Section: Forensic Medicine & Toxicology

Original Research Article

MOTORCYCLE RELATED FACTORS ASSOCIATED WITH DEATHS DUE TO ROAD TRAFFIC ACCIDENTS IN MUMBAI: A SINGLE CENTRE CROSS-SECTIONAL STUDY

Harish M Pathak[1], Vikrant N Waghmare[2], Girish V Tasgaonkar[3]

[1]Dean (Academics), Professor & Head, Department of Forensic Medicine & Toxicology, Seth GS Medical College & KEM Hospital, Mumbai, Maharashtra, India.
[2]Assistant Professor, Department of Forensic Medicine & Toxicology, Grant Government Medical College & Sir J. J. Hospital, Mumbai, Maharashtra, India.
[3]Associate Professor, Department of Forensic Medicine & Toxicology, Seth GS Medical College & KEM Hospital Mumbai, Maharashtra, India

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Corresponding Author:
Dr. Vikrant N Waghmare,
Assistant Professor, Department of Forensic Medicine & Toxicology, Grant Government Medical College & Sir J. J. Hospital, Mumbai, Maharashtra, India.
Email: viks2444@gmail.com

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ABSTRACT

Background: Road traffic accidents (RTAs) are a major public health concern in India, with motorcycle accidents accounting for a significant proportion of fatalities. This study aims to investigate motorcycle-related factors contributing to deaths in RTAs in Mumbai. This study aims to identify motorcycle-related factors, such as vehicle condition, road conditions, and helmet usage, associated with fatal road traffic accidents involving motorcycles in Mumbai.

Materials and Methods: This single-center cross-sectional study was conducted at the Department of Forensic Medicine and Toxicology of a tertiary care hospital in Mumbai from January 2024 to June 2024. Data was collected from post-mortem examination reports, police records, and crime scene investigations. Tyre ridges depth and brake-pad thickness were measured and compared with Bureau of Indian Standards.

Results: The study included 132 medico-legal autopsies related to two-wheeler RTA deaths. Males were significantly more affected (82.57%) than females (17.43%), with the majority of victims aged 21-40 years (56.1%). Most victims were from urban areas (66.67%), with a significant proportion being graduates or holding high school certificates (73.47%). A large number of accidents occurred when the age of the motorcycle was between 2 to 4 years (34.09%). Maximum accident cases i.e 57 (43.18%) occurred when brake-pad condition were between 1.1-2mm followed by 46 (34.85%) cases between 0-1mm. Furthermore, 41.67% of cases occurred when tyre ridges depth was between 0-1mm. In 57.58% of cases, both tyre ridges depth and brake-pad condition were below the legal limit. Skid and fall accidents were the most common type of collision (47.73%).

Conclusion: The study highlights the importance of motorcycle maintenance, adherence to traffic regulations, and road safety awareness to reduce fatal motorcycle accidents in Mumbai.

Keywords: Motorcycle Accidents, Road Traffic Accidents, Tyre Condition, Brake-Pad Thickness, Forensic Medicine.

INTRODUCTION

As per accidental and suicidal deaths (national bureau of crime record of India) over 1,94,347 were killed in road accidents in 2022 alone in India, that is more than number of people killed in all post-independence wars put together of India.[1] Road Traffic accident (RTA) is an unplanned event occurring suddenly, unexpectedly and inadvertently in an unforeseen circumstance. RTA cause 1 death every 9 minutes (160 every day and 60,000 every year) four and half times as many as non-fatal accidents.[2]

RTA injuries are currently ranked 9th globally amongst the leading cause of DALY (Disability adjusted life year). Low to middle-income countries account for 85% of the death, and for 90% of the annual disability adjusted life years lost because of road traffic injuries.[3] RTA related Injuries are more common among the two-wheeler vehicles. Motorcycle accidents accounts for 25% of total road crash deaths.[4]

