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ORIGINAL ARTICLE

Determinants of Motorized Two-Wheeler Crash Injuries in Lahore, Pakistan: A Hospital-Based Study

AMJAD IQBAL BURQ[1], MUHAMMAD SALEEM RANA[2], EJAZ AHMED QURESHI[3]
[1]*Associate Professor Department of Community Medicine, Islam Medical College Sialkot*
[2]*Professor Faculty of Allied Health Sciences, The University of Lahore*
[3]*Associate Professor Faculty of Allied Health Sciences, The University of Lahore*
Correspondence to: Amjad Iqbal Burq, Email: amjadburq@gmail.com

ABSTRACT

Background: Road traffic accidents (RTAs) are a leading cause of morbidity and mortality worldwide, with motorcycle riders being among the most vulnerable road users. In Pakistan, motorcycles are the most common mode of transport, but high crash rates impose a substantial burden on the healthcare system. Despite this, limited research has explored the combined role of demographic, behavioral, vehicular, and environmental determinants of motorcycle crash outcomes.

Objective: To identify the demographic, behavioral, vehicular, and environmental determinants of motorized two-wheeler crash injuries in Lahore, Pakistan.

Methods: A cross-sectional descriptive study was conducted at the trauma centers of Mayo Hospital, Jinnah Hospital, and Lahore General Hospital between April and June 2022. Using non-probability convenience sampling, 295 injured or deceased motorcycle riders were enrolled. Eligible participants included riders of any age or gender involved in road traffic crashes, while individuals with non-road trauma such as falls or assaults were excluded. Data were collected through a structured proforma and analyzed descriptively.

Results: Most victims were working-age riders (17–60 years), highlighting occupational and commuting exposure. Adolescents (<17 years) exhibited high-risk behaviors, particularly stunt riding. Evening commuting hours accounted for the majority of crashes. Helmet non-use, frequently linked to thermal discomfort, significantly increased injury severity. The majority of motorcycles were in serviceable condition, suggesting behavioral rather than mechanical causes. Human error, including over-speeding and traffic violations, emerged as the most significant determinant of crashes.

Conclusion: Motorcycle crash outcomes in Lahore are shaped primarily by demographic and behavioral factors, compounded by environmental risks. Targeted interventions including adolescent-focused safety programs, climate-appropriate helmets, and stricter enforcement of traffic laws are urgently needed.

Keywords: Motorized two-wheeler, crash injuries, helmet use, behavioral risk factors, road safety.

INTRODUCTION

Road traffic accidents cause multiple injuries to the victims who might result into their disability or death[1]. Substantial cost involved in the treatment bears a potential burden on the national healthcare system. The advent of motorized vehicles has elevated the standards of civilization and living to an immeasurable extent. Among these, motorcycles stand out as the most commonly used mode of transportation in Pakistan, primarily because they offer the most economical means of travel[2].

Research has shown that motorcycle-related trauma imposes a financial burden on the public healthcare system up to six times greater per vehicle than injuries resulting from other automobiles[3]. To illustrate, estimates from Ontario's Ministry of Health and Long-Term Care suggest that the province could save approximately $13.5 million annually if the collision rates remained constant and all registered motorcycles were replaced by cars. It is important to note, however, that this estimate is likely conservative for several reasons[4].

Pakistan is among the countries with a relatively high rate of roadside accidents, accompanied by considerable mortality and morbidity. The widespread use of motorcycles has further contributed to the rising frequency of motorcycle-related injuries[5]. According to the first roadside trauma surveillance report (2011), the incidence of road traffic accidents was 184.3 per 100,000 population, with a mortality rate of 5.7 per 100,000. This underscores the critical need to adopt effective local protocols aimed at reducing motorized two-wheelers accidents[6].

