12-12-2021

Low Acceptance of Helmet-Use and Injuries from Motorcycle Accidents in Rawalpindi and Abbottabad, Pakistan

Maryam Siddiqa
Government College University Lahore, maryam.siddiqa@iiu.edu.pk

Gulzar H. Shah
Georgia Southern University, Jiann-Ping Hsu College of Public Health, gshah@georgiasouthern.edu

A. Munam
Mayo Hospital Lahore, ata_munam2001@yahoo.com

Special Journal of Public Health, Nutrition & Dietetics

Low Acceptance of Helmet-Use and Injuries from Motorcycle Accidents in Rawalpindi and Abbottabad, Pakistan

Siddiqa M[1*], Shah G[2], Munam A[3]

Citation: Siddiqa M, Shah G, Munam A. Low Acceptance of Helmet-Use and Injuries from Motorcycle Accidents in Rawalpindi and Abbottabad, Pakistan Special Journal of Public Health, Nutrition, and Dietetics, 2021, 2 (1): 1-14

Highpoints

- Critically low acceptance of helmet-use continues among motorcycle riders in Pakistan, despite serious intervention efforts by public safety and public health agencies, which presents a serious public health crisis.
- Low acceptance of helmet use by motorcyclists poses a great risk of severe injury during a motorcycle accident and the odds warrant in-depth investigation for insight into effective intervention
- Low acceptance of helmet use generally poses 5 times higher odds of severe injuries and 2.2 times (adjusted odds ratio) of the same severe injury during an accident compared to their helmet use counterparts

Abstract:

Background: Motorcycle accidents are a major cause of head injuries and the current study evaluated the beneficial impact and effectiveness of helmet usage among injured Motorcycle users. This study has been performed to observe the Motorcycle collisions within 6 months in Rawalpindi and Abbottabad cities of Pakistan

Objectives: Implications of helmet usage were assessed and the risk factors for severe injury during motorcycle accidents were identified.
Methods: The impacts of several risk factors on injury severity were calculated using univariate and generalized ordinal logistic regression.
Results: The multivariate analysis indicated that riders without a helmet were more likely to experience severe (AOR, 2.216; 95% CI, 2.02 to 10.5) or moderate injury (AOR, 1.215; 95% CI, 0.84 to1.77). Riders who experienced crashes involving multiple vehicles were also significantly more likely to experience severe (AOR, 2.473; 95% CI, 1.0 to 3.93) or moderate injury (AOR, 1.192; 95%CI, 0.08 to 0.41). Thus, compared to helmet users, the odds of severe injury are five times higher among motorcyclists with no helmet use when no other factors were controlled for in the analysis. The adjusted odds of severe injuries maybe 2.2 times higher among the riders without helmets vs. riders with helmets.
Conclusion: Helmet use levels, injury type, and crash type were identified as risk factors that significantly influenced the risk of severe or moderate injury. Motorcycle riders can reduce their risk of severe injury by adopting preventive measures (helmet use) and by controlling these factors. Road safety strategies to prevent injuries, casualties, and loss of economical resources may benefit from our study findings and the risk of severe injuries can be reduced by proper implementation of Helmet use laws.

Keywords: Use; Motorcycle crash; Traumatic brain injury; Disability; Mortality

Addresses: 1. Department of Mathematics & Statistics, room# 228, Maryam block, Sector H-10 International Islamic University Islamabad, Pakistan. email: m.siddiqa85@gmail.com; maryam.siddiqa@iiu.edu.pk. 2. Department of Health Policy and Community Health, Jiann-Ping Hsu College of Public Health, Georgia Southern University, USA. P.O.Box 8015 Statesboro, GA 30460, email: gshah@georgiasouthern.edu. 3. Department of neurosurgery, Mayo Hospital Lahore, email: ata_munam2001@yahoo.com

Correspondence: Dr. Maryam Siddiqa, (Ph.D.). Assistant Professor, Department of Mathematics & Statistics, room# 228, Maryam block, Sector H-10 International Islamic University Islamabad, Pakistan. email: m.siddiqa85@gmail.com; maryam.siddiqa@iiu.edu.pk

Article history:
Received September 18, 2021: **Accepted:** November 3rd, 2021: **Published:** December 12, 2021

Background

Road accidents are a global health problem, and the majority of injuries from road crashes are related to motorcycles (1). Traumatic brain injury (TBI) is one of the leading causes of death and disability worldwide, and motorcycle accidents are among the foremost contributors (2,3). In developing countries such as Pakistan, head injury is one of the

most common types of injury in motorcycle crashes (4,5). According to the World Health Organization (WHO), around 1.24 million people die every day in road accidents, and 20 to 50 million non-fatal injuries occur in road accidents each year worldwide[6].

