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Orginal Article

CORRELATION BETWEEN MOTORCYCLE RIDING BEHAVIORS AND SEVERITY OF MAXILLOFACIAL INJURIES IN PESHAWAR, KHYBER PUKHTUNKHWA

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ABSTRACT

Objectives: *The objective of this study is to determine the correlation between riding behavior score of motorcyclists and maxillofacial injuries severity score.*

Materials and Methods: *This co relational Cross sectional study was conducted in the Department of Oral & Maxillofacial Surgery at Khyber College of Dentistry Peshawar from June 2022 to December 2024 on 264 patients who suffered Oral & Maxillofacial injuries as a result of motorcycle riding. Data was collected on a pre-validated Modified Motorcycle Rider Behavior Questionnaire & Facial Injury Severity Score. Categorical variables such as pattern of fracture (injury type), Educational Level, SES, addiction, registration status, accidents in the past, occupation and driving experience were expressed in terms of frequency and percentage while continuous variables such as age, MRBQ score and FISS was expressed as mean ± standard deviation (SD). Mean MRBQ score and Mean FISS were correlated using Pearson correlation. P<0.05 was considered statistically significant.*

Results: *The Facial Injury Severity Score (mean = 1.89 ± 0.69 SD) and Motorcycle Riding Behaviour Score (mean = 1.97 ± 0.65 SD) were strongly correlated (r = 0.847, p < 0.001). Motorcycle riding behaviour also showed strong positive correlations with traffic errors (r = 0.83) and facial injury severity (r = 0.83). Stunts score had moderate positive correlations with riding behaviour (r = 0.33) and injury severity (r = 0.38), while control error score had moderate negative correlations with both (r = –0.29 and –0.36, respectively). Past accidents were weakly to moderately associated with stunts (r = 0.56) and injury severity (r = 0.35). Risky riders were significantly more likely to be from lower educational backgrounds, have fewer years of driving experience, higher stunts and traffic error scores, and to lack safety equipment use (all p < 0.001).*

Conclusion: *These findings underscore the urgent need for targeted interventions focused on young motorcyclists, including road safety education, strict enforcement of traffic laws, and promotion of helmet use to reduce the incidence and severity of maxillofacial injuries.*

Key words: *Motorcycle riders, Maxillofacial injury, Aggressive driving behaviour*

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INTRODUCTION

Motorcycles play an essential role in transportation throughout Asia, especially in nations such as Pakistan, India, Indonesia, Vietnam, and Thailand. Their low cost, fuel efficiency, and ability to navigate easily through crowded city streets have made motor-

cycles the favored option for countless commuters. In numerous Asian nations, motorcycles greatly surpass cars in numbers. Elements like swift urban growth, insufficient public transportation networks, and financial limitations have led to their extensive adoption. Urban areas with dense populations depend on motorcycles for everyday travel, delivery services, and business operations. Nations such as Vietnam and Indonesia boast some of the highest rates of motorcycle ownership globally, where two-wheel vehicles are prevalent in traffic[1].

In Pakistan, a large proportion of the population relies on motorcycles as their main mode of transportation, particularly in both urban and rural settings. Due to increasing fuel costs and the expense associated with cars, motorcycles serve as a cost-effective option for individuals in middle- and lower-income brackets. Prominent cities like Karachi, Lahore, and Islamabad experience significant motorcycle congestion each day, as bikes are commonly utilized by office employees, students, and delivery personnel[2].

The rise in motorcycle use in Pakistan can be explained by a number of reasons: Motorcycles are significantly less expensive than cars, which allows more people to afford them. With petrol prices continuing to increase, motorcycles present a more economical choice for daily travel. In busy urban areas, motorcycles have the advantage of easily navigating through heavy traffic. Numerous banks and financial services provide installment options, making it easier for individuals to buy motorcycles[2].

Motorcycles have many advantages, but their growing use also raises questions about road safety. High accident rates are a result of unsafe riding practices, inadequate infrastructure, and lax enforcement of traffic laws. There is still a serious problem with helmet compliance, which causes serious head and maxillofacial injuries in collisions. Motorcycle commuting risks in Pakistan and the larger Asian region can be reduced by addressing these issues with enhanced road safety regulations, awareness programs, and infrastructure[3].

