Patterns of injuries and injury severity among hospitalized road traffic injury (RTI) patients in Bangladesh

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ABSTRACT

Background: Road traffic injuries (RTIs) are one of the key public health issues worldwide causing 1.3 million deaths every year. This study aimed to determine the patterns of injuries due to road traffic accidents (RTAs), the severity of injuries, and factors associated with injury severity.

Methodology: A cross-sectional study was conducted among RTA victims, who attended two large tertiary care hospitals located inside the Dhaka metropolitan area, through structured interview between 28 January and 22 March 2020.

Results: Among 375 RTI patients, a total of 1390 injuries were recorded among interviewed patients, yielding a mean of 3.7 injuries per patient. The most frequently injured systems were external (n = 351), lower limb (n = 235), head and neck (n = 151), and face (n = 150). The mean ISS were 20.96/C6/C7 12.027 with a maximum of 65 and a minimum of 4. Among patients, 87 (23.20%) had a severe injury, and 37 (9.87%) patients were critically injured. A statistically significant variation in ISS was observed in ANOVA among various categories of age, education, occupation, and purpose of going outside, vehicle type and fitness, accident type, road type, times required in hospitalization, and death history (p < 0.05).

Conclusions: Our study has revealed several important findings which will help stakeholders and policymakers devise better policies to reduce RTA and RTA related injuries in Bangladesh.

1. Introduction

Road traffic injuries (RTI) is a pressing public health issue worldwide and one of eight major causes of mortality. Every year more than 50 million people worldwide are injured due to RTAs which in turn makes it one of the leading causes of disability [1, 2, 3]. According to the World Health Organization (WHO), the number of deaths by RTAs continues to rise steadily leaping from 1.15 million in 2000 to 1.35 million in 2018 [4]. During the year 2018 around 56.9 million deaths occurred worldwide and RTIs account for around 2.37% of them [5]. RTIs are also one of the top three causes of death for people aged between 5 and 44 years, and the leading cause of death for young people between the ages of 5 and 29 years [6, 7]. By 2030 RTIs will become the 5th largest cause of mortality worldwide if the increasing trend continues [8].

Adequate laws for RTI related factors such as speediness, glazed-driving, drunk, seat-belt is present for only 7%-8% population worldwide [9, 10]. RTAs also have a significant impact on the global economy because in most cases economically productive population are subject to it due to the need for extensive travel and mobility [11]. Unfortunately, official RTIs statistics worldwide are often believed to be slightly inaccurate due to reporting problems including the absence of regular data, under-reporting, inconsistency, inaccessibility, and delay of data release [5].

RTAs are quite common in low- and middle-income countries (LMICs) where more than 90% of global road traffic-related injuries happen. More than 65% of LMICs don’t have policies in place to protect road users [11, 12]. The death rates due to RTA in LMICs are more than double in comparison to high-income countries and the situation is worse in rural areas. Therefore, RTAs have a significant impact on a country's economy.
as LMICs lose about 5% of their GDP due to RTIs compared to 3% for the rest of the world [13, 14]. RTIs also substantially impact health-related quality of life (HRQOL) as it has physical, psychological, and financial consequences [15, 16].

In Bangladesh, RTAs are a widely discussed public health issue resulting in over 21000 fatalities every year. Most of these deaths commonly occur among pedestrians and passengers of light vehicles. So, RTIs result in increased costs of health, personal, family, social care due to accidental death and disability. Moreover, due to rapid urbanization and the increased number of vehicles RTAs are increasing day by day. RTIs are now Sustainable Development Goal (SDG) issue as most of these global deaths are occurring in LMICs [17, 18, 19, 20, 21, 22, 23].

In the last few years, a continuing swing from infectious disease to non-communicable disease and injuries happened in Bangladesh. The United Nations (UN) announced the 2011–2020 period as a Decade of Action for Road Safety. Where, two SDG indicators aimed to decrease worldwide road traffic accidents, injuries and death by 50% by 2020 [24, 25].

