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ORIGINAL ARTICLE

ESTIMATING EXPOSURE-CONTROLLED CRASH RISK AT ROUNDABOUT AMONG DRIVERS OF VEHICLES IN ADDIS ABABA CITY

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ABSTRACT

Introduction*: Road traffic crash has become a global problem that threatens human health as a result of post-crash injury and property damage which mainly occurred by driver's fault.*

Objective: *Estimating Exposure-Controlled Crash Risk at Roundabout among drivers in Addis Ababa City Administration.*

Method: *A case control study was conducted for driver of two vehicle crash paired by collusion. A total of 162 cases and 162 controls were randomly selected. Crash data were collected from November 2018 to March 2019. A statistical analysis of quasi-induced exposure and conditional logistic regression were conducted using STATA 14 software. Ethical clearance was obtained from Addis Ababa University, College of Health Sciences ethical review board.*

Result*: The crash Involvement Ratio (IR) of the case-control middle age groups between 45 and 54 has larger crash propensity. Males cause accidents at a 1.5:1 rate relative to females. The incorrect left turn had exposed to a significant association with responsible vehicle crash (OR = 2.6, 95% CI= 1.0 – 5.6) compared to following too close driving fault. A driver having day time crash were at higher risk of vehicle crash responsibility compared to night time (OR = 1.7, 95% CI = 1.1 – 2.7).*

During incorrect left turn driving fault, roundabout crashes were more likely to happen with light truck driving license drivers (p-value for interaction = 0.03) than drivers with heavy truck driving license

Conclusion*: In this study, the risks for crash were associated with being men, middle age, light truck licensed driver, day time driving, and incorrect left turn driving fault. Therefore, there should be continual driver training to avoid fault driving until mastering new vehicle driving technology for specific vehicle, enforcement of traffic rules and regulation for drivers who incur at roundabout crash risks in general and for light truck licensed drivers in particular.*

Keywords: *Road traffic crash, vehicle crash responsibility, induced exposure*

INTRODUCTION

Vehicle to vehicle collisions are the most common accident type that bring life threatening injuries and property damage in the globe especially under developing countries including Ethiopia. The frontal impacts followed by side impacts being most common fatal and serious accidents (1). The report shows in low- and middle-income countries having 60 percent of the world's registered vehicles exposed to more than 90% of global road deaths (1-2). The average global mortality rate was 18.3 per 100 000 population, while 26.6/100,000 population in Africa. In Ethiopia, mortality rate is 26.7/100,000 population) (2-3)**.** A study revealed about 64 people die per 10,000 vehicles per year on Ethiopian roads (4). In 2018, there are 5117 number of death due to road traffic crash in Ethiopia. Of those 585 deaths are in Addis Ababa (5-6)

There are elements of the road traffic system that include motor vehicles, roads, and road users along with their physical, social and economic environments where crash event occurs (7-8). The study conducted in Mekele City, Ethiopia showed that the intersections of the roads were the main cause of RTAs (9). According to the study conducted in United Kingdom (UK), the two vehicle crashes were greater in number during the daytime for men and women than during evening or night time hours (11). Large proportion of car accidents happened in the daylight (12). Crash risk vary across different type and status of vehicles. A study showed that the Relative Crash Involvement Ratio (RAIRs) for the large-size vehicle drivers present the lowest crash risk (13). Regarding vehicle service year, when the vehicle service year was increased by a single year, the occurrence of accidental death was significantly decreased by 10%. (12).

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This literature may indicate familiarity with vehicle part that relate with driving were early learnt but through time driver get experience. Different factors associated with driver influence crash involvement. The driver's sex, age, occupation were significantly associated with RTA. (4, 8, 12- 15). Male drivers experienced a larger increase in crash risk during weekend time categories than female drivers (16). Drivers who operate their own vehicles were less likely involved in a crash compared with employed drivers (12). Experienced drivers had a lower risky driving behavior than novice drivers (9, 17). Another study showed that crash occurred when the drivers' not yielding right of way to other vehicles (18).

The mentioned factors that contribute to road crash could be considered preventable (19 16). Despite government efforts in the road development, road crashes remain to be one of the critical problems of the road transport sector in Ethiopia (20). The vehicle safety is determined by a combination of international and national regulation, consumer information, car industry policies and product liability considerations involving Intelligent Transport Systems. (1). Crash will decrease as the vehicle population equipped with collision avoid-ance technologies increases in the coming decades (21) Ethiopia did not apply vehicle standards despite vehicle crash increased from time to time (22).