Motorcyclists' aggressive riding behavior is a major cause of accidents and serious injuries, raising serious concerns about road safety. Because motorbikes provide less safety than cars in the case of an accident, riding recklessly or aggressively is particularly risky. The term "aggressive motorcycle riding" refers to dangerous, impatient, and illegal behaviors that put the rider and other drivers in danger. Typical aggressive riding tactics include the following: Driving too fast, swerving in traffic, reducing reaction time, riding too closely behind other cars, disregarding stop signs and traffic signals, driving around blind spots, around bends, or in congested areas, executing risky driving techniques on public roadways, such as wheelies and abrupt acceleration[4,5].

Several factors contribute to aggressive motorcycle riding, including: aggressive Personality Traits, Poor Traffic Conditions, lack of Peer Influence, Lack of Law Enforcement, poorly designed roads, lack of proper signage, and absence of designated motorcycle lanes may contribute to reckless riding[6].

Aggressive riding significantly increases the likelihood of accidents, often leading to Traumatic brain injuries, maxillofacial fractures, and limb amputations. Careless and aggressive riding is a contributing factor in a significant portion of motorcycle-related fatalities. For breaking traffic regulations, riders may be subject to fines, license suspension, or even incarceration. Damage to Public and Private Property: Vehicles, people, and road infrastructure can all sustain damage from high-speed collisions[7,8].

Motorcycle accidents, which frequently result in serious injuries, especially to the craniofacial region, continue to be a major global public health concern. It is crucial to investigate the association between motorcycle riding behaviors and the severity of these injuries since doing so can improve trauma care techniques, legislative decisions, and road safety measures[9,10].

Speeding, helmet noncompliance, and dangerous maneuvering are examples of risky riding behaviors that have been repeatedly associated with more severe injuries. Because it is exposed in motorcycle accidents, the maxillofacial region is particularly vulnerable and frequently sustains fractures, cuts, and soft tissue injury. Analyzing how particular riding patterns affect the severity of injuries might yield important information for therapeutic and preventative strategies[11,12].

Certain human behavior while riding a motorcycle leads to accidents and analysis of these behavioral patterns is important. The findings of this study will

contribute to the understanding of aggressive driving behavior and may assist in the early identification of high-risk or accident-prone drivers, thus enabling the early prevention of traffic accidents and subsequent injuries. This article investigates the correlation between riding behavior score of motorcyclists and maxillofacial injuries severity score.

MATERIALS AND METHODS

This Cross sectional study was conducted in the Department of Oral & Maxillofacial Surgery at Khyber College of Dentistry Peshawar Khyber Pakhtunkhwa Province of Pakistan during a period from June 2022 to December 2024 taking ethical approval from the Ethical committee of Khyber College of Dentistry Peshawar (No:102/ADR/KCD). The study was conducted on 264 patients who suffered Oral & Maxillofacial injuries as a result of motorcycle riding. Sample size calculated was 216 using WHO sample size calculator according to parameters extracted from the study by Hassanzadeh et al[13] (15% for mandibular fractures in motorcycle accidents). Precision was taken as 5 %, Prevalennce 15%, population size infinite, 10 % non-respondent rate and Confidence Interval 95%. Patients with any known psychological disorder for which the patient is presently using medications (as reflected by patient history) and GCS score of less than 13//15 were excluded from the study.

Patient were briefed and the purpose of this data collection explained to them. Patient were informed that any information collected will be kept confidential. Data was collected on a pre-validated Modified Motorcycle Rider Behavior Questionnaire (MRBQ) developed by Elliott, Baughan, and Sexton (2007)[14] with 43 items and modified and used by Savalee Uttra et al. (2020)[15] with 26 items. Savalee Uttra used 26 questions suitable for behavior of Thai people with 4 variables, including Traffic errors, Control errors, Speed violations, and Use of safety equipment. Six-point Likert-type scale (from 0 = never to 5 = always) is used. An email was sent to the principal author Savalee Uttra (savalee.utt@gmail.com) on 30th May 2022 and permission was granted on 31th May 2022 for its use in the present study.

