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ANALYSIS OF SINGLE-VEHICLE AND MULTIPLE-VEHICLE CRASHES ALONG THE HAWAN KIBO CRASH CORRIDOR, PLATEAU STATE, NIGERIA

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ABSTRACT
In-depth analysis of the characteristics of road traffic crashes at blackspots or hotspot locations is, generally, insufficient in Nigeria. This is despite the fact that blackspots represent recognized locations with road safety deficiencies and mitigation of crashes at such locations produce multiple benefits. This paper examines characteristics of road traffic crashes along Hawan Kibo route, one of the most recognized crash corridors in Nigeria, with particular emphasis on single-vehicle (SV) and multiple-vehicle (MV) crashes. The data shows that between 2015 and 2019, 355 crashes were recorded (SV: 219; MV: 136), with 1288 persons sustaining injuries (SV: 652; MV: 636) and 121 fatalities (SV: 46; MV: 75). The most important causes of crashes and casualties for SV crashes were brake failure, speed violation, and fatigue; while wrongful overtaking, brake failure and speed violations were the most prominent for MV crashes. Time of day for crashes was not significantly different between SV and MV crashes but number of persons injured per crash was significantly different between them. Though MV crashes were less in number, they appeared to be more severe. There was no statistically significant difference between the fatality rates per crash for SV and MV crashes even though SV fatality rates were significantly less than those for MV crashes. In the light of the fact that the most prominent causes of crashes and casualties are associated with poor human judgment and attitude, the study suggests that more creative and concerted efforts should be made to educate drivers and passengers on road safety. Use of technology to identify traffic regulation violators and enforcement of traffic laws are also recommended.

Keywords: Blackspots, Crashes, Fatality rates, Single-vehicle, Multiple-vehicle

INTRODUCTION
Road traffic crashes (RTC) are a global pandemic, responsible for over 1.35 million deaths annually, worldwide (WHO, 2018). Most of those affected are the young. Nigeria is widely recognized as possessing some of the most unsavoury crash statistics in the world. For example, Agbonkhese et al. (2013) reported that Nigeria ranked second out of 193 countries in RTC. Consequently, concerted efforts have been made to contain road traffic crashes, injuries and fatalities with mixed results. Among the strategies commonly used is to identify and mitigate crashes at crash hotspots or blackspots. These are locations with above average number of crashes, injuries and/or fatalities (Erdogan, 2009). Mitigating crashes requires developing appropriate strategies to prevent occurrence, and minimize injuries and fatalities. Understanding the characteristics of crashes at the blackspots is therefore important. Recent studies (Dong et al., 2018; Hong, Tamakloe & Park, 2019) have reignited interest in examination of similarities and differences between single vehicle (SV) and multiple vehicle (MV) crashes as a means towards filling in the gap in knowledge about safety deficiencies on the roadways. The insight gained is an important input in devising effective countermeasures to curb the threat and severity of RTCs because SV and MV crashes represent different mechanisms of crash occurrences.

First, studies have shown that the causes of SV and MV crashes are not necessarily the same. Therefore, determining the relationship between crash risk factors and the number of vehicles involved in a crash is critical to crash reduction (Hong et al., 2019). For example, SV crashes are generally associated with driver misbehavior, while MV crashes usually result from inadequacies in interaction between two or more vehicle drivers (Knipling, 2013). Second, the impact of crashes is different for SV and MV crashes. Hong et al. (2019) claimed that MV crashes claim more injury victims and have greater property damages than SV crashes. Furthermore, it has been found that modelling SV and MV crashes separately yield better results than if they were modelled together as a unit (Geedipally & Lord, 2010; Chen & Chen, 2011). This means that models of crashes developed separately for SV and MV crashes are better inputs in developing crash risk countermeasures than those developed without this distinction. It is therefore imperative to examine the characteristics of single-vehicle and multiple-vehicle crashes as a window to gaining better understanding of the mechanism of road traffic crashes.

Despite the obvious advantages of adopting this analytical approach to studying crashes, crash analysts in Nigeria have not paid much attention to it. A search and review of literature on crashes in Nigeria by these authors did not yield any such studies. If any had been conducted, they may be limited in number and circulation, at least to the best knowledge of the authors. This paper therefore presents an analysis of the characteristics of single-vehicle and multiple-vehicle crashes along the Hawan Kibo crash corridor route in Plateau State, Nigeria.

