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Factors Associated with Human-Controlled Motor Vehicle Fatal Crashes in Urban Area Using Fatality Ratio

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Abstract

Motor vehicle collisions (MVCs) remain a significant public health concern worldwide. This study analysed motor vehicle crashes in Tema-Ghana, focusing on factors associated with fatal crashes. Data extracted from road crash reports of the Driver Vehicle and Licensing Authority (DVLA) of Ghana from 2017-2020 were used. In total, 925 reports were found appropriate for the study. Descriptive statistics, correlation, and cross-tabulation analyses were conducted. The fatality ratio was further developed to investigate factors more likely to cause fatal crashes. The results showed that, in general, age, wrong overtaking, speeding, failure to yield right of way, and crash location had a statistically significant relationship with fatality. Furthermore, teenagers, unlicensed drivers, wrong overtaking, speeding, outside intersection areas, and uncontrolled intersections were factors that contributed to fatal crashes within the urban area. It was also found that males were more likely to be involved in fatal crashes than females. Several measures are outlined to address road crashes and fatality issues within urban areas.

1. Introduction

From the socio-economic development and public health perspective, road traffic crashes in Ghana and worldwide are a major problem. Just like any other country, Ghana has lost several lives through road crashes. Road traffic crashes in Ghana affect economic growth negatively [1]. As reported by the World Health Organization (WHO), about 1.3 million persons die each year in traffic crashes [2]. The trend in road crashes in Ghana shows no reduction, and the number of fatalities and injuries keeps escalating. The study of Avuglah, Adu-Poku and Harris [3] used the Autoregressive Integrated Moving Average (ARIMA) model and predicted that road crashes in Ghana will continue to increase. Another study by Damsere-Derry, Palk and King [4] indicates that the fatalities and deaths from road crashes in Ghana are on the rise, with males as riders/drivers more likely to die from fatal crashes. The most worrying issue threatening the sustainable development of Ghana is that the majority of people involved in fatal crashes and injuries are those in the active working group. For example, Hesse and Ofosu [5] found that 62% or more of road crash fatalities in Ghana occurred among people under 35. It has also been noted that out of every 72 persons who sustain serious injury relating to road traffic crashes in Ghana, at least 8 of them die [6]. It is estimated that, on average, about US$1687.60 in costs (direct and indirect) are spent by Ghanaian households on severe injuries sustained from road crashes yearly [6].

Studies have identified different factors that contribute to road crashes nationally and internationally. One major cause of traffic crashes that has recently received attention is related to driver behaviours [7]. Retallack and Ostendorf [8] studied the relationship between traffic congestion and road crashes at intersections and found a direct relationship between traffic volume and crash frequency, with higher volumes leading to an exponential increase in crashes. This is worsened when coupled with localised rainfall patterns. The impatience of drivers on the road, their distraction by attending to a co-vehicle occupant or operation of an in-car functionality compromises vehicle safety, thus contributing to crashes. Along this line, [9] developed a model where a fully autonomous car is encouraged to avoid crashes and liabilities passed onto the manufacturers, thereby eliminating the negligence of human drivers.

Humans may be largely accountable for the increasing number of road traffic crashes. However, failures of some mechanical systems in the vehicle could also result in crashes leading to fatalities, as indicated by the work of Oduro [10]. Road factors and human factors were found to impact road crashes significantly [11, 12].

Some believe that despite the numerous burdens' road crashes place on Ghana, the current research on road crashes is relatively low [13]. Even those that were conducted focused on rural at either the national or regional levels but failed to analyse crashes in urban cities with high population densities and extensive road networks, which present a complex environment for motor vehicle operations. For example, Ackaah, and Adonteng [14] studied fatal crashes in Ghana and found that a greater proportion of these crashes occurred in non-urban areas and mainly on highways.