There is inadequate crash analysis study in Ethiopia. Therefore, to provide an input for crash event the study examines the hypothesis that the two pairs of drivers differ on personal characteristics that may help us understand the crash process by assessing the effect of driver and vehicle characteristics on the risk of causing a collision between two vehicles in Addis Ababa City Administration.

MATERIALS AND METHODS

Addis Ababa City Administration is located in the central part of the country, and it is the Capital City of Ethiopia. Addis Ababa has an area of 540km^2 and average elevation of 2500m above sea level. It is the seat of the African Union (AU) and the United Nations Economic commission for Africa (UNECA). Addis Ababa was founded by Minilik II and Empress Taitu in 1887. The history of the City's road development in the City began from the conception of the City. Emperor Minilik was the first in importing two cars in Addis Ababa and introduced the car technology in the City 1907(23, 17).

The transport system in the city is characterized by frequent congestion and delays, high rate of road traffic accident and air pollution.

The previous study revealed that there were 125 major accident black-spots in Addis Ababa as a whole. Kirkos (26.77%), Bole (15.89%) and Arada (11%) sub-cities were the three leading crash hazardous sub-cities that mostly occur at roundabout (24). The current study was conducted in four randomly selected sub-Cities of Addis Ababa (Cherkos, Arada, Bole and Nifas silk sub City) to estimate difference in crash risk factor for at-fault driver and non at – fault driver at crash involvement trip.

The study was conducted from November 2018 to March 2019. We used the study design called "quasi induced exposure method" which is similar to case-control design was conducted.

Our source population was drivers who made trips in Addis Ababa during the study period and that trip ended up in two-vehicle collision initiated by the trip-maker driver at roundabout from which study subjects selected for the current study.

Cases were drivers (driver trips) who were responsible for a vehicle collision. Controls were drivers who were involved in the crash, but not responsible for a vehicle collision. Case and control status referred, therefore, to the driver's role in the crash in an accidental trip, not to the presence and absence of disease or injury, as is usual in case-control studies.

The way controls were interpreted correspond to the presumption that there were no structural differences between the sub-population of non-accidental trips and the sub-population of accidental trips of non-responsible drivers involved in two -vehicle collisions.

Cases and controls were identified by expert traffic police judgment based on the scene information including the scene plan taken by expert police. An eighteen years old and above driver who had on the trip that ended up with 4 and above wheeled two vehicle crash paired by collusion in which one of the crash participant drivers responsible for crash in the two-vehicle crash was included. A paired comparison of cases and controls avoided confounding by environmental factors, exposure to traffic.

Drivers with severe injury who were unable to give data and driver taken to hospital after he died and no source of data for crash occurrences during data collection were excluded.

The study also excluded both drivers involved in crashes were not responsible for crashes or both of them were responsible for crash because it would not contribute to the paired relative risk estimates.

To compare cases with control regarding exposure to crash risk factor, we calculated sample size for the above-mentioned case control study.

Based on the literature review (16) the risk of travel for private journey type in crash involvement for crash responsible driver was 68%, while non- crash responsible driver was 53%.

$$\text{Sample size} = \frac{r+1}{r} \frac{(p^*)(1-P^*)(Z_\beta + Z_{\alpha/2})^2}{(P_1 - P_2)^2}$$

$Z_{\alpha/2}$ = Standard normal variate for level of statistical significance (typically 1.96)
r = Ratio of control to cases (1)
P* = Average proportion of exposed = proportion of exposed cases + proportion of exposed control /2
Z_β = Standard normal variate for power (0.84)
$P_1 - P_2$ = Effect size. P_1 is proportion in cases and P_2 is proportion in control.
We have equal number cases and control; then the sample size per group will be:

$$= \frac{2(P^*)(1-P^*)(0.84+1.96)^2}{1\ (0.678-0.526)^2} = 162$$

Therefore, 162 cases and 162 controls were selected.

To assess determinants of crash at roundabout during the study time the independent variable included: Demographic data of driver, crash environment, Vehicle character.
Dependent variable: crash involved trip; crash responsible deriver on trip, crash non-responsible driver in similar crash involved trip.
Driver in trip is a single road traffic participation activity that takes place by a mobile person using vehicle as driver (vehicle- trip). Road traffic is any movement of a road vehicle on a given road network. Roundabout is a circular highway that includes sections of the road leading into it, within 20m.