Expert validation was performed by a panel of 5 experts from Khyber College of Dentistry, to check its suitability for Pakistani population. They thoroughly validated it and the following modifications were done on the basis of their opinion.

1. Demographic variables like age, occupation, addiction and consent signature were added

2. Driving experience were added.

3. In Question No. 5 “Ignoring the “GIVE WAY” sign when driving on narrow roads and not letting a driver from the other lane proceed” was replaced by “Not letting a driver from the other lane proceed when driving on narrow roads”.

4. In Question No. 18, “Having trouble with your visor or goggles fogging up” was replaced by “Having trouble with the front piece of helmet or goggles fogging up”.

5. In Question No. 21, “Pulling away too quickly and your front wheel lifts off the road” was added with “Front Wheeling” in brackets.

6. In Question No. 22, “Purposely doing a wheel spin” was omitted as it was the duplication of question No,21 and was replaced with “Using a mobile phone with or without Hands free”

7. In Question No.24, “Wearing motorcycle riding boots/protective trousers or jacket when riding” Was replaced by “Wearing helmet while riding”.

Facial Injury Severity Score (FISS) first suggested by Bagheri et al[16-18] in 2006, is a widely used scoring system and has pre-defined values with variables responsible for various facial fractures. It categorizes and grades maxillofacial fractures which in turn are based on their anatomic location in lower, middle and upper 3rd of face. It is an effective indicator of facial fractures with high reliability and accuracy in predicting severity of facial injuries. Every fracture is assigned with a specific score. The total score ranges from 1-30 (Min- Max) and can be further categorized as Mild (1-15) and severe (16-30). Maxillofacial injuries were diagnosed according to the standard diagnostic criteria (History, Clinical examination and Radiographs) and data was inserted in the scoring sheet. Data was collected by the author himself, Fellow of the college of Physician & Surgeon or a senior Resident well educated on the questions and their translation (interpretation) according to the patient preferences.

Data Analysis Procedure:

Categorical variables such as pattern of fracture

(injury type), Educational Level, SES, addiction, registration status, accidents in the past, occupation and driving experience were expressed in terms of frequency and percentage while continuous variables such as age, MRBQ score and FISS was expressed as mean ± standard deviation (SD). Mean MRBQ score and Mean FISS were correlated using Pearson correlation. P<0.05 was considered statistically significant.

The variable MRB_Binary was created by dichotomizing the Motorcycle Riding Behavior (MRB) score into two categories: 'Safe' and 'Risky'. Specifically, MRB_Binary (also referred to as MRB_Category) was derived from the categorical variable Motorcycle_Riding_Behaviour_Score, where participants classified as 'High (101–130)' were recoded as 'Risky', and all others were grouped as 'Safe'. The resulting variable was converted into a factor with two levels: 'Safe' and 'Risky'. This binary classification was used to compare riding behaviors and associated factors between the two groups.

RESULT

Among the 2,642 participants, the average age was 29.27 years (±12.03), with 38.6% aged 21–40, 33.7% under 20, and 27.7% over 40. Most respondents had middle-level (26.1%) or matric-level (23.5%) education, while 21.2% were illiterate. Laborers made up the largest occupational group (45.8%), followed by students (17.4%) and supporting staff (12.1%).

A majority (59.8%) came from poor socioeconomic backgrounds, and 25.4% used snuff. Nearly half (48.5%) had registered motorcycles. Geographically, 48.9% were from Peshawar, 16.7% from Merged Areas, and 9.8% were Afghan refugees.

Regarding accident history, 60.6% had none, 29.5% had one, and 8.0% had two accidents. Driving experience varied, with 28.8% having 2–5 years, and 20.1% having 16+ years of experience. Full details are provided in Table 1.

