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Original Research Article

Frequency and Severity of Head Injury Among Motorcycle Riders With and Without Helmet Use

Mubashara Waheed Siddiqui*, Mehak Hafiz Gaziani, Zohaib Ahmed

Department of Neurosurgery, Liaquat National Hospital & Medical College, Karachi
**Corresponding author`s email address:* mubasharasiddiqi@gmail.com

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Abstract: *-Related injuries are a growing public health concern worldwide, particularly head injuries, which are a leading cause of death and long-term disability among riders. Despite strong evidence supporting the protective benefits of helmets, helmet usage remains inconsistent, especially in low- and middle-income countries. Understanding the frequency and severity of head injuries in riders with and without helmets is essential for guiding safety regulations, promoting helmet use, and reducing the burden of traumatic brain injuries due to motorcycle accidents.* ***Objective:*** *The main objective of the current study was to determine the frequency and severity of head injury among motorcycle riders with and without helmet use presenting at the emergency ward of a tertiary care hospital.* ***Methods:*** *This cross-sectional study was conducted from November 15, 2024, to February 28, 2025, in the Department of Neurosurgery, Liaquat National Hospital & Medical College, Karachi. Participants of both genders, aged between 18-60 years, who were motorcycle riders or pillion riders presenting at the emergency ward with road accidents were included in this study. Mentally disabled patients and cases in which obtaining consent was not possible because unconsciousness of patients and the absence of their attendants were excluded from the current research study; the data were analyzed by using SPSS version 27.* ***Results:*** *A total of 195 motorcycle drivers injured in road accidents were included in the study; the mean age (years) of all patients was 33.24±15.73, and 80.5% (n=157) were male. Motorcycle male drivers with and without helmets presented as 88(89.8%) & 69(71.1%) compared with the female drivers as 10(10.2%) and 28(28.9%), p-value of 0.001. Glasgow Coma Scale (GCS) scores showed that motorcycle drivers with and without helmets were more often in mild (GCS-15) as 66 (67.3%) versus 27 (27.8%), p-value < 0.000. The moderate (GCS Score 9-12) severity of head injury was 4 (4.1%) versus 12(12.4%), respectively. Severe (GCS Scores 3-8) were observed as 8 (8.2%) compared to 24 (24.7%) with a statistically significant p-value < 0.005.* ***Conclusion:*** *The study shows that helmet use among motorcycle drivers significantly reduces the severity of head injuries. Riders who used helmets had a higher rate of mild Glasgow Coma Scale (GCS) scores and a lower number of severe injuries compared to those without helmets.*

Keywords: GCS Glasgow Coma Scale, SPSS Statistical Package for the Social Sciences

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Introduction

Road traffic injuries are among the leading causes of death, hospitalization, disability, and socioeconomic decline worldwide. Annually, road traffic accidents result in approximately 1.3 million deaths and 20–50 million non-fatal injuries, with about 1.24 million fatalities occurring globally each year. (1)

According to the Global Burden of Disease study, injuries account for around 10% of global deaths, and if current trends continue, this burden is expected to rise significantly over the next two decades. In many nations, road accidents lead to economic losses amounting to as much as 3% of their GDP. (2) Motorcycle use for transport is rising in many countries, causing more motorcycle-related injuries. These injuries are a significant yet often overlooked public health issue, contributing substantially to overall road traffic injuries. In developing countries, (3) motorcyclists, passengers, and pedestrians, especially those in their teenage years, are the most affected, largely due to rapid motorization, weak enforcement of traffic laws, inadequate health infrastructure, and limited access to healthcare services.

The most frequent cause of death in the 10-24 age group in 2019 due to road traffic injuries, which claimed around 200,112 young lives. Of the overall number of road traffic deaths in this age group, about a quarter of deaths, n=51,353 (26%), were related to motorbike riding. Motorcycle fatalities were overwhelmingly concentrated in low- and middle-income nations (94%). (4)

Injury-related motorbike accidents are becoming more and more important to global public health. In research (5), motorbike accidents made up 57% of all head injuries caused by traffic. Due to a lack of protection and safety measures, motorbike riders are naturally more prone to injuries than car occupants among vulnerable road users. (6-8) For example, the death rate for motorcyclists is 28 times greater than that of car occupants. (9) A motorcyclist's entire body, especially the head, is extremely vulnerable to harm. Motorcycle riders can be flung from their bikes in even small accidents, landing on their heads, making head injuries the most common among fatally injured riders and the primary cause of death in most cases. (10, 11)