Within urban settings, human-controlled motor vehicle crashes are a significant public safety concern due to the potential for severe injuries and fatalities. This study employed a fatality ratio, which can be defined as the number of fatalities relative to the total number of crashes, to assess the risk factors associated with the fatality of motor vehicle crashes. Exploring factors contributing to high fatality in urban motor vehicle crashes will enable policymakers, urban planners, and road safety stakeholders to understand the severity of crashes and develop targeted interventions aimed at reducing fatalities.

2. Literature Review

Motor vehicle collisions (MVCs) remain a significant public health concern worldwide, particularly in urban areas. These present unique challenges for traffic safety due to the high density of vehicles, non-motorized road users (pedestrians, cyclists), complex road networks, and various traffic control measures. Fatalities in urban motor vehicle collisions are influenced by various factors, including driver demographic factors, the crash's location, and the collision's underlying causes.

Driver demographic factors have been shown to influence crash fatality. Studies have found that male drivers are more likely to be involved in fatal crashes due to higher tendencies for risk-taking behaviours such as speeding and aggressive driving [15-17], resulting in higher fatalities among male drivers in urban collisions. Studies have also indicated that younger drivers (under 25) and older drivers (over 65) have higher fatality rates in crashes [18, 19]. For instance, Mayhew et al. [18] found that younger drivers' lack of experience and older drivers reduced physical capabilities contribute to higher fatality rates in urban crashes. Additionally, the type of driver's licence can also influence crash outcomes. Drivers with commercial licences generally have a lower record of fatality due to better training and stricter regulations [20]. Conversely, non-commercial drivers, particularly those with a restricted licence, show a higher risk of fatality. Masten and Peck [21] demonstrated that comprehensive driver training and licensing regulations could mitigate fatality risks in urban crashes.

The type of road segment, controlled, uncontrolled, and without intersections, can significantly influence the fatality rate. Controlled intersections, equipped with traffic signs to manage traffic flow and reduce collisions, are designed for safety. However, studies indicate that while these intersections decrease crash frequency [22], the severity of crashes can be high, particularly when traffic rules are disregarded and high-speed impacts occur [23, 24]. Abdel-Aty et al. [23] found that intersections with signals had lower overall crash rates but higher fatality rates during red-light violations. In contrast, uncontrolled intersections lack traffic signs and rely on driver judgment [25]. A study by Adanu et al. [26] suggests that these intersections experience higher crash rates due to ambiguity in the right-of-way, leading to increased fatalities. This ambiguity can result in severe collisions as drivers misinterpret the intentions of others on the road. Furthermore, crashes on straight road segments without intersections often result from factors such as speeding or driver inattention [26, 27]. For example, Chen and Chen's [27] study demonstrated that fatal crashes on these segments frequently involve high-speed impacts and limited driver reaction time, contributing to higher fatality rates compared to intersections.

There are considerable numbers of inappropriate driving behaviours on roads that serve as underlying causes of crashes, impacting the fatalities outcome. Among these behaviours are speeding, wrong overtaking, and failing to yield the right of way. According to a previous study, speeding and wrong overtaking determine the severity of crashes [7]. The National Highway Traffic Safety Administration [28] reports that speeding increases the likelihood of a crash and the fatality rate in urban crashes where speed limits are frequently exceeded. Wrong overtaking, especially in urban areas with dense traffic, could lead to head-on or side-impact collisions [29]. According to a report by the World Health Organization [2], wrong overtaking is a prevalent cause of fatal crashes, particularly on urban roads where space and visibility are often restricted.

Furthermore, a study has indicated that failure to yield the right of way is a common cause of urban crashes, particularly at intersections [30]. Zajac and Ivan [30] noted that such crashes often occur at controlled intersections, resulting in severe side-impact collisions with a high fatality risk. Along the same line, a factor affecting fatality is the mechanical failures of a vehicle on urban roads. A report by the Federal Motor Carrier Safety Administration [31] shows that faulty brakes, tyre blowouts, and steering issues can lead to uncontrollable vehicles, resulting in severe crashes with high fatalities, especially in densely populated urban areas.