Data collection from traffic police registry data by ongoing ascertainment of paired cases and controls over time**.** Each pair of drivers surveyed for crash risk noted that "exposure to accidents" evolved as a concept by analogy to "exposure to disease".

The data were collected using traffic police expert judgment report and driver involved in paired collusion data using structured check list. The check list was translated from English to Amharic and again to English by language experts. Pre-test was done for the data collection tools before conducting data collection.

A guideline on methods of data collection was prepared. After training data collectors and facilitator (expert traffic police) about the objective of the study and how to collect the data, the guideline and structured check list was given to them. Data regarding crash was collected by road traffic expert at roundabout crash site and traffic police office to get confirmed data.

After getting informed consent from driver, interview was conducted with selected study participant. The principal investigator supervised the data collectors and facilitators throughout the data collection period of time. To assure trustworthiness of the data the principal investigator worked with data collectors that minimized inter-observer bias and check for completeness. Every day, the collected data was checked for completeness and consistency. Double data entry was done to ensure accuracy.

Data were checked for completeness, missing values, consistency. Outliers were manually handled, coded and enter to computer using STATA 14 statistical software. The data were stored into computer, cleaned, validated and prepared for analyses. The indirect exposures measure of the crash, namely “quasi induced exposure” was used to assess the relative degree of risk or danger of road-traffic situations in a quantitative manner. For descriptive statistics tabulations of driver characteristics were performed by crash responsible (case) and non-responsible (control) status. The relative accident involvement ratio was conducted by using the Relative Accident Involvement Ratio (RAIR) formula.

RAIRi = pi|r/pi|n
RAIR = Relative Accident Involvement Ratio
P = proportion
i = refers to greater or equal to 4-wheel vehicle
r = responsible driver
n = non responsible driver
Where pi|r = proportion of type i (greater or equal to 4-wheel vehicle) drivers among the responsible drivers in two-vehicle collisions and pi|n = proportion of type i(greater or equal to 4-wheel vehicle) drivers among the non-responsible drivers in two-vehicle collisions.

Therefore, estimating the risk of involvement in a crash for type i (greater or equal to 4-wheel vehicle) of drivers/vehicles/crash environments were done by comparing the frequency of this particular driver's or vehicle's appearing in the population of responsible drivers with the frequency of the drivers/vehicles/ crash environments appearing in the sample of non-responsible drivers (25). For modeling crash responsible drivers and non-crash responsible drivers at roundabout crash that paired by collusion, conditional logistic regression analysis was implemented to identify the variable of interest effect on causing crash.

Ethical clearance was obtained from Addis Ababa University, Health Science College, Institutional Review Board (IRB) with Protocol number: 036/17/SpH, prior to conducting the study. Permission was obtained from Addis Ababa Police Commission which sent official paper to each sub-city police center to cooperate the data collection process. Before data collection, both drivers received detailed written information on the study and asked for consent. In the case of driver refusal, data collection was discontinued for respected driver. Complying with drivers 's request, the collected data were removed from the database and destroyed. The confidentiality of information about driver was kept.

RESULTS

Data were collected from an accidental trip paired by collusion from a total of 324 drivers (162 cases:162 controls) in 4 out of 10 sub cities (Cherkos, Arada, Bole and Nifas silk sub City) of Addis Ababa, Ethiopia.

There was no significant difference in the proportion of male drivers among the case group (95.3%) and the control group (93.8 %). The mean age of cases was 34.3 (SD=9.0) years and the mean age of controls was 34.6 (SD=10.7) years, the age ranging from 23 to 80 years in cases and 20 to 73 years in controls (Table 1).

Eighty-four (51.9%) of cases and 79(48.8 %) of controls completed their secondary education. Hundred (61.7%) among cases and 102(63.0%) among controls were married. In terms of car ownership, 36.4% of the drivers were car owners in the case group and 32.7 % of the drivers were car owners in the control group. The proportion of professional drivers were 57.4% (n=93) in the case group and 58.6% (n=95) in the control group.