MATERIAL AND METHOD
The Study Area
The Cable, an online Nigerian news outlet reported on May 3, 2022 that the Federal Road Safety Corps had deployed 15,000 officers to 31 recognized crash corridors in Nigeria to monitor and control expected increased motor vehicle traffic over the Sallah celebration period. One of the main objectives was to prevent road crashes and intervene to save lives in case of road traffic crashes. Among these recognized crash corridors is Hawan Kibo.

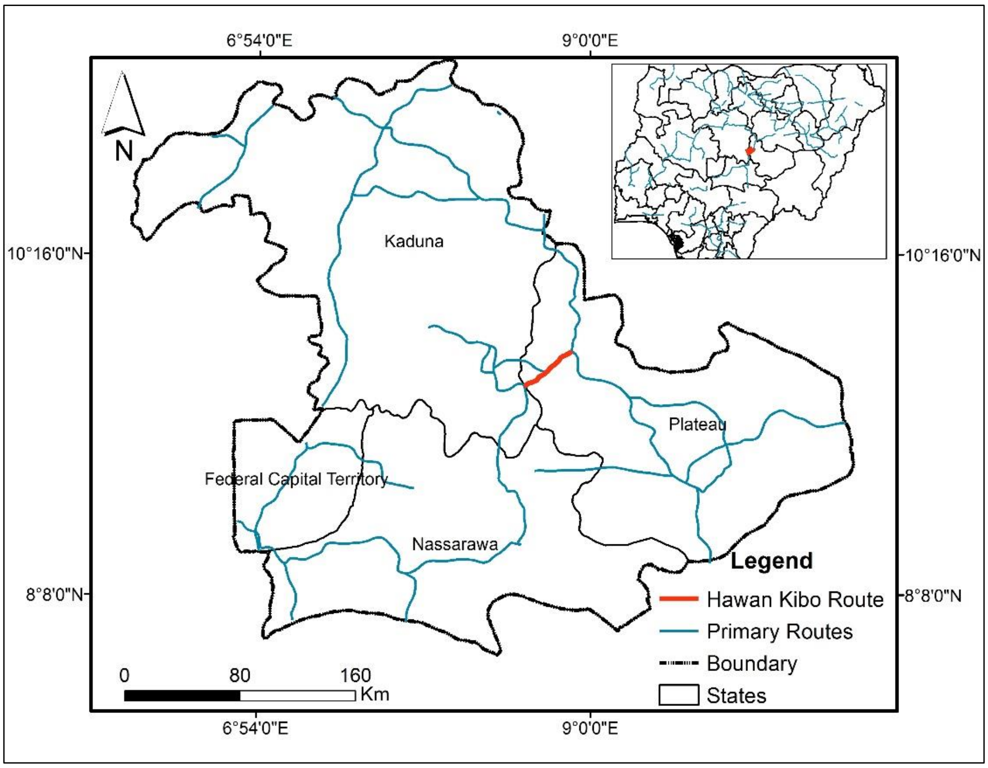

Figure 1: Hawan Kibo Crash Corridor, Plateau State, Nigeria

The Federal Road Safety Corps (FRSC) is the paramilitary agency in Nigeria saddled with the responsibility of ensuring safety on Nigerian Roads. It is structured into 12 Zonal Commands covering the entire country. Each zone has two or more Sector Commands. There are 37 of them with each state and the Federal Capital Territory (FCT), Abuja being a sector command. Jos Zonal Command covers Benue, Nasarawa and Plateau States (Sector Commands). Each sector command is made up of Unit Commands. There are 222 unit commands. The Plateau State Sector Command (RS4) has seven unit commands. One of them is the Hawan Kibo route, RS4.13, the study area.

The Hawan Kibo route (RS4.13) is a stretch of Federal Trunk A road that is the gateway route between Plateau State and Southern Kaduna, Nasarawa state and the FCT, Abuja. From Riyom town, the route passes through treacherously winding and steep escarpment of the Jos Plateau and ends at "Forest", a large area of planted deciduous (Teak trees) forest reserves that marks the boundary between Plateau and Kaduna states along the roadway. Halfway, on the edge of the Jos Plateau, is the Hawan Kibo, a stretch of hilly ("Hawa" is "uphill" in Hausa) roadway and the village (Kibo) just beneath the hilly escarpment from which the route got its name. The famous Assop Falls is at the base of the hill. The FRSC unit command office and clinic are located halfway between the foot of the hill and the "Forest."