Despite the availability of several different ways to measure the severity of a crash, there is no generally agreed-upon instrument. Police and hospitals classify the severity of RTIs in a different way [26]. The injury severity score (ISS) is an established medical scoring for measurement of injury severity has been found useful for epidemiological and metabolic research [27].

In low-income countries, due to poor implementation of traffic safety measures pattern of injuries changes and increased number of pedestrians and motorized two-wheelers are being affected. Previously conducted studies also showed educational status, sustaining with multiple injuries, being transported by ambulance from the scene of the accident were the explanatory variables found to have a statistically significant association with severity of injury [7, 28].

Bangladesh is passing crucial situation managing road traffic accidents. Though RTAs and RTIs are widely discussed national and public health issue in Bangladesh, there is a lack of research focusing on this specific area. Therefore, our study aimed to describe the patterns of road traffic injuries of victims admitted to hospitals in Dhaka city, the severity of injuries and factors associated with it.

2. Materials and methods

2.1. Study sites

This study was conducted in two well renowned tertiary care hospitals located inside the Dhaka metropolitan area. These hospitals were approached for the study because they proper record keeping facilities and a large number of injury patients.

2.2. Study design

Our study was designed as a hospital-based cross-sectional study. A structured questionnaire was used to determine the socio-demographic variables and road traffic injury-related characteristics. Here, the consequences of road traffic injuries were expressed by Injury Severity Score (ISS) which is a well renowned established medical score to determine the injury severity. If the ISS was found greater than 15, we concluded the injury as severe [29].

2.3. Ethical approval

The protocol for this research was approved by the Ethical Review Committee of the North South University. A written informed consent was taken from the patient himself or guardian/close relatives of a severely injured study participant.

2.4. Data collection

The data for this study were collected between 28th January and 22nd March 2020. Data were collected by using an interviewer-administered questionnaire through face-to-face interview with patients or close relatives of patients. If the condition of the injured patient did not permit the conversation, the close relatives or guardians were interviewed. Data were collected every day by the trained data collectors or researchers himself from one of every three patients who came to the Emergency Departments (EDs) of the selected hospitals.

2.4. Statistical analysis

Injured patients’ data collected from the targeted hospital were checked by the researchers themselves for completeness and consistency. IBM SPSS version 23 (IBM Corporation, USA) statistical package software was used regarding data management and analysis related task. To summarize our data, various descriptive statistics like frequencies and proportions were calculated. ISS variation among the characteristics was analyzed by ANOVA and degrees of association between injury severity and independent variables (socio-demographic and road traffic injury-related characteristics) were determined by multinomial logistic regression. Results with p-values of < 0.05 were considered as a statistically significant association.

3. Results

This was a hospital-based cross-sectional study conducted among 375 RTI patients admitted during the data collection period. The patients were aged between 12 to 65 years old with a mean age of 36.79 ± 13.6. Patients aged less than 10 years and more than 65 years were excluded.

3.1. Injury pattern of road traffic injury patients

A total of 1390 injuries were recorded among interviewed patients, which provided a mean of 3.7 injuries per patient. As shown in Figure 1, the most frequently injured systems were external (skin and soft tissues) seen among 351 participants out of 375. Lower limb (n = 225), head and neck (n = 151) and face (n = 150) were also seen frequently. The spine (n = 63), pelvis (n = 79), and chest (n = 82) were the less injured body systems.

3.2. Injury severity of road traffic injury patients

Looking at the severity of injuries, the mean ISS were 20.96 ± 12.027 with a maximum 65 and a minimum of 4. ISS was categorized into minor injury (1–8), moderate injury (9–15), serious injury (16–24), severe injury (25–49), and critical injury (≥50). Figure 2 indicates 128 (34.13%) patients were moderately injured, 113 (30.13%) were seriously injured, 87 (23.20%) had severe injury, and 37 (9.87%) patients were critically injured.