Among the 2,642 participants in Table-2, 2151 (81.4%) were categorized as having safe motorcycle riding behavior, while 491 (18.6%) were categorized as risky. Geographic distribution varied significantly across behavior categories ($p < 0.001$), with the majority of safe riders from Peshawar (112, 52%) and a notable proportion of risky riders also from

Table 1: Descriptive statistics of Categorical Variables (n=264)

Variable	Categories	n	%
Educational level	Illiterate	56	21.2
	Primary	25	9.5
	Middle	69	26.1
	Matric	62	23.5
	Intermediate	15	5.7
	Graduate	4	1.5
	Master	33	12.5
Occupation	Jobless	10	3.8
	Labour	121	45.8
	Buisness	24	9.1
	Professional	25	9.5
	Farmer	2	.8
	Landlord	4	1.5
	Supporting staff	32	12.1
	Student	46	17.4
Geographic location	Refugees	26	9.8
	Peshawar	129	48.9
	Mardan	15	5.7
	Bannu	13	4.9
	Malakand	6	2.3
	DI khan	1	.4
	Hazara	13	4.9
	Kohat	17	6.4
	Merged Areas	44	16.7
Socioeconomic status	Poor	158	59.8
	Satisfactory	72	27.3
	Good	34	12.9
Age Distribution	Below 20	89	33.7
	21-40	102	38.6
	Above 40	73	27.7
Facial Injury Severity	Mild Injury (1-10)	78	29.5
	Moderate injury (11-20)	136	51.5
	Severe injury (21-30)	50	19.0
Habits/ Addiction	No habit	159	60.2
	Ciggarrette	38	14.4
	Snuff	67	25.4
Licensing/ Registration	Registered	128	48.5
	Non registered	136	51.5
Number of Accidents	0	160	60.6
	in the past	78	29.5
	2	21	8.0
	3	5	1.9
	4	0	0

Peshawar (17, 35%), followed by equal representation from Mardan, Bannu, and Hazara (7, 14% each). Control Error Scores also differed significantly ($p < 0.001$), where all risky riders (49, 100%) had medium

Table 1: Descriptive statistics of Categorical Variables (n=264)

Variable	Categories	n	%
Driving experience	1 year & below	43	16.3
	2-5 years	76	28.8
	6-10 years	32	12.1
	11-15 Years	60	22.7
	16 Years & above	53	20.1

Table 2: Cross Tabulation of MRB categories with study Variables

Characteristic	Safe N = 215[1]	Risky N = 49[1]	p-value[2]
Geographic Distribution			
Refugees	19 (8.8%)	7 (14%)	<0.001
Peshawar	112 (52%)	17 (35%)	
Mardan	8 (3.7%)	7 (14%)	
Bannu	6 (2.8%)	7 (14%)	
Malakand	5 (2.3%)	1 (2.0%)	
DI khan	1 (0.5%)	0 (0%)	
Hazara	7 (3.3%)	6 (12%)	
Kohat	15 (7.0%)	2 (4.1%)	
Merged Areas	42 (20%)	2 (4.1%)	
Control_Error_Score			
15 and below	29 (13%)	6 (12%)	0.7
16-25	141 (66%)	32 (65%)	
26-35	8 (3.7%)	0 (0%)	
36-45	30 (14%)	9 (18%)	
46-55	7 (3.3%)	2 (4.1%)	
56 and above	0 (0%)	0 (0%)	
Control Error Score			
Low (0-15)	66 (31%)	0 (0%)	<0.001
Medium (16-30)	89 (41%)	49 (100%)	
High (31-45)	60 (28%)	0 (0%)	
Educational Level			
Illitrate	44 (20%)	12 (24%)	<0.001
Primary	16 (7.4%)	9 (18%)	
Middle	51 (24%)	18 (37%)	
Matric	58 (27%)	4 (8.2%)	
Intermediate	10 (4.7%)	5 (10%)	
Bachelor	3 (1.4%)	1 (2.0%)	
Master	33 (15%)	0 (0%)	

