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Factors Influencing Motorists' Injury Severities: An Empirical Assessment of Crashes in District Peshawar, Pakistan

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Abstract: *Travelling in a motor car is a popular mode of conveyance across Pakistan. Similarly, motorists constitute about 66% of total registered cars in Peshawar District which observed a 200% increase from 2006 to 2016. The current research estimates a Random Parameter Logit (RPL) Model by heterogeneousness means & variations in order to identify various parameters that contribute to the motorists' brutality of injury. The effects of motorist traits, temporal characteristics, motor vehicle features, roadway attributes, weather characteristics and effects of speed limits were predominantly considered for this analysis. Generally, typical approximation results show that the chance and severity of injuries increase for accidents including young drivers, winter indicators, and crashes that occurred between 10 AM-02 PM. Likewise, minor wound smashes are more likely to involve senior drivers, occurring during sunny weather, in the autumn season and in the month of August. Safety measures are suggested based on the findings of this research study to improve professional's motorist safety e.g. educating drivers about traffic rules and safety, zero tolerance for driving without a valid license, and enforcing speed limits on the roads. The results of this study will help in formulating strategies to improve motorists' safety.*

Key Words: Injury Severity, Motor Car, Random Parameter Logit Model, Motorists, Peshawar.

Introduction

Internationally, about 1.35 million individuals die yearly because of road traffic accidents. It is reported that half of worldwide road crashes are motorists (WHO, 2018). In Pakistan crashes involving motorists alone kills around 25,781 people yearly (WHO, 2015; Ahmad et. al., 2016). However, genuine figures of death might be more than real information in the record (Klair and Arfan, 2017). Further, the quantity of listed cars in Pakistan has expanded by 9.6% in a year time frame. Consequently, expanding the number of motor vehicles has augmented the probability of damages in the country (APP, 2019; Qayyum, 2015). A study was conducted between years 2003 to 2012 and it was determined that out of 3,280 crashes that happened in Peshawar, injuries were recorded about 74%. According to police records, overspeeding and carelessness are the primary causes of crashes in Peshawar (Shah et al., 2018). After a comprehensive review of the available literature, no studies focusing on factors impacting motor vehicle injury severity in Peshawar have been made (Hanifullah, Farooq & Shah, 2021). Further, no endeavour has likewise

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been made to alleviate these causes. Additionally, the factors that have a significant impact on the injury severity of motor vehicles in Peshawar are unidentified and constitute a key barrier to enhancing road safety. The present research investigates the factors influencing motorists' injury severities in the district of Peshawar. The motorists' crash data comes from two sources i.e. Peshawar traffic police and emergency rescue service Rescue 1122, Khyber Pakhtunkhwa (Khattak, Bhati & Ullah, 2022) utilized the RPL model to ascertain the main factors leading to the severity of injuries caused by motorists.

Past Literature

Based on previous research work, it has been determined that a variety of factors are associated with different degrees of injury severity (Wang et al., 2022; Yamamoto and Shankar, 2004). Major factors that are highlighted in different literature associated with increased injury severity are over-speeding (Abdelfatah, 2016; Waseem et. al., 2019), carelessness (Fountas et al., 2018; Fergusson et. al., 2002; Rehman et. al., 2015; Taamneh et al., 2016), without a valid driving license (Blows et al., 2005), ignorance of traffic rules (Jha et al., 2017; Aliane et al., 2011; Abdelfatah, 2016), age of the driver (Balbissi, A., 2003; Hailemariam et al., 2020; Polus et al., 2005; Casado-Sanz et al., 2020, not using a seat belt (Ibrahim et al., 2020), poor weather condition (Hammoudi, 2014; Kazmi and Zubair, 2013; Jalilian et. al., 2019; Ratanavaraha and Suangka, 2013), small carriageway (Eustace et al., 2011) and driving in dark condition (Gaca and Kiec, 2013; Jagerbrand and Sjobergh, 2016). The researchers used multiple modelling methods in early studies to estimate the severity of road crashes (Chung et. al., 2014) for example Poisson-gamma model (Lord D., 2006), ordered probit model (Rifaat and Chin, 2007; Garrido et al., 2014), discrete outcome model (Yasmin and Eluru, 2013), multinomial logistic regression model (Shiran et al., 2021; Wahab and Jiang, 2019), nested logit model (Razi et al., 2018; Haleem, and Abdel, 2010), loglinear model (Olmus and Erbas, 2012). These traditional models do not allow the explanatory variables between individual results to change and this is the key limitation of revealed models. In fact, individual results respond contrarily to descriptive variables and therefore cannot be measured as static. In addition, the severity of motorists' crash injuries may be influenced by some overlooked aspects and records on these factors are not possible. Avoiding these factors can lead to erroneous inference and parameter bias estimation (Mannering et al., 2016). These models can capture unobserved heterogeneity in crush data and ascertain the relationship between injury severity and factors contributing to crashes.

