

## **Examining Road Safety Compliance among Motorised Two-Wheelers in Delhi- A Cross-Sectional Study**

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**Abstract**— The paper presents the use of a multi-purpose questionnaire to examine one of the vulnerable road users (motorized two-wheelers) road safety compliance, driving behavior and injury prevention knowledge via self-reporting. The study was carried out among two-wheeler riders in Delhi using an interviewer-administered questionnaire. Compliance by riders to individual traffic rule and road safety measures was; 49.1% driving license, 60.6% ISI-marked helmet, 38.8% riding with one passenger, 65.6% driving at speed limit, 47.1% one-way driving, 51% traffic signal following. The study further shed light on the risk associated with non-compliance and lack of injury prevention knowledge. One significant finding was that although 36% of riders self-reported accident involvement in the past, however around 69% reported near-crash incidents while driving motorized two-wheelers which highlights their vulnerability on Delhi roads. The findings provide insights into two-wheeler riders' road safety preparedness to the policymakers and implementing agencies and suggested targeted road safety interventions and campaigns to educate them and help them change their unlawful behavior on the roads.

**Keywords**—Road Safety, Compliance, Motorised Two-Wheelers, Delhi

### **I. Introduction**

Road accident-related deaths are known to be the eighth leading cause of death and the first largest cause of death among adults in the age group 15-29 years. Globally, 54% of accident-related deaths are pedestrians, cyclists and, motorcyclists. This results in considerable economic losses not only to individuals, their families, but also to the nations as a whole. The losses are on account of cost of treatment as well as lost productivity for those killed or disabled by their injuries, loss of productivity of family members who need to take time off work or school to care for the injured etc. Road accidents claim more than 1.35 million lives each year and cause up to 50 million injuries. And, the sad fact is, every one of those deaths and injuries is preventable [1].

### **India Road Accident Statistics**

India ranks 1<sup>st</sup> in the number of road accident deaths across the 199 countries reported in the World Road Statistics, 2018 followed by China and the US and 3<sup>rd</sup> in terms of total accidents [2]. As per the WHO Global Status Report on Road Safety 2018, India accounts for almost 11% of the accident-related deaths in the World [1].

In India, over 1.50 lakh people lose their lives every year due to road accidents and many more suffer debilitating injuries. This causes immense economic hardship and emotional trauma to the affected families. In terms of road-user categories, the share of motorized two-wheeler (MTW) riders in total road accident deaths were the highest (36.5%) in 2018 [2]. Pedestrians comprise 15.0 percent of persons killed in road accidents during 2018, confirming the share provided by WHO.

The fatal road accidents on Indian roads account for roughly 3% of GDP every year. With India's GDP in 2018-19 being INR 190 lakh crore, these figures translate into a monetary loss of INR 5.70 lakh crore.

### **Age group most susceptible**

During 2018, like the previous two years, young adults in the productive age group of 18 - 45 years accounted for nearly 69.6 percent of road accident victims [2]. This also corroborates with the WHO, 2018 report which says that road traffic injuries are the leading cause of death for children and young adults aged 5–29 years [1].

### **Delhi Road Accident Profile**

National trends reveal that during the year 2018, Delhi ranks first among the cities in road accident-related deaths i.e. 1690 people lost their lives and stands second in total road accidents i.e. 6515 in which 6086 people were injured. There is a decrease of 2.36% in total accidents, however, there was an increase of 5.88% in the number of fatal accidents in Delhi as compared to the year 2017.

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Among the road user category, pedestrians were the most vulnerable road accident victims. In 2018, 45.86% of the total persons killed in road accidents were pedestrians. Scooter/Motorcycle riders were the second most accident-prone victims constituting 33.72% of the total persons killed and 2542 (41.76%) of all injured victims. Accident data thus suggests that two-wheeler riders have been involved in 1 of every 3 deaths or injuries.

Further, accident classification according to day and night shows that in 2018, 743 fatal accidents occurred during the day whereas 914 occurred during the night. Accidents tend to increase after 7 P.M. till 2 A.M. on all days of the week as, during these hours, commercial vehicles also start moving in Delhi, due to lifting of restrictions of no entry for them [3].

### **Causes of Road Accidents & Traffic Rule Violation**

Road accidents are multi-causal and are the result of an interplay of various factors. These can broadly be categorized into those relating to (i) human error, (ii) road environment, and (iii) vehicular condition. Accidents caused by human error include (i) cases of accidents caused by traffic rule violations, (ii) driving without valid driver license and (iii) non-use of safety devices [1].

### **Challan prosecution stats**

Enforcement is vital to the success of road safety laws. Effective enforcement is the key deterrent factor in ensuring road discipline and also increasing public awareness.