Motorcycle accidents increase the burden of injury, disability, and death. An estimated 60% of all road transportation deaths involve motorcyclists or their passengers (7). In the case of a crash, motorcyclists are more likely to incur severe injuries than drivers or passengers in other motor vehicles because they are not protected by the vehicle and may be thrown from the motorcycle into other vehicles or objects. One study in the biggest metropolis in Pakistan showed that the most common type of vehicle collision involves a motorcycle colliding with a car (4). In Iran, 24% of traffic accident deaths were caused by motorcycle accidents in 2015 (8).

Motorcyclists have 34 times the risk of fatality during an accident than drivers or passengers in other types of vehicles[9,10]. In 2007, motorcycle accidents accounted for 14.6% of deaths in the European Union, 12.1% in Australia, 9.1% in the United States, and 9.2% in Japan (11).

In Taiwan, approximately 1600 motorcycle riders die each year in motorcycle crashes, and 65% of these deaths occur due to head and neck injuries (11). Almost 70% of head injuries occur due to traffic accidents, primarily motorcycle accidents (12).

Motorcycle accidents can cause a range of head injuries, including memory loss, skull fracture, loss of eyesight, and facial injuries. In developing countries, deaths due to transportation accidents are likely to be the third most significant cause of death and severe injury in 2020, and a large ratio of these deaths is due to motorcycle accidents[7].

Injury, disability, and premature death impose social and economic costs on individuals, communities, and societies. The high volume of injuries due to motorcycle crashes may impose a financial burden on individuals and society, especially since it is expensive to treat head injuries. Motorcycle riders who fail to wear safety helmets are more likely to require extended hospitalization after a crash than those who wear a helmet (13-15).

Head injuries impose high costs on survivors, their families, and society due to the costs of initial and long-term care. Helmet usage is an effective prevention measure to protect motorcyclists against head injuries and reduce the risk of other severe injuries and motorcycle-related morbidity and disability. Regardless of helmet laws, approximately 41% to 69% of motorcycle riders do not wear helmets in low-to-middle-income countries; this is attributed to several factors, including the weight and cost of helmets, visual limitations, and discomfort due to hot weather[16].

Pakistan is a developing country that, lacks sufficient affordable private vehicles and where relatively few people own cars. Transportation by motorcycles is popular and affordable but risky. Motorcycles riders often fail to take proper preventative measures to reduce the risk of crashes, injury, disability, and death.

Pakistan began to strictly enforce motorcyclists' helmet use in September 2018. Now, per the orders of the Lahore High Court, the Punjab police enforce compulsory helmet usage for motorcycle drivers and passengers. The policy is often reinforced through roadside signs with messages such as "Wear a helmet or get off the road." However, little research has been done on the impact of motorcyclists' helmet use in Pakistan, and most existing research is

descriptive[17,18]. Many existing studies lack inferential evidence concerning the effectiveness of helmet use in preventing severe injuries in motorcyclists.

Objective

This study investigated the impact of helmet usage and associated risk factors on injuries related to motorcycle accidents in the study location

Materials and Methods

Data

This study utilized primary data collected through a structured proforma of motorcycle accident victims admitted to the neurosurgery departments of Allied Hospitals of Rawalpindi and Ayub Teaching Hospital in Abbottabad over six months. These hospitals treat a high number of trauma patients. The participating patients' data were extracted from their medical records by one of the researchers (AUM) and competent staff from the neurosurgery departments; data were collected from September 2018 to February 2019. The current study was a quantitative, prospective observational cohort study with specific inclusion and exclusion criteria of patients in the study, outlined below. The institutional review committee (an IRB) of the Department of Mathematics & Statistics, International Islamic University, reviewed and approved this study.