Data Collection

The study setting was the district of Peshawar, located in Khyber Pakhtunkhwa province in Pakistan, about 160km west of the capital city of Islamabad (Witte et al., 2019). According to the 2017 census, Peshawar has a population of 4.26 million, making it the sixth-largest district in Pakistan (Irfanullah et al, 2019). Motorists' crash information was collected from the Peshawar traffic police and Rescue 1122 Peshawar office from 1st Jan 2016 to 31st Dec 2019. Peshawar traffic police is a department of the provincial government responsible for directing traffic movement and enforcing traffic laws on Peshawar roads (UPU, 2018). The initial investigation report (FIR) is typically filed following any crash, and it outlines the cause of the incident. However, it is important to note that police-reported crashes primarily focus on those resulting in fatal or severe injuries, leading to a dearth of information regarding minor injuries or incidents with no injuries. The accident-related FIRs reported by the Peshawar traffic police have been identified as having significant issues with underreporting (Ayaz et al, 2016). In order to address this issue, the data collected from the traffic police and the Peshawar Office of Rescue 1122 were combined to ensure comprehensive information gathering. Rescue 1122 is an emergency response service operated by the provincial government, offering integrated emergency services across the district. This merging of data sources aimed to prevent the omission of any vital information during the data collection process (Amin, Khattak & Khan, 2018). The Peshawar office of Rescue 1122 utilizes a two-page form for documenting crash details in their reports. Combing these two data sources, a total of 3,454 road crashes involved a motorist. Final crash data includes driver demographic information (such as gender and age), temporal data (date, time, month/ year of incident), environmental details (weather/ season

information), the types of vehicles involved, information about the type of road and injury severity level sustained throughout incident by motorists. The reported injuries are classified into three categories: severe, minor and no injury (Table-1). From 3,454 reported cases, it was revealed that due to social and cultural restrictions, it is very rare for women to drive.

Table 1

Levels of Crash Severity

Level	Definition	Description	Percentage (Nos.)
1	No-Injury	No harm to the driver's body or only slight pain	17.4 (592)
2	Minor-Injury	It doesn't extend any risk to the life of the affected driver, however, certain body parts get affected (Examples of injuries include abrasions, lacerations, or minor cuts)	62.13 (2,446)
3	Severe-Injury	The risk extends to the well-being and lives of affected drivers, including potential injuries such as (neck, head, and spinal injuries, as well as single or multiple fractures).	20.73 (716)

On Peshawar roads, male victims dominate (98.46%), while the proportion of injured women is very low (1.53%). Middle-aged (18-35) drivers were mainly involved in crashes (64.27%). According to the observations, the proportion of motorists' crashes on weekdays (81.55%) and in summer (25.56%) is significantly higher. The frequency of crashes is also higher through peak hours (56.54%) & sunny dry weather (68.12%). It was also revealed that most of the crashes occurred on major roads (51.15%) and roads with a speed limit of (80km/ hr) were more (50.17%). Also, most of the crashes (32.68%) involved motor cars with low engine capacity (800cc). License holder drivers (69.36%) and road shoulder facility (64.44%) were recorded with a high frequency of crashes. Compared with the night (25.95%), the crush frequency during the day is higher (74.05%). Likewise, most crashes occur on 3–lane roads (48.67%) and fewer crashes were recorded under foggy weather (14.50%). Table 2 denotes descriptive statistics.