Motorized two-wheeler vehicles constitute a large portion of the vehicle fleet in India.[5] Two wheelers are preferred transportation vehicles for vast Indian families as they are cheaper, gives better mileage, carry at least 2 to 3 passengers, easy to park & ride in traffic congestion. The exponentially increasing number of automobile vehicles, poor adherence to traffic rules and regulations such as maintaining lane discipline, driving in zigzag patterns by public, poorly maintained motorcycles, poorly maintained and congested roads, abuse of alcohol, and lack of awareness about helmets and new generation of high-speed vehicles are altogether responsible for accidents.[6]

Rather incidence of RTA has been increasing at an alarming rate throughout the world, Road traffic accidents is the third major preventable cause of death. Indeed, Traffic Accidents are a major cause of severe injuries and demand on health system, whether at the primary health care level or hospital level.[7]

On an average in industrialized countries and also in many developing countries, one hospital bed in ten is occupied by an accident victim. In this study a sincere effort has been made to study the various motorcycle-related factors (like condition of motorcycle, condition of tyres and brakes, condition of road, wearing of helmet, quality of helmet, etc) responsible for road traffic accidents in Mumbai also suggest measures to be taken to decrease the road traffic accidents involving two wheelers.

MATERIALS AND METHODS

The present Single Centre Cross-sectional study was carried out on persons died due fatal motorcycle accidents brought for post- mortem examination at Department of Forensic Medicine and Toxicology of a tertiary care hospital, during period of January 2024 to June 2024. This is the first study in India which establishes the relationship between condition of vehicle (tyre ridges depth and brake-pad thickness) and susceptibility to road traffic accidents. The ethical permission has been obtained from Institutional Ethics Committee for conducting the study. Total 132 cases of fatal motorcycle accident out of 1969 medicolegal post-mortems conducted during study period were considered with reference to epidemiology, pattern of injuries and various factors responsible for two-wheeler motorcycle accidents.

All cases of death including rider and / or pillion due to motorcycle accidents involving vehicles with gear and without gear brought to mortuary at this tertiary care centre, for postmortem examination during study period were included. Details regarding epidemiological factors required for study purpose were derived from documents received for post-mortem examination which includes, requisition letter from police, inquest panchanama, accidental death report, statements of relatives, spot inquest and hospital records in cases of admitted patients. There was no direct contact between the investigators and relatives of the deceased.

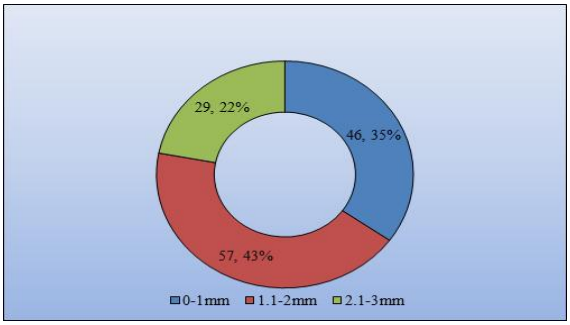
The pattern of injuries and various etiological factors were noted with the help of sketch diagrams, photographs, visiting the scene of crime and charts for easy understanding and interpretation. Motorcycle examination was carried out by visiting the crime scene and also at relevant police stations. The tyre ridges depth and brake-pad thickness were measured with the help of the tyre tread depth gauge in millimeters. For determination of values estimated, standard value set by Bureau of Indian Standard was used which is an authority which establishes standards for tyre and brake-pad dimension.

The data collected was filled in a special proforma prepared for this study purpose only. It was analyzed by using Microsoft excel.

RESULTS

Baseline Demographic Characteristics of the cases: Present data included 132 medico-legal autopsies, purely related to two-wheeler related RTA deaths. Two-wheeler fatalities were significantly higher in males (82.57%) 109 cases than females (17.43%) 23 cases. Majority of victims were in the age group of 21 to 40 years (56.1%) i.e. more young patients were involved in two-wheeler road traffic accidents.

The majority of the victims belonged to urban population (66.67%). Maximum victims were educated involving graduates and high school certificates (73.47%). More frequently involved victims in two-wheeler fatalities were unskilled 28 (21.21%) followed by semi-profession 21(15.91%) and students 19 (14.40%). Most victims were from socio-economic class III 56 (42.42%) followed by class IV 39 (29.55%) as compared to class I (1.52%) and class V (6.82%) and 70 (53.03%) were married.