The World Health Organization (WHO) advises wearing helmets as one of the primary methods of avoiding injuries from motor vehicle accidents. (12) The main defense against avoiding or minimizing brain injuries from motorcycle accidents has been the use of helmets, which are typically constructed of strong fiberglass or a shell made of plastic, lining, and a chinstrap. (13) The number of patients who had head injuries among motorcycle riders who used helmets and non-users was reported to be 10% and 86%, respectively, in a study assessing injury patterns among motorcycle users. (14)

Karachi is one of the busiest cities in Pakistan, with a land area of 3,780 km², serving as a transport hub and having an estimated population of 16,839,950 as of 2022. (15-17) Motorbikes are progressively becoming the preferred means of transportation due to their capacity to navigate congested highways and roads. Between 1956 and 1996, the total number of registered vehicles climbed by 17 times, while the number of cars on the road increased by a factor of five, the number of accidents increased by a factor of fourteen, and the number of deaths due to RTA increased by a factor of sixteen. (16) For instance, the number of motorbikes in use in Pakistan has increased dramatically, from 100,000 in 2000 to 2,000,000 now. (17)

Due to the high expenses of immediate and ongoing care, head injuries have a significant financial impact on survivors, their families, and society. Wearing a helmet is an efficient way to avoid brain injuries in motorcyclists and lowers their risk of suffering more serious injuries, as well as motorcycle-related morbidity and disability. Studies evaluating the impact of helmet use on head injury are rare in Pakistan and suffer from the limitation of a restricted sample size. (18, 19)Therefore, this study evaluates the frequency and severity of head injuries among motorcycle riders who used helmets or not.

The main objective of the current study was to determine the frequency and severity of head injury among motorcycle riders with and without helmet use presenting in an emergency room of a tertiary care hospital.

Methodology

The cross-sectional study was conducted from 15th November 2024 to 28th February 2025, in the Department of Neurosurgery, Liaquat National Hospital & Medical College, Karachi, after permission from the ethical review committee. The sample size of the current study was calculated by taking the frequency of head injury among motorcycle riders = 54% (14). The total calculated sample size was 195, with the help of the Open Epi software for sample size calculation. A total of 195 patients, i.e., 98 in group A (with helmet), were included to achieve the assumption of normality. The participants of both genders, aged between 18 - 60 years, motorcycle riders and pillion riders presenting to the emergency room with road traffic accidents, were included. Mentally disabled patients and cases in which taking consent was not possible because of the unconsciousness of patients and the absence of their attendants were not included in the current research study.

The study was conducted after approval from the hospital ethics committee and the CPSP. The study's purpose and benefits of the study were explained to study participants or to their attendants to get their consent to enroll them in the study. Confidentiality of the study subjects was assured throughout the study, and their medical records were tagged with other serial numbers to conceal their identities. The data, including patients' age, gender, occupation, education, number of years of using a motorcycle, time since injury, pupil reaction, helmet use, occurrence of head injury, and severity of head injury documented in a pre-designed study proforma.

Motorcyclists or pillion riders presenting to the emergency ward with traumatic injuries were included in the study. The neurosurgeon was informed by the emergency staff about the neurosurgical management of the affected patient. The assigned data collectors were to take demographic data from attendants/patients after obtaining their consent. In case attendants were not present at the time of the first patient visit to the emergency room and the patient was unconscious, the demographic information and consent were taken when attendants visited their patient. Data was entered into SPSS version 27 for statistical analysis. Categorical variables like gender, education, residence, patient type, helmet use, occurrence of head injury, and head injury severity were expressed as frequencies and percentages. Numerical variables such as age, years of motorcycle use, duration since injury, and GCS score were presented as frequency and percentage. The normality assumption was tested with the Shapiro-Wilk test. Effect modifiers such as age, gender, education, occupation, patient type, and use of a helmet are addressed through stratification. Post-stratification chi-square or Fisher's exact test was applied to determine the association with head injury and its severity. A p-value ≤ 0.05 was taken as statistically significant.

Results

A total of 195 motorcycle drivers who were injured in traffic crashes were included in the study. The mean age (years) of all included patients was 33.24±15.73, and 80.5% (n=157) were male. The level of education of motorcycle drivers is distributed in different groups. It was found to be an intermediate pass of 72(36.9%). More drivers belonged to urban areas, at 163(83.6%), and patient types were more motorcyclists, at 135(69.2%). likely to be used as 98(50.3%). Patient demographics are summarized in Table 1.