3.3. Socio-demographic characteristics of the study participants

The Out of 375 respondents who were the victims of road traffic injuries, 76% were male and 24% were female. Among the age groups between 12-65 years old, the most injured group was 20–35 years consist of 42.9%, and the 36–50 years old group was 26.7%. Among the respondents, 91.2% of participants were Muslim following the national statistics. The average monthly family income of study participants was 36,072 Bangladeshi Taka. Overall, 21.6% of participants were illiterate, 42.6% completed higher secondary education, and 8% was graduate. It was evident that 13.6% of the participants were transportation service workers (driver, helper, conductor, rickshaw puller etc.). In most of the
cases (65.6%) RTIs patients went outside to manage their livelihood and more than 51% had family income between 30000-50000 Bangladeshi taka (Table 1).

Our analysis also observed the variation in ISS score among various sociodemographic characteristics. A statistically significant variation was observed among various categories of age, education, occupation, and purpose of going outside (p < 0.05). A higher ISS score was observed among patients aged >50 years (22.87 ± 16.3), transport service workers (31.18 ± 14.3), or those who had limited education such as illiterate (23.25 ± 12.1) and with primary/informal education (23.75 ± 12.4) (Table 1).

3.4. Road traffic accident related variables

According to our analysis, 21.6% of road traffic injuries occurred due to various types of public buses such as city bus, local bus, long route bus, office bus etc. According to the respondents, more than 17% injury occurred when they were in a rickshaw or other manual three-wheelers. Motorized three-wheelers were also involved in 23.2% injury and two-wheelers bike/motorbike involved in another 14.1% of accidents. A statistically significant variation in the mean ISS score also observed in ANOVA. ISS score was observed relatively high in the bike (24.32 ± 11.6), small four-wheeler (23.97 ± 16.0), and leguna (transport for 12–14 person) accidents (23.46 ± 10.8). 67.2% of survivor reported that they were in the vehicle when the accident took place and the remaining were pedestrians. We also analyzed the frequency of various types of accidents where rear-end collision was most common (24%) followed by single-car accident (22%). A statistically significant variation in mean ISS score among various types of the accident was observed and a head-on collision was identified as the most dangerous one (27.64 ± 12.2). More than 60% of participants reported that the driver was over -speeding or driving recklessly and 15.2% mentioned the use of mobile phones during driving. For 44% of cases, the visual fitness of the accident involved car was poor, moreover, protective instruments (seat belt, helmet) were only used by 15.7% of respondents. Our analysis also indicates turning in roads increase the risk of fatal injuries. More than 40% of patients were not taken to the hospital within 1 h of injury and they showed higher ISS value (23.29 ± 11.5). When looking at the accident timing, the largest portion (22.4%) occurred during 21st to 24th hour (night time). However, accidents those happened after midnight were more serious (39.28 ± 16.8). We have collected information regarding the death history of RTIs in which respondents were injured. Among the accident happened, 66 (17.6%) respondents reported death history in their RTAs and known death history in RTIs shows a significant higher ISS mean score ANOVA (31.70 ± 13.4) (Table 2).

3.5. Multinomial logistic regression analysis using possible predictors

We have undergone a multinomial logistic regression analysis using significant variables of ANOVA test. Injury severity was further categorized into mild (ISS<15) and severe (ISS>15). Educational level, occupation, purpose of going outside, vehicle involved, visual fitness of car, and taking patients to a hospital within 1 h was identified as a significant predictor of severe injury (P < 0.05). Our analysis indicates being highly educated is a protective factor against severe injury (AOR Figure 1. Injury pattern of road traffic injury (RTI) patients, 2020.

Figure 2. Injury severity of road traffic injury patients using Injury Severity Score (ISS).
4. Discussion

Our study focused on road traffic accident in the context of Bangladesh which is one of the most pressing public health issues. We sought to explore the pattern and severity of injury together with factors associated with injury severity. Our findings are extremely pertinent to policymakers working in healthcare and transportation sectors. Additionally, our findings can also be valuable to scholars and practitioners working in urban and regional planning, road safety, and law enforcement.