Table 2

Statistics of Key Variables

Variables Used in the Model	%age
Severity of Crush	
No injury to motorists/Minor injury to motorists/Severe injury to motorists	17.14/62.13/20.73
Month of Year	
Jan, Feb, Mar, Apr, May, June, July, Aug, Sep, Oct, Nov, Dec.	7.06/6.42/9.99/10.56/10.60/7.64/9.30/8.62/8.33/8.30/6.91/6.22
Day of Week	
Mon, Tue, Wed, Thu, Fri, Sat, Sun	16.18/15.40/15.63/16.53/16.10/10.13/10.01
Weekday/Weekend	81.55/18.44
Weather Forecast	
Sunny Dry/Cloudy/Rainy	68.12/23.36/8.51
Season throughout the Year	
Summer Season/Winter Season/Spring Season/ Autumn	25.56/19.71/31.15/23.56
Time of the Day	

Variables Used in the Model	%age
00:00-02:59/03:00-05:59/06:00-08:59/09:00-11:59/12:00-14:59/15:00-17:59/18:00-20:59/21:00-23:59	4.91/1.86/9.64/16.46/17.72/19.19/18/12.22
02:00-05:59/06:00-09:59/10:00-13:59/14:00-17:59/18:00-21:59/22:00-01:59	4.08/37.78/10.45/19.33 21.01/7.32
Peak(07:00-09:59)/ **Off-peak** (16:00-18:59)	56.54/43.45
Roadway Type	
Major Road /Minor Road/Collector Road	51.15/34.56/14.27
Posted Speed Limits	
50km/h, 60km/h, 80km/h, 120km/h	14.50/34.68/50.17/0.63
Presence of Road Shoulder:	
Yes/No	64.44/35.56
Driver Details	
Age: Below 18yrs/18-35yrs/36-50yrs/Above 50yrs	3.01/64.27/23.30/9.40
Gender: Male/Female	98.46/1.53
Presence of Driving License:	
Yes/No	69.36/30.64
Presence of Street Light:	
Yes/No	52.70/47.30
Foggy weather:	
Yes/No	14.50/85,50
Vehicle Engine CC Capacity	
660cc/800cc/1000cc/1300/1600cc/ 2200cc/2500cc	0.75/32.68/21.13/26.20/16.44/ 0.50/2.28
Reported cause:	
Overspeeding/ Carelessness	54.28/45.71

Methodology

According to recent works (Waseem et al, 2019, Chen et al, 2018, Dong et al, 2018), taking into account the heterogeneity of mean and variance, a random parameter logit model is predictable to ascertain key aspects which affect the brutality of injury to motorists in Peshawar. The absence of certain variables, such as the condition of the automobile during the crash time, driving speed, and traffic conditions at the time of the collision, could introduce unobserved variations and potentially influence the observed variables on collision extremity. This may outcome parameter changes & incorrect inferences (Mannering et al., 2012). The estimated model allows for variations in the mean and variance of the observation-wide random variable, so it can capture the observation-specific variations of the effects of the independent variable in the best possible way (Hanifullah, 2021; Waseem, 2019). The severity function of the crash is defined as

(i) $D_{in} = \beta_i X_{in} + \varepsilon_{in}$

Where D_{in} determines the severity of the category injury *i* for any crash n; β_i is the estimated parameter vector for the discrete result *i*; X_{in} refers to the vector of explanatory variable and ε_{in} is the error term. The unobserved variations in means & variances of the random parameters are estimated by considering βi as a vector of parameters which differ over crashes. This approach is well-defined (Mannering et al., 2016)

(ii) $\beta_i = \beta + \mathfrak{Q}_{i\,Zi} + \sigma_i \text{ EXP } (\omega_{i\,Wi})\ v_i$

Estimate βi signifies the mean parameter for all observations, while Zi & Wi are attribute vectors used to capture heterogeneity in the mean (σi) & corresponding parameter vector ωi. The vector of estimated parameters is denoted as Ωi, and vi represents the disturbance term. Error term εin supposed to follow a generalized extreme value distribution. The resulting probability obtained from the standard multinomial logit

model allows for parameters to diverge over observations, as described in (Milton et al., 2008).

(iii) $P_n(i) = \int \quad x \frac{EXP[\beta_i X_{in}]}{\sum EXP[\beta_I X_{in}]} f(\frac{\beta}{\omega}) d\beta$

Pn (i) indicates the probability of crash severity of outcome i for a particular crash n and I show the category of the severity of the series of injuries. $f(\frac{\beta}{\omega})$ represents the density function of β and ω shows the parameter vector of the density function. To determineβ, density function $f\left(\frac{\beta}{\omega}\right)$ is used, which accounts for unobserved heterogeneity. For given values of ω, estimate the probability by extracting the values of β from $f\left(\frac{\beta}{\omega}\right)$ (Wu et al., 2014). The estimation of the model was carried out using a maximum likelihood approach, employing Halton draws. Halton draws proved to be more effective than random draws, as often mentioned in the existing literature (Train, 2009). In our model estimation, we utilized 500 Halton draws, which have been demonstrated in previous studies (Train, 2009) to be sufficient for accurately estimating the parameters (Shaheed et al., 2013).