All 475 patients meeting the inclusion and exclusion criteria were included in the study, constituting a sample considered large enough to yield reliable estimates. The minimum sample size appropriate for logistic regression was determined using the formula, $\boldsymbol{n = \frac{11k}{p}}$, as recommended by Peduzzi et al. (19). According to this rule (with p = 0.5, k = 11), the minimum desirable sample size was 220 patients.

Exclusion Criteria: The study only measured helmet use in motorcyclists who had accidents and were admitted to the hospital because of those accidents. Some percentage of motorcyclists might wear helmets but not have accidents or be admitted to the hospital. For the current study, the researchers excluded the data for *non-hospitalized* patients from the analyses. We also excluded data for accidents that were not related to motorcycles and those involving large vehicles, which would have made helmet use irrelevant, including trains, coach buses, trucks, and trailers.

Inclusion Criteria: This study used data involving motorcycle crashes for all motorcycle riders, regardless of whether they were drivers or passengers admitted to the hospital for more than one day.

Measures

The *response variable* for this study was operationalized by computing the injury severity score based on the Glasgow coma scale, which was further converted into head injury classification. The final response variable was an ordinal categorical variable, with three categories: severe head injury (GCS score of 8 or less), moderate head injury (GCS score of 9 to 12), and minor head injury (GCS score of 13 to 15).

Independent variables representing potential risk factors of motorcycle crash-related injuries were identified from the existing literature and per recommendations of subject matter experts such as the Neurosurgeons. The primary predictor (of the injury severity) for this research was the dichotomous variable helmet use. Other potential risk factors (and control variables) included: gender (male or female), age (≤25

years, 26-39 years, and ≥40 years), injury type (Head, Facial, Traumatic brain and Lower Extremity Injuries), hospital stay (≤ 4 days, 5-10 days, ≥ 11 days), crash type (Single vehicle, Multi-vehicle), region (Abbottabad, Rawalpindi), crash time (Night time, day time), rider type (First rider - driver, Second rider - passenger), discharge status (Stable, Discharge, Morbidity, Disability, Mortality) and crash location (Rural, Urban).

Statistical Analysis

We computed the descriptive statistics (frequency and percentages) for categorical variables. The Chi-Square test of association and univariate odds ratios from logistic regression were performed to identify factors potentially associated with the dependent variable. Diagnostic tests of outliers and multicollinearity were conducted. We tested the proportional odds assumption to build the appropriate multivariate logistic regression model.

After the violation of parallel odds assumptions, the generalized ordinal logistic regression model was employed to investigate the risk factors of injury severity score of motorcycle crash riders. DFBETA test was used to examine the outliers in the data. Multicollinearity of the data was checked by the VIF test. After diagnostic tests, the Brant test was applied to test the assumption of the proportional odds ratio. Brant test results suggested that the ordinal logistic regression model's assumption (proportional odds ratio) was violated, so we opted for the generalized ordinal logistic regression model.

In the multivariate analysis, we initially included all variables that showed significant associations with the dependent variable (at $p<0.10$) in the univariate analysis.

For the final model, we used the backward elimination method for the selection of the risk factors. The Generalized ordinal logistic regression was used to analyze the ordered categorical variable because it relaxes the ordered logit model's assumptions for analyzing ordinal outcome variables. The data were analyzed descriptively and analytically using STATA 13 and IBM SPSS version 20.

Results

Our data show strikingly low rates of helmet use, as only 11.22% of admitted crash victims were wearing a helmet during the accident. The remaining 88.78% reported no helmet use. A large majority (83.66%) of the crash victims were males, and nearly half (48.29%) were under 25 years old. The descriptive statistics of Motorcycle users' characteristics are presented in Table 1.