Although studies on urban areas have gained popularity nationally, factors related to fatalities in the context of urban areas have received minimal attention in the available literature, especially in Ghana. Therefore, the study used a fatality ratio to understand the underlying factors influencing fatal crashes in an urban city in Ghana.

3. Materials and Methods

This study was conducted in the Greater Accra Region of Ghana, specifically in the Tema Metropolis. Tema is an industrial hub of Ghana, and it has significant economic activities due to the presence of industries and an international seaport. The Metropolis is a fully urbanised area with a total population of 285,139 and 70,797 households. Out of the total population, 72.0 % are aged 15 years and above and are economically active, of which 90.4% are employed [32].

The data for this study was collected from a road crash report written by technical officers from the Driver Vehicle and Licensing Authority (DVLA) of Ghana. In total, 1,157 road crash reports were received and coded; out of the total number, 925 were suitable for this study. A crash report was considered suitable for the study if all the necessary information was recorded. Therefore, a report form that did not capture the gender, age, primary cause, and location of the crash was eliminated from the study. The crash reports available were written for the period of 2017-2020. Information such as driver's age, gender, class of licence, location of the crash, and cause of the crash was obtained from the crash report form and used as independent variables. Additionally, crash fatality recorded on each report document was extracted and treated as a dependent variable.

The data extracted from the crash report forms were coded and computed into IBM SPSS version 25 for statistical analysis. An assumption test was conducted by subjecting the dataset to linearity, normality, and multicollinearity checks. Descriptive statistical correlation (to determine the strength and direction of the linear relationship between the variables) and cross-tabulation analyses were conducted. Furthermore, we developed a fatality ratio to investigate factors that contributed to road crash fatality within urban area.

3.1. Calculation of Fatality Ratio

Cross-tabulation analysis was first conducted to examine the relationship between road crash fatality and other variables to calculate the fatality ratio. Having established the relationship between the variables, the next step was to apply the formula in Equation. 1 to calculate the fatality ratio using Microsoft Excel. This ratio determines how individual items in each variable contributed to the fatality of road crashes. Therefore, the fatality ratio was defined as the proportion of fatal crashes to the total number of crashes under the individual item of a variable.

$$Fr = \frac{FVi}{Tni},$$

where, Fr, is the fatality ratio, FVi, is the number of drivers involved in fatal crashes and Tni, is the total number of drivers involved in crashes under a particular variable item

4. Results and Discussions

4.1 Reliability and Assumption Test

For the purpose of reliability, an assumption test was carried out on the dataset. A collinearity test was conducted to investigate the existence of multicollinearity. Variance inflation factors (VIF) and tolerance were used to measure multicollinearity. The assumption test results (Table 1) indicate that the maximum value of VIF is 1.416, and the minimum tolerance is 0.706, which falls within the acceptable cut-off. According to Garson [33], if the maximum value of VIF does not exceed ten or the minimum tolerance value is not less than 0.10, there is no multicollinearity problem. Based on the cut-off value for both VIF and tolerance, it was concluded that there is no problem with multicollinearity, as all the values of each independent variable were within the acceptable limit.

Furthermore, the normal distribution of residual and the presence of outliers were investigated using standard residual and Crook's distance. The results show that the residuals were normally distributed (-3.222 to 1.807, and a mean of 0.014) when the cut-off value of -3 to 3 is considered. Also, Crook's distance ranging from 0.000 to 0.027 indicates no outliers exist. The rule of thumb is that if Crook's distance is more than 1, then there are outliers that can influence the result of any regression models [34].