In Delhi, the city traffic police had issued over 6.7 million challans from which a total amount of 1.09 billion Indian rupees was realized as compounding amount and the MTWs were among the most commonly registered vehicles for violations in 2018. Prosecution of various types of the vehicle reveals that in 2018, maximum challans i.e. over 2.8 million were issued against two-wheeler riders [3].

A review of violations and crashes in European (EU) countries concluded that violations promote crashes but the relationship between the two was neither deterministic nor strong [4].

### **Two-Wheeler unique riding pattern**

MTW riders are among the most vulnerable road users to road accidents due to their unsafe and erratic riding patterns. MTW related road accidents have over the years remained constant despite active awareness about road safety and implementation of various countermeasures. MTWs possess several unique behaviors that lead them to exhibit erratic and chaotic trajectories when making a move in the traffic stream [5]. Its small size and aggressive riding patterns can considerably affect the overall traffic flow characteristics and safety [6].

## **II. LITERATURE REVIEW**

### **A. Motorized Two-Wheeler Behavior and Traffic Violation**

Mixed traffic with the motorcycle is a major traffic type in some Asian countries, for example, in Taiwan, Malaysia, Vietnam, India, etc. As a mode of transportation, motorcycles offer many environmental and space utilization advantages relative to automobiles. They are more fuel-efficient and potentially emit significantly fewer pollutants, and require less lane and parking space. Despite the above advantages, traffic mixed with two-wheelers become more hazardous under interruption caused by them. MTWs appear to be the most dangerous form of motor vehicle transport going by accident statistics, especially in India. The greatest growth rate in the number of motor vehicles in the world is expected in the Asian countries, and most of this increase is likely to be in the motorized two-wheeled and three-wheeled vehicles [7]. Currently, two-wheeled vehicles account for more than 70% of all the transport motor vehicles in India [8]. The number of deaths from MTW accidents in the world is highest in India and MTW riders remain the most vulnerable victims of road accidents in India over the years [9]. Violation of traffic rules is the main factor associated with these accidents in India [10].

Some studies [11] have shown that motorcyclists have less knowledge of road safety rules. This is similar to the study by Ndagire et al. [12] which indicates that less training regarding road safety rules increases the risk of boda-boda (motorcycle) riders in Kampala, Uganda being involved in accidents. The use of helmets by motorcyclists is known to reduce death and injury in the event of an accident [13]. A study by Mittal [14] in India indicated that existing traffic rules without enforcement yield poor results.

There are many reasons for MTW high road accident involvement: 1. Automobile drivers tend to be inattentive with regard to motorcyclists and have conditioned themselves to look only for other automobiles as possible collision dangers. This explains the classic auto-driver excuse of having never seen the motorcycle until after the collision [15]. 2. Motorcycle operation is a complex task, requiring excellent motor skills and physical coordination [16]. Some motorcyclists may have reflex and physical coordination limitations that significantly increase their accident risk. Furthermore, any sort of operator impairment (e.g. alcohol, medication) will have a much greater impact on the likelihood of accident involvement when compared to automobile accident involvement. 3. Many motorcycle riders' are not properly trained in the intricacies of motorcycle operation, and this contributes to higher accident involvement. Motorcycling involves many counterintuitive tasks such as counter-steering, simultaneous application of front and rear brakes, and opening the throttle while negotiating turns [17]. If operators are not trained to overcome their instinctive responses, their actions, when facing roadway dangers, often contribute to the likelihood of an accident. 4. Because of the dangers involved, motorcycling may tend to attract risk-seeking individuals in all age and socioeconomic categories [16].

### **B. Usage of Safety devices**

One of the main reasons for their vulnerability is due to the non-compliance to qualified helmet and exposed body parts during a collision. The compliance rate for seat belt and helmet

usage is low in India compared to the other countries; it is even worse for pillion riders [18]. Hurt et al. [19] also reported a lower usage of safety helmets among young motorcyclists. Motorcyclists below the age of 27 were found to use helmets less regularly than the average users. This suggests that as age increases, maturity increases and the tendency to think rationally may also subsequently increase. This could probably be the reason why the older age group tends to comply with safety regulations as compared with the younger group. Studies in India also indicate that age plays a key role in adherence to traffic regulations. A study by Mohan [20] also concluded that older persons often tend to follow traffic regulations more often compared to younger people.

Helmets are designed to prevent head injuries and are regarded as the most important piece of personal protective equipment. The injury-reducing effects of good quality helmets are well known by motorcyclists. But, injury pattern of 921 Powered Two-Wheeler (PTW) accidents in Europe [21] from 5 countries were investigated and revealed that lower extremity (legs) injuries made up 31.8% of all PTW injuries, followed by upper extremity (arms) injuries which made up 23.9% of all injuries. Head injuries accounted for 18.7% of all reported injuries.

