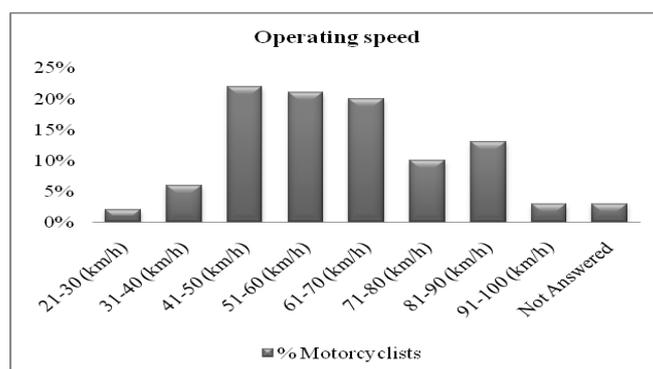


Figure 9: Operating speed of motorcyclists

4.9 Underreporting of Crash Data

To quantify the underreporting in the crash data recording system, crash and fatality data were recorded from 5 National Daily Newspapers for the period of one year. It was found that the number of crashes and fatalities recorded by the police (191 crashes and 158 fatalities) vary from the newspaper recorded data (325 crashes and 388 fatalities) in the same year (Table 5 & Table 6).

Table 5: Police Vs Newspaper reported motorcycle crashes and fatalities by day of the week

Day of Week	Newspaper Reported		Police Reported	
	MC Crashes	MC Fatalities	MC Crashes	MC Fatalities
Monday	40	42	31	24
Tuesday	40	46	23	17
Wednesday	43	55	25	23
Thursday	41	48	22	21
Friday	39	48	34	28
Saturday	56	67	26	23
Sunday	66	82	30	22
Total	325	388	191	158

Table 6: Police Vs Newspaper reported motorcycle crashes and fatalities by month of the year

Month	Newspaper Reported		Police Reported	
	MC Crashes	MC Fatalities	MC Crashes	MC Fatalities
January	33	41	12	12
February	58	64	19	12
March	11	12	22	20
April	28	35	10	8
May	8	11	24	19
June	18	21	13	16
July	14	20	14	14
August	15	17	15	10
September	37	44	9	6
October	30	36	16	15
November	31	35	22	16
December	42	51	15	10
Total	325	387	191	158

Recorded data showed almost 3 times under reporting of motorcycle fatality data. This quantity could be more if more number of newspapers would have been considered. The police reported data showed very little fluctuations in daily motorcycle crash and fatality rates, whereas newspaper recorded data showed daily variation in both crashes and fatalities. The fluctuations are shown in Table 5. Again, police reported data also showed less fluctuation in monthly motorcycle crashes and fatalities whereas newspaper reported data showed a variation in the distribution (Table 6).

5. DISCUSSIONS

This study demonstrates the increasing trend of motorcycle crashes and fatalities along with the increasing share of the motorcycle in total vehicles of Bangladesh. This upward trend of the motorcycle crash and fatality rates (per 10, 000 motorcycle) is alarming, particularly in the rural areas of the country. The greater fatality of motorcyclists in rural areas might be caused by lower volume and hence the higher speed of the vehicles in this area. In urban areas, the flow is congested with lower speed and stop-go situation. This could be one of the reasons behind the lower share in fatalities. Again, the mixing of short tripped motorcycle with high speed vehicles and frequent access from the connecting road might be responsible for higher motorcycle crashes in national highways. The higher edge drop of pavement, lack of adequate shoulder, loose materials after repairing works and damage pavement surface also aggravate the safety of the motorcyclists in the highways. These situations should be addressed by road designers and maintenance authorities. Research emphasizes to take into account the interaction between motorcycles and other heavy vehicles in road planning, design, and operation (Nguyen, 2013). Study suggests exclusive or inclusive lane for motorcycle to prevent interaction among motorcycle, Non Motorized Vehicle (NMT), passenger private car and other heavy vehicles, especially in city areas (Hoque, Chowdhury & Rashedi, 2015). It is also emphasized that motorcyclists should maintain lane while driving. It is found that higher speed and careless driving are the primary contributing factors to these fatalities. This is also substantiated by the survey result regarding operating speed during crashes. Besides, it is seen that the fatality rate is highest among the young motorcyclists. Several factors such as drugs, alcohol and suicidal tendencies are prominent for these young motorists' behavior and risky rides which eventually contribute to this rate (Harrison & Christie, 2005; Steg & Brussel, 2009). However, no adequate study is found in Bangladesh regarding the young motorcyclists' behavior on risky rides. Setting speed limit for motorcyclists and enforcement of laws is necessary in this circumstance. Again, the use of helmets is essential for motorcyclists. Research indicates that the use of helmets could decrease the likelihood of these deaths. Compared with helmeted motorcyclists, non-helmeted motorcyclists are more than four times as likely to have head injuries and ten times as likely to have brain injuries (Yu, Chen, Chiu & Lin, 2011). Public awareness regarding the importance of helmet uses is highly needed since the death rate of non-helmeted motorcyclists is found higher in this study.

This study shows that the lower part of the body is mostly prone to injury in motorcycle crashes. However, studies in developed countries found different injury patterns, especially higher injury rates of lower extremity, chest and abdomen. Studies in California and Britain reported that multiple intra-thoracic and intra-abdominal injuries, as well as pelvic ring fractures associated with long bone injuries and the rib fractures were common serious injuries in motorcycle crashes (Kraus, Peek-Asa & Cryer, 2002; Ankarath, et al., 2002). It is also seen that injury risk appears to be related to crash types (Patricia, Gabriel, Shiu & Braver, 2006). In Bangladesh, higher sideswipe collisions along with side sway during head on and rear end collisions could be responsible for different injury patterns. Along with collision types, daily riding time also plays an important role in crashes and injuries. Though the survey results demonstrate the lower daily riding time, it could be higher if the survey were conducted in rural areas where long distance trips are generated. This long riding time induces fatigue and decreases riding quality of the motorcyclists (Ma, Williamson & Friswell, 2003).

This study has also quantified the underreporting of the crash data which affects understanding the crash magnitude and total loss, setting target and evaluating the countermeasures. Bangladesh police

has to be more concern regarding crash reporting issues. Besides, training on reporting and recording of road traffic crash data will play a significant role in reducing the underreporting.

6. CONCLUSIONS

Being a convenient mode of transport, motorcycle is continuing to play a great role in the transport sector of Bangladesh. Hence, motorcycle crashes and fatalities are going to be an alarming issue unless the safe mobility of motorcyclists can be ensured. This study has put some insights into facts, causes and behavioral aspects of motorcyclists. The safe road infrastructures, speed management strategies, safety awareness and behavior of motorcyclists should be considered by road planners, designers, engineers and respective agencies. Moreover, mitigating underreporting problems will definitely play a greater role in motorcyclists' safety research, plan, design and implementation of the above strategies.

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