We found external system injury (skin and soft tissues) to be most prevalent – followed by lower limb injury, head and neck injury, and facial injury. A similar study carried out in Nepal reported lower limbs (in 42.0% cases) injured with superficial injuries (bruise/abrasion) to be the most common body region followed by soft tissue injuries [30]. Another Nepal-based study reported that most of the road traffic injuries were seen in the upper and lower extremities while most impacts were seen in the upper and lower extremities or head/face region [31]. Our study population comprised 76% male and 24% female. A previous study conducted in the context of Bangladesh reported that more than two-thirds of road traffic injury patients are male – which is congruent with our results [32]. The most injured group was found to be 20–35 years (22.87% morbidities and death due to road traffic accidents [17]. We observed a higher ISS score among patients aged >50 years (22.87 ± 16.3), Transport service workers (31.18 ± 14.3), people with limited education such as illiterate (23.25 ± 12.1) and primary/informal education (23.75 ± 12.4).

Table 1. Frequency distribution of socio-demographic variables and ANOVA using ISS.

| Variables                  | Category           | Frequency | percent | Mean ± SD    | F value   | Sign. |
|----------------------------|--------------------|-----------|---------|--------------|-----------|-------|
| Age of patients            | <20 years          | 39        | 10.40%  | 17.85 ± 8.6  | 3.656     | 0.013 |
|                           | 20–35 years        | 161       | 42.90%  | 22.34 ± 10.3 |           |       |
|                           | 36–50 years        | 100       | 26.70%  | 18.52 ± 11.5 |           |       |
|                           | >50 years          | 75        | 20.00%  | 22.87 ± 16.3 |           |       |
| Sex                       | Male               | 285       | 76.00%  | 21.54 ± 12.7 | 2.812     | 0.094 |
|                           | Female             | 90        | 24.00%  | 19.11 ± 9.26 |           |       |
| Religion                  | Muslim             | 342       | 91.20%  | 20.66 ± 11.5 | 2.367     | 0.125 |
|                           | Others             | 33        | 8.80%   | 24.03 ± 15.9 |           |       |
| Income (Bangladeshi taka)  | <30000             | 135       | 36.00%  | 22.63 ± 12.1 | 2.044     | 0.131 |
|                           | 30000–50000        | 192       | 51.20%  | 20.05 ± 12.5 |           |       |
|                           | >50000             | 48        | 12.80%  | 19.92 ± 9.21 |           |       |
| Education level           | Illiterate         | 81        | 21.60%  | 23.25 ± 12.1 | 4.451     | 0.002 |
|                           | Primary/informal   | 72        | 19.20%  | 23.75 ± 12.4 |           |       |
|                           | Secondary education | 33        | 8.80%   | 22.94 ± 13.9 |           |       |
|                           | H. Secondary/undergraduate | 159 | 42.40%   | 18.03 ± 10.1 |           |       |
|                           | Graduate or higher | 30        | 8.00%   | 21.43 ± 15.0 |           |       |
| Occupation                | Business           | 93        | 24.80%  | 20.71 ± 14.2 | 6.842     | 0.000 |
|                           | Day labourer       | 15        | 4.00%   | 21.13 ± 12.4 |           |       |
|                           | Government service | 23        | 6.00%   | 18.39 ± 8.33 |           |       |
|                           | Private service    | 69        | 18.40%  | 17.13 ± 6.6  |           |       |
|                           | Housewife          | 24        | 6.40%   | 18.13 ± 12.3 |           |       |
|                           | Student            | 45        | 12.00%  | 21.53 ± 8.24 |           |       |
|                           | Transport service worker | 51  | 13.60%   | 31.18 ± 14.3 |           |       |
|                           | Unemployed/        | 27        | 7.20%   | 18.22 ± 11.8 |           |       |
|                           | Others             | 18        | 4.80%   | 19.0 ± 6.06  |           |       |
| Living area               | Urban              | 336       | 90.60%  | 20.71 ± 11.8 | 1.416     | 0.235 |
|                           | Rural              | 39        | 10.40%  | 23.13 ± 13.7 |           |       |
| Purpose of going outside at that time | Educational | 39 | 10.40% | 22.26 ± 8.56 | 3.009     | 0.030 |
|                           | Family need        | 57        | 15.20%  | 18.09 ± 8.66 |           |       |
|                           | Occupational (earning) | 246 | 65.60%   | 21.95 ± 12.9 |           |       |
|                           | Others             | 33        | 8.80%   | 17.03 ± 12.5 |           |       |

\( p < 0.05 \) indicates statistically significant [bold].

