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Indicator Variables for Road Traffic Injury Severity in District Gujrat, Pakistan

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ABSTRACT

Road Traffic Injuries (RTIs) are unexpected and unpredicted events involving at least a single vehicle. They claim the lives of around 1.3 million people every year. **Objective:** To determine the indicator variables that play roles in forecasting the injury severity levels (slight, moderate, and severe) of road traffic accidents in the populous city of Gujrat and correspondingly design explicit health policies for the public health system. **Methods:** An analytical cross-sectional study was conducted for six months from June 2023 to December 2023 on 342 subjects with and without fatalities; excluded were the ones with non-RTA emergencies. The response variable, injury severity, was divided into three categories: slight, moderate, and severe. Chi-square and multiplicative logit tests were applied to determine a predictive model using Stata version 15, respectively. **Results:** Pearson X2 associated p-values for 'time lapse until help' and marital statuses were 0.086 and 0.123, respectively. A multinomial logit model of road accident injury severity concluded that if distance from first aid increases along with foggy weather, the chances of severe injuries are e higher. The increase in education level will decrease the frequency of severe injuries. Licenses gained without training result in 116 times more severe injuries. **Conclusions:** This study showed that distance from first aid, weather, age, education, and license gained affect the risks of severe injuries. The public health care sector should take on recommended initiatives to manage the resource burden of RTA in tertiary care hospitals that could be used for combating other systemic illnesses.

INTRODUCTION

Road Traffic Accidents (RTA) claim the lives of around 1.3 million people every year. Around 20 to 50 million additional persons are impacted by non-fatal RTA injuries, which also increase morbidity in many circumstances [1]. Among the global RTA rates, 92% occur in low-and-middle-income countries [2]. In Pakistan, pedestrians and riders of motor transport (2 or 3-wheelers) are more in danger; they account for 41% and 39%, respectively, of fatal RTAs [3]. Road Traffic Injuries (RTIs) are unexpected and unpredicted events involving at least a single vehicle [4]. Fatal RTIs are those whereby life is lost during accidental time or a maximum of 30 days after incidence [5]. Injuries, disabilities, and mortalities as a result of RTIs are considered the major concerns in public health [6]. One of the leading causes of death, hospitalization, disability, and mental health is RTIs; in addition to this, it also adds an enormous socioeconomic burden on people [7-9]. RTA is an issue not just in Pakistan but largely affects the global population. The top five reasons for deaths in the US in 2022 include accidents; this is as important as COVID-19, and both share consecutive positions in the rankings [10]. Accidents, including motor vehicles, falls, and poisoning, are the top three preventable deaths, which account for approximately 85% of the total preventable injury-related deaths in the US [10, 11]. The count of many preventable deaths is also directly linked with the demographics, social,

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environmental, and mental conditions of the victims. If we split the prevalence of accidents in the US in 2022 Age-wise, it is the leading cause of death till the age of 44 years and stays in the top 5 until the age of 64 years [10]. This means it should be given equal attention as gained by cancer or COVID-19. Males under 25 account for about 3/4 (73%) of all traffic accidents in Iran, and they are almost disproportionately more likely to die in a street automobile collision than are the girls of the same age [11, 12]. These losses are mostly caused by two factors: expensive medical care and widespread poverty. According to Pakistan's Traffic Accident Annual Report (2021), 9701 road accidents were recorded there in the 2019–2020 fiscal year, with Punjab accounting for the majority of instances (4294). Of the 9701 incidents, 46% resulted in fatalities, with the remaining accidents being non-fatal. About 5436 people died in accidents, and 12371 were wounded [13]. Additionally, RTA causes considerable economic losses for individuals, families, and indirectly. Additionally, in third-world countries like Pakistan, where health insurance and free medical facilities are limited, the patient has to bear the losses himself, leading to economic loss. Furthermore, the attendants accompanying the patient also have to miss work or school, which might result in a loss of income for the family. Road Traffic Accidents (RTAs) cost around 3% of a country's global GDP, according to WHO [14]. There are four major factors that contribute to an increase in accidents: the human factor, the vehicle factor, the road factor, and the environmental factor. In addition, avoiding crashes by identifying their influential factors is possible via accurate prediction modeling.