There is a widespread belief that motorcycles are more difficult to detect in traffic than any other motorised vehicles. Earlier studies of individual collisions involving motorcycles [19, 22, 23, 24] have indicated that drivers who violate motorcyclists' right-of-way often claim not to have seen them before the collision ("looked but failed to see").

Hurt et al. [19] investigated almost every aspect of 900 motorcycle accidents in the Los Angeles area. The accident data were analyzed to determine accident and injury causes of motorcycle accidents, evaluate safety equipment, clothing and rider protective devices, and the motorcycle features which contribute to the serious and fatal injuries to the rider and passenger.

One of the significant findings of Hurt et al. [19] report was that only 30% of the motorcycles in the accident data had the headlamp on in daylight but 60% of the motorcycles in the exposure data had the headlamp on in daylight. Such comparison identifies the use of the headlamp on in daylight as a powerful and effective way of reducing accident involvement, by making the motorcycle more conspicuous in traffic. The other significant findings of the report besides the use of the headlamp on in daylight are that high visibility jackets definitely reduce accident involvement. All motorcycle riders need training, licensing, citation-related driver improvement, bright upper torso garments, and head and eye protection to reduce accident involvement and injury frequency and severity.

### ***C. Road Safety Interventions for Two-Wheelers***

Malaysian Government also took cognizance of the evidence that improving the conspicuity of motorcycles reduces accidents, and a nation-wide "Daytime Running Headlight"

campaign was proposed and launched in July 1992. This was followed by the compulsory use of headlights regulation in September 1992.

Further to validate the running headlights intervention to conspicuity-related motorcycle accidents in Malaysia a detailed analysis of the impact of the has been reported by Radin et al. [24, 25]. The study revealed that the running headlight intervention reduced conspicuity-related motorcycle accidents by about 29%.

As competition for road space increases, there is a risk that motorcyclists are forced into closer contact with other vehicles which increases conflicts and chances of road accident. To circumvent that, Malaysian Government brought the notion of segregating motorcycles from other traffic by the use of a motorcycle lane. In the early seventies, the world's first motorcycle lane was constructed along the F02 in Malaysia, under a World Bank project. Only a few cities around the world have attempted to segregate motorbikes from the general traffic. Special motorbike lanes have been built in Taipei, China, Malaysia, Brazil, and a few other countries [26]. The purpose of this segregation has been to improve the capacity of the roadway and to reduce accidents. In India also, Tiwari et al. [27] performed conflict analysis for prediction of fatal crash locations in mixed traffic streams and suggested segregation and traffic calming techniques development with special reference to motorized two-wheelers.

Further, in Malaysia, the reduction in motorcycle accidents was highly significant following the opening of an exclusive motorcycle lane, with an average reduction of about 39%. Fatality reduction among motorcyclists is highly significant with a marked reduction of 600%. The benefit/cost ratio of providing an exclusive motorcycle lane ranges from 3.3 to 5.22, suggesting that the provision of exclusive motorcycle lanes is highly cost-effective in containing motorcycle problems for highly motorcycled countries [28-29].

Special treatment at intersections is given to motorcycles to facilitate their clearance from the intersection quickly, and thereby reduce delays to other vehicles. In Taiwan, motorcycles are allowed to store behind the stop line at a few intersections [5]. In Chennai, India a study by Asaithambi et al. [30] suggested that for MTW dominated traffic (70% MTWs) at signalized intersections, the discharge rates can be inherently increased (less delays) with the provision of exclusive stopping space for motorized (ESSM) two-wheelers near the stop line.

For the safety of MTWs and traffic improvement, Transport for London (TfL) also took a decision which was to allow motorcycles to ride in bus lanes permanently based on a reduction in journey times and emissions for motorcyclists, and the lack of any adverse safety impact on other road users [31]. Several cities have allowed PTWs to use bus lanes, including London, Oslo, Norway and Madrid [32].

Targeted road safety interventions are very crucial for vulnerable road users related to policymaking, awareness

campaigns, road engineering, etc. Malaysian Government to contain motorcycle casualties launched a National motorcycle safety program in 1997 that involved exposure control, crash prevention, behaviour modification and injury control related to humans, vehicles and the environment based on pre-crash, crash and post-crash scenarios of motorcycle accidents [28].

### D. Road Safety Training and Implications

In London, BikeSafe [33] is a course funded by TfL and delivered by the Metropolitan Police Service. It is designed to improve behaviour management among motorcycle riders, and ‘bridge the gap’ between compulsory training, and the more advanced courses available. It costs £45 to attend, for a one-day course. Another, training course (RIDE) which is The Rider Intervention Developing Experience to which motorcyclists are referred by police services, including the Metropolitan Police. It is offered to motorcyclists who have committed road offences, as an alternative to prosecution. The costs are met by the participant. It is a one-day, classroom-based course.