Motorcycle male drivers with and without helmets presented as 88(89.8%) & 69(71.1%) compared with the female drivers as 10(10.2%) and 28(28.9%) with a p-value of 0.001. The average age of patients with and without helmets was 31.56±13.94 versus 34.94±17.26, with a statistically significant p-value of 0.028. It was also observed that there was no statistically significant difference found among head injuries with and without helmets, as 0.355. (Table 2)

Glasgow Coma Scale (GCS) scores showed that with and without helmets, motorcycle drivers were more often in mild (GCS -15) 66(67.3%) versus 27(27.8%), p-value < 0.000. The mild severity of head injury according to the GCS score was 86(87.8%) and 61(62.9%), moderate 4(4.1%) versus 12(12.4%) with and without a helmet, respectively. Severe GCS scores (3-8) were observed as 8(8.2%) compared with 24 (24.7%) without a helmet, which was statistically significant. (Table 3)

Table 1: Demographic information of research participants

Research Variables		**f(%)**
Age (Mean ± SD)		33.24±15.73
Grouped Age	10-19	46(23.5%)
	20-29	62(31.8%)
	30-39	40(20.5%)
	40-49	7(3.6%)
	50-59	24(12.3%)
	60-69	8(4.1%)
	≥ 70	8(4.1%)
Gender	Male	157(80.5%)
	Female	38(19.5%)
Educational Level	No Formal Education	24(12.3%)
	Primary	36(18.5%)
	Matriculation	24(12.3%)
	Intermediate	72(36.9%)
	Graduation and above	39(20.0%)
Residence	Rural	32(16.4%)
	Urban	163(83.6%)

Patient type	Motorcyclist	135(69.2%)
	Pillion Rider	60(30.8%)
Average year of motorcycle use		17.43±14.62
No. of years since motorcycle use (years)	≥ 1 --- -≤ 20	155(79.5%)
	≥ 21 --- -≤ 50	32(16.4%)
	≥ 51	8(4.1%)
Using Helmet	Yes	98(50.3%)
	No	97(49.7%)

Mean ± Standard deviation

Table 2: Injury Distribution with Study Groups

Research Variable		Study Group With Helmet	Without Helmet	p-value
Gender				
Male		88(89.8%)	69(71.1%)	0.001
Female		10(10.2%)	28(28.9%)	
Age		31.56±13.94	34.94±17.26	0.028
Age group				
10-19		30(30.6%)	16(16.5%)	0.002
20-29		22(22.4%)	40(41.2%)	
30-39		23(23.5%)	17(17.5%)	
40-49		7(7.1%)	0(0.0%)	
50-59		12(12.2%)	12(12.4%)	
60-69		2(2.0%)	6(6.2%)	
≥ 70		2(2.0%)	6(6.2%)	
Mechanism of Motorcycle Injury				
Motorcycle versus motorcycle		38(38.8%)	62(63.9%)	0.00
Motorcycle slipping on the road		58(59.2%)	29(29.9%)	
Any other (please specify)		2(2.0%)	6(6.2%)	
Head Injury	Yes	95(96.9%)	92(94.8%)	0.355
	No	3(3.1%)	5(5.2%)	

Chi-square/Fisher's exact test was applied. P-value < 0.05 is considered significant. *Significant at 0.05 level.

Table 3: Comparison of Glasgow Coma Scale (GCS) Score and Severity of Head Injury among Motorcycle Riders with and without Helmets

Outcome Variable		Study Group With Helmet	Without Helmet	p-value
Glasgow Coma Scale (GCS) Score				
5		2(2.0%)	6(6.2%)	0.000
6		2(2.0%)	6(6.2%)	
8		4(4.1%)	12(12.4%)	
12		2(2.0%)	6(6.2%)	
13		8(8.2%)	0(0.0%)	
14		14(14.3%)	40(41.2%)	
15		66(67.3%)	27(27.8%)	
Severity of Head Injury	Mild GCS Score (13-15)	86(87.8%)	61(62.9%)	0.000
	Moderate GCS Score (9-12)	4(4.1%)	12(12.4%)	
	Severe GCS Score (3-8)	8(8.2%)	24(24.7%)	

Chi-square/Fisher's exact test was applied. P-value < 0.05 is considered significant. *Significant at 0.05 level.

Discussion

Motorcycle accidents remain a major public health concern, with a rising incidence in recent years. In the current study, 97(49.7%) of riders were not using helmets at the time of the accident. Notably, without helmets, riders were over twice as likely to sustain severe traumatic brain injuries, the strongest predictor of mortality, while helmet use significantly reduced the risk of death without increasing neck or cervical spine injuries.

The study included 195 motorcycle drivers injured in traffic accidents. The average age of the participants was 33.24±15.73 years. Among them, 72(36.9%) drivers had an intermediate level of education. Many of the drivers resided in urban areas, 163 (83.6%), and most were motorcyclists, 135 (69.2%). Helmets were used by 98(50.3%) drivers, additionally, motorcycle accidents predominantly involved males, accounting for 157(80.5%), which is like other studies conducted in Campina Grande, Brazil (85.8%), (20) and Kenya (80.8%), (21) but higher than the study done in Kenya.