Univariate analysis (Table 2) showed that male riders were more likely to experience a severe injury than female riders (OR, 1.027; 95%CI, 0.60 to 1.74). Older motorcyclists also had a higher risk of severe injuries (OR, 2.331; 95%CI, 1.34 to 4.05). non-helmeted motorcyclists had higher risks of severe injury than those wearing a helmet at the time of the crash (OR, 5.291; 95%CI, 2.94 to 9.25). In addition, head injuries were significantly more likely to be severe than facial injuries (OR, 0.255; 95%CI, 0.12 to 0.53). Rider position was also significantly associated with the severity of the injury; a passenger sitting behind the motorcycle driver was less likely to experience a severe injury than the driver (OR, 0.376; 95%CI, 0.04 to 0.56) (Table 2).

Multi-vehicle crashes were more likely to result in severe injury than single-vehicle crashes (OR, 2.184; 95%CI, 1.35 to 3.53), and nighttime crashes were more likely to result in severe injury than daytime crashes

(OR,1.505; 95%CI, 0.98 to 2.30). Accidents requiring an extended hospital stay (>11 days) were more likely to have caused severe injury than those involving a hospital stay of 11 days or fewer (OR, 8.825; 95%CI, 3.95 to 19.64).

The patient's discharge status (i.e., stable, discharged, disabled, expired) was also significantly associated with injury severity: Patients with a status of "discharged" rather than "stable" (but not discharged) had minor injuries (OR, 1.129; 95%CI, 1.01 to 2.34).

Overall, the analysis revealed that the helmet use, rider position, crash type, crash location, hospital stay, and discharge status are significantly associated with the severity of injury at a 5% level of significance. In contrast, demographic variables such as gender, age, and region where the patient was from were not statistically significant ($p>0.05$).

While facial injuries were significantly less likely to be severe than head injuries ($p <0.01$), the likelihood of severe injury did not differ significantly for other injury types (compared to head injury). Crash time (night vs. day) was at the borderline of significance ($p=0.059$).

Table 3 displays the results of the multivariate analysis of factors affecting head injury severity after controlling for other covariates in the ordered logit model.

Table 1. Demographic and clinical characteristics of patients (N=410)

Variable	Variable Attributes	Frequency	Percentage
Gender	Male	343	83.66
	Female	67	16.34
Age	≤25	198	48.29
	26-39	126	30.73
	≥40	86	20.98
Helmet use	Yes	46	11.22
	No	364	88.78
Injury type	Head	276	67.32
	Facial	26	6.34
	Traumatic brain	91	22.20
	Lower Extremity Injuries	17	4.14
Injury severity	Minor	44	10.43
	Moderate	106	25.85
	Severe	260	63.41
Rider type	First rider	287	70.00
	Second rider	123	30.00
Crash type	Single vehicle	290	70.73
	Multi-vehicle	120	29.27
Crash time	Day time	266	64.88
	Nighttime	144	35.12
Crash location	Rural area	158	38.54
	Urban area	252	61.46
Length of hospital stay	≤ 4 days	262	63.90
	5-10 days	62	15.12
	≥ 11 days	86	20.98
Discharge status	Stable	88	21.46
	Discharge	127	30.98
	Disability	86	20.98
	Mortality	106	25.85
Geographic Region	Abbottabad	131	31.95
	Rawalpindi	279	68.05

Table 2: Univariate Analysis - Odds Ratios and Confidence Intervals of Post-Crash Injury Severity Score

Variable	Category	Univariate Logistic Regression	p-value
		Odds Ratio (95%CI)	
Gender	Female *		
	Male	1.027(0.60- 1.74)	0.821
Age	≤25 years*		
	26-39	1.172(0.76- 1.80)	0.470
	≥40 years	2.331(1.34- 4.05)	0.003
Helmet use	Yes*		
	No	5.291(2.94- 9.25)	<0.001
Injury type	Head*		
	Facial	0.255(0.12- 0.53)	<0.001
	Traumatic brain	1.098(0.68- 1.75)	0.696
	Lower-Extremity Injuries	2.317(0.64- 8.31)	0.197
Rider type	First rider*		
	Second rider	0.376(0.04- 0.56)	0.033
Crash type	Single vehicle*		
	Multi-vehicle	2.184(1.35- 3.53)	<0.001
Crash time	Day*		
	Night	1.505(0.98- 2.30)	0.059
Crash location	Urban*		
	Rural	0.654(0.26- 0.93)	0.002
Hospital stay	≤ 4 days*		
	5-10 days	4.103(1.89- 8.907)	<0.001
	≥ 11 days	8.825(3.95- 19.64)	<0.001
Discharge status	Stable*		
	Discharge	1.129(1.01- 2.34)	0.021
	Disability	3.410(2.016- 5.76)	<0.001
	Mortality	10.246(4.87- 21.53)	<0.001
Region	Abbottabad*		
	Rawalpindi	0.340(0.12- 2.12)	0.106