Despite the significant safety concerns associated with motorcycles, the body of literature on motorcycle safety in Pakistan remains limited[7]. Most existing studies (Minhas et al., 2016) have primarily emphasized helmet use and road safety legislation, while only a few, such as Waseem et al. (2019), have examined injury severity in detail. There is a pressing need for more country-specific research to explore the influence of multiple factors, including traffic patterns, road conditions, environmental factors, and rider behavior, on the occurrence of motorcycle crashes[8,9].

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In Oslo, Norway during 2018. a systematic review and meta-analysis study was conducted where authors evaluated 21 studies on subject - effects of compulsory helmet use on injuries by legislation. Compulsory use of helmet reduced the head injury by 20%. Serious injuries were also reduced by 55%. Author did not find any adverse effect by this legislation. Deterrent effect of cycling by use of helmet bears no weight when the matter comes to person's safety[10,11].

During a study which was conducted in Greece during 2020, researchers identified the risk factors associated with two-wheelers crash accidents. Authors classified the identified risk factors according to likelihood and severity of injuries. They also differentiated the risk factors associated with driver behavior, motorcycle, environmental and socioeconomic conditions and traffic safety laws[12].

Muhammad Asim conducted a study in Peshawar, Pakistan during 2021. He concluded in his study that salient risk factors for motorcycle crash accidents are poor traffic intellect, drivers working for long hours leading to fatigue, human errors, over speeding, traffic rules violation while overtaking, rough conditions of roads, traffic congestion and road encroachments leading to cause of obstacles in traffic flow[13].

Researchers conducted a study in France. They conducted their research on 132 power two-wheeler riders. They selected only those responses which belong to risk factors. They specifically highlighted that mutual misunderstanding, conspicuity and ignorance of driving situations' determinants are important risk factors[14]. As this study was conducted in France which is a developed country having high income people, they emphasized on the fact that diversity of vehicles with their various specifications makes difficult for one driver to understand the capability of other driver's vehicle in conflict situations. This is an important risk factor which is being ignored while developing road safety measures[15].

A study was conducted in India. Researchers found that use of motorized two-wheelers in India has been increased being an economical mode of transportation and due to their abundance,

road traffic accidents and resulting injuries have been increased substantially[16]. Motorcycle riders face high level of both physical and mental stress which contributes to inattention, poor vision, weak reflexes and compromised coordination. Daily use of motorcycle for commutation causes angular deviations at various levels of musculoskeletal system. Lumbar region (L1-L5) is usually affected. These angular deviations give rise to muscular spam and poor activity of nervous system. All these collectively affect the performance of motorcycle driver which ultimately contribute to road traffic accident[17].

Researchers found in their study which was conducted in France that those powered two-wheelers who filter through the traffic along the way of bus lanes, carriages or lane splitting are at high risk of getting road crashes. Usual reason for practicing this attitude is overseeding or riding for exciting purpose[18].

Researchers led a study in Karnataka, India. They found that negative emotions have antagonistic influence on persons with high-risk riding. Pillion riders reported that attitude of high-risk riders was more aggressive both verbal and non-verbal. They frequently engage in such situations where opposing rider finds difficulty in finding his way which result in collision[19].

During the study which was conducted in France, researchers after examining the 565 accident cases found that there is anticipation failure by the motorized two-wheeler riders when they feel difficulty for coordinated driving. In such scenarios, their actions are also misleading signals to other drivers on the road. This grave incompatibility give rise to collision which often result into violent accident. Such accidents are cause of severe injuries leading to high rate of disability and mortality[20,21].

Researchers conducted study in India during 2021. They focused on contributing factors for degradation of driving performance. They identified time pressure and distraction as two main contributing factors. Previously researchers studied the same variables in car drivers but researches in this study focused on motorized two-wheelers belonging to low- and middle-income countries[22]. They also counted demographic, psychological and socioeconomic factors. Authors collected the 513 responses from the online survey. Structural equation modelling revealed that riders driving under time pressure are positively correlated with distraction from driving. Influence of time pressure also give rise to necessity to talk with pillion rider, mobile phone talking and harsh conversation with other riders. Bewildered perception of the drivers due to low visibility, poor vision and defective brake system are the causative factors for such road traffic crashes[11,17].