Table 1. Assumption test results

Variables	Tolerance	VIF	
Gender	0.944	1.059	
Age	0.908	1.102	
Class of license	0.904	1.106	
Causes of crash	0.721	1.388	
Location of accident	0.706	1.416	
	Minimum	**Maximum**	**Mean**
Cook's distance	0.000	0.027	0.001
Std. residual	-3.222	1.807	0.014

4.2. Descriptive Analysis of Demographic, Vehicle Characteristics and Crash Variables

As indicated in Figure 1, a total of 925 crashes recorded from 2017 to 2020 were analysed. In 2017, 194 drivers (21%) were involved in a crash, while 215 (23.2%), 232 (25.1%) and 285 (30.7%) were involved in a crash in 2018, 2019 and 2020 respectively. It can be seen that the number of crashes increased each year. This result is congruent with the work of [35].

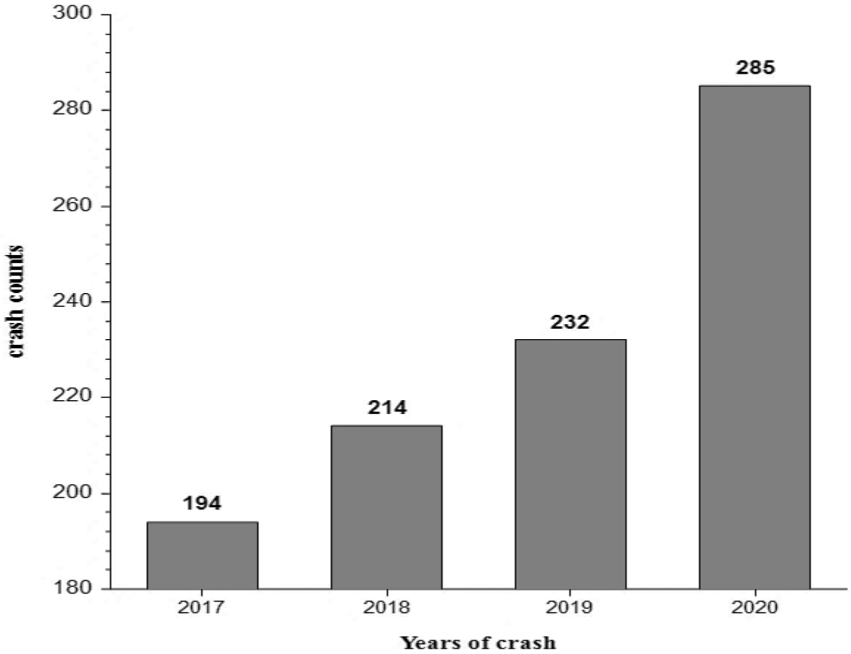

Figure 1. Crash counts

Table 2. Descriptive analysis of demographic characteristics of drivers

Variables	Items	Frequency	Percentages (%)
Gender	Male	864	93.4
	Female	61	6.6
Age	Below 20 years	36	3.9
	20-30 years	211	22.8
	31-40 years	303	32.8
	41-50 years	232	25.1
	51-60 years	111	12
	Above 60 years	32	3.5
Class of license	B	404	43.7
	C	188	20.3
	D	133	14.4
	F	75	8.1
	Not Licensed	125	13.5

Table 2 shows the demographic characteristics of drivers involved in crashes. According to the data, 93.4% of the drivers involved in crashes are male, while only 6.6% are female. 32.8% were between the ages of 31 and 40 years as the maximum percentage, while 3.5%, the minimum percentage, were above 60 years. The majority (43.7%) hold licence B while 8.1%, the minimum percentage, hold license F. Drivers without licence amount to 13.5% of the total sample size.

The results presented in Table 3 highlight key characteristics of motor vehicle crashes in urban areas. Notably, 61.7% of crashes occurred at uncontrolled intersections (road intersections without traffic regulation signs or devices to control traffic movement), 20.6% on straight roads, and 17.6% at controlled intersections (road intersections where traffic signs and devices control traffic movement). The primary cause of these crashes was the failure of drivers to give way, accounting for 58.5%. Other significant causes included speeding (18.6%), mechanical failure (13.6%), and wrong overtaking (9.3%). Regarding outcomes, 14.1% of crashes were fatal, whereas 85.9% were non-fatal.