\( = 0.181; 95\% CI: 0.038–0.855 \). Motorbike accidents indicated a higher risk towards severe injury (AOR = 9.78; 95\% CI: 1.629–58.73), followed by motorized 3-wheeler (AOR = 7.193; 95\% CI: 1.469–35.23). Moreover, failure to take the patient to hospital within 1 h of accident (AOR = 4.081; 95\% CI: 1.667–9.992) and injury occurred after midnight (AOR = 3.581; 95\% CI: 0.693–18.494) had a higher odds of severe injury (Table 3).

Our study found that the mode of vehicle – at the time of the accident – was rickshaw (or any other manual three-wheelers) in more than 17% of cases, motorized three-wheelers in 23.2% of cases, and two-wheelers (bike/motorbike) in another 14.1% cases. Prior studies also supported our finding noting a huge number of collisions leading to road traffic injury happens due to collision of three-wheelers or other informal three-wheelers [33, 34]. A previous study also reported three-wheelers (16.3%), motorcycle (7.5%), bicycle (8.8%) to be the mode of transport at the time of fatal road traffic injury [17]. The contrast of findings of the study mentioned latter with ours can be attributed to the difference in classification of vehicles in both studies. Likewise, the latter study only considered cases with a fatal road traffic injury.

In our study, we found over-speeding (reported by more than 60% of the participants) to be the key contributing reason behind accidents. A similar study from Ethiopia reported a congruent result as they...
mentioned high speed (reported by 48.9% injured patients) to be the leading cause behind accident [35].

The largest portion of accidents was reported during 21st to 24th hour in our study. Two previous studies based on Addis Ababa, Ethiopia resonated with our finding [36, 37]. However, a previous study reported in contrast where they found that the highest number of crashes took place during morning time [38]. A plausible explanation of our finding could be that in Bangladesh, trucks and other heavy vehicles delivering goods enter Dhaka during the night time. Moreover, many long-distance buses travel at night e.g., buses at Dhaka to Chittagong route. High traffic of heavy vehicles coupled with high speed and darkness may contribute to a high incidence of accidents during this time frame.

Our analysis indicates being highly educated is a protective factor towards severe injury (AOR = 0.181; 95%CI: 0.038–0.855). A previous study noted that the odds of developing severe injury following a road

