INVESTIGATION OF ROAD ACCIDENT SCENARIO IN CHATTOGRAM CITY

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ABSTRACT

Road traffic accidents are a global concern that is on the rise due to rapid urbanization and population growth, especially in a developing country like Bangladesh. Chattogram is one of the largest cities in Bangladesh, where a growing number of deaths and injuries are apparent. The study aims to investigate the road accident scenario in Chattogram. The study used the data collected from the First Information Record (FIR) filed in different police stations across the city from 2015 to 2019. A total of 335 accidents occurred during the period. Analysis of variances test revealed motorized vehicles are significantly more involved in fatal road accidents than non-motorized vehicles and pedestrians. Buses/minibusses and trucks comprised 65.5% of the accidents that occurred in these years. Microsoft Excel was used to conduct the statistical t-test of the data, which showed that males (42.8 persons per year) were significantly more susceptible to fatalities than females (8.2 persons per year). Staggeringly, 46.3% of the casualties belonged to the age group of 21–35 years. Furthermore, 83.7% of the accidents occurred during working hours. The accident severity index was found to be four times higher for males than for females. The average severity index for Chattogram City was found to be 78.40 per 100 accidents, which is alarmingly higher than that of a similar city such as Kolkata but comparable with the capital of Bangladesh, Dhaka. This finding raises a question on the reliability of using FIR data for accident analysis. The accident fatality risk per lakh was a maximum of 1.5 in 2016 and a minimum of 0.7 in 2017 for the study area. However, there is room for improvement in traffic safety. This paper presents road accident statistics of Chattogram which can be used for sustainable transportation planning in an urban setting.

Keywords: *Accident model, casualty, fatality risk, FIR,* road *accidents.*

1. INTRODUCTION

Since the beginning of human movement, there have been transportation dangers associated with traffic accidents. Road traffic accidents (RTA) have now become a global concern due to the increasing number of deaths and injuries all over the world specifically in developing countries like Bangladesh. Rapid urbanization, population growth, uncontrolled traffic management, the absence of modern traffic monitoring systems, and increased economic activities resulted in an increased number of vehicles which has given rise to several accidents. Currently, road accidents are a global health, economic, and social crisis; it is the 10th leading cause of death in lower-middle-income countries responsible for the death of approximately 1.3 million people and suffering of between 20 to 50 million from non-fatal injuries along with many incurring a disability as a result of their injury (WHO,2023). Also, road traffic accidents cost nations 3% of their yearly gross domestic product (GDP), which has a significant negative effect on their economics (WHO, 2023). In developing nations like Bangladesh, public safety is appalling; it affects social standing and the overall economy. When compared to high-income countries, the death rates from road traffic accidents (RTAs) are more than twice as high in low and middle-income countries, with about 90% of all RTA deaths happening in low and middle-income countries (Uddin & Mizunoya, 2020).

Bangladesh is a densely populated low-lying country with increasing road accidents and corresponding injuries and fatalities. As per police-reported data, more than 3300 individuals lose their lives annually along with a loss of 2% gross domestic product (GDP) even though Bangladesh is the lowest motorized country (motorization level 2.3) in the world. Which makes it the worst fatality case rate scenario in the Asia-Pacific region (Anjuman et al., 2007). On average, road accident is the cause of death of 20 people every day (Islam & Dinar, 2021). From the year 2019-2022, Bangladesh observed approximately 24,639 deaths due to road accidents (Prothom Alo, 2022). But the actual fatality rate is likely to be higher as the official statistics are prone to underreporting (Maniruzzaman & Mitra, 2005). So, the above context indicates that road accidents are now becoming an alarming situation for the road safety situation of Bangladesh. But Bangladesh must decrease the rate of road traffic accidents and injuries to half of the total number as per Sustainable Development Goals (SDGs)-2030 and its GOAL-3.6 (WHO, 2023). Chattogram is the second biggest city, the commercial capital as well as the largest port in the southeast region of Bangladesh. With a population density of 1,497 per square kilometer, the contribution of the Chattogram seaport to the gross domestic product (GDP) is about 12% (LGED, 2023). So far our knowledge, in Chattogram city, till to date, there has been a lack of research works in the detailed spectrum of road accidents to fully understand its effects and develop remedial measures. This work can be used in future road accident research in Chattogram city. A study (Quazi et al., 2005) showed the road traffic accident situation in Khulna city during the year 2001-2002. About 157 accidents occurred during this period in which almost 25% out of the total victims were between the age group of 30 to 39 years. Motorized vehicles like buses and trucks were responsible for about 30% of deaths and non-motorized vehicles like rickshaws were accountable for 19% of deaths. Also, they showed that pedestrians are the worst victims of road traffic accidents.