Another study was conducted in Malaysia. Researchers found that in spite of many efforts to reduce the road traffic accidents involving two-wheeler riders, unlicensed riding of motorcycles remained a concern in Malaysia. One fifth of the causalities were found in motorcyclists who drive without license[15].

Researchers conducted a study in Karachi, Pakistan during 2020 to find out the factors contributing to two-wheeler crash accidents. They observed that like other developing countries, motorcycle is also being extensively used as means of routine transportation by middle and low-income group of people in Pakistan. Now motorcycles make up the 74% of total vehicles registered in Pakistan[16]. Development of road safety by-laws for motorcycle users are still at infancy. In this study, researchers chose two years data 2014-2015 through road traffic surveillance system in Karachi. Authors found that riders of old age, weekends and night times correlate with more severe two-wheeler accidents[8,14].

During 2021, a study was conducted in Chandigarh, India. Researchers found that females usually travel as a pillion rider and head injuries are common to them in two-wheeler accidents. Now trend of wearing helmet in female is on the rise though very slow. This is due to increasing awareness among the females. They proposed that helmet manufactured should be widely used irrespective of sex, creed and religion. Among the total 6136 autopsies, 31.9% belong to road traffic accidents. Females died in 209 cases, so representing 10.7% of total road traffic accidents. 87 out of total autopsies belonged to two-wheeler accidents[18-20].

MATERIALS AND METHODS

It was cross-sectional descriptive study. This study was carried out at Trauma Centers of 3 Tertiary care Hospitals of Lahore (Mayo Hospital, Jinnah Hospital and General Hospital). Sampling was done by non-probability convenience sampling technique. This study was conducted during 3 months from April, 2022 to June 2022. Inclusion criteria was set to include motorized two-wheeler deceased and injured brought to Tertiary Care Hospitals Emergency Department irrespective of their age and gender, consented injured or deceased persons. Exclusion criteria includes patients with trauma other than a road side crash for example with history of fall or fight. Study population was all motorized two-wheeler riders. Sampling frame was Motorized two wheelers, riding in Lahore city. Sampling size was 295 injured or deceased two-wheeler rides.

RESULTS

Characteristics related to the circumstances of the accidents were examined, including the time of accident, weather conditions, season, road condition, and day of accident. Table 1 summarizes the descriptive statistics for these variables. The time of accident ranged from category 1 to category 4 (Mean = 2.45, SD = 0.89). Weather conditions ranged from category 1 to category 12 (Mean = 1.89, SD = 0.69), while seasons ranged from category 1 to category 4 (Mean = 1.40, SD = 0.73). Road condition scores ranged from category 1 to category 6 (Mean = 2.71, SD = 1.57). The day of accident ranged from category 1 to category 2 (Mean = 1.81, SD = 0.40). A total of 295 valid cases were analyzed.

Table 1: Descriptive Statistics for Time of Accident, Weather, Season, Road Condition, Day of Accident

	N	Minimum	Maximum	Mean	Std. Deviation
Time of accident	295	1.00	4.00	2.4508	.89031
Weather	295	1.00	12.00	1.8881	.68836
Season	295	1.00	4.00	1.4000	.73494
Road condition	295	1.00	6.00	2.7051	1.57288
Day of accident	295	1.00	2.00	1.8068	.39550
Valid N (listwise)	295				

Figure 1 illustrates the distribution of respondents by age group and their corresponding driving experience. It shows that the majority of respondents aged 17–60 years reported having more than one year of driving experience, whereas respondents under 17 years mostly had little or no driving experience. Those above 60 years were few in number but predominantly reported extensive driving experience. This visual pattern highlights a clear relationship between age and accumulated driving skills.