| Variables where | Frequency | Percent | Mean ± SD | F value | Sign. |
|-----------------|-----------|---------|-----------|---------|-------|
| The vehicle where |           |         |           |         |       |
| survivor was or | Public bus| 81      | 21.60%    | 17.37 ± 11.7 | 3.075 | 0.004 |
| reason of injury| Truck/lorry/heavy vehicle | 11 | 2.90% | 19.91 ± 12.7 |
|                  | Motorbike/bicycle | 53 | 14.10% | 24.32 ± 11.6 |
|                  | Three wheeler (motor) | 87 | 23.2% | 22.30 ± 11.2 |
|                  | Four-wheeler (small) | 33 | 8.8% | 23.97 ± 16.0 |
|                  | Three-wheeler (manual) | 64 | 17.10% | 17.83 ± 9.16 |
|                  | Leguna | 35 | 9.30% | 23.46 ± 10.8 |
|                  | Others/Don't know | 11 | 2.90% | 22.91 ± 17.8 |
| Survivor status | In vehicle | 252 | 67.20% | 21.62 ± 12.2 | 2.302 | 0.102 |
|                  | Road crossing | 51 | 13.60% | 21.57 ± 13.1 |
|                  | Footpath/Roadside/Parking | 72 | 19.20% | 18.24 ± 9.97 |
| Accident type | Single car accident | 84 | 22.40% | 20.33 ± 9.52 | 3.655 | 0.003 |
|                  | Rear-end collision | 90 | 24.00% | 19.20 ± 10.1 |
|                  | Side collision | 78 | 20.80% | 19.12 ± 10.1 |
|                  | Head-on collision | 42 | 11.20% | 27.64 ± 12.2 |
|                  | Multiple vehicle pile-up | 18 | 4.80% | 23.06 ± 12.1 |
|                  | Others | 63 | 16.80% | 21.54 ± 14.8 |
| Driving overspeed/recklessly | Yes | 227 | 60.50% | 21.09 ± 12.3 | 2.021 | 0.134 |
|                  | No | 112 | 29.90% | 19.64 ± 9.99 |
|                  | Don't know | 36 | 9.60% | 24.22 ± 12.2 |
| Visual fitness of car | Good | 180 | 48.00% | 21.01 ± 11.3 | 4.427 | 0.013 |
|                  | Poor | 165 | 44.00% | 19.83 ± 12.1 |
|                  | Don't know | 30 | 8.00% | 26.87 ± 14.2 |
| Driver in mobile phone | Yes | 57 | 15.20% | 23.28 ± 12.2 | 1.391 | 0.250 |
|                  | No | 186 | 49.60% | 20.25 ± 11.1 |
|                  | Don't know | 132 | 35.20% | 20.96 ± 13.1 |
| Seat belt/helmet (for biker) | Yes | 59 | 15.7% | 21.34 ± 11.4 | 0.039 | 0.962 |
|                  | No | 207 | 55.20% | 20.85 ± 11.5 |
|                  | Don’t know/Not applicable | 109 | 29.1% | 20.97 ± 13.2 |
| Road type | Straight road | 171 | 45.60% | 17.72 ± 9.83 | 7.943 | 0.000 |
|                  | Simple turning | 132 | 35.20% | 24.19 ± 12.6 |
|                  | U turn | 24 | 6.40% | 27.54 ± 14.2 |
|                  | Signal | 30 | 8.00% | 21.10 ± 15.9 |
|                  | Others | 18 | 4.80% | 19.06 ± 6.01 |
| Divider | Yes | 165 | 44.00% | 21.49 ± 12.4 | 0.350 | 0.705 |
|                  | No | 198 | 52.80% | 20.62 ± 11.9 |
|                  | Don’t know | 12 | 3.20% | 19.33 ± 6.4 |
| Taken to hospital within 1 h | No | 153 | 40.80% | 23.29 ± 11.5 | 9.910 | 0.002 |
|                  | Yes | 222 | 59.20% | 19.36 ± 12.1 |
| Injury time | Morning | 60 | 16.00% | 20.78 ± 8.4 | 25.96 | 0.000 |
|                  | Mid-day | 61 | 16.30% | 18.87 ± 9.8 |
|                  | Afternoon | 77 | 20.50% | 19.95 ± 10.1 |
|                  | Evening | 57 | 15.20% | 16.18 ± 8.95 |
|                  | Night | 84 | 22.40% | 18.93 ± 9.79 |
|                  | After midnight | 36 | 9.60% | 39.28 ± 16.8 |
| Death history | Yes | 66 | 17.60% | 31.70 ± 13.4 | 44.13 | 0.000 |
|                  | No | 285 | 76.00% | 18.11 ± 9.97 |
|                  | Don’t know | 24 | 6.40% | 25.29 ± 12.1 |

p<0.05 indicates statistically significant [bold].
Table 3. Multinomial logistic regression analysis using possible predictors.