Mahmud (2011) conducted a study to show the overall scenario of road accident trends in Bangladesh (Mahmud, 2011). In their study, they evaluated and visualized the road accident trends and fatalities for the years 1970 to 2007. With the growth of motorization, population, and road users over time, the number of road accidents and fatalities also increased. From the year 1971 to 2007, the population has almost increased by double, the fatalities from 0.41 to 2.98 and accidents from 1.14 to 3.87 per 100,000 populations respectively. Also, the conducted study showed the decreasing rate of fatalities per 10,000 registered vehicles which were 62 in 1985 to 45 in 2007. Another study (Mahmud Hasan Mamun et al., 2015) evaluated the road traffic accident condition of Rajshahi city for the data of three years (2011-2013). The study 51 accidents in the considered time span and identified six intersections and four midblocks as the most hazardous, where the rate of accident frequency is high. They also showed that among road accident victims 41.67% were in between the age group of 20 to 35 years. Buses (23%) and trucks (26%) are the most responsible vehicles for accidents. Trucks and buses contributed to the death of about 32.56% and 23.26% respectively. Another study (Roy & Chakraborty, 2005) showed the traffic accident characteristics of Kolkata from 1995 to 2000, where the total number of accidents

increased by 24% from 8,895 to 11,306. They found the decreased number of accident deaths by 5.8% from 480 to 452 during the period 1995-2000. They calculated different indices and found an increasing trend in accident risk from 198.88 in 1995 to 241.86 in 2000 which indicated the chances of non-fatal accidents were gradually increasing, making the people of Kolkata more vulnerable.

Although few works have been done in a few cities in South Asia including Bangladesh regarding traffic accident characterization, no such work has been done in the context of Chattogram city. Therefore, the accident situation is particularly important for metropolitan cities like Dhaka, Chattogram, Khulna, and Rajshahi where about 20% of road accidents occurred (Hoque, 1991). So, the primary objectives of this study are to provide information on the characteristics of road traffic accidents (types, distribution) and to calculate different accident indices and compare them with cities like Dhaka and Kolkata.

2. METHODS AND MATERALS

2.1 Study Area

Chattogram is located in the southeast of Bangladesh at 22°13'N-22°27'N and 91°40'E-91°53'E on the banks of the Karnaphuli River and the Bay of Bengal (Mia et al., 2015). Chattogram city consists of an area of 155.04 sq. km. and 7616352 population (BBS, 2022). According to the Bangladesh Road Transport Authority (BRTA), the number of registered vehicles in Chittagong city is about 3,00,000 and those vehicles consisting of 2,099 buses, 1,52,000 motorcycles, and more than 36,000 private cars. There are 1,169 kilo meters of roads in the city, of which 150 kilo meters are main roads as per Chattogram City Corporation (CCC) (The Business Standard, 2023).

2.2 Data Collection

A precise and comprehensive system of documenting and collecting accident data is needed to study the traffic accident and their characteristics in a city as these collected and recorded data helps to put some insight of the causes of accidents and also to suggest possible remedial measures. The road accident data are collected and recorded by Bangladesh police in the form of a First Information Record (FIR). Some other sources of availability of accident data are hospitals and newspaper reporting. In this study, data were collected from the First Information Record (FIR) of thirteen police stations in the city for the period of five years (2015 to 2019). The collected accident data in the study include accident date, time, the number and type of vehicles involved, collision type, accident type, number of deaths, and cost of property damage for each accident during the study year from 2015 to 2019.