The aimed of this study is to determine and assess the indicator variables that lead to severities in injuries and thus design suggestive health policies based on the indicator variables to combat the rising burden of RTA-leading deaths so that valuable guidance can be generated for the development and implication of solutions in the public health sector.

METHODS

An analytical cross-sectional study was conducted for six months from June 2023 to December 2023. The data were collected from three health localities: Trauma Centre Lalamusa, Tehsil Head Quarter Hospital Kharian, and Aziz Bhatti Shaheed Teaching Hospital Gujrat. Purposive sampling technique was applied with 95% confidence interval, 5% level of significance, 56% prevalence, and 5% margin of error using the formula n=Z21-α/2 P(1-P)/d2 [15]. Cases with and without fatalities were included; excluded were the ones that faced emergencies other than RTA. A structured questionnaire was developed based on two sections, i.e., driver characteristics and accident characteristics (Cronbach Alpha's value = 0.623). The calculated sample size was 378, but a total of 385 accident cases were gathered with informed consent. The resulting data were coded into a convenient computer-ready form. The indicator variables considered for the study were divided into two groups: accident characteristics: accident time (X1), accident location (X2), distance from first aid (X3), time lapse until help (X4), mode of hospital transfer (X5), accident type (X6), accident reason (X7), and weather (X8); and driver characteristics: smoking behavior (X9), education (X10), marital status (X11), residence (X12), license gained (X13), job status (X14), and us (X14), and age (X15). The obtained data had three distinct categories of injury severity (response variable) for which the model was predicted: slight injury that was healed through first aid only; moderate injury with an open wound and bone fracture healed without the need of surgery; severe injury that required surgery and prolonged hospital stay. Analysis was performed on Stata version 15. A chi-square test of independence was applied to determine the correlations of indicator variables with injury severity levels. Multinomial logit regression was applied to evaluate the effect of correlated risk factors on the injury severity. The rules and regulations set by the ethical committee of UOL (University of Lahore) were followed while conducting the research, and approval was attained (REC-UOL-493-08-2023), respectfully fulfilling the rights of the research participants.

RESULTS

The prevalence of correlated accident characters within the three injury severity levels is demonstrated in the contingency analysis (table 1). It shows that the highest proportion of severe accidents occurred in the afternoon or noon time (13.1%). These results may be due to the rush hours of that time. Chowk area faced the highest proportion of accidents with slight injuries (100%). The most severe injuries (42.6%) occurred when the distance was 21–30 km from first aid. When victims were transferred using others' vehicles, 75% severe injuries resulted. The maximum number of severe injuries were due to collision (60%). An elevated proportion of severe injuries arose in foggy weather conditions (63.6%). The Pearson chi-square (X2) value and associated significant values concluded that all the indicator variables were highly associated with the injury severity levels ($p<0.001$) except X4 ($p=0.086$) and X11 ($p=0.123$).

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Table 1: Chi-Square Contingency Analysis of Accident Characteristics Within Injury Severity Levels