Considering the fault driving risk factors, the study found out that 60(37.0%) cases and 50(30.9%) controls had made following too close driving fault. The driver with secondary educational status had incurred in crashes involving 52.0% cases and 49. 0% controls. Whereas 30.3 % case drivers and 20.4 control drivers had made block the overtaking vehicle path (Table 1).

Table 1: Socio-demographic characteristic of cases and controls, Addis Ababa City, 2019

Characteristics		Cases (n=162) Number (%)	Controls (n=162) Number (%)	Total Number (%)
Sex of driver:	Male	155(95.7)	152(93.8)	307(94.8)
	Female	7(4.3)	10(6.2)	17(5.2)
Marital status :	Married	100(61.7)	102(63)	202(62.4)
	Unmarried	62(38.3)	60(37)	122(37.7)
Educational status:	Primary education	36(22.1)	38(23.5)	74(22.8)
	Secondary education	84(51.9)	79(48.8)	163(50.3)
	Higher education	42(26.0)	45(27.8)	87(26.9)
Driver type :	Owner of the car	59(36.4)	53(32.7)	112(34.6)
	Hired driver	103(63.6)	109(67.3)	212(65.4)
Occupation:	Business man	57(35.2)	52(32.1)	109(33.6)
	Student	6(3.7)	4(2.5)	10(3.1)
	Driver	93(57.4)	95(58.6)	188(58.0)
	Civil servant	6(3.7)	11(6.8)	17(5.3)
Driving fault:	Following too closely driving	60(37.0)	50(30.9)	110(34.0)
	Careless driving*	26(16.0)	40(24.7)	66(20.4)
	Blocking overtaking vehicle	49(30.3)	33(20.4)	8225.3)
	Fault right turn	15(9.3)	16(9.9)	31(9.6)
	Fault left turn	12(7.4)	23(14.1)	35(10.8)

Based on Relative Accident Involvement Ratio (RAIR), driver graph showed the case-control males' driver ratio (1.02) and the case-control females' driver ratio (0.7). The computed Odds Ratio (OR) was the RAIR MALE / RAIR FEMALE = 1.02/0.7=1.5. As can be seen, males cause accidents at a 1.5:1 rate relative to females. The crash Involvement Ratio (IR) of the case-control middle age groups between 45 and 54 has larger crash propensity (1.1), and those for above 54 years old has lower RAIR (0.4) in which Odd Ratio (OR) was RAIR of middle age/ RAIR of above 55 years old (2.8).

The risk of accident involvement ratio for case - control during blocking overtaking vehicle fault (1.5) were higher than the drivers fault who turn to right (0.65) in which the (OR) was 2.3. The RAIR of private journey type case-control ratio (1.2) was higher than the RAIR of home to work journey case- control ratio (0.88) in which Odd Ratio (OR) private journey to home over work journey cause accidents at a 1.4:1 rate (Fig 1.).