2.3 Data Analysis

2.3.1 Two sample T-test

T-test is used to examine the significant difference between the two results. It is a widely used statistical test. Here T-test is applied to distinguish between male and female accident fatality rate. The null hypothesis was that there is no significant difference between male and female accident fatality rate. Alternative hypothesis is that there is significant difference. Null hypothesis will be rejected if P-value of for null hypothesis is less than α which is set to be 0.05 for 95% confidence.

2.3.2 Analysis of Variance (ANOVA)

Analysis of variance is used to test for differences among three or more groups of results. ANOVA test is very popular among road accident researchers. Hunde et al (2015), Gulzar et al (2012), Sikdar et al (2017) and many more researchers used ANOVA as a means of statistical test in their research. Here ANOVA is used with the null hypothesis that the mean fatality rate of pedestrian, motorized, and non-motorized user groups are the same. The alternative hypothesis is that it is not the same. P-value resulting less than α=0.05 will result in the rejection of the null hypothesis indicating a significant difference in different results with at least 95% confidence.

2.3.3 Fisher's Least Significant Difference

Fisher's least significant difference is used to find which group's result differs significantly from other groups after finding there is a significant difference among groups using ANOVA. For groups with certain means and variance, a significant difference between groups can be calculated using the following formula:

$$\mathrm{LSD} = t_{0.025,\mathrm{DF_w}} * \sqrt{\mathrm{MS_w}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)} \quad (1)$$

$t_{0.025,DFw}$ is the t-critical value from the t-distribution table with α=0.025 and DF_w is the degrees of freedom within groups from the ANOVA table. MSW is the mean squares within groups from the ANOVA table. n1 and n2 are the sample sizes of each group. If the difference between any two groups is more than calculated LSD then it can be said to have significant differences between them with 95% confidence.

2.3.4 Trend Analysis

Trend analysis is a way of evaluating the changes in road accidents and identifying trends. It can use different methods, graphical representation, or compare road accident data among different user groups. This study evaluated yearly fatality rate and casualty among different user groups like male and females and different age groups respectively. Also, the involvement of various types of vehicles for the casualties and hourly distribution of those casualties was also evaluated.

2.3.5 Accident Severity Index

Accident severity index represents how deadly the accidents are. It is simply the number of fatalities per hundred accidents. In our study, accident severity index was calculated for the period of 2015 to 2019. Accident severity index is a dimensionless value that indictes the hazardness of a location. Accident severity index was calculated by the following equation:

$$\text{Accident Severity Index} = {\text{No. of Fatalilities} * 100}/{\text{Total Accidents}}$$

A study conducted in Kolkata, calculated the accident severity index for the period of 1995-2002 to show the trend followed the same approach (Roy & Chakraborty, 2005). Also, analyzed data was compared with the calculated index of Dhaka.

2.3.6 Accident Prediction Model

Accident severity index of Kolkata, which is another megacity with similar population density and urban environment is also calculated to be compared with that of Chittagong and Dhaka. To calculate Kolkata's severity index, an accident prediction model was used that was developed by Roy & Chakraborty, (2005).

Total accident model,

$$\frac{C}{N} = 0.003764\left(\frac{N}{P}\right)^{-0.73} \quad (2)$$

Fatality model,

$$\frac{F}{N} = 0.0001025\left(\frac{N}{P}\right)^{-0.998} \quad (3)$$

Where, C is the Total number of accidents, F indicates total number of fatalities, N represents Number of registered vehicles and P is the total population.

2.3.7 Accident Fatality Risk

The accident fatality risk can be defined as the number of people who succumb to death by road accident per 1,00,000 population. In this conducted study, accident fatality risk was calculated and compared with cities like Dhaka and Kolkata.

3. TAFFIC ACCIDENT SITUATION IN CHATTOGRAM CITY

3.1 Overview of Accidents in Chattogram City

Accident-related data were recorded from FIR collected from 13 different police stations across the Chattogram metropolitan area from 2015 to 2019. A total of 335 (see Table 1) accidents were reported during this period. Highest accidents were recorded under the Bandar Police Station. Fisher's least significant difference (LSD) which was 5.07 accidents per year revealed accident are significantly (95% confidence) more prone in area under Bandar Police station with respect to Patenga, EPZ, Sadarghat, Khulshi and Bayezid police stations.