Table 2: Cross Tabulation of MRB categories with study Variables

Characteristic	Safe N = 215[1]	Risky N = 49[1]	p-value[2]
Driving experience (In Years)			
1 year & below	37 (17%)	6 (12%)	<0.001
2-5 years	55 (26%)	21 (43%)	
6-10 years	20 (9.3%)	12 (24%)	
11-15 Years	50 (23%)	10 (20%)	
16 Years & above	53 (25%)	0 (0%)	
Facial Injury Severity Score			
Mild (1-10)	78 (36%)	0 (0%)	<0.001
Moderate (11-20)	136 (63%)	0 (0%)	
Severe (21-30)	1 (0.5%)	49 (100%)	
Habits_Addiction			
Male	215 (100%)	49 (100%)	>0.9
Female	0 (0%)	0 (0%)	
Addiction			
No habit	140 (65%)	19 (39%)	<0.001
Ciggarrette	17 (7.9%)	21 (43%)	
Snuff	58 (27%)	9 (18%)	
Medicines	0 (0%)	0 (0%)	
Others	0 (0%)	0 (0%)	
Number of Accidents in the past			
0	138 (64%)	22 (45%)	0.018
1	59 (27%)	19 (39%)	
2	13 (6.0%)	8 (16%)	
3	5 (2.3%)	0 (0%)	
Motorcycle_Riding_Behaviour_Score			
Registered	112 (52%)	16 (33%)	0.022
Non registered	103 (48%)	33 (67%)	
Occupation			
High (101-130)	0 (0%)	49 (100%)	<0.001
Low (0-50)	59 (27%)	0 (0%)	
Medium (51-100)	156 (73%)	0 (0%)	
Indicator_of_each_last_matching_case_as_Primary			
Jobless	10 (4.7%)	0 (0%)	0.008
Labour	87 (40%)	34 (69%)	
Buisness	20 (9.3%)	4 (8.2%)	
Professional	24 (11%)	1 (2.0%)	
Farmer	1 (0.5%)	1 (2.0%)	
Landlord	3 (1.4%)	1 (2.0%)	
Supporting staff	28 (13%)	4 (8.2%)	
Student	42 (20%)	4 (8.2%)	

Table 2: Cross Tabulation of MRB categories with study Variables

Characteristic	Safe N = 215[1]	Risky N = 49[1]	p-value[2]
Indicator of each last matching case as Primary			
Duplicate Case	206 (96%)	49 (100%)	0.20
Primary Case	9 (4.2%)	0 (0%)	
Safety equipment Score			
Low (0-5)	166 (77%)	42 (86%)	<0.001
Medium (6-10)	42 (20%)	0 (0%)	
High (11-15)	7 (3.3%)	7 (14%)	
Socio economic			
Poor	118 (55%)	40 (82%)	0.002
Satisfactory	63 (29%)	9 (18%)	
Good	34 (16%)	0 (0%)	
Stunts Score			
Low (0-5)	128 (60%)	0 (0%)	<0.001
Medium (6-10)	49 (23%)	49 (100%)	
High (11-15)	38 (18%)	0 (0%)	
Traffic Errors Score			
Low (0-20)	88 (41%)	0 (0%)	<0.001
Medium (21-40)	127 (59%)	1 (2.0%)	
High (41-55)	0 (0%)	48 (98%)	
[1]n (%),			
[2] Chi-squared/Fisher's Exact Test			

scores, whereas safe riders were spread across low (66, 31%), medium (89, 41%), and high (60, 28%) categories. Educational level was significantly associated with risk category ($p < 0.001$); middle-level education was most frequent among risky riders (18, 37%) while safe riders were predominantly matriculate (58, 27%). Driving experience showed a significant trend ($p < 0.001$), with 43% of risky riders having 2–5 years of experience, compared to only 26% of safe riders. All riders with severe facial injuries (49, 100%) were in the risky category, while moderate injuries dominated among safe riders (136, 63%). Addiction was also strongly associated with risky behavior ($p < 0.001$); cigarette use was more common among risky riders (21, 43%) compared to safe riders (17, 7.9%). Risky riders had more past accidents ($p = 0.018$), with 16% reporting two previous accidents compared to only 6% of safe riders. Additionally, non-registered motorcycles were more frequent among risky riders (33, 67%) than safe riders (103, 48%) ($p = 0.022$). Occupational status and safety practices also differed significantly; 100% of risky riders had high occupation-related risk scores, and 86% had low safety equipment usage ($p < 0.001$). Finally, risky riders were predominantly from poor socioeconomic backgrounds (40, 82%) and had medium stunt (49, 100%) and high traffic error scores (48, 98%) ($p < 0.001$ for all).