| Variables                          | Category                  | Estimate | Sign. | AOR (95% CI)          | P value |
|------------------------------------|---------------------------|----------|-------|-----------------------|---------|
| Age of patients                    | <20 years                 | -0.303   | 0.716 | 0.739 (0.145-3.77)    | 0.075   |
|                                   | 20–35 years               | 0.224    | 0.739 | 1.25 (0.337-4.645)    |         |
|                                   | 36–50 years               | -0.968   | 0.116 | 0.38 (0.113-1.271)    |         |
|                                   | >50 years                 | reference|       | -                     | -       |
| Education level                    | Primary/informal          | 0.652    | 0.269 | 1.919 (0.605-6.093)   | 0.029   |
|                                   | Secondary education       | 0.865    | 0.271 | 2.374 (0.508-11.089)  |         |
|                                   | H. Secondary/undergraduate| -0.591   | 0.266 | 0.554 (0.195-1.569)   |         |
|                                   | Graduate or higher        | -1.707   | 0.031 | 0.181 (0.038-0.855)   |         |
|                                   | Illiterate                | reference|       | -                     | -       |
| Occupation                         | Day laborer               | -1.67    | 0.095 | 0.188 (0.027-1.335)   | 0.010   |
|                                   | Government service        | 3.021    | 0.001 | 20.599 (3.429-122.6)  |         |
|                                   | Housewife                 | 1.139    | 0.176 | 3.123 (0.6-16.247)    |         |
|                                   | Others                    | -1.19    | 0.209 | 0.304 (0.048-1.947)   |         |
|                                   | Private service           | 0.52     | 0.355 | 1.681 (0.56-5.051)    |         |
|                                   | Student                   | 3.091    | 0.043 | 22.005 (1.097-441.3)  |         |
|                                   | Transport service worker  | -0.163   | 0.827 | 0.85 (0.196-3.658)    |         |
|                                   | Unemployed/               | -0.232   | 0.764 | 0.718 (0.082-6.255)   |         |
|                                   | Business                  | reference|       | -                     | -       |
| Purpose of going outside at that time | Educational              | -1.315   | 0.426 | 0.268 (0.01-6.863)    | 0.018   |
|                                   | Family need               | -2.036   | 0.002 | 0.13 (0.035-0.488)    |         |
|                                   | Others                    | -0.739   | 0.437 | 0.477 (0.074-3.077)   |         |
|                                   | Occupational              | reference|       | -                     | -       |
| The vehicle where survivor was or reason of injury | Truck/lorry/heavy vehicle | -0.18    | 0.877 | 0.835 (0.886-8.158)   | 0.001   |
|                                   | Motorbike                 | 2.28     | 0.013 | 9.78 (1.629-58.73)    |         |
|                                   | Three wheeler (motor)     | 1.973    | 0.015 | 7.193 (1.469-35.23)   |         |
|                                   | Four-wheeler (small)      | 1.439    | 0.101 | 4.217 (0.756-23.52)   |         |
|                                   | Two/Three wheeler (manual)| 0.1      | 0.918 | 1.105 (0.165-7.406)   |         |
|                                   | Legion                     | 1.371    | 0.128 | 3.939 (0.674-23.014)  |         |
|                                   | Others/Don't know         | 1.787    | 0.068 | 5.972 (0.879-40.59)   |         |
|                                   | Public bus                | Reference|       | -                     | -       |
| Accident type                      | Rear-end collision        | -0.348   | 0.541 | 0.706 (0.232-2.153)   | 0.713   |
|                                   | Side collision            | -0.662   | 0.352 | 0.516 (0.128-2.08)    |         |
|                                   | Head-on collision         | -0.099   | 0.91  | 0.905 (0.16-5.11)     |         |
|                                   | Multiple vehicle pile-up  | -0.1     | 0.904 | 0.905 (0.178-4.601)   |         |
|                                   | Others                    | -0.909   | 0.153 | 0.403 (0.116-1.402)   |         |
|                                   | Single car accident       | reference|       | -                     | -       |
|                                   | Visual fitness of car     | Poor      | 1.358 | 0.013 | 3.887 (1.324-11.413)  | 0.003   |
|                                   | Don't know                | 2.3      | 0.001 | 9.971 (2.444-40.674)  |         |
|                                   | Good                      | reference|       | -                     | -       |
| Road type                          | Simple turning            | 0.982    | 0.034 | 2.67 (1.077-6.62)     | 0.101   |
|                                   | U turn                    | -0.333   | 0.643 | 0.717 (0.176-2.927)   |         |
|                                   | Signal                    | 0.552    | 0.423 | 1.736 (0.45-6.701)    |         |
|                                   | Others                    | 1.766    | 0.04  | 5.847 (1.084-31.532)  |         |
|                                   | Straight road             | Reference|       | -                     | -       |
| Taken to hospital within 1 h      | No                        | 1.496    | 0.002 | 4.081 (1.667-9.992)   | 0.002   |
|                                   | Yes                       | reference|       | -                     | -       |
| Injury time                        | Morning                   | 0.944    | 0.132 | 2.571 (0.753-8.776)   |         |
|                                   | Mid-day                   | 0.276    | 0.634 | 1.318 (0.422-4.116)   | 0.141   |
|                                   | Afternoon                 | 0.243    | 0.615 | 1.275 (0.495-3.28)    |         |
|                                   | Evening                   | -0.334   | 0.548 | 0.716 (0.241-2.13)    |         |
|                                   | Night                     | Reference|       | -                     | -       |
|                                   | After midnight            | 1.276    | 0.128 | 3.581 (0.693-18.494)  |         |
| Death history                      | Yes                       | 0.456    | 0.546 | 1.578 (0.359-6.94)    | 0.414   |
|                                   | Don't know                | 2.127    | 0.042 | 8.389 (1.079-65.2)    | 0.414   |
|                                   | No                        | reference|       | -                     | -       |