Table 1: Descriptive statistics of total accidents recorded in Chattogram city (2015-2019).

Groups	Years	Total Accidents	Average	Variance
Chadgaon Police station	5	32	6.4	21.3
Khulsi police station	5	18	3.6	10.8
Bayazid Bostami Police Station	5	18	3.6	11.3
Panchlaish Police Station	5	25	5	17.5
Doublemooring Police Station	5	38	7.6	32.3
Pahartali Police Station	5	33	6.6	8.8
Akbar shah Police Station	5	29	5.8	7.7
Halishahar Police Station	5	25	5	4
Kotwali Police Station	5	29	5.8	13.2
Bandar Police Station	5	50	10	55
Patenga Police Station	5	16	3.2	6.7
Epz Police Station	5	13	2.6	14.3
Sadarghat Police Station	5	9	1.8	4.7
	Total=	**335**		

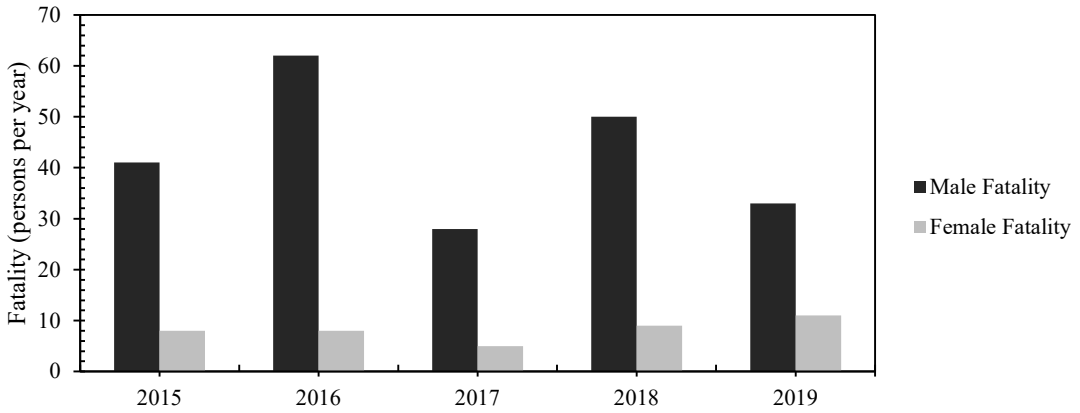

Figure 1: Yearly fatality rate in male and female groups in Chittagong city.

Further analysis of the data showed discrepancies in fatality rate among different demographic groups (as seen in Figure 1). The average fatality rate for males and females were found to be 42.8 and 8.2 per person per year. The significant (p-value =0.0022) difference could be due to significantly more male road users in the city (Sakaki & Shigeyuki, 2018). A similar situation could be seen in Dhaka city where most of the victims were male (Jianxin et al., 2021). Age-wise casualty distribution (see Table 2) reveals a staggering 46.3% of victims are aged 21-35 years. After young adults, people aged 36-50 are most prone to accidents in Chittagong city. This result indicated working class people are more succumb to accidents as they are the most active road users daily. Children less than 10 years of age face the least

accidents as they are most of the time accompanied by guardians on the road. Also, few casualties were reported for people older than 50 and between 10 and 20. This could be due to the low user number of this age group in the road.

Table 2: Age-wise casualties during 2015-2019 in Chattogram city recorded as found in FIR report.

Age	Fatality	Injury	Total	Casualty
<10	14	9	23	5.2%
10 -20	23	30	53	12.0%
21-35	117	87	204	46.3%
36-50	61	45	106	24.0%
>50	40	15	55	12.5%

ANOVA test of the fatalities in pedestrian, non-motorized vehicle (NMV) and motorized vehicle (MV) users indicate significant (see Table 3) difference in their mean fatality rate. Highest fatalities were observed with the accidents involving motorized vehicles (average 43 persons per year).

Table 3: Analysis of variances of fatalities among pedestrian, NMV and MV user groups.