Graph 1. Distribution of cases as per brake-pad Thickness

Table 1: Distribution as per age of motorcycle.

Age of motorcycle	Cases	Percentage
< 1 year	3	2.27
1 to 2 years	21	15.92
2 to 4 years	45	34.09
4 to 6 years	30	22.72
6 to 8 Years	17	12.88
8 to 10 Years	13	9.85
> 10 Years	3	2.27
Total	132	100

Maximum incidences occurred when age of motorcycle was 2 to 4 years i.e. 45 (34.09%) cases followed by 4 to 6 years 30 (22.72%) cases and 1 to 2 years 21 (15.92%).

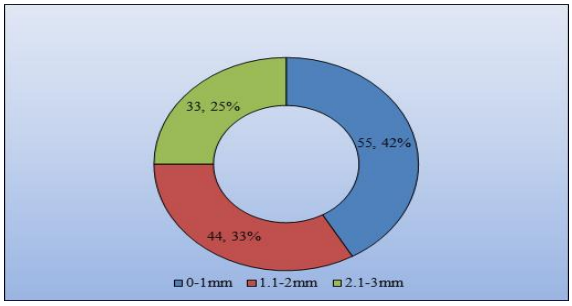
Distribution of cases as per brake-pad Thickness: Maximum accident cases i.e. 57 (43.18%) occurred when brake-pad condition was between 1.1-2mm followed by 46 (34.85%) cases between 0-1mm.

Table 2: Distribution of cases as per age of tyres.

Age of Tyres	Cases	Percentage
< 1 year	06	4.55
1 to 2 years	27	20.45
2 to 4	49	37.10
4 to 6	35	26.51
6 to 8	8	6.10
8 to 10	7	5.32
> 10 years	0	0
Total	132	100

Maximum number of cases i.e. 49 (37.10%) occurred when age of tyre was 2 to 4 years followed by 35 (26.51%) cases when age of tyre was 4 to 6 years. Maximum accidents occurred i.e. 84 (63.63%) cases when age of tyre was between 02 to 06 years.

Distribution of cases as per tyre ridges depth: Maximum incidences occurred when tyre ridges depth was between 0-1mm i.e. 55 (41.67%) cases followed by 44 (33.33%) cases when tyre ridges depth was between 1.1-2mm.



Graph 2. Distribution of cases as per tyre ridges depth

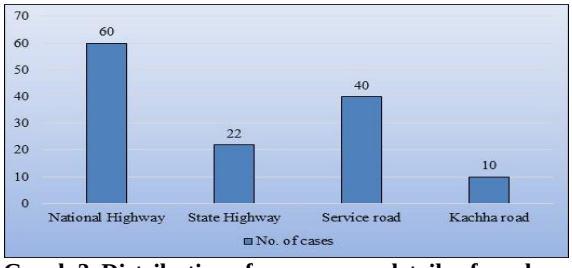
Table 3: Distribution of cases according of brake-pad condition and tyre ridges depth.

Defect	≤1.6mm	%	>1.6mm	%
Tyre ridges depth	79	59.85	53	40.15
Brake-pad condition	84	63.64	48	36.36
Tyre ridges depth+ Brake-pad condition	76	57.58	56	42.42

Out of 132 cases, there were 76 (57.58%) cases in which both tyre ridges depth and brake-pad condition were below legal limit i.e. 1.6mm.

Distribution of cases as per details of road

Maximum two-wheeler accidents occurred on national highway 60 (45.45%) cases followed by service road 40 (30.30%) cases.



Graph 3. Distribution of cases as per details of road

Table 4: Distribution as per place of incidence

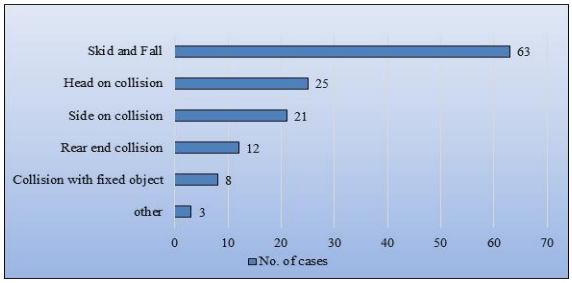
Place of incidence	No. of cases	Percentage
Near house	1	0.76
At Market	2	1.51
At signal	13	9.85
At Speed breaker	18	13.64
At turn	31	23.48
At U-turn	4	3.03
At End of Bridge	3	2.27
Over bridge	15	11.36
At Junction	26	19.70

Near Pothole	18	13.64
Ghat	1	0.76
Total	132	100

Maximum accidents occurred at turn in 31 (23.48%) cases followed by at junction in 26 (19.70%) cases.