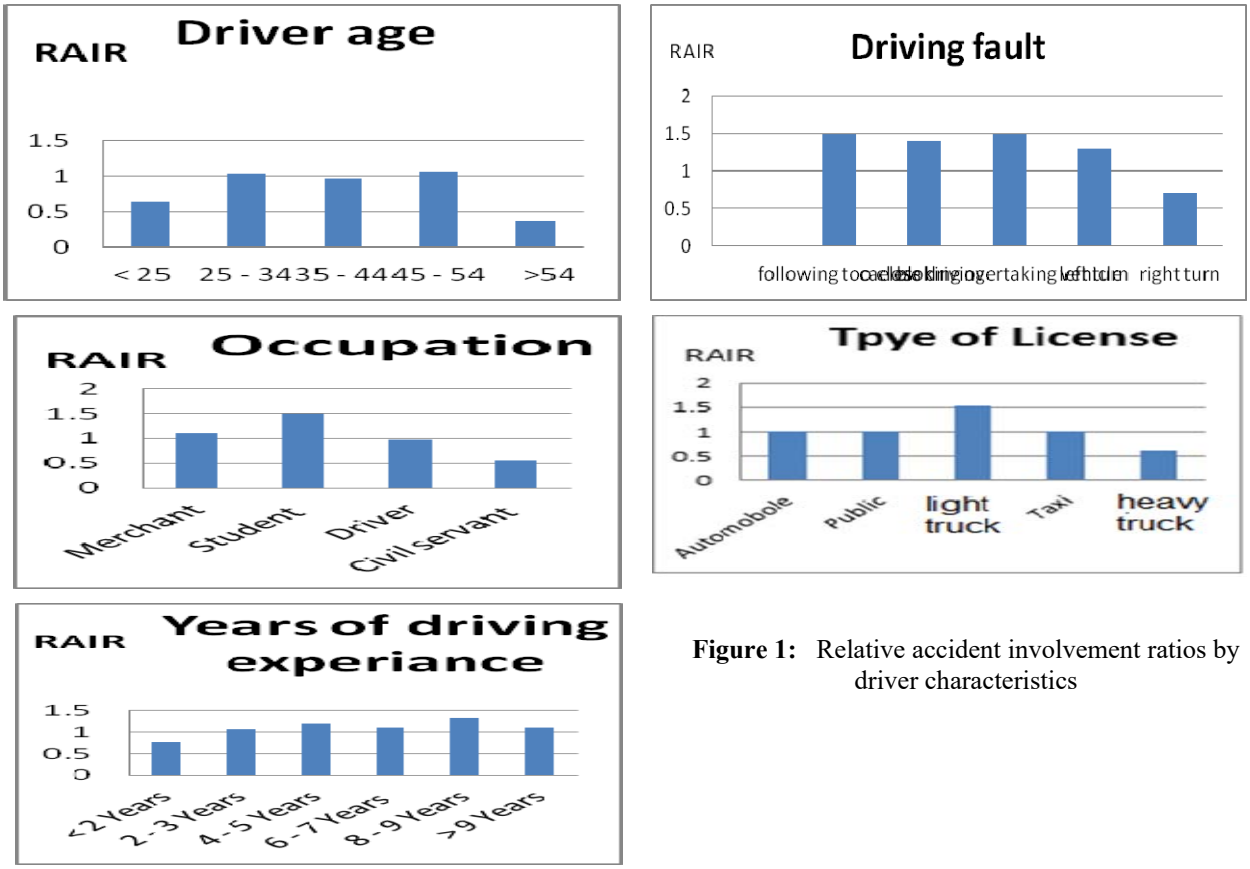


Figure 1: Relative accident involvement ratios by driver characteristics

The RAIR of light truck licensed driver case-control ratio (1.6) was higher than heavy truck licensed driver (0.6). The Odd Ratio (OR) indicated that the light truck licensed driver cause the most roundabout accidents at a 1.4:1 rate relative to heavy truck. The RAIR of less than five-year vehicle registration case-control ratio (1.7) was higher than vehicle registration above 14 years old involving case- control ratio (0.58) that revealed under 5-year vehicle age cause accident at a 2.9: 1 rate. The RAIR of day time crash case-control ratio (1.3) was higher than night time crash (0.76) where day time crash caused accident at a rate of 1.7:1 rate (Fig 2.).

The conditional logistic regression compares crash responsible drivers(cases) versus non-crash responsible drivers(controls) using drivers related risk factors for crash at roundabout.

The age between 45 and 54 years had about four hold risk of crash responsibility compared to under 25 years old (OR= 3.9, 95%CI = 1.0 – 14.9). Taxi drivers (OR=2.5 95% CI=1.0- 5.9) were at higher risk of crash responsibility at roundabout crash compared to Automobile driving. The incorrect left turn had led to a significant association with responsible vehicle crash (OR = 2.6, 95% CI= 1.0 – 5.6) compared to following too close driving fault (Table 2.).

Table 2: Summary findings from conditional logistic regression model, Addis Ababa City, 2019

Parameter	Wald x2	Odds ratio	95%Wald confidence limits		P - value
Age in year					
< 25	5.092				.278
25 – 34	.981	2.141	.475	9.652	.322
35 – 44	3.190	3.288	.891	12.136	.074
45 – 54	3.939	3.904	1.017	14.98	.047
>54	3.108	3.881	.859	17.526	.078
Type of license					
Automobile	9.724				.045
Public	3.422	2.200	.954	5.070	.064
Light truck	.069	1.127	.463	2.741	.792
Taxi	4.414	2.506	1.064	5.904	.036
Heavy truck	.262	1.322	.454	3.850	.609
Cause of crash					
Following too close	8.440				.077
Careless driving*	4.306	2.630	1.055	6.553	.038
Block overtaking car	.327	1.325	.505	3.479	.567
Incorrect left turn	4.252	2.629	1.049	6.589	.039
Incorrect right turn	.622	1.594	.501	5.075	.430
Vehicle age in year:					
< 5	5.451				.244
5 – 9	1.043	.635	.266	1.517	.307
10 – 14	2.422	.531	.240	1.178	.120
15 – 19	2.626	.466	.185	1.173	.105
>19	4.810	.296	.100	.879	.028
Hour of a day: Day hour	5.626	1.710	1.09	2.663	.018

*Incorrect reverse, crashing parked car, breaking signal, uncontrolled speed, incorrect starting, move on illegal path.