Table 3. Descriptive analysis of crash variables

Variables	Items	Frequency	Percentages (%)
Crash location	Uncontrolled intersections	571	61.7
	Controlled intersections	163	17.6
	Outside intersection	191	20.6
Cause of crash	Speeding	172	18.6
	Failure to yield right way	541	58.5
	Mechanical failure	126	13.6
	Wrong overtaking	86	9.3
Fatalities	Fatal crash	130	14.1
	Non-fatal crash	795	85.9

4.3 Chi-square Analysis on Fatality, Demographic Characteristics, Cause, and Crash Location

A cross-tabulation analysis at a confidence level of 95% was conducted to determine the relationship between fatalities, demographic characteristics, cause, and crash location. The following null (HO) and alternate (*H1*) hypotheses were tested using Pearson's Chi-square ($\chi 2$):

Ho: The crash fatality and age, gender, class of licence, cause of the crashes, and the crash location are independent of each other.

H1: The null hypothesis is false.

Considering the 0.05 level of significance and the chi-square critical value of 3.84 matching the smallest degree of freedom (1) of the dataset, a judgment can be made as to whether to reject or reject the null hypothesis. The decision rule, therefore, is: Reject H0 if $\chi 2 \geq 3.84$. The results (Table 4) showed that the chi-square value estimated for gender is smaller than the critical chi-square value, revealing no statistically significant relationship between gender and crash fatality. Based on this result, the null hypothesis stating that fatality and gender are independent of each other is not rejected. However, the chi-square value estimated for the rest of the variables (age, class of licence, cause of crashes, and crash location) was higher than the critical chi-square value. This indicates that age, class of licence, causes of crashes, crash location, and crash fatality are dependent on each other and are significantly associated. Hence, the null hypothesis for these relationships was rejected. These results suggest that these risk factors are critical in influencing fatal outcomes.

Table 4. Cross-tabulation analysis on the relationship between fatality and demography, causes, and crash location

Variables		Fatal	Non- fatal	Total	Chi-Square	Sig(2-sided)	H0 Rejected?
Age	>20 years	15	21	36	100.839	0.000	Yes
	20-30 years	64	147	211			
	31-40 years	34	269	303			
	41-50 years	12`	220	232			
	51-60 years	10	101	111			
	<60 years	0	32	32			
Gender	Male	124	740	864	.962	0.327	no
	Female	6	55	61			
Class of Licence	B	63	341	404	19.082	0.001	yes
	C	22	166	188			
	D	7	126	133			
	F	9	66	75			
	Not Licensed	29	96	125			
Causes of crash	Speeding	50	122	172	91.801	0.000	yes
	Failure to yield the right way	42	499	541			
	Mechanical failure	7	119	126			
	Wrong overtaking	31	55	86			
Crash Location	Uncontrolled	59	512	571	57.411	0.000	yes
	Controlled	12	151	163			
	Outside intersection	59	132	191			

4.4. Correlation Between Fatality, Demographic and Crash Factors

The strength and direction of the linear relationship between fatality and demographic characteristics of drivers, vehicle factors as well as crash factors were explored using Pearson correlation analysis (Tab.5). It was observed that fatality positively correlated with age of the drivers ($r=0.297$, $p> 0.01$) and age of the vehicle ($r=0.079$, $p> 0.05$), but negatively correlated with crash location ($r=-0.233$, $p> 0.01$). This means that fatality decreases with a crash location. Further, it was noticed that fatality had no significant relationship with gender, class of license, and causes of crash. This result supports the findings of [35], who found no correlation between sex, class of license, and crash involvement.