Indicator Variables		Injury Severity Levels N (%)			Total	X^2 (p-Value)
Accident Characters	Categories	Slight	Moderate	Severe		
Accident Time X_1	Morning	31 (51.7%)	8 (13.3%)	21 (35%)	60	26.056 (<0.001) **
	Noon/Afternoon	146 (80.2%)	12 (6.6%)	24 (13.1%)	182	
	Evening/Night	76 (76%)	14 (14%)	10 (10%)	100	
Accident Location X_2	Bridge	47 (96%)	2 (4.08%)	0	49	109.379 (<0.001) **
	Chowk	125 (91.2%)	2 (1.5%)	10 (7.3%)	137	
	Filling Station	6 (100%)	0	0	6	
	GT Road	29 (29%)	27 (27%)	44 (44%)	100	
	Link Road	60 (63.8%)	14 (14.9%)	20 (21.3%)	94	
	Other	0	2 (50%)	2 (50%)	4	
First Aid Distance X_3	< 10 Km	144 (73.5%)	32 (16.3%)	20 (10.2%)	196	50.791 (<0.001) **
	11 – 20 Km	78 (84.8%)	2 (2.1%)	12 (13%)	92	
	21 – 30 Km	31 (57.4%)	0	23(42.6)	54	
Time Lapse Until Help X^4	<15 minutes	22 (13.3%)	29 (17.5%)	115 (69.3%)	166	4.908 (0.086)
	<15 minutes	12 (6.8%)	36 (20.5%)	128 (72.7%)	176	
Transfer Mode X_5	Self	80 (89.9%)	8 (9%)	1 (1.1%)	89	31.156 (<0.001) **
	Ambulance	77 (61.6%)	12 (9.6%)	36 (28.8%)	125	
	Others' Vehicle	96 (75%)	14 (11%)	18 (14%)	128	
Accident Type X_6	Bike Slip	137 (87.8%)	12 (7.7%)	7 (4.5%)	156	122.501 (<0.001) **
	Collision	14 (28%)	6 (12%)	30 (60%)	50	
	Fell from Vehicle	33 (84.6%)	6 (15.4%)	0	39	
	Walk on Road	22 (50%)	6 (13.6%)	16 (36.4%)	44	
	Other	47 (88.7%)	4 (7.5%)	2 (3.8%)	53	
Accident Reason X_7	Careless Driving	47 (73.4%)	12 (18.8%)	5 (7.8%)	64	98.105 (<0.001) **
	Mobile Phone Usage	8 (72.3%)	0	3 (27.3%)	11	
	Damaged Vehicle	33 (89.2%)	2 (5.4%)	2 (5.4%)	37	
	Overspeed	134 (80.7%)	10 (6.02%)	22 (13.3%)	166	
	Skill Error	4 (66.7%)	0	2 (33.3%)	6	
	Slippery Road	14 (87.5%)	2 (12.5%)	0	16	
	Tiredness	6 (75%)	0	2 (25%)	8	
	Tyre Burst	1 (100%)	0	0	1	
	Wrong Turn	4 (40%)	4 (40%)	2 (20%)	10	
	Other	2 (8.7%)	4 (17.4%)	17 (73.9%)	23	
Weather X_8	Clear	34 (58.6%)	20 (34.5%)	4 (6.9%)	58	229.963 (<0.001) **
	Cloudy	37 (94.9%)	0	2 (5.1%)	39	
	Dry	11 (33.3%)	4 (12.1%)	18 (54.5%)	33	
	Fog	3 (13.6%)	0	19 (63.6%)	22	
	Smog	15 (83.3%)	0	3 (16.6%)	18	
	Rainy	31 (93.9%)	2 (6.06%)	0	33	
	Strong Wind	100 (90%)	6 (5.4%)	5 (4.5%)	111	
	Sun Glare	1 (14.3%)	2 (28.6%)	4 (57.1%)	7	
	Other	21 (100%)	0	0	2	

The prevalence of correlated driver characters within the three injury severity levels is demonstrated in Table 2. The highest proportion of severe injuries were observed among smokers (28.6%), intermediate education level drivers (28.9%), students (34.3%), urban drivers (22.3%), and licensed drivers without training (20.6%). Drivers with an age range of 10-25 years had the highest proportion of overall (64%) and severe (18.3%) injuries. Judgements based on percentages are misleading, and further investigations are required for accurately determining the predictor variables. The Pearson chi-square (X2) value and associated significant values concluded that all the indicator variables were highly associated with the injury severity levels (p<0.001) except X11 (p=0.123) and X11 (p=0.123). Hence, time lapse until help and marital status of the driver had no effect on the accident occurrence and injury severity.