The vehicle older than 19 years significantly decreased the risk of responsible vehicle crash by 70% compared to vehicle younger than 5 years (OR= 0.3, 95%CI = 0.1 – 0.88). A driver having day time crash was at higher risk of vehicle crash responsibility compared to night time vehicle crash at roundabout (OR = 1.7, 95% CI = 1.1 – 2.7) (Table 2).

Following development of the main effect model and confirmation of the preceding risk factors, the regression analysis explored the possible significant interactions between the risk factors. It was found that there were three interaction factors associated with at round about crash. These were interaction between young age and diving fault of driver (p-value for interaction = 0.001), middle age and diving fault of driver (p-value for interaction = 0.001), and vehicle age and incorrect left turn diving fault (p-value for interaction = 0.001). The other interaction were vehicle age and careless driving (p-value for interaction = 0.030) and careless driving and driving license type (p-value for interaction = 0.03).

Figure 3 shows the effects of the interaction factors by relative accident involvement ratios. The results showed that the driving fault difference was mainly presented in the young and middle age groups. The result revealed that young and middle age group were more likely to incur at roundabout crashes during obstructing overtaking vehicle fault than careless driving fault. The driving fault effects were different in vehicle age groups.

For vehicle age less than five years and ten to fourteen years, roundabout crashes were more likely to occur during following too closely driving fault and obstructing the overtaking vehicle than incorrect left turn and careless driving fault, respectively. The results showed the interaction effect between driving fault and type of driving license. `During incorrect left turn driving fault, roundabout crashes were more likely to happen with light truck driving license drivers than drivers with heavy truck driving license.