Table 5. Results of correlation between variables

Variables	Gender	Age	Class of licence	Age of vehicle	Crash location	Causes of crash	Fatality
Age of vehicle	0.059	.117**	-0.061	1			
Crash location	0.037	-.115**	-0.058	-.069*	1		
Causes of crash	0.004	.162**	0.01	.169**	.424**	1	
Fatality	0.032	.297**	-0.029	.079*	-.233**	-0.005	1

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

4.5. Fatality Ratio Analysis

To determine the frequency of fatal and non-fatal crashes in individual items in each variable, a cross-tabulation test was conducted between fatalities, demographic characteristics of drivers, causes of the crash and location of the crash. Having undertaken the cross-tabulation test, the total number of drivers involved in fatal and non-fatal crashes was obtained for each variable item. For example, the individual items for the age variable are drivers under 20 years, 20-30, 30-40, 41-50, 51-60, and above 60 years. Applying Equation 1, as explained earlier, we calculated the fatality ratio to determine the individual items involved in fatal crashes compared to others. Thus, the fatality ratio is the proportion of fatal crashes to the total number of crashes under the individual item.

Table 6. Analysis of the fatality ratio of individual items in each variable

Variables	Individual items	Fatal	Non- fatal	Total	Fatality Ratio
Age	>20years	15	21	36	0.417
	20-30 years	64	147	211	0.303
	31-40 years	34	269	303	0.112
	41-50 years	12`	220	232	0.052
	51-60 years	10	101	111	0.090
	<60 years	0	32	32	0.000
Gender	Male	124	740	864	0.144
	Female	6	55	61	0.098
Class of License	B	63	341	404	0.156
	C	22	166	188	0.117
	D	7	126	133	0.053
	F	9	66	75	0.120
	Unlicensed	29	96	125	0.232
Causes of crash	Speeding	50	122	172	0.291
	Failure to yield right way	42	499	541	0.078
	Mechanical failure	7	119	126	0.056
	Wrong overtaking	31	55	86	0.360
Location of crash	Uncontrolled intersection	59	512	571	0.103
	Controlled intersection	12	151	163	0.074
	Outside intersection	59	132	191	0.309

The results, as shown in Table 6, revealed that for the age variable, drivers under the age of 20 years (0.417) were more involved in fatal crashes than any other age group, followed by drivers 20-30 years old. It was also observed that older drivers (<60 years) are less likely to be involved in fatal crashes. For the gender variable, males are involved in fatal crashes at a higher rate (0.144) compared to females (0.098).

It was further noted that unlicensed drivers (0.232) were more involved in fatal crashes than licensed drivers. Among licensed drivers, those holding Category B licenses (0.156) and Category F licenses (0.120) were more frequently involved in fatal crashes than those holding other types of licenses. Again, the causes of the crash variable were investigated, and the result revealed that wrongful overtaking (0.360) represents the highest ratio of drivers involved in fatal crashes, followed by speeding (0.291). Finally, the section of the road (location of the accident) in the urban areas where a crash is likely to be fatal was assessed. The result showed that crashes at no intersection (0.309) areas are more fatal than crashes at uncontrolled (0.103) and controlled (0.074) intersections.

5. Discussion

This study explores risk factors associated with fatalities in human-controlled motor vehicle crashes on urban roads. The descriptive analysis revealed an annual increase in road crashes from 2017 to 2020, which is consistent with studies predicting an increase in road traffic crashes over the years [2, 3, 35]. The results further indicate that 32.8% of drivers involved in crashes fall within the age range of 31 to 40 years, supporting findings by [19, 36]. This age group, often in their prime driving years, engages in regular commuting for work and personal activities, increasing their exposure to traffic risks. Their mix of confidence and risk-taking behaviours may also contribute to higher crash involvement.

Notably, while most drivers held license B, which is the minimum class of driving license required to drive a four-wheeled motor vehicle in Ghana, 14% of drivers involved in crashes were unlicensed. Most crashes occurred at uncontrolled intersections due to drivers' failure to give way. This aligns with findings from previous studies [7, 14, 37], indicating that most road traffic crashes in Ghana could be associated with drivers not comprehending the meaning of ‘give way’ signs and unwilling to yield the right of way to oncoming vehicles. High traffic density and frequent interactions between vehicles and pedestrians worsen the issue in urban settings. The failure to yield the right of way indicates a significant problem with driver behaviour and compliance with traffic laws, leading to higher collision rates and more severe outcomes.