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Table 2: Chi-Square Contingency Analysis of Driver Characteristics within Injury Severity Levels

Indicator Variables		Injury Severity Levels N (%)			Total	X^2 (p-Value)
Driver Characters	Categories	Slight	Moderate	Severe		
Smoking Behavior X_9	Smoker	52 (61.9%)	8 (9.5%)	24 (28.6%)	84	13.014 (0.001) **
	Non-Smoker	201 (77.9%)	26 (10.1%)	31 (12.01%)	258	
Education X_{10}	Primary	49 (65.3%)	6 (8%)	20 (26.7%)	75	54.687 (<0.001) **
	Matric	60 (73.2%)	15 (18.3%)	7 (8.5%)	82	
	Intermediate	55 (61.1%)	9 (10%)	26 (28.9%)	90	
	Bachelors	4 (50%)	2 (25%)	2 (25%)	8	
	Uneducated	85 (97.7%)	2 (2.3%)	0	87	
Marital Status X^{11}	Married	13 (11.3%)	12 (10.4%)	90 (78.3%)	115	4.189 (0.123)
	Un-Married	21 (9.3%)	43 (18.9%)	163 (71.8%)	227	
Residence X_{12}	Urban	137 (69.5%)	16 (8.1%)	44 (22.3%)	197	14.080 (<0.001) **
	Rural	116 (80%)	18 (12.4%)	11 (7.6%)	145	
License Gained X_{13}	With Training	145 (78%)	16 (8.6%)	115 (69.3%)	166	83.304 (<0.001) **
	Without Training	100 (76.3%)	4 (3.05%)	27 (20.6%)	131	
	No License	8 (32%)	14 (56%)	3 (12%)	25	
Job Status X_{14}	Student	59 (54.6%)	12 (11.1%)	37 (34.3%)	108	50.586 (<0.001) **
	Manual work	62 (87.3%)	6 (8.5%)	3 (4.2%)	71	
	Private Car Driver	2 (100%)	0	0	2	
	Self-Employed	6 (75%)	0	2 (25%)	8	
	Unemployed	124 (82.1%)	16 (10.6%)	11 (7.3%)	151	
Age X_{14}	10-25	159 (72.6%)	12 (11.1%)	40 (18.3%)	219	31.364 (<0.001) **
	26 - 40	72 (82.8%)	8 (9.2%)	7 (8.04%)	87	
	41 - 55	6 (30%)	6 (30%)	8 (40%)	20	
	56 - 70	12 (100%)	0	0	12	
	71 - 85	4 (100%)	0	0	4	

The unadjusted and adjusted odds ratios evaluated through multinomial logistic regression are represented in table 3. All the variables were checked for unadjusted odds ratio. Weather, education, license gained, and accident reason were not significant during unadjusted odds ratio analysis and thus were excluded from final regression. The Nagelkerke value indicated that the model prediction fits 90.7% of the considered indicators. Accidents that occurred in evening/night were 4.9 times more likely to cause moderate injuries than slight. A distance of less than 10 km from first aid caused more severe injuries by 1.3 times. Bridge, Chowk, and GT Road were 4.2 times, 9.8 times, and 2.05 times more likely to cause severe injuries than slight. Collisions and rural drivers who performed manual work by profession caused 8.7, 3.33, and 7 times more severe injuries than slight injuries.