Data Collection

Data on road traffic crashes for the period 2015 to 2019 were collected from the Federal Road Safety Corps (FRSC), Plateau State Sector Command headquarters in Jos. The data contained the following pieces of information on each crash: date and time of crashes; crash, report, arrival and response time; route and location (not coordinates); vehicle number, type, category, make and model; name of organization/fleet operators and name of driver; causes of crash; and, number of injured, killed and people involved (adult and children).

Using the information provided on vehicle number, type, category, make and model, the number of vehicles involved in any particular crash was determined. A single-vehicle crash is a crash that involves only one car, such as a run-off-the road crash. Crash involving two or more vehicles is a multiple vehicle (or multivehicle) crash, e.g., a head-on collision or crash (Hong et al., 2018). These two crash types were identified and processed. Information on crash time, number of persons injured, killed and people involved, and the cause of crashes were extracted into frequency tables for each crash type for each year (2015-2019). These variables are then summed up for the entire five-year period.

Percentage of crashes based on crash type (SV and MV) and casualties per number of people involved were calculated. Also, crash injury and fatality rates based on number of crashes involved were computed. The contingency Chi-Squared test was used to determine any significant difference in time of crash occurrences between SV and MV crashes. The independent t-test statistics was used to determine if there was any significant differences in the rates of crash injuries, and for rates of fatalities between SV and MV for the study period. The independent t-test for two samples is represented as:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} \frac{S_2^2}{n_2}}} \quad (1)$$

Where $\overline{X_1}$ and $\overline{X_2}$ are means of samples 1 and 2, respectively; S_1^2 and S_2^2 are the variances for samples 1 and 2, respectively; and, n_1 and n_2 are the number of observations for samples 1 and 2, respectively.

There are two forms of the t-test: one that assumes equal variances (homoscedasticity) and the other that assumes unequal variances (heteroscedasticity). The t-test assuming equal variances has degree of freedom computed as:

$$df = n_1 + n_2 - 2 \quad (2)$$

Where n_1 and n_2 are number of observations for samples 1 and 2, respectively.

The t-test assuming unequal variances has degree of freedom computed as follows:

$$df = \frac{\left(\frac{S_1^2}{n_1} - \frac{S_2^2}{n_2}\right)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1-1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2-1}} \quad (3)$$

The F-test was therefore employed to test for equality of variances. The null hypothesis is that the variances of the samples are equal or same. The formula for the F-test is:

$$F = \frac{S_1^2}{S_2^2} \quad (4)$$

Where S_1^2 and S_2^2 are the larger and smaller variances of the samples, respectively.

For both the F test and t-test, the null hypothesis is rejected when the calculated value is greater than the table or critical value; or when the p-value is less than the level of significance. The results of the data analyses are presented as frequency tables for ease of understanding.

RESULTS AND DISCUSSION

General Characteristics of Crashes

Within the five year study period, there were 355 crashes involving 507 vehicles and 2782 people, resulting in 1288 injuries and 121 fatalities. These approximate to an average of 71 crashes, 258 injuries and 24 deaths every year. There were nearly four injured persons for every crash and at least one death for every three crashes. The data presented on Table 1 also shows that there were 1409 casualties, which means that about 51% of people involved in a road traffic crash along the route either incurred some injury or died. These are undoubtedly worrisome statistics. The data were further analyzed based on single-vehicle and multiple-vehicle crashes to examine any similarities and/or differences between them.

Single-Vehicle and Multiple-Vehicle Crashes

Of the 355 crashes, single-vehicle crashes made up 61.69% while multiple-vehicle crashes accounted for the remaining 38.31%. Single-vehicle crashes had 50.62% of the injured persons (about 3 injured persons for every one crash), and 38.02% of fatalities (about 1 death for every five (5) crashes). Multiple-vehicle crashes accounted for 49.38% of the injured (about 5 injured for every one crash), and 61.98% of fatalities (at least 1 death for every two crashes). Despite the lower number of crashes, multiple-vehicle crashes involved more vehicles than single-vehicle crashes. According to Hong et al. (2018) even though multi-vehicle crashes are fewer than single-vehicle (SV) crashes, they (MV crashes) have more victims compared to SV crashes. In the study area, there was a slightly greater number of casualties associated with MV crashes (50.46%) than with SV crashes. This was prominently the case with fatalities. MV crashes were responsible for 62.98% of all fatalities recorded within the study period. These differences may not be unconnected with the suggestions that SV and MV crashes have different causative risk factors, thereby the risk factors have varying effects on SV and MV accident probability (Hong et al., 2018).