* indicates the reference category, Abbreviation: CI, Confidence Interval

Table 3. Multivariate analysis- Generalized Ordered Logistic Regression of Head Injury Severity

Variables	Injury category severe (vs. minor)		Injury category moderate (vs. minor)	
	AOR (95%CI)	P-value	AOR (95%CI)	P-value
Helmet non-use (vs. yes use)	2.216(2.02-10.5)	0.029	1.215(0.84-1.77)	<0.001
Injury type (Head vs Facial, Traumatic brain, Lower Extremity)	1.607(0.32-1.89)	0.041	1.843(0.09-1.94)	0.018
Crash type (Single vehicle vs. multi-vehicle)	2.473(1.0-3.93)	<0.001	1.192(0.08-0.41)	<0.001
Gender (Female vs. Male)	2.064(0.87-4.89)	0.696	1.075(0.20-1.14)	0.241
Age (≤25 years vs. 26-39, ≥40 years)	2.21(0.85-2.25)	0.197	0.718(0.56-1.18)	0.321
Rider type (First rider vs. Second rider)	0.524(0.23-1.17)	0.121	1.301(0.85-4.27)	0.251
Crash location (Urban vs. Rural)	0.939(0.53-1.64)	0.821	1.835(0.60-1.85)	0.321
Region (Abboatabad vs. Rawalpindi)	1.216(0.65-2.25)	0.231	1.130(1.11-1.27)	0.270
Discharge Status (Stable vs. Discharge same day, Disability, Mortality)	1.331(1.11-1.59)	0.470	1.021(0.62-1.89)	0.296
Hospital stays (≤ 4 days vs. 5-10 days, ≥ 11 days)	3.740(2.12-6.56)	0.124	0.619(0.15-0.64)	0.176

Abbreviation: CI, Confidence Interval; AOR, Adjusted Odds Ratio

The risk factors of severe injury

The significant risk factors impacting the severity of injury due to motorcycle-related collisions were organized into two panels; one panel compared severe injury to minor injury, and one compared moderate injury to minor injury.

Outcome variable comparisons for the two panels did not differ significantly. Table 3 also shows that three factors were significantly associated ($p < 0.05$) with severe injury (vs. minor) - helmet non-use (AOR, 2.216; 95%CI, 2.02 to 10.5), injury type (AOR, 1.607; 95%CI, 0.32 to 1.89), and crash type (AOR, 2.473; 95%CI, 1.0 to3.93).

Injury category moderate (vs. minor) have the same three significant predictors- helmet non-use (AOR, 1.215; 95% CI, 0.84 to 1.77), injury type (AOR, 1.843; 95%CI, 0.09 to 1.94), and crash type (AOR, 1.192; 95%CI,0.08 to 0.41) at p-value< 0.05. The odds of both severe vs. minor injury and moderate injury vs. minor injury were not significantly altered by other factors in the model.

Non-significant injury predictors

The non-significant predictors ese non-significant predictors displayed in Table 3 included gender (AOR, 2.064; 95% CI , 0.87 to 4.89), (AOR, 1.075; 95% CI, 0.20 to1.14), age (AOR, 2.21; 95% CI, 0.85-2.25), (AOR, 0.718; 95% CI,0.56 to1.18)], rider type (AOR, 0.524; 95% CI, 0.23 to1.17), (AOR, 1.301; 95% CI, 0.85 to 4.27), crash location (AOR, 0.939; 95% CI, 0.53 to1.64),(AOR, 1.835; 95% CI, 0.60 to 1.85)], region (AOR, 1.216; 95% CI, 0.65 to2.25), discharge status (AOR, 1.331; 95% CI, 1.11 to 1.59), (AOR, 1.021; 95% CI ,0.62 to 1.89) and hospital stay (AOR, 3.740; 95% CI, 2.12 to 6.56),(AOR, 0.619; 95% CI, 0.15 to 0.64).