The Initial Rider Training (IRT) project created a European initial rider training programme by Federation of European Motorcyclists, now FEMA [34] which includes a modular approach to initial rider training, the essential elements and aspects for initial rider training, a method and approach to support initial rider training, and a comprehensive manual for use in a range of situations.

In order to increase the proper use of helmet, a six months Community Based Programme (CBP) was carried out in 2012 in two districts of the city of Putrajaya, Malaysia. The programme involved social marketing campaigns, education and enforcement activities to encourage higher compliance with proper helmet wearing. In the concerned districts, proper helmet wearing rate increased from 70% to 86% among riders and from 64% to 82% among pillion [35].

Non-compliance with road safety laws in low-income countries like India is attributed to education, culture, and inefficient law enforcement. Efficient law enforcement and effective safety education taking into account cultural diversity are the key aspects to reduce traffic-related injuries and fatalities in low-income countries like India [36]. Survey of BikeSafe [33] course motorcyclists revealed that 93 percent said their road behaviour had changed as a result of the course.

The current study is an attempt to highlight the often overlooked road safety issue of MTWs, omnipresent in growing Indian cities from their viewpoint so that critically examining their perception, traffic rules compliance behavior, riding behavior, injury prevention knowledge and view on some traffic improvement strategies may lead to bridge the road safety gap between their concerns and traffic enforcement agencies and policymakers.

### Study Objectives

Keeping aspects mentioned above in mind, the objectives of the present study are to examine Delhi MTW riders’ (a) driving

experience on roads (driving speed, near-crash experience, accident history, etc.) (b) compliance to traffic rules (e.g., traffic signal rules, driving license, over speeding, carrying one passenger, etc.) (c) injury prevention knowledge (e.g., use of helmet for driver and pillion, use of bright colored clothes/retro-reflective jacket, use of any protective gear, running headlight ON, etc.) and (d) opinion on few specific traffic improvement and safety strategies (e.g., exclusive/inclusive lane for MTW, bus lane access to MTWs, special waiting area at intersections)

## II. Study Design & Setting

### A. Questionnaire design

To understand MTW riders’ riding behavior, compliance to traffic rules and road safety consciousness, a detailed questionnaire was designed covering various aspects of road safety.

The survey form for two-wheeler riders included four sections **Section A:** socio-demographic variables (gender, age, level of education, income range, marital status) and other variables like ownership of two-wheelers, year of purchase, driving experience, taught to ride by, driving frequency and average trip length; **Section B:** Accident, traffic violation history and compliance-related; **Section C:** Road accident prevention-related; **Section D:** Traffic improvement strategies related

#### A.1 Sample size

We determined the sample size using Kish Leslie formula for simple random sampling (Kish, 1965). We tolerated a maximum error of 5%, at 95% confidence level and adjusted the calculated sample size to cater for non-response of 10%. We used the prevalence of helmet use in Delhi at 70% from study by IRSC-TRIPP [42] to estimate prevalence of compliance to road safety measures among two-wheeler riders.

$$N = (z^2 pq) / d^2 = z^2 P (1 - P) / d^2 \tag{1}$$

where N = sample size; d = precision/error: a precision of 5% was used considering; z = standard normal deviation corresponding to 95% confidence interval which is 1.96.

P = 70% adapted from IRSC-TRIPP [42]

$$N = (1.96^2 \times 0.7 \times 0.3) / 0.05^2 = 323$$

With non-response rate of 10%,  $N / (1 - d) = 323 / (1 - 0.05) = 340$

The sample size that was considered for this study was 340 two-wheeler riders.

#### A.2 Data collection & Rider recruitment

A cross-sectional study was undertaken in December 2019 in urban areas of Delhi. The survey was conducted at parking lots, market areas of few accident-prone zones identified from the Delhi Traffic Police accident statistics [3, 37-39]. The criteria behind location selection were that these traffic circles identified

consisted of roads having the maximum number of accident-prone zones in the previous 3-4 years. Also, they were spatially distributed i.e. North district (Civil Line traffic circle), North-West district (Burari and Model Town traffic circles), South-East district (Kalkaji traffic circle) which provides a representative sample of MTW riders in Delhi. The interviewer team consisted of 3 research assistants.

Further, the MTW riders' in the targetted age-group of 18-45 were randomly selected at the following locations in traffic circles of Delhi namely, **Burari circle**- Sant Nagar, Mukundpur; **Kalkaji Circle**- Nehru Place; **Civil Line Circle**- Burari Chowk, ISBT Kashmere Gate; **Model Town circle**- Nirankari Colony, Guru Tegh Bahadur Nagar, Mukherjee Nagar.

### A.3 Ethical Consideration

The purpose of the study was explained to each participant and consent was obtained from them before conducting the interview.