Table 3: Multinomial Logit for Injury Severity Levels with Unadjusted Odds Ratios

Indicator Variables	Categories	Moderate		Severe	
		Un-Adjusted OR (95% CI)	p-Value	Un-Adjusted OR (95% CI)	p-Value
Accident Time	Noon/Afternoon	-			
	Morning	1.2 (0.1 – 10)	0.9	4.1 (2 – 8.3)	0.000
	Evening/Night	4.9 (1 – 25)	0.05	0.8 (0.4 – 1.8)	0.6
Transfer Mode	Self	-			
	Ambulance	1.6 (0.6 – 4)	0.4	37.4 (5 – 279.6)	0.000
	Others	1.5 (0.6 – 3.7)	0.4	15 (2 – 114.8)	0.009
Time Lapse	>15 minutes	-			
	<15 minutes	2.2 (1 – 4.6)	0.04	1.3 (0.7 – 2.4)	0.3
First Aid Distance	21 – 30 Km	-			
	<10 Km	3.6 (0.8 – 15.4)	0.000	0.2 (0.9 – 0.4)	0.000
	11 – 20 Km	4.1 (0.4 – 4.2)	0.000	0.2 (0.9 – 0.5)	0.000
Accident Location	Other's	-			
	Bridge	1.6 (1.4 – 1.9)	0.000	1.7 (0 – 2)	0.9
	Chowk	6 (5.1 – 7)	0.000	3 (1.3 – 6.8)	0.000

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	Filling Station	9.5 (9.3 – 9.8)	1	1.5 (0 – 1.8)	0.9
	GT Road	3.5 (4 – 5)	0.000	5.8 (1.3 – 2.5)	0.000
	Link Road	3.5 (4 – 5)	0.000	1.3 (1.5 – 1.6)	0.000
Accident Type	Walk on Road	-			
	Bike Slip	1.03 (0.3 – 3.3)	0.9	1.2 (0.2 – 6)	0.8
	Collision	5.04 (1.2 – 20.4)	0.02	50.4 (10.7 – 237.4)	0.000
	Fell from Vehicle	2.1 (0.6 – 8.2)	0.3	3.02 (2.7 – 3.3)	0.000
	Other	3.2 (0.8 – 12.5)	0.09	17.1 (3.6 – 80.9)	0.000
Smoking Behavior	Smoker	-			
	Non-Smoker	0.8 (0.4 – 2)	0.7	0.3 (0.2 – 0.6)	0.000
Marital Status	Unmarried	-			
	Married	1.1 (0.5 – 2.3)	0.7	0.5 (0.3 – 1)	0.05
Residence	Urban	-			
	Rural	1.3 (0.6 – 2.7)	0.4	0.3 (0.1 – 0.6)	0.001
Job Status	Unemployed	-			
	Student	0.5 (0.1 – 2)	0.4	7.1 (3.4 – 14.9)	0.000
	Manual Work	0.8 (0.3 – 2)	0.6	0.5 (0.1 – 2.03)	0.5
	Private Car Driver	2.6 (2.1 – 2.9)	1	6.2 (0 – 7)	1
	Self Employed	2.9 (2.4 – 3.2)	1	5.6 (0.9 – 34.3)	0.06
Age	71 - 85	-			
	10- 25	1 (0.2 – 3.4)	0.000	1.2 (0.4 – 3.7)	0.000
	26- 40	8.8 (2.3- 34)	0.000	4.7 (1.2- 17.9)	0.000
	41-55	8 (7.2 – 8.6)	1	6.6 (5.8 – 12.9)	1
	56-70	1 (0 – 2)	1	1 (0 – 2)	1

The multinomial logit model for injury severity levels in road traffic accidents identified several key predictors with adjusted odds ratios. Accident timing was significant, showing that accidents in the evening or night had a higher likelihood of moderate injuries (Adjusted OR = 4.9, p = 0.05). Transfer mode indicated that injuries were more severe when patients were transferred via other means rather than by ambulance. Time lapse until receiving help was critical, as a delay of more than 15 minutes significantly increased the severity of injuries. Distance to the nearest first aid center also played a role, with closer distances (under 10 km) being associated with a lower likelihood of severe injury (Adjusted OR = 1.3, p = 0.003). Locations like bridges, chowks, and GT Road were linked to higher severity, as was accident type, especially for collisions and falls from vehicles. Socioeconomic factors, including residence, job status, and age, further influenced severity; rural residents, manual workers, and older individuals showed increased risk of severe injury. The results highlight specific areas where policy interventions and targeted safety measures could mitigate the severity of injuries in road traffic accidents (Table 4).