Discussion

This study's main objectives were to evaluate the effectiveness of helmet use during motorcycle collisions for preventing severe injury and to model other risk factors for severe injury using statistical modeling techniques. Previous literature has quantified the consequences of not wearing a helmet while riding a motorcycle. Existing research shows that helmeted motorcyclists are less likely to experience head injuries than non-helmeted motorcyclists, but very little research has been done on our population of Pakistan's motorcyclists (4, 16-18).

A critical finding of this study is the alarmingly low rate of helmet use in Pakistan; in our study, only one in ten accident victims wore a helmet. This low level of helmet use means that either the helmet safety laws are not well understood or that motorcyclists fail to comply with the laws due to one or more reasons suggested by the health belief model(2021). That is, motorcyclists may believe that they have low susceptibility to accidents or injury. They may believe that they will not experience severe injury if they do not wear a helmet. It is also possible that they perceive the inconvenience of helmet use to outweigh the benefits of wearing a helmet.

Finally, there may be barriers to helmet use (e.g., poor helmet design for hot weather, prohibitive cost of helmets). Low helmet use may also be due to low self-efficacy in helmet use. These modifiable factors should be considered in the design of efforts to improve road safety by encouraging motorcyclists to wear helmets. Helmet usage can reduce the severity of head injuries and the risk of mortality, disability, and hospital expenses due to a motorcycle collision. Previous studies have suggested that low levels of

awareness of the benefits of helmet use are among the main reasons for nonuse in developing countries(22-24).

Our results show that helmet use (vs. nonuse) is a strong predictor of injury severity ($p<0.001$); non-usage of helmets more than doubled the risk of severe injury. These findings regarding the protective value of helmet use, particularly in averting severe injury, could provide a selling point for programs developed by the government and non-profit organisations' programmes to increase road safety. Our findings support those of previous studies in other contexts that highlight the role of helmet use in preventing injury and death due to motorcycle accidents(25-29).

For instance, one previous study[16] found that helmet use (compared to nonuse) significantly ($p<0.05$) helped prevent injury for both drivers (OR 4.1, 95% CI 1.7-9.5) and passengers on motorcycles (OR 3.00, 95% CI 1.5-8.00); this aligns with our findings. Another study (29) found that helmet usage significantly reduced injury in motorcycle accidents, including head, neck, and fatal injuries. In line with our findings, other previous studies (13, 30) also support the protective impact of helmet use in reducing the risk of severe TBI.

The current study also shows that, when a helmet is not worn, the risk of severe facial injuries, TBI, and other head and brain injuries is significantly higher as compared to only head injuries. The findings of previous studies support these results(30). Our study also showed that crash type (single vehicle vs. multi-vehicle) significantly impacted injury severity; multiple-vehicle crashes were more likely to result in severe injury.

These findings also align with those of a previous study showing a significant impact of crash type on injury severity[28]. These findings imply that road safety may be increased through better signage, warning signs (e.g., for poor weather conditions of fog, smog, etc.), and better preparation of roads for severe weather. Reducing the risk of multiple-vehicle crashes could also reduce the burden of injury eventually.

This study also has some limitations. First, the study findings may be only generalizable to other settings with similar helmet laws and enforcement patterns. Second, additional variables, particularly other probable risk factors for motorcycle-related injuries in our population, could have been included in the study. Examples of such risk factors include a history of previous motorcycle accidents, alcohol consumption before the crash, and a history of traffic violations. These types of variables were not included in the present study due to the unavailability of historical records, the social stigma associated with alcohol consumption, and misreporting/lack of cooperation in reporting socially undesirable behaviors.

Conclusions

Critically low helmet use was observed in this study, despite serious intervention efforts by government public safety and public health agencies. At the individual level, the low helmet use in the study population indicates gaps in awareness, knowledge, attitudes, motivation, skills, opportunities, and behaviours related to helmet use among motorcyclists in Pakistan.