The correlation between fatality, demographics, and crash factors suggests that as the age of the driver increases, the likelihood of a fatal crash also increases. Older drivers generally have more experience, which can lead to safer driving behaviours. However, as people age, physical changes such as decreased vision, slower reaction times, and reduced flexibility can affect driving abilities, especially in complex urban areas. Increased weakness makes older drivers more vulnerable to fatal crash injuries [38]. Additionally, older vehicles are more likely to be involved in fatal crashes due to a lack of advanced airbags, stability control crash avoidance technologies, and potential maintenance issues [39]. The study also found that certain crash locations are less likely to result in fatalities. Urban areas with lower speed limits and better traffic control measures might be contributing factors.

The analysis of the fatality ratio revealed some interesting findings. Among the age groups, the less than twenty-year-old group (>20 years) was more involved in a fatal crash than other age groups, suggesting that young drivers, particularly teenagers, are disproportionately involved in fatal crashes compared to their older counterparts. Younger drivers generally have less driving experience, which can impair their ability to react appropriately in hazardous situations. Their limited experience possibly results in poorer judgment and decision-making during critical moments, leading to a higher likelihood of a fatal outcome. Additionally, younger drivers are often prone to risky behaviours [38]. These behaviours may have contributed to the increasing probability of fatal outcomes in the event of a crash. Moreover, young drivers tend to overestimate their driving skills and underestimate the dangers on the road, further aggravating their risk.

Following teenage drivers, the next most affected age group comprises drivers aged 20-30. While this group is generally more experienced than teenagers, the persistence of a relatively high fatality ratio suggests that young adults may still engage in risk-taking behaviours. This age group is also in a transitional life stage, often balancing responsibilities such as work, education, and social activities. This can lead to fatigue and stress, adversely affecting their driving performance.

The elderly (above 60 years) were less likely to be involved in a fatal crash. In general, fatality reduces as the age of a driver increases. A study has demonstrated that older drivers are experienced and mature [40]. They often avoid risky manoeuvres and drive in less challenging conditions. These qualities may contribute to better judgment and decision-making on the road, which will likely contribute to less fatality on urban roads. Additionally, older drivers might drive less frequently and for shorter distances than younger drivers, reducing their exposure to hazardous driving situations.

The results further show that male drivers are involved in fatal crashes at a higher rate than females. This difference may reflect behavioural and societal factors. Research indicates that male drivers often exhibit risky driving behaviours compared to females [15]. Additionally, males tend to drive more miles on average than females, particularly in professions involving extensive driving. Greater exposure to road environments naturally increases the likelihood of crash involvement [15]. Such behaviours and increased exposure to driving activity raise the probability of being involved in crashes, which may explain the higher percentage of male drivers in the crash data.

With the right training, drivers learn to drive motor vehicles more safely, although few studies argue that there is no correlation between drivers who attended driving school and road crashes. However, learning to drive through either apprentice training or driving school provides drivers with knowledge of traffic regulations that can guarantee a certain level of safety on the road. Passing a driving test to acquire a driving license indicates that the driver has demonstrated adequate knowledge of road signs, markings, and traffic regulations to protect life and properties. Such a driver, under normal circumstances, holding any class of license, should drive in a safer manner than unlicensed drivers. This is evident from the results, as unlicensed drivers are more likely to be involved in severe or fatal crashes than their licensed counterparts. This result could be attributed to the fact that unlicensed drivers typically lack formal driving education and training, leading to poorer driving skills and less awareness of traffic laws and safe driving practices. The results further show significant variances in crash involvement based on the license type, even within the licensed driver population. Driving licenses B and F were more frequently involved in fatal crashes than drivers holding other licenses. Category B license holders are typically permitted to operate commercial vehicles such as taxis, which include a wide range of drivers with varying experience levels. These categories of drivers, who form the majority of drivers on the road, navigate complex urban traffic conditions, which involve frequent interactions with pedestrians, cyclists, and other vehicles, naturally increasing their involvement in crashes. Similarly, drivers with license F usually operate articulators and higher occupancy buses, and driving this type of vehicle in urban areas becomes cumbersome, making them more dangerous in crashes.