Table 1: Summary of Crash Data (2015 – 2019)

Year	Type of Crash	No. of Injuries	RTI per Crash	No. of Fatalities	RTF per Crash	No. of Crashes	% RTC by Type of Crash	No. of Vehicles Involved	No. of Casualties	No. of People Involved	% Casualty per No. of People Involved
2015	Single	143	2.55	14	0.25	56	68.67	56	157	269	58.36
2016	Single	117	3.25	15	0.42	36	61.02	36	132	189	69.84
2017	Single	138	2.94	7	0.15	47	62.67	47	145	288	50.35
2018	Single	157	3.08	7	0.14	51	57.30	51	164	289	56.75
2019	Single	97	3.34	3	0.10	29	57.69	29	100	187	53.48
	Total	**652**	**2.98**	**46**	**0.21**	**219**	**307.35**	**219**	**698**	**1222**	**57.12**
2015	Multiple Vehicles	123	4.73	6	0.23	26	31.33	57	129	236	54.66
2016	Multiple Vehicles	71	3.23	15	0.68	22	38.98	49	86	229	37.55
2017	Multiple Vehicles	140	5.00	30	1.07	28	37.33	57	170	337	50.45
2018	Multiple Vehicles	158	4.16	16	0.42	38	42.70	78	174	492	35.37
2019	Multiple Vehicles	144	6.55	8	0.36	22	42.31	47	152	266	57.14
	Total	**636**	**4.68**	**75**	**0.55**	**136**	**192.65**	**288**	**711**	**1560**	**45.58**
	Grand Total	**1288**	**3.63**	**121**	**0.34**	**355**		**507**	**1409**	**2782**	**0.51**

Source: Computed from data collected from FRSC, Plateau State Sector Command Headquarters, Jos

Causes of Crashes

The National Bureau of Statistics/Federal Road Safety Corps (NBS/FRSC) Report (2020) provided a list of 18 causative factors for road traffic crashes in Nigeria. Nine (9) of these factors were identified as causes of SV crashes, while MV crashes had 10 recorded causes (Table 2).

Table 2: Causes of Single-Vehicle and Multiple-Vehicle Crashes

SINGLE-VEHICLE CRASHES				MULTIPLE-VEHICLE CRASHES				TOTAL			
CAUSES	**RTI**	**RTF**	**RTC**	**CAUSES**	**RTI**	**RTF**	**RTC**	**CAUSES**	**RTI**	**RTF**	**RTC**
BFL	193	18	69	**BFL**	127	28	27	**BFL**	320	46	96
FTQ	95	3	20	**FTQ**	65	17	15	**FTQ**	160	20	35
LOC	67	7	32	**LOC**	38	3	13	**LOC**	105	10	45
ROV	7	0	3	**ROV**	3	0	3	**ROV**	10	0	6
SLV	8	4	5	**SLV**	3	0	1	**SLV**	11	4	6
SPV	162	10	47	**SPV**	188	10	27	**SPV**	350	20	74
TBT	58	3	18	**TBT**	6	0	4	**TBT**	64	3	22
WOV	47	1	20	**WOV**	165	12	37	**WOV**	212	13	57
OTHERS	13	0	4	**OTHERS**	0	1	1	**OTHERS**	13	1	5
DOV	2	0	1	**DAD**	12	4	3	**DAD**	12	4	3
				DGD	29	0	5	**DOV/DGD**	31	0	6
TOTAL	**652**	**46**	**219**	**TOTAL**	**636**	**75**	**136**	**TOTAL**	**1288**	**121**	**355**

BFL: Brake failure; DAD: Driving under Influence of Alcohol/Drugs; DGD: Dangerous Driving; DOV: Dangerous Overtaking; FTQ: Fatigue; LOC: Loss of Control; ROV: Road Obstruction Violation; SLV: Signal Light Violation; SPV: Speed Violation; TBT: Tyre Burst; WOV: Wrongful Overtaking; OTHERS: e.g., Hit and Run; non-determined cause because of removal, etc

Except for three, both SV and MV have similar causes of crashes recorded. The apparent most important causes for both SV and MV crashes are brake failure (BFL), speed violation (SPV), fatigue (FTQ), wrongful overtaking and loss of control (LOC). It goes without saying that some of these causes are more significant than others for either of the crash types (SV and MV). The causes, in descending order of contribution, are: BFL, SPV, WOV, LOC, FTQ and TBT.