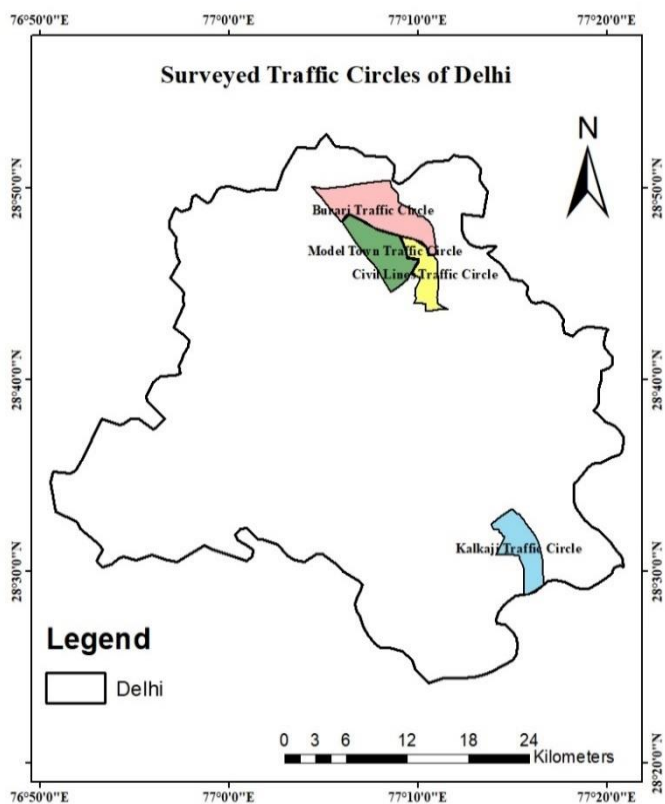


Figure 1: Two-Wheeler Rider Survey Locations in Delhi

Table 1: General Characteristics of MTW Rider Respondents (Sample Size, N= 340)

Variable	Frequency	Percentage (%)
<b>Gender</b>		
Male	307	90.3
Female	33	9.7
<b>Age</b>		
< 18	20	5.9
18-29	228	67.1
30-39	66	19.4
40-49	20	5.9
50+	6	1.8
<b>Highest Level of education</b>		
Never went to school	9	2.6
5 <sup>th</sup> Pass	10	3
10 <sup>th</sup> Pass	46	13.5
Undergraduate	204	60
Postgraduate	71	20.9
<b>Ownership of MTW</b>		
Employer	7	2.1
Family/Relative	150	44.1
Friend	22	6.5
Self	161	47.4
<b>MTW Driving Experience</b>		
< 1	57	16.8
1-5	130	38.2
5.1-10	96	28.2
10.1-20	48	14.1
> 20	9	2.6
<b>Taught to ride by</b>		
A friend/relative	181	53.2
Self	156	45.9
Driving School	3	0.9
<b>Driving Frequency</b>		
Everyday	188	55.3
2-3 times in a week	152	44.7
<b>Average Trip Length (one-side travel)</b>		
< 5 km	90	26.5
5-10 km	108	31.8
11-20 km	71	20.9
> 20 km	71	20.9





Figure 2: Glimpses of Two-wheeler Rider Survey in Delhi



### III. Results

#### A. Socio-demographic characteristics of riders

Characteristics are shown in Table 1.

#### B. Compliance to Traffic Rules

##### B.1. Driving License

Of all the 340 MTW riders, 274 (80.5%) said they carry a valid driving license while driving. Of the 274 MTW riders that said they carry a valid driving license, only 167 (60.9%) had their driving license on-site. 181 (53.2%) were taught to ride by a friend/relative, 156 (45.9%) riders themselves learned to ride a two-wheeler and only 3 (0.9%) went to a driving school to learn to ride the two-wheeler. Prevalence of carrying a valid driving license while driving was 49.1% (167/340). Also, only 19 (5.59%) riders carry the driving license in electronic form which highlights lack of awareness on this aspect. It is therefore opportune to mention here that use of DigiLocker or mParivahan platform to carry documents such as registration certificate (RC), insurance, fitness and permit, driving license (DL), pollution-under-control certificate (PUC) and any other relevant documents is valid and legally recognized at par with the original documents [40].

##### B.2. Riding with one passenger

Of all the 340 MTW riders, only 132 (38.8%) riders reported that they never carry more than one passenger with them while driving. However, around 208 (61.2%) admitted triple riding while driving which is a serious traffic offense and possess the threat of injury to not only the MTW occupants but also to other road users.



### ***B.3. Wrong side driving***

Of all the 340 MTW riders, 160 (47.1%) riders reported that they never violated one-way, however, the rest 180 (52.9%) self-admitted wrong side driving, driving on footpath and cycle track. This admission of flouting traffic rules by small size vehicles like two-wheeler not only makes them vulnerable to involvement in road accidents but at the same time causes nuisance in traffic and problem to other road users which is a grave cause of concern.