P value from likelihood ratio test; p < 0.05 indicates statistically significant [bold].
traffic injury for respondents who “can read and write” was found to be 35.2 times higher than those attained a higher educational level [37]. However, two previous studies on the Ethiopian and south Asian context contradicted our findings as they found no impact of education on injury deaths [39, 40]. Our study also found that motorbike accidents indicate a higher risk of severe injury (AOR = 9.78; 95%CI: 1.629–58.73). This is supported by a previous study that reported that motorcyclists who used >100 cc engine capacity motorcycles had an RTA incidence rate that was significantly higher [41].

One of the key strengths of this study lies in the richness of data and a wide number of factors considered. It allowed the researchers to interview patients injured from various sorts of accidents over a long period which makes our findings more inclusive and generalizable. A comprehensive questionnaire helped us to collect range of data regarding various aspect of road traffic injury. A robust analysis also helped us discover some interesting trends. Furthermore, it has created new avenues for future studies on road traffic injury.

5. Limitations

The study was completed with several limitations. In spite of the availability of various tools for measurement of injury severity, only Injury Severity Score (ISS) was used. We did not include alcohol use related variable though alcohol use is associated with accidents including traumatic brain injury [42]. Furthermore, we were largely dependent on patients/close relatives of the patient regarding the collection of data for various variables which might have produced the probability of social desirability bias to some extent.

6. Conclusions

Our study has several important findings which would be pertinent to policymakers working in the healthcare and transportation sectors. The injury pattern analysis disclosed the nature of common injuries that occurred due to RTA’s in Bangladesh. The study also identified vehicles that are more prone to RTA’s, type of accidents, common road type for injuries, and time in which RTA’s are most common. Additionally, these findings as well as associated factors of injury severity can also be valuable to researchers and practitioners working in urban health, road safety, regional planning, and law enforcement.

Declarations

Author contribution statement
Subarna Roy: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data. Mohammad Delwer Hossain Hawlader, Mohammad Hayatun Nabi and Sanjana Zaman: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data. Promit Ananyo Chakraborty: Performed the experiments; Wrote the paper.
Mohammad Morshad Alam: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement
Data will be made available on request.

Declaration of interests statement
The authors declare no conflict of interest.

Additional information
No additional information is available for this paper.

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