Brake failure (BFL) is by far the most common cause of road traffic crashes along the Hawan Kibo route. It made up 27% of all crash causes with wrongful overtaking (WOV) coming a distant second (16%). Interestingly, while BFL is the chief cause of SV crashes, WOV takes the prime position in MV crashes. The following causes of crashes are reported, in order of importance, for SV crashes: BFL, SPV, LOC, FTQ and WOV, and TBT. For MV crashes, they are: WOV, BFL, SPV, FTQ and LOC. Except for TBT, which was prominent for crashes only, all the other causes may be considered important for both SV and MV.

Brake failures and tyre bursts may be considered mechanical failures and driver negligence in proper maintenance of vehicles may be part of the problem. Nigerians are notorious for poor vehicle maintenance. Okafor et al. (2018) determined that not more than ten percent only of long distance commercial vehicles in Benin City, Nigeria were road worthy. Several studies have contended that brake failure, defective light systems and bad tyres are responsible for many crashes and fatalities on Nigerian roads (Ovuwori, 2001; Adi, 2011). Despite not being the largest contributor to MV crashes, BFL is the largest cause of fatalities for both SV and MV crashes. On its own, BFL may not have made the significant impact on crash injuries and fatalities as it did. The situation was compounded by speed violation (SPV) by drivers. There is almost always a seeming rush on roads by drivers. It must be noted that there are hardly speed limit signs on Nigerian roads. However, there is a general expectation of controlled driving speed on the roads. This is even more so as most Nigerian roads are in deplorable conditions. Speed violation is recognized as a prime culprit in many crashes globally (Boateng, 2021; National Highway Transportation Safety Administration (NHTSA), 2021) and especially in Nigeria (Yero et al., 2015; NBS, 2020; Yahaya et al., 2021; Yunus & Abdulkarim, 2021). The cocktail of high speed, and defective brakes and tyres is a recipe for severe crashes and injuries (Institute for Road Safety Research, 2012). Nearly 50% of all injured persons and 54.55% of all fatalities for the study period were accounted for by BFL and SPV together.

Wrongful overtaking is responsible for the largest number of crashes, second largest number of injured persons and third largest number of fatalities for MV crashes. The Hawan Kibo road has some of the most treacherous stretches of winding routes, probably in Nigeria. In some sections, it is difficult, because of the winding route and hills through which the road passes, to see more than a few feet of roadway at a time especially when trailing another vehicle. Drivers, usually in a hurry, take unnecessary risks to overtake vehicles ahead of them by “faith” rather than by “sight” and in the process end in collision with oncoming vehicles. Table 2 shows that this is the most common cause of crashes and important sources of injuries and fatalities for MV crashes.

Fatigue also registered highly as a cause of crashes for both SV and MV crashes and especially as the second most important contributor to fatalities for MV crashes. Many drivers drive long distances without adequate rest. In many instances, the fatigue is an accumulated stress from many days of plying the route without any break at all. This may result into drivers sleeping on the steering wheel or reacting much slower than they should be to dangers on the roads. Data on Table 2 indicates that fatigue contributes to both SV and MV crashes in near equal measures but has more relatively devastating consequences (more fatalities) for MV than for SV crashes. Some studies have found correlation between time of day of crash and SV crashes from fatigue. Ivan et al. (2000) contended that SV crashes occurred more in the evening and night time as a result of drowsing driving, while MV crashes are more common in the day time. They therefore concluded that time of the day is important in understanding certain types of crashes because it correlates with types of trips made and level of driver alertness to dangers on the roadways.

Time of Crash

Table 3 shows that for both SV and MV crashes, the time period between 4:00 pm and 6:00 pm had the largest number of crashes within the study's two-hour aggregation temporal framework used. The period between 10:00pm and 12 midnight had the least crash frequency counts for both SV and MV crashes.