Distribution of cases as per type of collision

Maximum cases of two-wheeler accidents were due to skid and fall i.e. 63 (47.73%) cases followed by 25 (18.94%) cases of head on collision and 21 (15.91%) cases of side on collision.



Graph 4. Distribution of cases as per type of collision

Table 5: Distribution of cases according to type of collision with respect to tyre ridges depth and brake-pad condition

Type of collision	Tyre ridges Depth		Brake-pad condition		Tyre ridges depth + Brake-pad condition	
	≤1.6mm	>1.6mm	≤1.6mm	>1.6mm	≤1.6mm	>1.6mm
Skid & Fall (n=63)	34(53.97%)	29(46.03%)	37(58.73%)	26(41.26%)	33(52.38%)	30(47.62%)
Head on collision (n=25)	13(52%)	48(22.64%)	15(60%)	10(40%)	13(52%)	12(48%)
Side on collision (n=21)	14(66.67%)	07(33.33%)	13(61.90%)	8(38.09%)	12(57.14%)	09(42.86%)
Rear end collision (n=12)	10(83.33%)	2(16.67	11(91.67%)	1(8.33%)	10(83.33%)	2(16.67%)
Collision with fixed object (n=8)	5(62.50%)	3(37.50%)	5(62.50%)	3(37.50%)	5(62.50%)	3(37.50%)
Others (n=3)	3(100%)	0(00%)	3(100%)	0(00%)	3(100%)	0(00%)

In maximum accident occurred due to skid and fall when tyre ridges depth and brake-pad condition were 1.6mm and below 1.6mm in 33 (52.38%) cases, followed by head on collision in 13 (52%) cases.

Figure 1: Tyre Ridges Depth Examination with Tyre Tread Depth Gauge

Figure 2: Tyre With No Ridges In Centre

DISCUSSION

Road traffic injuries are a major cause of death, hospitalization, disability, and socio-economic loss in India, driven by factors such as economic liberalization, rapid industrialization, migration, and evolving values among the growing middle-class, youth, and working-age population.

Gender-wise Distribution: Among total 132 cases of death due to two-wheeler motorcycle accidents studied, 109 (82.57%) were males and 23 (17.43%) were females, male to female ratio obtained was 4.7:1. This might be due to the fact that male is more active in our society and uses two-wheeler commonly.

Similar findings were noted in studies of Kumar A et al,[8] where males belonged to 88.22% and females 11.77% and in the study of Singh YN et al,[9] males belonged to 86.96% and females belonged to 13.04% and similarly 83% of males and 17% of females were involved in a study by Gururaj G et al.[10] The predominance of male can be explained by the fact that males lead a more active life, travel more, drive more and so are exposed to the hazards of traffic, accidents and trauma.

Age-wise Distribution: Most Vulnerable age groups that are the active population of the study resulting were those persons of third decade 21-30 years (36.36%) followed by fourth decade 31-40 years (19.70%), second decade 11-20 years (14.40%) and fifth decade 41-50 years (13.64%). A large number of cases in the young age group can be justified by the fact that young persons in this age group are at the peak of enthusiasm, energy and creativity. They lead active life and have the tendency to take undue risk

like speed driving, overtake wrongly, triple riding of bike, boarding over running vehicle etc. which expose them to the hazards of accidents and injuries.

Religion-wise Distribution: Present study shows that maximum number of cases were from Hindu religion 109 (82.57%), followed by Muslims 22 (16.67%). There was also 01 (0.76%) case of Buddhist religion. This finding is consistent with Rajeev Kumar et al (2010) and study done by Sinha ND et al.[11] This is because majority of Hindus (67.39%) in the study population and other religions are quite less populated in the study region.