The Facial Injury Severity Score had a mean of 1.89 ± 0.69 SD while Motorcycle Riding Behaviour Score had a mean of 1.97 ± 0.65 SD, showed a strong positive Pearson correlation of 0.847, statistically significant at the $p < 0.001$ level. The motorcycle riding behaviour score was strongly and positively correlated with both traffic errors score ($r = 0.83$) and facial injury severity score ($r = 0.83$). Stunts score showed a moderate positive correlation with the motorcycle riding behaviour score ($r = 0.33$) and facial injury severity score ($r = 0.38$. Control error score demonstrated moderate negative correlations with both the motorcycle riding behaviour score ($r = –0.29$) and facial injury severity score ($r = –0.36$. The number of accidents in the past had a weak-to-moderate positive association with stunts score ($r = 0.56$) and facial injury severity score ($r = 0.35$). Detail in Fig-1 to 4.

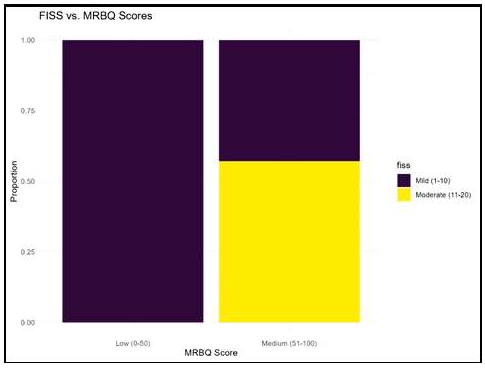

Fig 1: FISS vs MRBQ scores

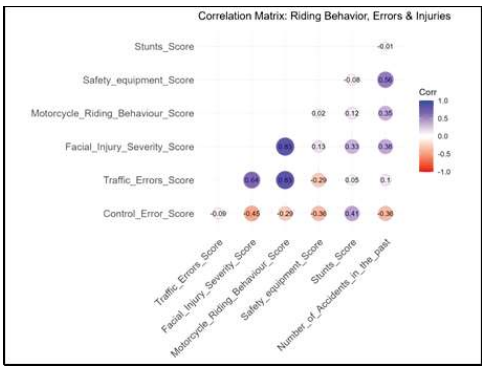

Fig 2: Pairwise Correlation

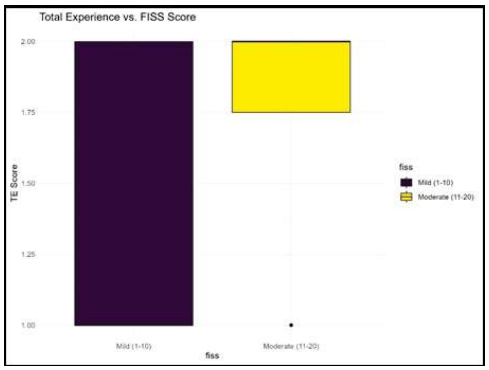

Fig 3: Total Experience Vs FISS score

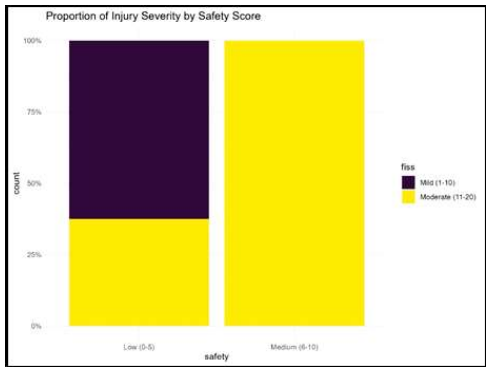

Fig 4: Proportion of injury Severity by safety score

DISCUSSION

The mean age of patients who sustained maxillofacial injuries due to motorcycle accidents in this study was 29.27 years (±12.03 SD), indicating that such trauma predominantly affects young individuals. The largest proportion of injuries (38.6%) occurred among individuals aged 21–40 years, followed by those below 20 years (33.7%), while patients above 40 years comprised only 27.7% of the sample. This pattern reflects global trends in road traffic trauma, where younger age groups, particularly males in their second and third decades of life, are disproportionately affected due to higher levels of risk-taking behavior and increased use of motorcycles for transportation and economic activity[19,20].