Table 3: Time of Crash

Time	No. of Crashes		% of Crashes	
	SV	MV	SV	MV
12 Midnight - 6:00 am	11	5	5.02	3.68
6:00 - 8:00 am	20	10	9.13	7.35
8:00 - 10:00 am	16	16	7.31	11.76
10:00 - 12 Noon	27	18	12.33	13.24
12Noon - 2:00 pm	34	22	15.53	16.18
2:00 - 4:00 pm	34	14	15.53	10.29
4:00 - 6:00 pm	37	30	16.89	22.06
6:00 - 8:00 pm	19	11	8.68	8.09
8:00 - 10:00 pm	18	9	8.22	6.62
10:00 - 12 Midnight	3	1	1.37	0.74
Total	**219**	**136**	**100**	**100**

The two hour period adopted is considered fine enough to provide detailed crash time but also broad enough for meaningful aggregation of crashes. The window of aggregation can also be expanded easily to accommodate larger time scales. For example, this study reconfigures the time windows into four time scales: morning time (6:00 am to 12 Noon), afternoon time (12 Noon to 6:00 pm), Evening-Night time (6:00 pm to 12 Midnight), and Night-Morning time (12 Midnight to 6:00 am).

The afternoon time period (12 Noon – 6:00 pm) recorded the largest number of crashes. There were 105 (47.95%) SV and 66 (48.53%) MV crashes. This was followed by the morning time period (6:00 am – 12 Noon) with 63 (28.77%) and 44 (32.35%) SV and MV crashes, respectively. The evening-Night time (6:00 pm – 12 Midnight) registered 40 (18.26%) and 21 (15.44%) SV and MV crashes in that order. The night-morning time period had the least number of crashes (SV: 11 or 5.02% and MV: 5 or 3.68%).

The pattern of distribution between SV and MV crashes in terms of time of crashes was similar. Unlike other studies (e.g., Ivan et al, 2000), which found significant differences in crashes between SV and MV crashes based on time of the day crashes occurred, there was none for the study area within the study period. Ivan et al. (2000) reported that SV crashes were more likely to occur at night time while MV crashes were more common in the day time. A chi-squared test returned a p-value of 0.779348, which shows that there was no significant difference in time of crashes based on the expanded time scale. This may be better understood by the percentages of crash counts for the time periods, which were similar.

It is pertinent to point out that within the study period from 2015 to 2019, the country has been steeped in a lot of insecurity problems such that night travel, especially along the Hawan Kibo route was paltry. This may account for the fact that 4:00 pm to 6:00 pm had the largest counts of crashes in the initial time scale. This may be because travelers were trying to their destinations before nightfall. The evening-night and night-morning time periods recorded small numbers of crashes for the same reason that much of night travel had been lost.

Crash Injuries and Fatalities Rates

Generally, crashes are significant events largely because of their impacts on human life, through injuries and fatalities. Table 2 presents details of the number of injured persons and fatalities for SV and MV. Frequency counts of injured persons and fatalities does not usually tell the whole story because it does not account for the risk of an injury or fatal crash occurring. It is necessary to take this risks into consideration for devising crash mitigation and management strategies. Consequently, crash rates are often computed and they are also used to compare crash values across different units of analysis. Crash frequency counts are therefore normalized by a standard factor that is considered a crash risk factor. The most common risk factors used are population (number of crashes, injured or fatalities per 100,000 of the population) or vehicle miles travelled (VMT) (number of crash, injured or fatalities per 100,000 VMT). This study, however, adopts the number of crashes as the risk factor and computes rates of injured and fatalities per crash because of dearth of data on vehicle miles travelled and population data at local levels. The rate of road traffic injuries incurred is computed as the number of injured persons divided by the number of crashes to obtain the number of persons injured, on average, per single crash.

The data (Table 2) shows that for SV crashes, there were, on average, about three persons were injured for every single crash that occurred; while nearly five persons were injured in every single MV crash. Overall, nearly four persons are injured for every one crash that occurred for both SV and MV crash. Fatality rates were one death for every five SV crashes; one fatality for every two MV crashes; and, one death for every three crashes (SV and MV). The study determines if there are any significant differences in crash injury and fatality rates for SV and MV crashes. A two sample independent t-test statistics was employed to test the hypothesis since SV and MV crashes are independent of one another. However, there is a need to determine homoscedasticity of variances to allow for the selection and deployment of the appropriate technique. The F-test was used to test for equality of variances. Table 4 presents the results.