Results & Discussions

Table-3 presents the outcomes of the model estimation, including the overall results and marginal impacts of the significant variables. The goodness-of-fit of the model is assessed and reported in Table-4, indicating a reasonable fit. Additionally, Table 5 provides a summary of the likelihood ratio tests carried out for examining temporal instability in both uncorrelated and correlated random parameters models. The marginal effect illustrates how a unit variation in the independent variable influences the probability of injury to extremities. The results from the final model (Table 3) demonstrate that the parameters are statistically significant. In total, eleven variables were identified as statistically significant, and the subsequent paragraphs discuss these significant variables in detail.

Heterogeneity OF Means and Variances

All variables in the model were subjected to testing for heterogeneity in means and variance, resulting in the identification of statistically significant random parameters. Specifically, two variables, namely "old age drivers" and "road shoulder indicators," exhibited statistically significant random parameters. However, it should be noted that the "old driver indicator" had a random parameter that showed heterogeneity in mean only, which was influenced by the "Friday indicator." Interestingly, the mean estimate for old drivers decreased when the accident occurred on a Friday, indicating a lower likelihood of minor injury for old drivers on that specific day. Results are consistent with previous findings (Aplin, 2009) as older motorists have better driving skills, and experience and are more conscious towards driving. Similarly, crush occurring on roads having road shoulder is associated with less severe injuries as it provides clear space for a motor car to stop in emergency cases, for maintenance purpose, enabling the motor car to avoid crashing with other car and thus enhance safety. (Casado-Sanz et al, 2020; Gitelman et al, 2017)

Table 3

Overall Model Estimation and Marginal Effects of Significant Variables

Variables	Estimated Parameter	t-stat	No-injury	Minor-injury	Severe-injury
The constant of Minor Injury [MI]*	1.517	6.47			
The constant of Severe Injury [SI]*	3.509	13.41			
Random parameters (normally distributed)					
Indicator of Old Driver (1 if driver age was > 50 years, otherwise 0) [MI]	0.794	3.24	-0.0009	0.0023	-0.0014

Variables	Estimated Parameter	t-stat	No-injury	Minor-injury	Severe-injury
Standard Deviation of Over speeding (normally distributed)	2.070	2.64			
Indicator of road shoulder (1 if road shoulder was provided, otherwise 0) [SI]	-3.448	-9.52	0.0151	0.0496	-0.0647
Standard Deviation of Over speeding (normally distributed)	2.017	5.38			
Random Parameter of Heterogeneity in mean					
Old Driver indicator [MI]: Indicator of Friday (1 if the accident happened on Friday, otherwise 0)	-0.917	-1.86			
Characteristics of Driver					
Indicator of driver driving license (1 if driver of accident-involved vehicle had driving license, otherwise 0) [SI]	-1.042	-7.61	0.0132	0.0428	-0.0560
Indicator of driver seatbelt (1 if the driver of the crash-involved vehicle was wearing a seatbelt, 0 otherwise) [SI]	-2.609	-17.78	0.0201	0.0622	-0.0824
Indicator of the young driver (1 if the age of the driver was less than 18 years, otherwise 0) [SI]	2.516	6.87	-0.0017	-0.0059	0.0075
Weather and seasonal characteristics					
Indicator of sunny weather (1 if the accident happened in sunny weather, otherwise 0) [MI]	0.210	2.50	-0.0159	0.0257	-0.0098
Winter indicator (1 if the crash happened in the Winter season, 0 otherwise) [MI]	-0.287	-2.82	0.0075	-0.0111	0.0036
Autumn indicator (1 if the crash happened in the Autumn season, 0 otherwise) [MI]	0.380	3.71	-0.0090	0.0151	-0.0061
Temporal Characteristics					
10-2 pm indicator (1 if the crash happened in the time range 10-2 pm, 0 otherwise) [MI]	-0.273	-2.14	0.0034	-0.0054	0.0019
August indicator (1 if the crash occurred in the month of August, 0 otherwise) [MI]	0.445	2.80	-0.0036	0.0062	-0.0027