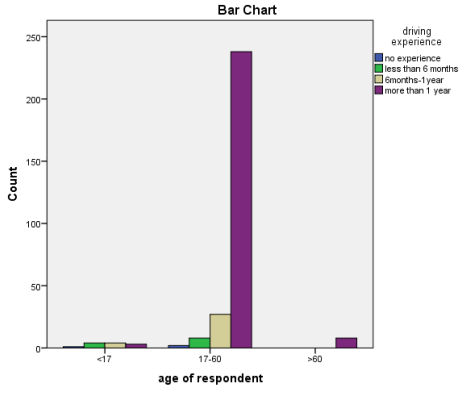

Figure 1: Distribution of Respondents by Age and Driving Experience

Figure 2 illustrates the distribution of road traffic accidents across different times of day by age group of respondents. The majority of accidents occurred among individuals aged 17–60 years, with evening accidents being the most frequent in this age category. For respondents under 17 years, accidents were more commonly reported in the morning, whereas for those over 60 years, accidents were relatively few and distributed across all times of day.

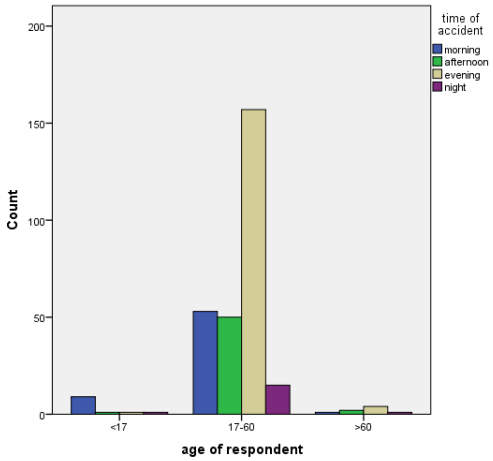

Figure 2: Distribution of Respondents by Age and Time of Occurrence

A bar chart was plotted to visually represent relationship between age of respondents and helmet thermal discomfort (Figure 3). The chart shows that thermal discomfort was most frequently reported by respondents aged 17–60 years, followed by those under 17 years, with relatively few reports among respondents over 60 years. For all age groups, the proportion of respondents reporting thermal discomfort ("yes") was higher than those who did not ("no"), particularly in the 17–60 age range.

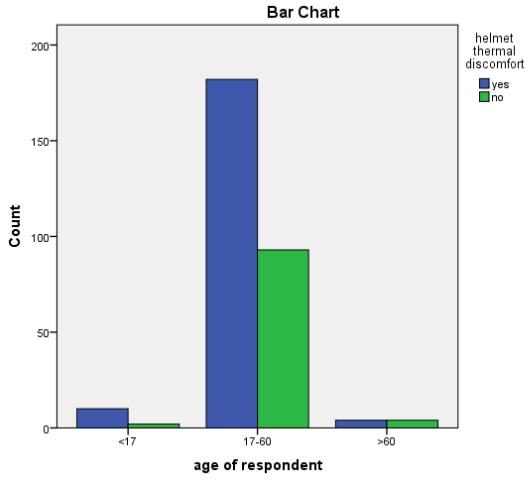

Figure 3: Distribution of Respondents by Age and Helmet Thermal Discomfort.

The majority of accidents occurred among individuals aged 17–60 years, with evening accidents being the most frequent in this age category. For respondents under 17 years, accidents were more commonly reported in the morning, whereas for those over 60 years, accidents were relatively few and distributed across all times of day. The data indicate that most respondents aged 17–60 years reported having vehicles in satisfactory condition (200 out of 275), followed by a smaller proportion with unsatisfactory vehicles.

The data show that the majority of respondents across all age groups reported engaging in at least one risky behavior, with over-speeding being the most prevalent. Respondents aged 17–60 years accounted for the highest proportion of such behaviors, followed by those under 17 years. In contrast, respondents over 60 years reported lower engagement in risky behaviors. Human error was reported with a mean score of 1.20 (SD = 0.40), and traffic volume with a mean score of 1.22 (SD = 0.41)". A total of 295 valid cases were included in this analysis.