Region-wise Distribution: In the present study it is observed that incident was more in the Urban areas this reveals the common outdoor working time of the urban regions. It was observed out of 132 cases 44 victims (33.33%) were from rural areas and 88 (66.67%) are from urban areas. Findings observed in Mohammed Sarwar Mir et al,[12] found 52.14% from urban areas and 47.85% from rural areas, Jan Mohammadi et al,[13] found 45.1% from rural and 57.9% from urban road collisions and Singh Y N et al,[14] found 16.98% of victims from rural areas and 83.02% were from urban areas, which is consistent with our study.

Education-wise distribution: The present study showed that incidences were more common among graduates 54 (40.90%), High school certificates 43 (32.57%) followed by middle school certificates 19 (14.40%). This might be due to the fact that in metropolitan city, most of the population uses two-wheeler motorcycles for their jobs, colleges, school etc. Findings observed by Jakkam Surender et al,[15] Literates are 228 (76.77%), Illiterates found in this study are 50 (16.83%), which is similar to our study. Greater proportion of victims in two-wheeler RTA is illiterates and low education personals and it may be correlated with poor road sense / Ignorance of road safety rules and traffic sense.

Occupation-wise Distribution: The present study shows that frequency of two-wheeler accidents was more in unskilled worker 28 (21.21%) followed by semi-profession 21 (15.91%) and students 19 (14.40%). This might be due to fact that there is shifting of educated and skilled population from rural areas for job and employment purpose in metropolitan city. This finding is consistent with Neeta PN et al,[16] who observed that two-wheeler accidents were more common in employed victims (26%) than unemployed victims (15%). This might be due to fact that the most common motorcycle accident injured patients were generally laborers.

Socio-economic status-wise Distribution: The present study shows that maximum victims were from lower middle class 56 (42.42%) followed by upper lower class 39 (29.55%) and upper middle class 26 (19.70%).

These findings were consistent with Sinha ND et al,[11] who found that People from middle and low socioeconomic class were affected more i.e. 198 (55%) and 114 (31.66%), respectively. Jakkam Surender et al,[17] observed that most of the people are from middle socio-economic group the number of people died in that group are 189 (63.64%). This is because of usage of two-wheeler is increasing in populations from different sets of people. This can be interpreted as to the affordability of the people to maintain the vehicle.

Marital Status-wise Distribution: The present study shows that there was not much difference between married and unmarried victims involved in two-wheeler accidents. Married victims were 70 (53.03%) and unmarried were 62 (46.97%). Similar findings were noted by Reddy Ananda et al,[18] married 70 (49%) and unmarried 61 (43%). Verma PK et al,[19] observed that the annual incidence of traffic injuries was more common in the married group as compared to those in the separated or divorced group. Guntheti BK et al,[20] found that Married persons 82 (75.92%) outnumbered unmarried persons 24 (22.22%).

This might be due to fact that they are prime bread earners of the family and thus remained outdoors during most of the day.

Age of Motorcycle: Maximum incidences occurred when age of motorcycle was 2 to 4 years i.e. 45 (34.09%) cases followed by 4 to 6 years 30 (22.72%) cases and 1 to 2 years 21 (15.92%). This finding is consistent with Sinha ND et al,[11] observed that Out of the total 246 vehicles involved, 162 (65.85%) were old and 84 (34.14%) were new. Out of 42 fatal accidents caused by motor vehicles, 33 (78.57%) were due to old ones. Old vehicles were also responsible for majority of non-fatal accidents i.e. 129 (43.67%). Smith L et al,[21] observed that the majority of the scooters were 5 years or less while more than half of the sports and retro bikes were over 5 years old. This might be due over-aged ill-maintained vehicles.

Condition of brake-pads thickness: The present study shows that maximum accidents occurred when condition of brake pad thickness of motorcycles at the time of accident were 1.1-2mm in 57 (43.18%) motorcycles followed by 0-1mm in 46 (34.85%) motorcycles. It also shows that least number i.e. 29 (21.97%) motorcycles who met accidents, the brake pad thickness was 2.1-3mm. we found 70 cases of head injuries when brake-pad condition was below 1.6mm and only 38 cases were recorded when brake-pad condition was above 1.6mm. Though the 18 victims were wearing helmet, chances of head injury due to brake-pad condition below legal limit is 75 %. Hence periodic examination and replacement of brake-pad significantly lowers the chances of head injury.