At the macro level, low levels of helmet use may highlight flaws in helmet use policies or the practical implementation of these policies. The current study also showed that helmet use has a strong protective impact on moderate and severe injury due to motorcycle accidents. In addition, the study highlights additional factors associated with severe injury from motorcycle accidents; these

findings can inform Pakistan's injury-prevention programmes.

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki and ethical clearance of study from departmental Ethics review committee of International Islamic University Islamabad; [Protocol number (MATH-FBAS/FC/2019-1) was issued, moreover, all the ethical values/rules were observed by relevant guidelines and regulations during the study.

Consent for publication

Not applicable.

Availability of data and materials

Data will be available upon request from the corresponding author.

Competing interests

The authors declare that they have no competing interests.

Funding

Non-funded study. This research received no external funding.

Authors' contributions

M.S: Conceptualization, formal analysis, writing original draft, review & editing.

G.H.S: Formal analysis and methodology, review & editing.

A.U.M: Conceptualization, data collation, review & editing.

All authors have read and agreed to the published version of the manuscript.

References

1. Chisholm-Mefire A, Atashili J, Tsiagadigui JG, Fon-Awah C and Ngowe-Ngowe MA prospective pilot cohort analysis of crash characteristics and pattern of injuries in riders and pillion passengers involved in motorcycle crashes in an urban area in Cameroon: lessons for prevention. *BMC Public Health*. 2015, *15*(1), pp.1-8.
2. Faried A, Bachani AM, Sendjaja AN, Hung YW and Arifin MZ. Characteristics of moderate and severe traumatic brain injury of a motorcycle crash in Bandung, Indonesia. *World neurosurgery.* 2017, *100*, pp.195-200.
3. Harmon KJ, Marshall SW, Proescholdbell SK, Naumann RB, and Waller, A.E. Motorcycle crash-related emergency department visits and hospitalizations for traumatic brain injury in North Carolina. *The Journal of head trauma rehabilitation.* 2015, *30*(3), pp.175-184.
4. Hasan O, Sheikh S, Fatima A, Abbas A, Zahid N, Baloch N. Motor-vehicle Crash Patient Injury Pattern from a Level One Trauma Center in a Metropolitan City: A Cross-Sectional Study. *Cureus*. 2019, 11(2), 4073. doi: 10.7759/cureus.4073.
5. Sisimwo PK, Onchiri GM. Epidemiology of head injuries and helmet use among motorcycle crash injury: a quantitative analysis from a local hospital in Western Kenya. *Pan Afr Med J*. 2018, 2, 31-70. doi: 10.11604/pamj.2018.31.70.16988.
6. Banstola A, Mytton J. Cost-effectiveness of interventions to prevent road traffic injuries in low-and middle-income countries: a literature review. *Traffic Inj. Prev*. 2017, 18(4), 357-362.
7. Crompton JG, Bone C, Oyetunji T, Pollack KM, Bolorunduro O, Villegas C,