### ***B.4. Over speeding***

From the 340 riders surveyed, 117 (34.4%) self-admitted disobeying speed limit mandated for them while driving on roads late at night or in early hours of the morning. This behavior should also be looked in context with the available accident data which reveals that two-wheeler riders caused most accidents from 1900- 2400 hrs [3]. It is therefore pertinent that traffic enforcement agencies should take stringent actions to curb this unlawful behavior of two-wheeler riders.

### ***B.5. Traffic Signal Following***

Of all the 340 MTW rider surveyed, almost 167 (49.1%) admitted that they have violated traffic signal in past. Majority 115 (33.8%) among them were riders who reported that such violations were done 1-2 times by them. To promote road safety and curb traffic rules violations, initiative taken up by Delhi Police and Maruti Suzuki [41] on one of the road corridor in Delhi is noteworthy which not only track the presence of vehicles but also captures multiple offences like red light violation, speed violation, stop line violation and wrong-side violation, along with the registration number of the vehicle using 3-D radars and high resolution cameras. The system then automatically encrypt and transfer the data of violation to the centralized server at the Delhi Traffic Police headquarters in Todapur. It also facilitates generation of e-challans along with photo evidence and sends it to the violators through SMS or email or post.

## ***C. Compliance to Road Safety Measure***

### ***C.1. ISI-Marked Helmet Usage***

#### **Rider**

Most of the MTW riders 317 (93.2%) reported wearing a helmet and out of these, 242 (71.2%) were seen by the enumerators. 36 (10.6%) wore helmet which was not ISI-marked. ISI-certified helmets go through various stringent tests (impact absorption test, retention system test, comfort padding, peripheral vision, etc.) to prevent brain injuries and withstand any impact as per the IS: 4151. Prevalence of compliance to use of ISI-marked helmets was 60.6% (206/340). However, maximum challans i.e. 12,37,745, had been issued for 'Without helmet' in the year 2018 by Delhi Traffic Police. The increase in helmet usage can be due to stricter enforcement and higher challan fines after the implementation of new motor vehicle act-2019 in India.

#### **Pillion passenger**

Of all the 340 MTW riders, only 129 (37.9%) riders reported that the fellow passenger also always wear a helmet while riding with them. 102 (30%) reported occasionally wearing of helmet by fellow passenger but 108 (31.8%) admitted non-usage of helmet by fellow passenger which is a cause for concern and necessitates awareness.

## ***D. Injury Prevention Knowledge and Risk associated with Unawareness***

### ***D.1. Wearing Helmet Pattern***

Delhi has a good record of MTW riders wearing helmets due to stricter enforcement but the majority of them can still end up with head injuries in case of a road accident because they don't fasten the helmet properly. Out of the riders surveyed, only 236 (69.4%) reported that they fasten the helmet properly; 61 (18%) don't fasten the strap of helmet; 21 (6%) kept helmet on the vehicle handle and wore occasionally and 9 (2.6%) admitted that they wore helmet only when the traffic police are present to avoid challan. Investigation of PTW rider accidents in Europe revealed that there were cases of helmets coming off the riders' head due to improper fastening of the retention system or helmet damage during the crash sequence [21]. The above self-reported behavior of MTW riders is alarming and needs attention because it suggests a lack of knowledge about proper helmet usage.

### ***D.2. Bright colored clothes/Retro-reflective jacket Use & Road Accident Involvement***

The ability of the MTW rider to be seen is a critical element of its road safety. Conspicuity or visibility in the traffic stream to other road users is very crucial for road safety, especially during night time. The riders who took the survey were therefore asked whether they wear bright-colored clothing or retro-reflective jackets knowingly. The analysis showed significant finding, that out of the 37 (10.88%) riders who wear such clothing, only 9 (24.3%) were involved in road accidents rest 28 (75.7%) reported 'No' accident involvement. Also, the rest 303 (89.1%) riders not adhering to such clothing were 113 (92.6%) of total riders who were involved in road accidents in the past. This should also be viewed in context with the Delhi road accidents in which two-wheeler riders were involved in most accidents from 1900-2400 hrs [3]. This emphasizes the usefulness of bright-colored clothing or retro-reflective jackets during traveling on MTWs especially during night time.