Table 4: F-Test Two-Sample for Variances

	RTI per SV Crash	*RTI per MV Crash*	*RTF per SV Crash*	*RTF per MV Crash*
Mean	3.0326	4.7323	0.2113	0.5537
Variance	0.0964	1.4886	0.0162	0.1106
Observations	5	5	5	5
Df	4	4	4	4
F	0.0648		0.1462	
P(F<=f) one-tail	0.01063		0.0446	
F Critical one-tail	0.1565		0.15654	

The results show that for both rates of injury per crash and rate of fatality per crash for SV and MV, the p-values are less than the level of significance (0.05), which means that the null hypotheses (the variances of injury rates for SV and MV are the same, and fatality rates for SV and MV are the same, respectively) are rejected. The variances are not equal for SV and MV crash injury rates and also for crash fatality rates. The independent t-test for unequal variances is therefore recommended in both cases. The results of these tests are presented in Table 5.

Table 5: t-Test: Two-Sample Assuming Unequal Variances

	RTI per SV Crash	*RTI per MV Crash*	*RTF per SV Crash*	*RTF per MV Crash*
Mean	3.0326	4.7323	0.2113	0.5537
Variance	0.0964	1.4886	0.0162	0.1106
Observations	5	5	5	5
Hypothesized Mean Difference	0		0	
Df	5		5	
t Stat	-3.0189		-2.1507	
P(T<=t) one-tail	0.0147		0.0421	
t Critical one-tail	2.0150		2.0150	
P(T<=t) two-tail	0.0295		0.0842	
t Critical two-tail	2.5706		2.5706	

The first hypothesis is that there is no significant difference in the rates of injured persons per crash between SV and MV crashes. Since the p-values for both 2-tail and 1-tail tests are 0.0295 and 0.0147, respectively, which are lower than the level of significance (0.05), the null hypothesis is rejected. This means that there is a significant difference in rates of injured persons per crash between SV and MV crashes in the study area. It may be noted from the table that the mean values for SV ad MV crashes have a difference of 1.70 injured persons per crash. This may be approximated, for convenience to a difference of about two persons injured per crash for MV than for SV crashes.

The results for the rates of crash fatalities are even more interesting. The p-value at two-tail is 0.0842, which is larger than the level of significance (0.05). The null hypothesis therefore is not rejected. The implication is that there is no evidence that a significant difference in fatality rates per crash exists between SV and MV crashes. However, at one-tail level, the p-value of 0.0421 shows that there is evidence to the effect that fatality rates per crash for SV crashes are significantly less than for MV crashes. The one-tail tests is used for a directional hypothesis that suggests one of two samples is either greater (positive one-tail test) or smaller (negative one-tail test) than the other sample. The negative t-stat result (t = -2.1507) for crash fatality rates suggest that the one-tail test is negative, which means that the hypothesis being tested is to the effect that the SV crash fatality rates are smaller than the MV fatality rates. This is borne out by the results of the study. Except for the year 2015, all the subsequent years display larger crash fatality rates for MV crashes than for SV crashes. The year 2017 is particularly interesting. There was at least one death recorded per one MV crash in that year, while only one fatality was incurred per seven crashes. Also 2017 was a sort of watershed in crashes along the route in the study period; there was a decreasing trend in rates of fatality per crash for both SV and MV crashes annually from 2017. This probably suggests that efforts to minimize crash casualties may be paying dividends.

CONCLUSION

A combination of brake failure and speed violations were responsible for most of the crashes and casualties for both SV and MV crashes. Fatigue and wrongful overtaking were also found to be important. Rates of injury per crash were found to be significantly different for SV and MV crashes. The data indicate that MV crashes resulted in more significantly larger proportion of injuries per crash than SV crashes. Fatality rates were not significantly different even though it was found that SV crashes resulted in significantly less deaths (fatalities) per crash than MV crashes. The major causes of crashes and casualties in the study area point to human errors in judgment and poor attitudes of drivers on the road. The most effective measure against these is education. However, it appears that current educational campaigns have not been effective. Current emphasis on drivers may need to be complemented by increasing involvement of the general public on road safety education. A firm word of caution to a reckless or careless driver on the road by a number of safety-conscious and safety-educated passengers may produce better driver composure than if the driver was assumed to know better and allowed to single-handedly decide on driving decisions. Modern technology, such as the use of CCTV at strategic locations may also coerce good driving behaviour especially if those caught on camera in violation of traffic rules and regulations are punished according to the laws. Also the current format of data collection by the FRSC is not adequate enough to engage more complex statistical methods to mine hidden patterns on crashes as information on driver age, road geometric characteristics, weather conditions, type of crashes (e.g., head-on collision, side swipe, run-off-the-road, etc) and coordinate information on location of crashes, among others, are missing.

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