Haider AH. Motorcycle helmets associated with lower risk of cervical spine injury: Debunking the myth. *J AM COLL SURGEONS*. 2011, 212(3), 295-300.
8. Haqverdi MQ, Seyedabrishami S, Groeger JA. Identifying psychological and socio-economic factors affecting motorcycle helmet use. *Accid Anal Prev*. 2015, 85, 102-110.
9. Fernandes FAO De-Sousa, R.A. Motorcycle helmets—A state of the art review. *Accid Anal Prev*. 2013, 56: 1-21.
10. Lin MR, Kraus JF. A review of risk factors and patterns of motorcycle injuries. *Accid Anal Prev*. 2009, 41(4), 710-722.
11. Keng SH. Helmet use and motorcycle fatalities in Taiwan. *Accid Anal Prev*. 2005, 37(2), 349-355.
12. Chiu WT, Kuo CY, Hung CC, Chen M. The effect of the Taiwan motorcycle helmet use law on head injuries. *Am. J. Public Health*. 2000, 90(5), 793.
13. Rowland J, Rivara F, Salzberg P, Soderberg R, Maier R Koepsell T. Motorcycle helmet use and injury outcome and hospitalization costs from crashes in Washington State. *Am. J. Public Health*. 1996, 86(1), 41-45.
14. Coben JH, Steiner CA, and Miller TR. Characteristics of motorcycle-related hospitalizations: comparing states with different helmet laws. *Accident Analysis & Prevention.* 2007, *39*(1), pp.190-196.
15. Mertz KJ and Weiss HB. Changes in motorcycle-related head injury deaths, hospitalizations, and hospital charges following the repeal of Pennsylvania's mandatory motorcycle helmet law. *American Journal of Public Health.* 2008, *98*(8), pp.1464-1467.
16. Khan I, Khan A, Aziz F, Islam M, Shafqat S. Factors associated with helmet use among motorcycle users in Karachi Pakistan. *Acad. Emerg. Med*. 2008, 15(4), 384–387.
17. Ishaq M, Ahmed A, Alam I, Khan M, & Shah SN. Patterns of Motorbike Accidents Related Head Injuries in Patients Presenting to a Tertiary Care Hospital of Peshawar. *Pak. J.* Neurol. Nurg. 2017, *21*(2), 79-85.
18. Yaqoob U, Nadeem Z, Mehmood M, Batool D, Irshad T, Ali SS, & Ibrahim S. Descriptive Pattern of Fractures among Motor Bike Riders Presenting in Jinnah Postgraduate Medical Centre, Karachi. *Br J Med Med Res*. 2016, 18(1), 1-8.
19. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J. Clin. Epidemiol*. 1996, 49(12), 1373-1379.
20. Ha NT, Ederer D, Vo VAH, Pham AV, Mounts A, Nolen LD, Sugerman D. Changes in motorcycle-related injuries and deaths after mandatory motorcycle helmet law in a district of Vietnam. *Traffic Inj. Prev*. 2017, 19(1): 75-80.
21. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Commun*. 2015, 30(6), 566-576. doi:10.1080/10410236.2013.873363
22. Akaateba MA, Yakubu I, and Akanbang BAA. Correlates and barriers associated with motorcycle helmet use in Wa, Ghana. *Traffic injury prevention.* 2015, *16*(8), pp.809-817.
23. Ruedl G, Kopp M, Rumpold G, Holzner B, Ledochowski L, and Burtscher M. Attitudes regarding ski helmet use among helmet wearers and non-wearers. *Injury prevention.* 2012, *18*(3), pp.182-186.
24. Karuppanagounder K, and Vijayan AV, 2016. Motorcycle helmet use in Calicut, India: User behaviors, attitudes, and

perceptions. *Traffic injury prevention*, *17*(3), pp.292-296.
25. Sung KM, Noble J, Kim SC, Jeon HJ, Kim JY, Do HH, Park SO, Lee KR, Baek KJ. The preventive effect of head injury by helmet type in motorcycle crashes a rural Korean single-center observational study. *Biomed Res Int.* 2016.
26. Khor D, Inaba K, Aiolfi A, Delapena S, Benjamin E, Matsushima K, Demetriades D. The impact of helmet use on outcomes after a motorcycle crash. *Injury*. 2017, 48(5), 1093-1097.
27. Olivier J, Creighton P. Bicycle injuries and helmet use: a systematic review and meta-analysis. *Int. J. Epidemiol*. 2017, 46(1), 278-292.
28. Buckley L, Bingham CR, Flannagan CA, Carter PM, Almani F, Cicchino JB. Observation of motorcycle helmet use rates in Michigan after partial repeal of the universal motorcycle helmet law. *Accid Anal Prev*. 2016, 95, 178-186.
29. Rice TM, Troszak L, Ouellet JV, Erhardt T, Smith GS, Tsai BW. Motorcycle helmet use and the risk of head, neck, and fatal injury: Revisiting the Hurt Study. *Accid Anal Prev*. 2016, 91, 200-207.
30. Ganti L, Bodhit AN, Daneshvar Y, Patel PS, Pulvino C, Hatchitt K, Gabrielli A. Impact of helmet use in traumatic brain injuries associated with recreational vehicles. *Int J Prev Med*. 2013