Variables	Estimated Parameter	t-stat	No-injury	Minor-injury	Severe-injury
Roadway characteristics					
Median indicator (1 if the crash occurred on a divided road, 0 otherwise) [NI]*	0.454	2.00	0.0586	-0.0497	-0.0089
Correlated Random Parameters	Old Driver indicator	Shoulder indicator			
Old Driver indicator (MI) [Correlation Matrix Coefficient]	2.070[1.000]	-1.767[-0.876]			
Shoulder indicator (SI) [Correlation Matrix Coefficient]	-1.767[-0.876]	0.973[1.000]			
Number of Observations		3454			
Number of estimated parameters		18			
Log-likelihood at zero LL(0)		-3192.2022			
Log-likelihood at convergence LL(β)		-2588.1230			
ρ2 = 1 – LL(β)/LL(0)		0.189			
[NI]* = No Injury, [MI]* = Minor Injury, [SI]* = Severe Injury					

Table 4

Model Goodness of Fit Values

Model Goodness of Fit values	Uncorrelated Model	Correlated Model
Log-likelihood at the convergence of overall model LL(β2016-2019)	-2591.4999	-2588.1230
Log-likelihood at the convergence of 2016 model LL(β2016)	-715.1086	-715.0050
Log-likelihood at the convergence of 2017 model LL(β2017)	-570.0942	-568.0044
Log-likelihood at the convergence of 2018 model LL(β2018)	-633.8012	-618.6926
Log-likelihood at the convergence of 2019 model LL(β2019)	-413.5382	-413.5382
X2=-2[LL(β2016-2019)-LL(β2016)-LL(β2017)-LL(β2018)-LL(β2019)]	517.9154	545.7656
Degrees of Freedom (No. of statistically significant parameters in the overall model)	16	18
Level of Significance	99%	99%
Critical X2 value	32.00	34.80
Conclusion	Parameters are not equal over 4 years (temporally unstable)	Parameters are not equal over 4 years(temporally unstable)

Driver Attributes

Very young motorists (under Eighteen-18 years) were found most conceivably confronting severe accidents. This is intuitive as drivers below 18 years of age are too inexperienced to drive safely and commit extreme violations of traffic rules due to their inexperience as well as naivety regarding traffic rules and regulations. Mccartt et al. (2003) concluded in their study that young teen drivers (14 and 15 years of age) are at a high risk of more severe accidents than older drivers due to their limited experience, continued physical and cognitive development and overall immaturity. Furthermore, the variable "driver driving license indicator" exhibited a statistically significant fixed parameter for the outcome of severe injuries. The results showed that licensed drivers were less prone to experiencing severe injury crashes. This finding aligns with common intuition, as licensed drivers are generally expected to drive cautiously and adhere to traffic regulations. It also corresponds to previous research findings. For instance, Palumbo et al. (2019) discovered that licensed drivers make traffic violations lesser compared to drivers who are not licensed, due to which they are facing fewer accidents. Similarly, the analysis revealed that drivers wearing seatbelts are not confronted with severe injuries as compared to those who are not used them at the time of the accident. This outcome shows consistency with the judgments of Yu et al. (2020), who found that drivers not wearing seatbelts were more susceptible to suffering severe injuries.

Weather and Seasonal Characteristics

The analysis revealed that the presence of the "sunny weather indicator" increased the possibility of minor injury accidents. It can be attributed to clear perceptibility & favourable light situations during sunny weather, which significantly reduces the chances of severe injuries. On the other hand, the "winter indicator" was found not probably to result in minor injury crashes. It could be because of reduced daylight period & compromised visibility, especially in foggy conditions, during the winter season. Previous research supports these findings that fog, rain, snow & overcast conditions during severe winter, contribute to a higher risk of driver accidents or severe injuries (Ahmed et al., 2018; Hao et al., 2016). Furthermore, the analysis indicated that the "autumn indicator" was more probably resulted in minor-injury accidents. In countries like Pakistan, the autumn season encompasses the months of September, October & November which are characterized by moderate weather, ordinary visibility & favourable environments for driving. These factors contribute to a lower occurrence of severe injury driver crashes during this season.