Groups	Periods (years)	Sum	Average (per year)	Variance
Pedestrian	5	147	29.4	40.3
NMV	5	111	22.2	17.2
MV	5	215	43	179.5

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	1115.73	2	557.87	7.06	0.009	3.885
Within Groups	948	12	79			
Total	**2063.73**	**14**				

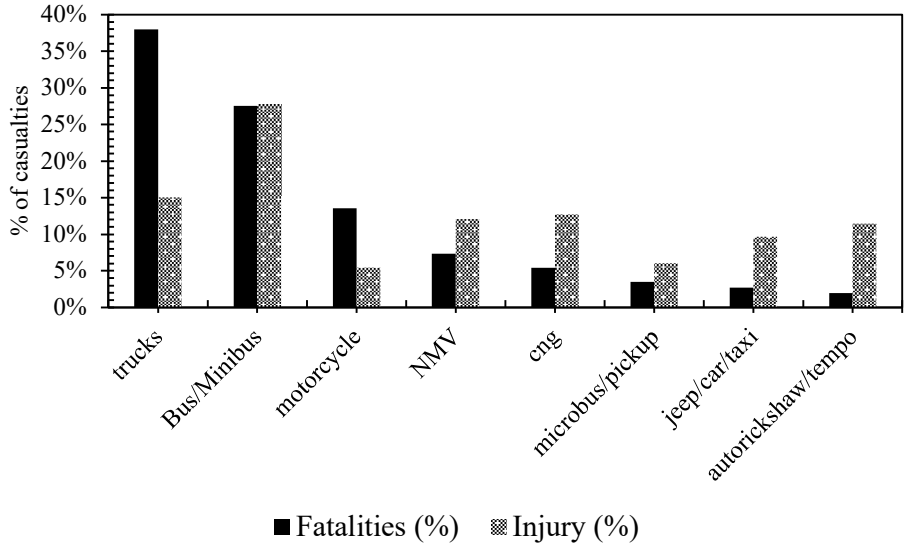

Figure 2: Proportion of vehicles involved in casualty in traffic roads in Chattogram city.

During these 5 years, a total of 258 fatalities and 166 injuries were reported in the FIR across the city. Casualty distribution with involved vehicles indicates trucks are responsible for most fatal accidents in the city (see Figure 2) with 38% of total fatalities closely followed by buses with 27.5% of total fatalities

and motorcycles with 13.6%. NMVs like rickshaws and cycles, CNG, microbus/pickup, car, and tempo constitute the rest. Accidents involving trucks and motorcycles resulted in higher fatalities but for bus/ minibus number of fatalities and injuries was similar. For other modes, the risk of injury is higher than fatality as Figure 2 shows higher injuries than death in such cases.

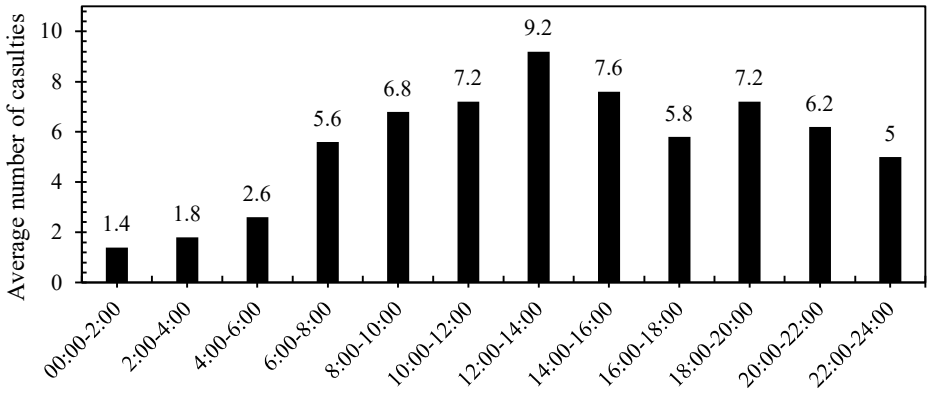

Figure 3: Hourly casualty distribution recorded in Chattogram city.