The analysis of crash causes revealed wrongful overtaking and speeding as primary driving behaviours significantly contributing to fatal motor vehicle crashes in urban areas. This suggests that wrongful overtaking is particularly dangerous in urban environments, where traffic density and complex road interactions make such driving behaviour highly risky. In urban settings, wrong overtaking can easily lead to head-on collisions or side-impact crashes, both of which have a high potential for fatalities due to the direct force of impact and limited reaction time for both overtaking and overtaken vehicles. Likewise, in an urban area, where pedestrian activity, traffic signals, and crosswalks are prevalent, speeding is likely to increase fatality rates for both motorists and non-motorists. This could be attributed to speeding, reducing the driver's ability to react to sudden changes in traffic conditions, increasing the stopping distance, and magnifying the impact force in the event of a collision.

Further, the analysis reveals a significant variance based on the location of the crash. It was observed that crashes occurring in non-intersection areas have a fatality ratio, which is substantially higher than crashes at uncontrolled intersections and controlled intersections. Unlike intersections, non-intersection areas may lack traffic control devices (e.g., stop signs, traffic lights), leading to higher-speed impacts and less predictable driving behaviours. According to previous studies, when drivers know they are being monitored at a non-intersection location, they are more likely to comply with traffic rules, which could reduce fatal crashes [41, 42]. In addition, pedestrians crossing at non-intersection points may be more vulnerable due to the lack of designated crossing zones, leading to higher fatality rates in vehicle-pedestrian crashes. This finding is in line with other studies, which found that about 30% of crashes outside intersections were fatal [14].

It is also worth noting that the fatality ratio at uncontrolled intersections is lower than in non-intersection areas. Studies have shown that uncontrolled intersections lack explicit signals, leading to potential confusion over the right of way [43]. This ambiguity could result in more severe collisions than those at controlled intersections.

6. Conclusions

Road traffic crashes and their associated impacts have placed a demand on policymakers and city authorities to find strategies to reduce road crashes. This study analyzed urban road crashes by focusing on factors associated with fatal crashes. To reduce road crashes at controlled and uncontrolled intersections, efforts must be directed toward fixing cameras at the intersections to monitor drivers. Although COVID-19 restricted traveling during the initial stages of the pandemic due to lockdowns in many cities, the analysis revealed that road crashes increased yearly from 2017 to 2020 with concomitant fatalities. Furthermore, a strong relationship was revealed between fatality, age, causes, and location of the accident. The study shows that the demographic characteristics of ‘drivers’ influence fatalities, and males were found to be more associated with fatal crashes than females, and young drivers had more fatal crashes. Again, unlicensed drivers were involved in fatal crashes, and among the licensed drivers, those with licenses B and F had more fatal crashes. Similarly, the result of the fatality ratio shows that wrong overtaking and speeding were factors leading to the majority of the fatal crashes, whereas outside intersections and uncontrolled intersections of the road section were locations with high fatality crashes.

Urban transportation benefits all citizens, regardless of economic status, and should be sustainable. Preventing road crashes and fatalities is one way to promote sustainable urban transportation, and policies emphasizing monitoring drivers should be formulated and enforced. The findings underscore intervention strategies for urban traffic safety. Promoting safe driving behaviours among male drivers could significantly reduce crash rates. The findings further suggest that different age groups may require tailored interventions to address their specific risk factors aimed at reducing fatal crashes among young drivers. Strategies could include implementing Graduated Driver Licensing (GDL) programs that impose driving restrictions on young drivers and gradually introduce them to more complex driving situations.

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