Several studies have reported similar age distributions in maxillofacial trauma, with the 20–40 age group being most frequently involved in road traffic accidents, particularly in low- and middle-income countries where motorcycles are a primary mode of transport[21,22]. The high involvement of individuals below 20 years is also concerning, as it suggests early exposure to road traffic risks, potentially due to inadequate enforcement of licensing laws or helmet use. In contrast, the relatively lower incidence in older age groups may be attributed to reduced motorcycle usage and more cautious driving behavior among older individuals. These findings underscore the urgent need for targeted interventions focused on young motorcyclists, including road safety education, strict enforcement of traffic laws, and promotion of helmet use to reduce the incidence and severity of maxillofacial injuries.

The findings reveal that individuals with middle-level education (26.1%) and matriculation-level education (23.5%) represent the largest proportions of patients who sustained maxillofacial injuries due to motorcycle accidents. Notably, a significant portion of the sample is illiterate (21.2%), highlighting the vulnerability of individuals with limited educational attainment to road traffic injuries. The small proportion of respondents with higher education—12.5% holding a master's degree and only 1.5% with undergraduate degrees—suggests that individuals with lower education levels are disproportionately affected. This aligns with existing literature indicating that lower educational status is associated with increased exposure to high-risk environments and limited awareness or adherence to road safety practices[25,26].

Educational attainment often correlates with occupational roles and socioeconomic status, which further contextualizes the occupational data from the study. Laborers make up the largest occupational group (45.8%), reflecting the dominance of manual and informal sector employment among the injured. This supports findings from previous studies, where individuals engaged in physically demanding, low-wage occupations often rely on motorcycles for commuting or livelihood, thereby increasing their exposure to road hazards. The substantial representation of students (17.4%) and supporting staff (12.1%) further illustrates how road traffic injuries cut across various socioeconomic strata but disproportionately affect those with limited resources or mobility options[27,28].

The occupational and educational profile of the affected population underscores the need for targeted road safety interventions. Public health strategies should focus on raising awareness about protective behaviors, particularly in vulnerable groups with lower education levels and informal employment.

Additionally, improving infrastructure and enforcing traffic laws may help reduce injury rates among these high-risk populations[29,30].

In Pakistan, motorcycles are a primary mode of transportation, particularly among young men and those from lower socio-economic backgrounds. According to traffic data from major urban centers like Lahore and Karachi, motorcycles constitute more than 70% of all registered vehicles. However, despite their widespread use, enforcement of traffic laws such as helmet usage, lane discipline, and speed regulation remains weak. Helmet compliance, for example, is reportedly below 50% in many areas, with even lower rates among pillion riders, especially women and children[31]. The working-class individuals, particularly daily wage earners and manual laborers who often commute long distances under hazardous traffic conditions. According to a report by the Pakistan Bureau of Statistics, laborers represent a significant segment of the informal workforce, typically with limited access to formal training or road safety education. This increases their vulnerability to traffic-related injuries, especially in the absence of protective gear and adherence to traffic regulations[32].

Internationally, similar occupational patterns have been observed in LMICs. For example, in India and Vietnam, laborers and informal workers make up a significant proportion of motorcycle crash victims, often due to long commuting distances, poor road infrastructure, and minimal law enforcement[33]. In contrast, high-income countries report a more diverse rider demographic and better safety outcome, largely due to stringent traffic regulations, higher public awareness, and comprehensive insurance and training programs[34].

In the current study, the majority of participants (60.6%) reported no history of road traffic accidents (RTAs), suggesting a relatively low exposure to such incidents among the study population. This finding aligns with previous epidemiological data indicating that a substantial proportion of road users remain accident-free over extended periods, particularly in regions with robust traffic safety measures and educational campaigns targeting driver behavior and awareness. Notably, 29.5% of the participants had experienced one accident, while smaller proportions reported two (8.0%) and three (1.9%) accidents, respectively. The absence of any reports of four or more accidents may reflect either effective post-incident behavioral adaptation or a survivorship bias, where individuals with higher accident frequencies may be underrepresented due to withdrawal from driving or severe outcomes. These findings underscore the heterogeneous distribution of RTAs among road users and highlight the need for targeted interventions focusing on individuals with repeated accident histories. Recurrent accidents are often associated with specific risk factors such as younger age, male gender, risk-taking behavior, and certain personality traits, which should be explored further in future analyses. Understanding the distribution and determinants of accident frequency can provide critical insights for traffic safety policymakers and public health practitioners aiming to reduce accident-related morbidity and mortality[35,36].