The casualty pattern (as seen in Figure 3) of Chattogram city closely follows daily profile of traffic volume in Chattogram city. As Chattogram city does not show typical AM/PM peak of traffic flow (Sakaki & Shigeyuki, 2018) indicating a busy road throughout the whole day, accidents related casualties does not show significant peak from morning till night. Although, peak casualty rate of 9.2 was observed during 12 PM – 2 PM, it cannot be said to be significantly higher than casualty rate observed during 6 AM to 10 PM. ANOVA test indicate significant difference in means but further exploration with Fisher's Least Significant Difference (which was calculated to be 3.74 casualties for 95% confidence interval) test reveals that this difference in only between midnight (10 PM-6 AM) and the rest (6AM -10 PM).

3.2 Accident Severity Index

Table 4 contains the calculated accident severity index for Chattogram city for the period of 2015 to 2019. The index increased from 72.06 to 91.67 from 2015 to 2016 but suddenly dropped in 2018 and started increasing again the following year. Severity index for Dhaka city is also shown in Table 4 for comparison. Dhaka city has a slightly lower average accident severity index, but this is insignificant (p value= 0.205) if variance is considered. Although this index decreased by 6.8% in Dhaka, the index rose 5.23% in 2019 from 2015 for Chattogram city.

Table 4: Accident severity index for Chattogram city.

Year	Number of fatalities	Total Accidents	Accident Severity Index for Chattogram	Accident severity index for Dhaka*
2015	49	68	72.06	73.59
2016	70	82	85.37	72.39
2017	33	36	91.67	69.66
2018	59	88	67.05	71.43
2019	44	58	75.86	68.55
	Average		**78.40**	**71.13**

***Accident severity index for Dhaka was calculated from data presented by Jianxin et al., (2021).**

Figure 4 shows how severely different genders are affected by road accidents. In figure 4, the accident severity curve for males is almost 5 times larger than for female counterparts (The average severity

index for males is 65.48 and females is 12.92). It indicates risk of a male road user dying in an accident in Chattogram city is 5 times greater than female road user.

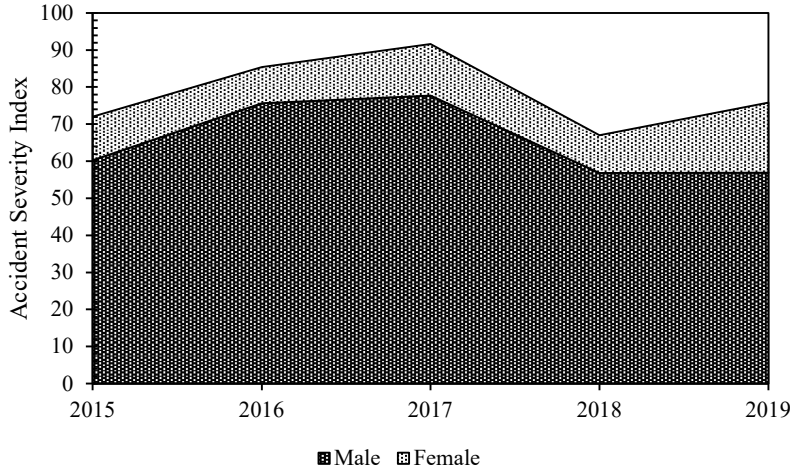

Figure 4: Accident severity index of Chattogram city (Severity of male + Severity of female).

Accident severity index of Kolkata, which is another megacity with similar population density and urban environment is also calculated to be compare with that of Chattogram and Dhaka. Using the equations (2) and (3) number of accidents and fatalities were found to be 24460 and 1478 respectively for Kolkata using the population and registered vehicle data of 2016. And the accident severity index for that year was calculated to be 6.04 which is consistent with the indexes shown in the study (Roy & Chakraborty, 2005). Unfortunately, the severity index for Chattogram is alarmingly higher than that of Kolkata despite the number of fatalities being lower. It indicates that accidents in Chattogram are deadlier than in Kolkata which is unlikely. The unnatural high index of Chattogram could be due to the underrepresentation of actual accident numbers. An FIR is reported when police are informed of an accident or an accident that caused a huge disruption in traffic flow or insurance is claimed. As a result, there could be a massive number of accidents being unreported to police especially which does not involve severe injury or property damage. So, fatality to accident ratio is seen dangerously higher in FIR data.