### ***D.3. Running Headlight ON***

To make roads safer for two-wheelers in India, the Ministry has mandated 'Automatic Headlamp On' (AHO) in two-wheelers considering the fact that AHO has been found beneficial in reducing crashes involving two-wheelers in many parts of the world. The riders were asked about its usage and whether they know the significance of it. 115 (33.8%) riders do not know about it; 86 (25.3%) did not keep headlight ON despite knowing, 88 (25.9%) kept it on during daytime and rest 50 (14.7%) had the AHO feature by default. The use of driving with Headlamps On during daytime by motorised two-wheelers has

been shown to reduce visibility-related crashes in several countries by between 10% and 15%. In a study of 14 states in the United States with motorcycle headlight-use laws, a 13% reduction in fatal daytime crashes was observed [43]. In Singapore, a study conducted, 14 months after the introduction of legislation requiring motorcyclists to switch on their headlamps found that fatal daytime crashes had reduced by 15% [44].

## ***E. Cross-Classification Analysis***

To gain more insights into the categorical (nominal) data, cross-classification or cross-tabulation technique is used.

### ***E.1. Road Accident Involvement and Driving Experience***

Of the 340 respondents, 122 (35.8%) riders self-reported accident involvement in the past. Interestingly, out of them, the riders with driving experience 1-5 years were the most affected 44 (36.1%), 37 (30.3%) riders having 6-10 years, 24 (19.7%) 11-20 years and the accident involvement decreased as the driving experiences increases. Thus, it can be inferred that young drivers with less driving experience are more prone to accident involvement than the more experienced MTW riders which corroborate with the MoRTH statistics also [2].

### ***E.2. Road Accident Involvement & Average Trip Length***

To understand the effect of trip length on accident involvement cross-classification was done and we found that riders with 5-10 km trip length had 43 (35.2%) accident involvement, followed by 28 (23%) accident involvement for < 5 km trip length, 25 (20.5%) rider with 11-20 km and 26 (21.3%) for > 20 km trip length. Therefore, two things can be inferred that drivers with medium-length trips and shorter length trips are most accident-prone rather than the long trip riders but it also reveals that long trip riders are also prone to accidents. This necessitates use of qualified safety helmet and other injury prevention protective gear for all riders.

### ***E.3. Road Accident Involvement & Helmet Usage***

Non-usage of safety devices such as helmets do not cause accidents but are critical for averting fatal and grievous injuries in an event road accident occurs. Out of the 340 riders surveyed, only 75 (61.5%) of those involved in an accident in past wore helmet always; 16 (13.1%) accident involved riders self-reported wearing helmet which is not ISI-marked, 12 (9.8%) wore helmet occasionally, 8 (6.6%) started wearing only after imposition of Motor Vehicle Amendment Act-2019 due to imposition of high challan/fines, and 10 (8.2%) riders self-reported that they don't wear helmet. The response shows that there is still a considerable proportion of two-wheeler riders who are not aware of the importance of the use of qualified safety helmet and enforcement agencies need to take cognizance of that and spread awareness regarding that.

### ***E.4. Road Accident Involvement & Wearing protective gear***

To understand the road safety preparedness and injury prevention knowledge among the MTW riders, it is important to know whether MTW riders wear any other safety device apart from helmet (which only safeguard head) to protect other exposed body parts (legs, hands, eyes etc.). The respondents were asked about the usage of any protective gear (thick clothes on knees and arms, hand gloves, eye goggles, etc.) to reduce impact/injury in case of a road accident. The responses are glaring since 122 (35.8%) drivers self-reported accident involvement in the past and out of them 56 (46%) do not wear any protective gear and 61 (50%) don't have knowledge about any such protection equipment available. The response reveals that MTW riders lack knowledge of injury prevention and required necessary awareness.

### ***E.5. Traffic Offence history and Training on Road Safety rules or visit to Traffic training Park***

Knowledge of traffic rules and awareness of road safety measures significantly impact driving behavior and improve compliance to traffic rules. Five Traffic Training Parks have been established in Delhi with a view to impart road safety education to road users in a practical way. These parks simulate actual road conditions and utilize various methodologies such as practical training in cycling, literature distribution, lectures, film shows to inculcate safety habits among road users [3]. Only 67 (19.7%) riders have attended such training on traffic rules and made visit to traffic training park. Interestingly, of them 46 (68.7%) have reported 'No' traffic offence and only 21 (31.3%) riders have reported traffic offence. Thus, it can be inferred that attending training on road safety or traffic rules had a positive impact on road users and help them to be a safe and law-abiding road user.

### ***E.6. Road Accident Involvement and Accident Reporting***

The problem of under-reporting accident data always exists, except for fatal accidents, especially for vulnerable road users. Accident reporting is one of the fundamental duties of the road user as it not only ensures appropriate legal action against the culprit road user but also aids in the development of the database necessary for identifying causal factors and further in suggesting remedial actions to make the roads safer for all. Of the 122 (35.8%) drivers who self-reported accident involvement in the past, only 29 (23.8%) reported the road accident, whereas the rest 93 (76.2%) chose not to report the road accident. One of the biggest challenges for government agencies is to educate road users in this regard and also advocate good Samaritan policies, so that people need not hesitate to help the road accident victims to reach the nearest hospital, in case they come across one.