DISCUSSION

This research delivers us a complete investigation of demographic, environmental, vehicular, and behavioral factors contributive of motorized two-wheeler crashes in Lahore, Pakistan[1]. The predominance of victims aged 17–60 years is consistent with national and international evidence identifying this group as the most active in occupational and commuting travel, thereby increasing daily exposure to traffic hazards. Younger riders (<17 years) demonstrated distinct risk-taking patterns, particularly the significantly higher prevalence of one-wheeling, which is in agreement with global literature linking adolescent risk-taking behavior to impulsivity, limited driving skills, and weaker adherence to traffic laws[17,21].

Temporal analysis indicated that the evening hours were associated with the highest crash frequency, especially among working-age riders. Similar patterns have been documented in India, Malaysia, and Thailand, where increased traffic density, reduced daylight visibility, and end-of-day fatigue contribute to elevated crash risk during peak commuting times .Seasonal variations and adverse weather conditions further compounded risks, underscoring the WHO's recommendation for adaptive enforcement strategies during high-risk environmental conditions[14,22].

Vehicular characteristics showed that most motorcycles were in serviceable condition, suggesting behavioral rather than mechanical causation. Risky behaviors; including ignoring safety regulations, red signal violations, rash driving, and frequent lane changes, were prominent among the middle-age group[20]. Non-use of helmets, coupled with widespread reports of thermal discomfort, mirrors findings from Vietnam, Cambodia, and Nigeria, where comfort-related barriers have undermined helmet compliance. WHO's Global Status Report on Road Safety emphasizes that engineering helmets for ventilation and climate suitability can improve compliance in hot-weather countries[23].

Human error emerged as the most significant contributory factor, particularly in the 17–60-year group, indicating that experience alone does not guarantee safe driving practices. Overconfidence and habitual violations may offset the protective effect of years of riding[24]. The strong association between youth (<17 years) and one-wheeling emphasizes the need for targeted adolescent-focused interventions, such as school-based road safety programs, graduated licensing systems, and strict enforcement against stunt riding[20].

The results of this study revealed a significant association between demographic, behavioral, environmental factors and the occurrence of motorized two-wheeler crashes[7]. Specifically, younger age, male gender, risky driving behaviors such as speeding, and environmental hazards such as poor lighting or road conditions were significantly linked with higher crash involvement. These results align with previous studies reporting that human error and behavioral risk-taking are the predominant contributors to road traffic accidents[13,19].

In alignment with the United Nations Decade of Action for Road Safety 2021–2030, these findings highlight necessity for multifaceted intervention strategy: infrastructure upgrades to address poor road conditions, climate-adapted safety gear to improve helmet compliance, and behavior modification programs for high-risk groups[21]. Policy responses should integrate enforcement, public education, and community engagement,

supported by sustained data-driven monitoring through provincial and national road safety observatories[23].

CONCLUSION

This study highlights the significant role of demographic, environmental, vehicular, and behavioral factors in motorized two-wheeler crashes in Lahore. The predominance of working-age riders, the heightened risk among adolescents engaging in stunt riding, and the concentration of crashes during evening commuting hours emphasize the interplay of exposure, risky behavior, and environmental conditions in shaping crash outcomes. Non-use of helmets, largely due to discomfort, further exacerbates injury severity, underscoring the urgent need for climate-appropriate safety gear and stronger enforcement. Human error emerged as the leading cause of crashes, cutting across both young and middle-aged riders, which reflects behavioral rather than mechanical vulnerabilities.

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Authors' Contributions:

- AIB: Conceptualization, study design, data analysis, manuscript drafting.
- MSR: Supervision, critical review of manuscript, validation.
- EAQ: Data collection, literature review, manuscript editing.

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