The comparison of motorcycle riding behavior between individuals categorized as safe riders (N = 215) and risky riders (N = 49) revealed several statistically significant associations across multiple variables. Geographic distribution was strongly associated with riding behavior ($p < 0.001$), indicating location-related differences in safe vs. risky riding patterns. Socioeconomic status ($p = 0.002$) and educational level ($p < 0.001$) were both significantly associated with riding behavior, implying that individuals with higher education and better economic standing were more likely to engage in safe riding practices. Driving experience was significantly related to riding behavior ($p < 0.001$), with more experienced riders tending to ride more safely Addiction history showed a strong association with risky riding ($p < 0.001$), suggesting that substance use may influence unsafe behaviors. Behavioral sub-scores also showed strong associations: Safety Equipment Score, Control Error Score, Stunts Score, and Traffic Errors Score all had p-values < 0.001, indicating that these behavioral components were significantly worse among risky riders compared to safe riders. These findings highlight that risky motorcycle riding behavior is significantly associated with several demographic, behavioral, and experiential factors, most notably socioeconomic status, education, addiction, driving experience, and safety-related behaviors[37,38]. The present study identified a strong and statistically significant positive correlation ($r = 0.847$, $p < 0.001$) between the Facial Injury Severity Score (mean = 1.89 ± 0.69) and the Motorcycle Riding Behaviour

Score (mean = 1.97 ± 0.65), suggesting a close association between risky motorcycle riding behaviors and the severity of facial injuries sustained in traffic incidents. These findings align with prior literature, which has established that unsafe riding practices significantly increase the risk and severity of injuries in motorcycle crashes, especially in vulnerable anatomical regions such as the head and face[37,38].

Furthermore, the Motorcycle Riding Behaviour Score was strongly correlated with both the traffic errors score and the facial injury severity score (r = 0.83 for both), highlighting the critical role of cognitive and operational errors in accident outcomes. These findings support previous studies which have emphasized that traffic errors—such as failure to adhere to traffic signals, speeding, and distracted driving—are key predictors of both crash incidence and injury severity among motorcyclists[39,40]. The moderate positive correlation observed between the stunts score and both the riding behavior score (r = 0.33) and facial injury severity score (r = 0.38) underscores the hazardous consequences of performing stunts or engaging in thrill-seeking behaviors while riding. This aligns with earlier research indicating that stunt-related riding is strongly associated with high-impact crashes and severe craniofacial trauma[41,42].

Interestingly, control error scores demonstrated moderate negative correlations with both the motorcycle riding behaviour score (r = –0.29) and the facial injury severity score (r = –0.36). This may suggest that riders who exhibit poor vehicle control are either less prone to high-risk behaviors or possibly more cautious due to self-awareness of their limitations. However, such findings require further validation as the relationship between control errors and injury outcomes remains complex and context-dependent[43].

Additionally, the number of past accidents showed a weak-to-moderate positive correlation with both stunts score (r = 0.56) and facial injury severity score (r = 0.35), indicating that individuals who frequently engage in stunt behaviors may have a higher propensity for repeated accidents and more severe injury outcomes. This finding reinforces the need for behavioral interventions and training programs focused on discouraging dangerous maneuvers and enhancing rider safety awareness[44,45].

CONCLUSION / RECOMMENDATIONS

O1. These findings underscore the urgent need for targeted interventions focused on young motorcyclists, including road safety education, strict enforcement of traffic laws, and promotion of helmet use to reduce the incidence and severity of maxillofacial injuries.

2. Moreover, policymakers should consider subsidies or incentives for purchasing high-quality protective gear, particularly for low-income riders. Addressing these behavioral factors can play a vital role in reducing the burden of facial injuries and improving overall road safety.

3. Overall, these results highlight the multifaceted interplay between risky riding behaviors, error types, and injury severity, pointing to critical targets for injury prevention strategies in motorcycle populations.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

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Conception or Design:	BR,MK,MR, HSQ, MK, BM, RBN
Acquisition, Analysis or Interpretation of Data:	BR,MK,MR, HSQ, MK, BM, RBN
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.