## ***F. Opinion on Traffic Improvement Strategies***

The last section of the questionnaire was envisaged keeping in mind the road safety interventions and road engineering



measures taken in different parts of the world which gives special preference to motorized two-wheeler safety and mobility. The riders were also shown the relevant photographs of the road engineering measures in order to report their views on such kind of facilities in Indian context especially Delhi. The obtained rider responses will also facilitate policymakers in decision making.

### ***F.1. Use of Exclusive or Inclusive Two-Wheeler Lane***

Majority of riders 319 (93.8%) responded that they will use this facility if provided on Delhi roads. Only 21 (6.2%) of riders responded that they will not use the facility if provided in future.

### ***F.2. Use of Bus Lanes which allow access to Two-Wheelers***

It was a divided house among riders for usage of such facility in future, with 229 (67.4%) riders reporting that they will not use the facility to use bus lanes if provided while 109 (32.1%) reported that they will welcome such special access.

### ***F.3. Provision of Exclusive Stopping Space (waiting area) for Two-Wheelers at signalized intersections***

The majority of the riders 312 (91.8%) responded that they will use this special treatment at intersections while there were some 28 (8.2%) riders who did not support such treatment at intersections.

## **IV. Discussion**

The study provides a much-needed fact check about the know-how of one of the vulnerable road users' road safety preparedness. Further to sensitize two-wheeler riders on a large scale, it is also suggested that the multi-dimensional questionnaire used in the current study can be distributed and mandated to be filled by the riders at point of sale of two-wheelers, at regional transport office (R.T.O.) during issue of driving license, and vehicle registration cards, at pollution under control centers (PUCC), during vehicle insurance process, during challan by traffic police personnel so that targeted sensitization programmes can be recommended for them to be safe and law abiding road user.

Almost half of the two-wheeler riders 152 (45%) reported traffic offence history, suggesting that a significant proportion of MTW drivers do not follow traffic laws and often flout them. The proportion of those committing these traffic violations may be higher than that reported because people tend to under-report or lie about their bad behavior [45].

The experience from studies abroad suggests that the basic motorcycle rider course is effective in training motorcycle riders. Those trained riders are both less involved and less injured in motorcycle accidents. The course or its equivalents should be made a prerequisite, or at least corequisite, of two-wheeler use and should be applied in driver improvement for

those two-wheeler riders who have received traffic challans or who have been involved in accidents. No road safety initiative either from Governments or riders themselves can ever make two-wheeler riding risk-free. This is also true for walking or cycling. However, road safety knowledge gap can be adequately filled by educating young riders how to tackle these risks and how to adapt and live comfortably in our modern society. This will unquestionably have an important impact to reduce injuries and accidents, which remain part of everyday life. There is a need to put two-wheelers safety concerns into the right context and the growth of two-wheelers should not be used as an excuse that it is becoming less safe.

Fiscal incentives such as reduced GST (goods and services tax) rates for protective equipment, high visibility apparels can easily lead riders to more safety-oriented choices.

## **V. Limitations**

The MTW riders who participated in this study may not be representative of all such riders in the city, but no data on the profile of MTW drivers in the city are available to assess the extent of such a bias in this study sample. Hence, the results of this study should be viewed within these limitations.

## **VI. Conclusions**

The current study is an attempt to gauge the status quo of two-wheeler riders on different aspects related to their safety on roads so that by critically examining their responses, requisite awareness and policies can be formulated which will ensure their safe mobility on roads.

The data from this study show a significant proportion of riders driving without a license, non-complying to traffic laws, moderate use of ISI-marked helmet by riders and fellow passengers, and unawareness of injury prevention features and equipment among the motorized two-wheeler vehicles in Delhi city. The study shows very limited use of digital platforms (DigiLocker or mParivahan) to carry documents such as driving license (DL). The findings suggest stricter enforcement of a ban on sales of non-ISI marked helmet and mandatory use of an ISI-marked helmet also ensuring its proper usage.

The findings also give the extent of vulnerability of two-wheeler riders on Delhi roads based on the near-crash experiences they had while driving. Targeted awareness campaigns should highlight the usefulness of visiting traffic training parks and use of other protective equipment which includes high visibility clothing, gloves, knee and arm guards. It is high time that government policymakers and traffic enforcement agencies in order to reduce mortality and morbidity among riders of the motorized two-wheelers due to road accidents should take cognizance of effective and proven road safety interventions for two-wheelers such as use of headlight-ON, protective clothing/apparel, safety equipment awareness among two-wheeler riders and at least have a temporary run of these policies so that decision making for mandatory use in future can be taken based on pilot run.

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