Table 4: Multinomial Logit for Injury Severity Levels With Adjusted Odds Ratios

Indicator Variables	Categories	Moderate		Severe	
		Adjusted OR (95% CI)	p-Value	Adjusted OR (95% CI)	p-Value
Accident Time	Noon/Afternoon	-			
	Morning	1.2 (0.1 – 10)	0.9	10.8 (0.001 - 21)	0.2
	Evening/Night	4.9 (1 – 25)	0.05	0.01 (1.07 – 109729.4)	0.6
Transfer Mode	Self	-			
	Ambulance	1.3 (0.2 – 8.06)	0.8	0.002 (1.03 – 3.7	0.6
	Others	0.9 (0.2 – 5.08)	0.9	2.03 (1.8 – 6)	0.2
Time Lapse	>15 minutes	-			
	<15 minutes	2.7 (0.6 – 12.5)	0.2	6.4 (0.008 – 7.8)	0.1
First Aid Distance	21 – 30 Km	-			
	<10 Km	12.08 (1.7 – 87.6)	0.7	1.3 (0.5 – 3.08)	0.003
	11 – 20 Km	6.7 (0.09 – 9.6)	0.8	0.001 (0 – 2.2)	0.4
Accident Location	Other's	-			
	Bridge	3.1 (3 – 3.2)	0.9	4.2 (1.5 – 5)	0.000
	Chowk	2 (1.9 – 2.5)	0.9	9.8 (4 – 10)	0.000
	Filling Station	1.3 (0.3 – 5.5)	0.8	2.1 (0 – 7.2)	0.6

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	GT Road	0 (0 – 2.2)	0.9	2.05 (1.5 – 8.7)	0.000
	Link Road	5 (4.8 – 5.1)	0.9	1.8 (1.6 – 2)	1
Accident Type	Walk on Road	-			
	Bike Slip	5.4 (0.8 – 34.5)	0.07	0.3 (2.8 – 3.1)	0.9
	Collision	2.3 (0.2 – 25.3)	0.4	8.7 (2.5 – 30.9)	0.009
	Fell from Vehicle	0.6 (0.04 – 8.6)	0.7	5 (2.2 – 11.3)	0.01
	Other	14.9 (1 – 230.2)	0.05	2397 (26.2 – 21986)	0.6
Smoking Behavior	Smoker	-			
	Non-Smoker	0.5 (0.05 – 5.7)	0.6	8.2 (0.1 – 49.5)	0.06
Marital Status	Unmarried	-			
	Married	0.5 (0.08 – 2.8)	0.4	21.2 (1.04 – 43.2)	0.8
Residence	Urban	-			
	Rural	1.9 (0.3 – 11.3)	0.5	5.8 (4.2 – 8.5)	0.003
Job Status	Unemployed	-			
	Student	1.8 (0.3 – 12.8)	0.5	0.03 (0.01 – 1.4)	0.5
	Manual Work	3.5 (0.2 – 48)	0.3	7 (6.9 – 7.1)	0.01
	Private Car Driver	4 (0.5 – 5.2)	0.96	1.5 (1.2 – 1.9)	0.8
	Self Employed	243.2 (2.5 – 250)	0.92	2.05 (0.7 – 5.3)	0.3
Age	71-85	-			
	10 – 25	3.3 (1.4 – 7.3)	0.9	1.7 (1.2 – 24.3)	0.5
	26 – 40	5 (2.2 – 11.3)	0.9	2.2 (1.6 – 2.9)	0.8
	41 – 55	5.8 (2.5 – 13)	0.9	8 (1.09 – 58.8)	0.8
	56 - 70	0.6 (1.2 – 3.7)	0.9	6.9 (1.4 – 32.1)	0.1