3.3 Accident Fatality Risk

Figure 5 represents trend of accident fatality risk of Dhaka and Chattogram city. The accident fatality risk in Chattogram city was determined from FIR data and for Dhaka city, it was calculated from the data represented found the study of Jianxin et al., (2021).

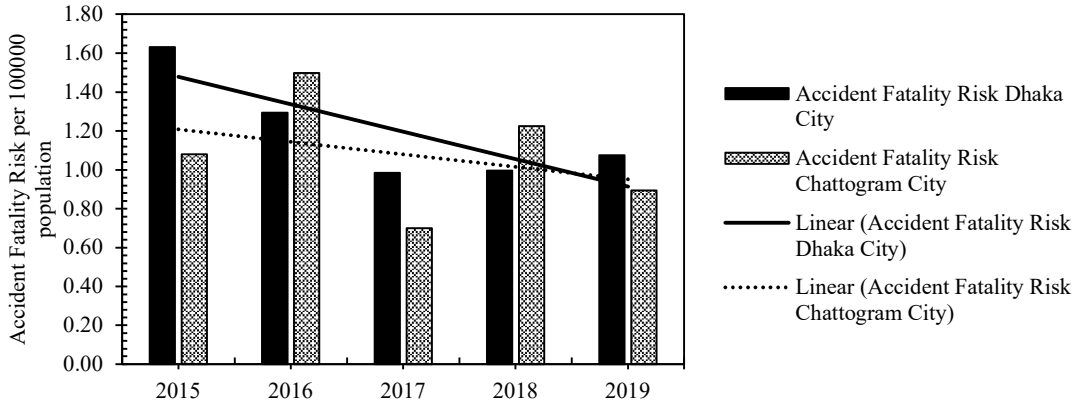

Figure 5: Accident fatality risk trend in Chattogram city.

The accident fatality risk shows a downward trend both in Chattogram and Dhaka. But, in Chattogram the risk is decreasing slower. Again, comparing the average accident fatality risk of Chattogram with Kolkata shows enormous discrepancies. The fatality risk in Chattogram was 1.5 and for Kolkata, it was calculated using equations (2) and (3) and the population of Kolkata in 2016 to be 10.18 per 1,00,000 population which is ten (10) times higher than that of Chattogram. It indicates that Chattogram is a safer city than Kolkata where the probability of death related to road accidents is 10 times less likely. Further study is required to describe the discrepancies observed in the fatality risk.

4. CONCLUSIONS

This study is conducted on road traffic accidents trend in Chattogram, Bangladesh using the FIR data collected from police stations in the city from 2015-2019. It revealed some alarming findings such as trucks and buses were the major accident causing elements involving highest fatalities, males are more susceptible to fatalities than females especially those in the age group of 21-35, accident severity index in Chattogram city is suspiciously higher than Kolkata but comparable with Dhaka, accident fatality risk for Chattogram city is decreasing in much lower rate than Dhaka and it is significantly lower than Kolkata making it a safer place than Kolkata. This study underscores the pressing need for targeted interventions and sustainable transportation planning in rapidly urbanizing regions. The alarming findings, such as higher fatality risks for males and a significantly elevated accident severity index, emphasize the urgency of implementing effective safety measures to mitigate the growing impact of road accidents on public health and urban development. With urgency in mind the authors recommend improving traffic management and monitoring systems, strictly enforcing traffic rules and regulations, raising public awareness and education about traffic accidents, and developing sustainable transportation planning to improve the current situation of road traffic accidents.

Limitations like solely depending on the FIR data could result in biasness toward showing excess severity in road accidents. Because FIR is prone to underreporting, people facing minor accidents tend to avoid reporting to police as a result only severe cases of accidents gets reported. A study also suggested the same and concluded that non-fatal types of injuries are under-reported, and one accident out of 125 that occurred is reported to the police (BRAC, 2004). Therefore, using only FIR data could result in a high severity index, as can be seen in this case. With limitations in mind the authors suggest that some future studies should be undertaken to investigate the possible causes of involvement of trucks and buses in road accidents to find suitable remedial measures using alternative data source. Bangladesh is a developing country with gradually growing urban population and the nation suffers from deaths, injuries and damages due to road traffic accident. The findings of this study can be a door for future research options and could have significant implications for safety measures and policy formulations.

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