A study by Oltaye et al. (1) reviewed 274 patient medical records, of which 151(55.1%) patients were admitted to the emergency department due to motorcycle accidents. Among these, 118(78.1%) were males and 33(21.9%) were female patients, yielding a male-to-female ratio of 3.6:1. Most of the individuals affected, 67%, were between 20 - 49 years old. Additionally, 53.6% resided in rural areas, while 46.4% were from urban locations (1). These findings were consistent with studies from Campina Grande, Brazil (33.9%) and Nakuru County, Kenya (42.3%). In the present study, 157(80.5%) of motorcycle accident victims were male. This proportion aligns closely with figures reported in Campina Grande, Brazil (85.8%) and Kenya (80.8%), though it is higher than results from other Kenyan research. (20, 21)

A study conducted by Hounkpe et al. (22) found no significant difference in the average age between individuals with head injuries (35.6 ± 12.7 years) and those without (36.7 ± 12.1 years). In both groups, males were the majority, 93.4% among those with head injuries and 88.6% among those without. Head injuries were significantly ($p < 0.05$) more frequent in males than females, particularly in the 30–39 age group. (22)

In the current study, helmet usage showed a clear gender distribution: 88(89.8%) of helmet riders were male compared to 69971.1% without helmet riders, with a statistically significant p-value of 0.001. The average age was significantly lower among helmet riders (31.56 ± 13.94) than those without helmets (34.94 ± 17.26), with a p-value of 0.028. However, one observed variable showed no statistical significance ($p = 0.355$).

Hounkpe et al. (22) emphasized that not wearing a helmet significantly increases the risk of head injuries in motorcycle crashes, highlighting the need for targeted awareness campaigns aimed at high-risk individuals. Their 2020 case-control study involved 242 cases (individuals with head injuries) and 484 controls (without head injuries), selected from traffic crash victims treated at five hospitals between July 2019 and January 2020. Helmet use at the time of the crash was notably lower among those with head injuries (69.8%) compared to those without (90.3%). After adjusting for other variables, the risk of head injury was 3.8 times higher in those not wearing helmets. Additionally, the head injury was 1.9 times greater among fatigued riders and 2.0 times higher in those without any prior medical history. (22, 23)

The Glasgow Coma Scale (GCS) scores in this study revealed significant differences between with and without helmet motorcycle drivers. Among helmet riders, 66(67.3%) had mild head injuries (GCS-15), compared to only 27(27.8%) in the without helmet group ($p< 0.000$). Moderate head injuries (GCS 9-12) were less common in helmet drivers 4(4.1%) than in helmet drivers 12(12.4%). Severe head injuries (GCS 3-8) were also significantly lower in the helmet group 8(8.2%) compared to the helmet group 24(24.7%).

Motorcycle accidents continue to be a major public health concern, often resulting in high rates of severe injuries and fatalities. Brockhus et al. (24) investigated the relationship between helmet use and injury outcomes, hypothesizing that helmets reduce the risk of head injuries without increasing the likelihood of cervical spine trauma. Findings revealed that helmeted riders more frequently sustained injuries to the lower (62.3%) and upper (59.3%) extremities, whereas head injuries were most common among those without helmets (54.4%). Non-helmeted riders were also more likely to arrive with a Glasgow Coma Scale (GCS) score below 9 (14.7% vs. 7.5%, $p < 0.001$), and experienced higher rates of major trauma and severe head and facial injuries. Despite similar median Injury Severity Scores (ISS) between groups, non-helmeted riders had significantly greater odds of severe trauma ($ISS > 15$ or ≥ 25). Helmet use was associated with a 15% reduction in mortality risk, and lower GCS on admission remained the strongest predictor of death. They concluded that helmets provide substantial protection against severe head injuries and reduce the risk of death without increasing cervical spine injury rates. Fewer such injuries were observed among helmeted riders. These findings support the need for strong public health efforts to enforce universal helmet laws both nationally and globally. (24)

Conclusion

This study demonstrates a strong link between helmet use and a lower incidence and severity of head injuries among motorcycle riders. Without helmets, riders were significantly more prone to severe traumatic brain injuries and had a higher risk of mortality. These results emphasize the vital importance of helmet use in preventing serious head trauma and highlight the need for stronger helmet laws and increased public education to improve rider safety.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MMS-033-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

MWS

Manuscript drafting, Study Design,

MHG

Review of Literature, Data entry, Data analysis, and drafting articles.

ZA

Conception of Study, Development of Research Methodology Design,

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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