Temporal Characteristics

The analysis revealed that crashes happening between 10 am and 2 pm were less likely to result in minor injuries to drivers. This time period represents an intermediary phase between morning and afternoon peak hours, characterized by a reduction in traffic congestion from the morning peak. During this time, vehicles tend to move at higher speeds with sufficient space between them, which raise the probability of more severe driver injury accidents. These outcomes align with the research conducted by Wu et al. (2016), who found that driver injury severity was lower for crashes that occurred during peak hours compared to off-peak hours. August indicator was found to be positively associated with minor injury severity outcome. August marks the peak of the summer season in Pakistan with bright sunshine, extremely warm and humid weather conditions and normal visibility. Driving conditions aren't unfavourably impacted due to the weather in August. Therefore, there is a lesser probability of severe injury driver accidents in the month of August.

Table 5

Temporal Instability in Uncorrelated & Correlated Random Parameters Models

	Full model (2016-2019)	
Model Statistics	**Uncorrelated**	**Correlated**
Number of Parameters	16	18
Number of Observations (N)	3454	

	Full model (2016-2019)	
Log-likelihood at zero	-3192.2022	
Log-likelihood at convergence	-2591.4999	-2588.1230
Akaike Information Criteria (AIC)	5215.0	5212.2
AIC/N	1.510	1.509
Bayesian Information Criteria (BIC)	5313.4	5322.9
BIC/N	1.538	1.541
Degrees of freedom	2	
Level of confidence	95%	
Computed chi-square	6.754	
Critical chi-square	5.99	

Roadway Characteristics

The analysis indicated a positive relationship between the "median indicator" and the outcome of no injuries. This finding is intuitive since median barriers provide protection against head-on collisions and generally contribute to reducing severe injuries during crashes (Tarko et al., 2008).

Summary and Conclusion

This article uses motorists' crashing data (2016-2019) for the district of Peshawar to study aspects impacting motorists' injury severities using the RLP model with heterogeneity in means & variances. Data regarding Motorist crashes collected from the Peshawar traffic police and Rescue 1122 Peshawar office were utilized for the analysis. Motorists' injury severity levels were distributed into three categories: severe-injury, minor-injury & no-injury to calibrate the model. The model based on four years dataset was able to capture the two significant factors, old-aged drivers (above 50 years old) and the existence of road shoulder. Their estimated parameters turned out to be a normal distribution instead of a fixed value during the observation. Other significant fixed factors are: driver age less than 18, driving license, seat belt, sunny weather, winter, autumn season, a time period between 10 am to 2 pm, month of August and road median.

The results show that the probability of severe-injury declines with road shoulder, drivers holding a driving license, usage of seat belts and in the autumn season. While severe injury rises due to drivers driving the vehicles with age, less than eighteen-18 years. Similarly, the likelihood of minor injury to motorists declines for crashes occurring in the winter season and when crushes happen during off-peak hours (10M – 2 PM). Likewise, minor injury to motorists rises when drivers with old age, more than 50 years are involved, during sunny weather, the autumn season and occurring in the month of August. Also, by providing a centre median in the road, the probability of no injury increases.

In view of the results obtained, various countermeasures are recommended. Traffic rules and regulations must be enforced and refreshed for those motorists' who break and violate traffic rules, in addition to sanctioning processes, which must be stricter when a driving license didn't exist with the user. Enhancing and increasing the number of traffic signals along the route where crushes are high or applying alternative calming devices can be a possible solution to reduce traffic injuries. Evidence shows that providing a centre median on different routes will definitely show a reduction in traffic crushes. Similarly, another possible countermeasure could be shoulder widening. Moreover, arranging promotion campaigns and awareness programs can also improve road safety. Another interesting alternative could be useful to decrease traffic injuries by making it essential every few years for drivers to re-testing and vision test senior drivers. Actions regarding the execution of regulations concerning the use of safety seatbelts can decrease the consequences of road crushes. Effective measures related to poor visibility should be considered by the execution of laws concerning the headlights of vehicles.

Maximum results in this research are most reliable with the available literature on motorists' crash severity, but their implications are important because Pakistan's driving environment is so different from developed countries. Data related to motorists' crashes were collected from reports maintained by the Peshawar traffic police and Rescue 1122 Peshawar office. Although there is underreporting likely for crashes with a minor and no injury (Younis et al., 2019) which might affect the accuracy, however, this is the only data

available for crashes that occurred in the district of Peshawar. That is the reason for merging the two sources to obtain more reliable and effective final data. Moreover, the availability of authentic and quality data in future can develop more opportunities for assessing motorists' safety in the country.

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