DISCUSSION

The study aimed to determine the predictors that influence the injury severity levels of 342 road accidents that occurred in the district of Gujrat, Pakistan, in 2023. After a chi-square correlation test, a multinomial logit model was estimated for predicting the probability of three injury severity levels: slight, mild, and severe. The analysis concluded that among fifteen variables (X1-X15), X8, X6, X2, X7, X3, X13, X10, X14, and X15 have been successful in estimating the probability of severe injuries in a good fit model. With respect to the chi-square correlation test, all of our indicator variables except time lapse until help (X4) and marital status (X11) were not statistically significant at 95% confidence interval. In another study that investigated the prediction of different driver, vehicle, temporal, geometrical, and environmental factors on fatal, non-fatal, and no injuries, gender, day of the week, and natural lightning worked out to be non-related in the chi-square test [16]. In another study that investigated the correlation of traffic knowledge with demographics, it was indicated that age, gender, RTA knowledge, residence, education, and occupation were correlated, indicating significant X2 and Cramer's V coefficients [17]. Contingency analysis conducted in this study revealed that bike slips resulted in a high proportion of slight injuries, whereas collisions resulted in severe injuries. This is consistent with the findings of a study that reported that 51.7% of the cases were motor-cycle-related injuries [18]. The study also reveals that the Injury Severity Score was lowest for emergency transfers using ambulances, whereas this study shows that the highest proportion of severe injuries occurred in transfers incorporating ambulances (10.5%). This may be due to the poorly equipped ambulances in the city or due to increased distance from the health facility. Current study concluded that student drivers undergo more severe injuries. It is contradicted by employed drivers undergoing more fatal injuries [19]. Chi-square statistics showed that weather, accident type, accident location, accident reason, distance from first aid, driver education, license gained, job, and age were highly correlated to injury severity. Among these, distance from first aid (<10 km), weather (fog), age (41-55 years), education (matric), and license gained (with and without training) significantly predicted the injury severity outcomes model. A high chi-square value for the accident predictor model (X2 = 406.33) with a small p-value (0.000) indicates the goodness-of-fit; one such is also designed in research [16]. This study concluded that drivers aged 41-55 years are at higher risk of severe injuries, which deviates from the findings of studies where older drivers faced more fatal injuries, except one study, which indicated drivers of age 55 and above facing fatal injuries [16, 18, 20-22]. The under-discussion study also revealed that drivers with matriculation were more prone to moderate and slight injuries than severe injuries. The findings are concomitant with findings where primary-educated drivers were at higher risk of accident fatalities [16, 17]. Studies of show that license education to drivers decreases the fatality rates; this supports the drop by 53 units in RRRs of severe injuries when license was gained

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with professional training [21]. Foggy weather conditions were 116 times more likely to cause severe injuries when compared to slight injuries. But this is contradicted by the summer season resulting in fatal injuries compared with no injuries [16]. In a study conducted in 2024, the logistic regression showed that time lapse until help and mode of hospital transfer were significantly correlated to injury RTI, but this study showed no correlations in any statistics [19]. The public health care sector should take on recommended initiatives to manage the resource burden of RTA in tertiary care hospitals that could be used for combating other systemic illnesses. Moreover, the health system, rather than the governmental societies, should educate such drivers on the biological and health havocs of RTAs for an action-oriented result. It is recommended for further researchers to include more factors as predictors of severe RTI injuries so that a comprehensive road-map be generated for health policy makers.

CONCLUSIONS

In crash severity analysis, accurate and efficient classification models are crucial for assessing crash outcomes based on severity. This study found that factors such as proximity to first aid (within 10 km), foggy weather conditions, drivers aged 41-55, and uneducated drivers who obtained licenses without formal training were associated with a higher risk of severe injuries. These insights highlight specific risk factors that could inform targeted interventions to reduce crash severity.

Authors Contribution

Conceptualization: SH
Methodology: SH
Formal analysis: SH
Writing, review and editing: SH, ZT, ZA, AS, MI, KP, AT

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

Conflicts of Interest

All the authors declare no conflict of interest.

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