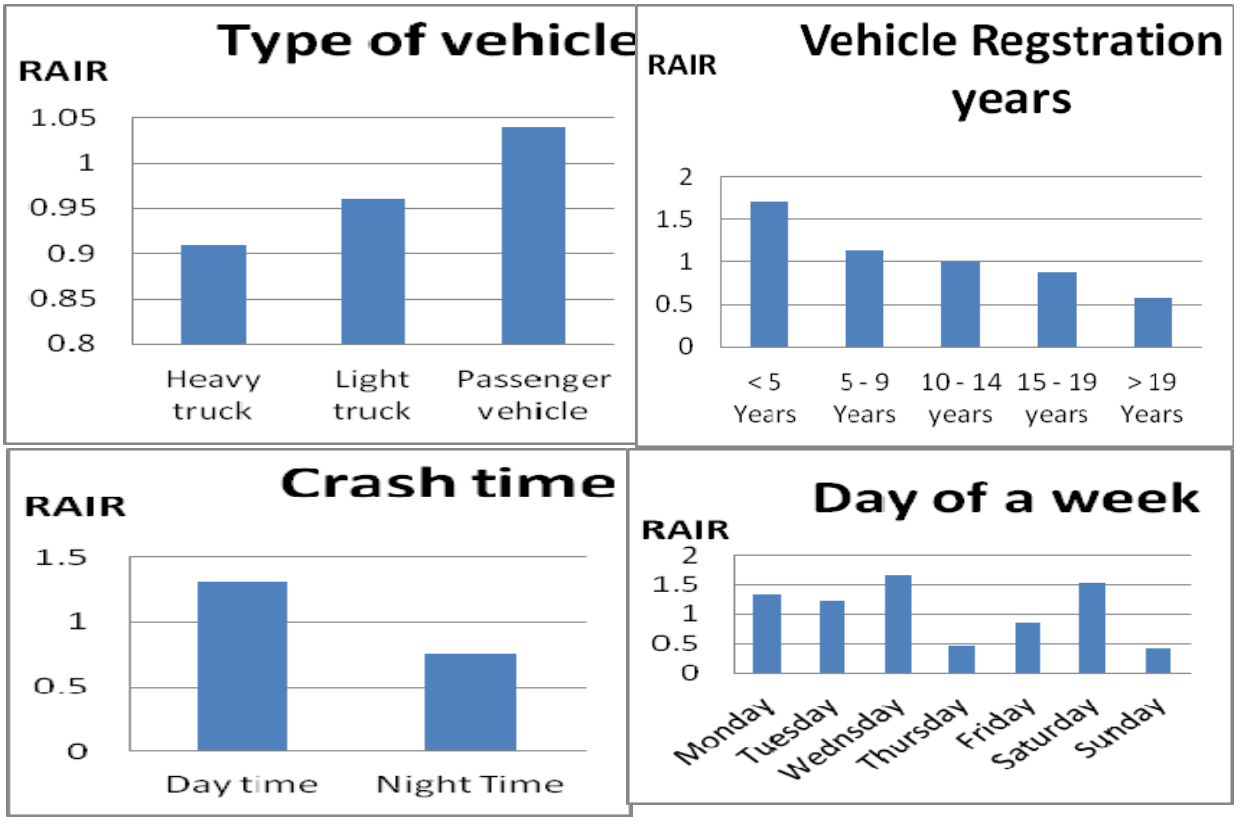


Figure 2: Relative accident involvement ratios by vehicle/environment characteristics

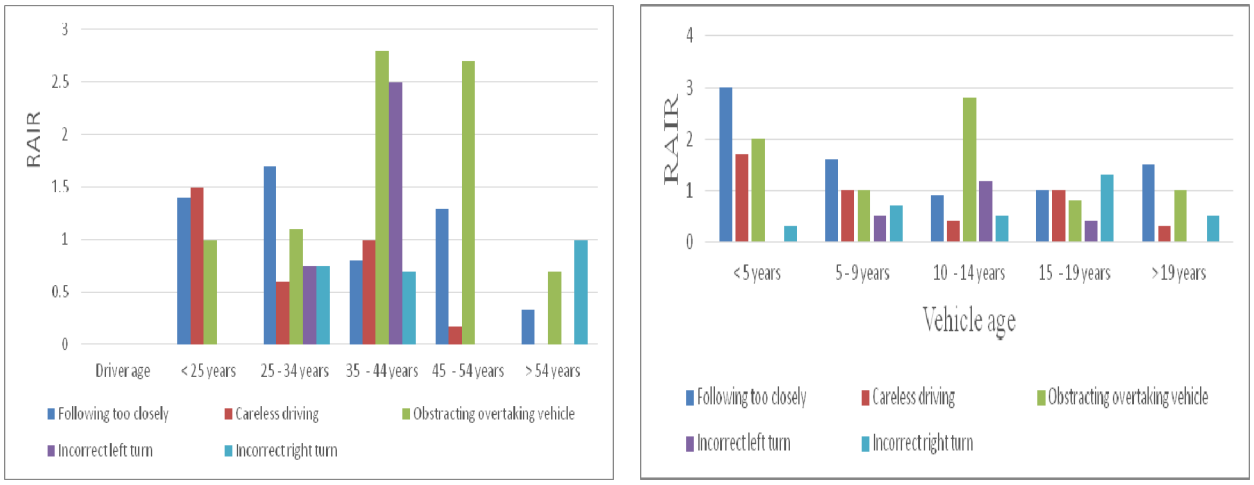
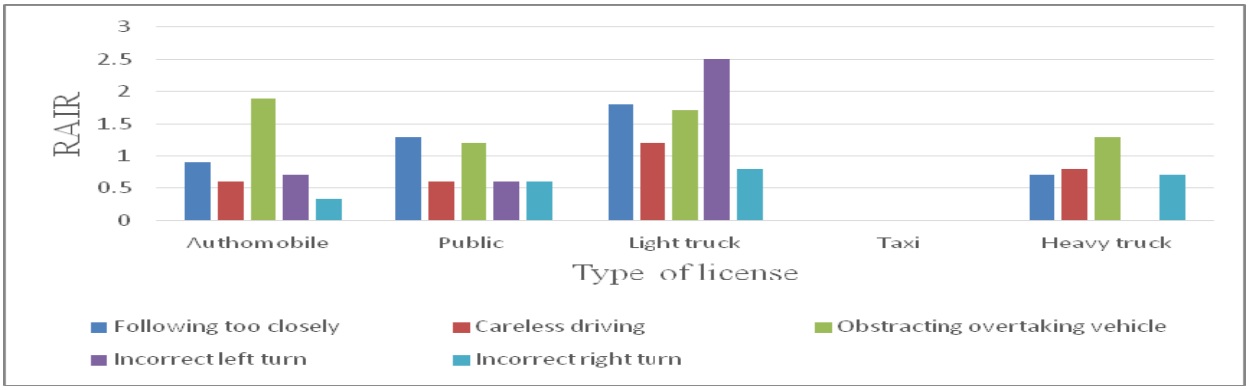