As per Indian standard bureau the brake-pads should be changed when the brake-pad thickness is reduced to legal limit i.e. 1.6mm due to wear and tear.[22] It was observed that in 84 (63.64%) motorcycles that met with accidents, the brake-pad thickness was below the legal limit i.e. 1.6mm. This may be due to there are no strict laws on periodic checking of motorcycles for brake-pad conditions and most of the people does not know this legal limit.

Tyre ridges depth: The present study shows that maximum accidents occurred when motorcycle tyres ridges depth were between 0-1mm i.e. 55 (41.67%) cases followed by 1.1- 2mm 44 (33.33%) cases. It also shows least accidents occurred when tyre ridges depth was between 2.1-3mm in 33 (25.00%) cases. Hence periodic examination and replacement of tyres significantly lowers the chances of head injury. This finding is consistent with S Moodley et al,[23] who observed that the most common tyre defect was smooth tyres where ridges depth was less than 01mm or where the ridges depth was below the ridges depth indicator i.e 1.6mm.

Eun-Ha Choi et al,[24] observed that of all the tyres with ridges depth between 0 and 2/32″ i.e. 0 and 1.6mm, 26.2 percent were mounted on tyre- related crash vehicles. In regard to tyre with adequate tyre ridges depth, the data show that 8 percent of the tyres with ridges depth in the range 3-4/32″ i.e. 2mm and 3mm belonged to tire-related crash vehicles.

Road-wise Distribution: The present study shows that maximum number of motorcycle accidents occurred over national highways i.e. 60 (45.45%) cases followed by over city road in 40 (30.30%) cases and state highways 22 (16.67%). This finding is similar with Reddy Ananda et al,[18] observed that maximum accidents occurred on national highways 30% followed by city road 24%. Guntheti BK et al,[20] observed that the highest number of RTA (60 [55.55%]) cases took place on national highways followed by state highways (30 [27.77%]) and city roads (10 [9.25%]).

The reasons for high incidence of accidents on the highways [national & state] and city roads might be these roads are busiest, very narrow, too much traffic during peak hours, no traffic signals at junctions, and no strict enforcement of road safety rules.

Type of collision: The present study shows that maximum accidents occurred due to skid and fall in 63 (47.72%) cases followed by head on collision in 25 (18.94%) cases and side on collision in 21 (15.91%) cases. This finding is similar with Nupur pruthi et al,[25] who found that commonest mode of accident as skid and fall (45.5%). Jha N et al,[26] found skid and fall in 37% cases followed by different types of collision in 29.3% cases.

The reason for maximum cases of skid and fall and head on collision in our study might be due to the fact that worn-torn tyres and poor brake-pad thickness leads to ineffective balancing and braking which may result in skidding and increase in stopping distance.

CONCLUSION

We concluded that there is male preponderance with most commonly involved age group 21 to 40 years specially in Urban areas. Unskilled personnel and semi-profession worker specially belonging to lower- and middle-class socio-economic group are involved. Maximum motorcycles involved are old aged between 2 to 6 years. Most of accidents occurs when brake-pad thickness is between 0- 1mm. Maximum accidents occurs when tyre age was between 2 to 4 years. Maximum cases tyre ridges depth is between 0 to 1mm. Maximum accidents occurs on national highways. Most of the accidents occurs due to skid and fall followed by head on collision.

Enforcement of rules which give access for periodical checking up of various parts of vehicles will reduce the incidence of RTAs. Making it compulsory regarding use of devices like governors in all motor driven vehicles which shall check over speeding of vehicles. Providing of Anti-locking brake system. Providing wear and tear indicator on tyres and brake-pads regarding legal limit of replacement. Sufficient numbers of accident relief units which include ambulance, medical personnel who are well trained in handling casualty victims and a couple of paramedical personnel if provided will be highly rewarding.

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