Figure.3: Effects of interaction factors by relative accident involvement ratios



DISCUSSION

In this study, higher risk for crash were associated with being men, middle age between 45 and 54 years, light truck licensed driver, day time driving, and being newer vehicle driver.

The study points out that the RAIR of middle age groups between 45 to54 years incurred larger crash propensity than younger age, This finding is in agreement with those of the previous studies conducted in Romania and Nigeria (14,16) in which younger age group was responsible for the crash. One possible explanation for the difference might be linked with the difference in study design where the previous study (7, 14) used the data that involved mainly vehicle with pedestrian crash rather than vehicle to vehicle rash. Our study used vehicle to vehicle crash that was paired by collusion. Therefore, in paired by collusion the groups between 45 to 54 years and the female sex prevent crash. The middle age highly involvement may be attributed to the fact that the middle age group driving fault occur due to their more engagement in commercial activity that can divert and decrease the attention of control driving.

The most frequent driving fault by which large proportion of crash responsible driver(case) involved were blocking overtaking vehicle driving path and driving by following other vehicle too close. Whereas, the most frequent driving fault that mainly victimized controls were careless driving fault and left turn driving fault. This finding was inconsistent to the previous study conducted in Addis Ababa(18). Thus the finding suggests that victims incurred in crash innocently due to other driver who turn vehicle to illegal path and drive carelessly.

RAIR of the responsible driver characterized by like blocking overtaking vehicle driver path and incorrect left turn was higher risk for crash. This finding is in line with finding of previous study conducted in United State of America (1, 13). This may be explained by the fact that drivers moving on the left side in narrow roundabout may face the problem of vehicle crash occurrence. Therefore, this study indicated that the majority of road traffic crash at roundabout frequently occurs due to the driving fault that lack careful controlling of road traffic.

There were higher RAIR of crash for vehicles less than 10 years of vehicle registration this finding was inconsistent with the study conducted in the earlier study (12). The vehicles older than 19 years significantly decrease the risk of responsible vehicle crash.

This finding is in agreement with thie findings of other studies conducted in Addis Ababa(17) , which showed fatal accident associated with more experienced driver. In contrast to study conducted in Mekele and Bahirdar(9,17) . The possible explanation could be as driver become user friendly for driving vehicle he/she may consider that comfort not to be reversed by crash risk factor. RAIRs for the large-size vehicle drivers presented the lowest crash risk. This finding was similar to that of other study conducted in Florida (13). This finding suggests that the latest vehicles may require a driver who was familiar with the vehicle part having latest technology to drive automatically compared to driver who drive manually for older vehicles.

Day time driving was significantly a higher risk of vehicle crash at roundabout compared to night time driving. This finding is in Agreement with that of a study conducted in United Kingdom(UK) (11), but in contrast to the study conducted in Australia and France(10, 16). The possible explanation is that in our setting there was limited traffic crash controlling mechanism at night time to visualize the at fault driver. Male drivers (51.5%) experienced a larger increase in crash risk during night time than female drivers (23.5%). This may be due to making more night trips by males than females.

The study explored the possible significant interactions between the risk factors associated with at round about crash by relative accident involvement ratios that show young and middle age group are more likely to incur at roundabout crashes during obstructing overtaking vehicle fault than careless driving fault. ` This may be attributable to the fact that roundabout traffic is very congested in Addis Ababa. As a result, driver may incur risky driving behavior for instance obstructing overtaking vehicle path by racing with vehicles. During incorrect left turn driving fault, roundabout crashes are more likely to happen with light truck driving license drivers than drivers with heavy truck driving license. This result is in contract to a that of a study conducted in Florida (13). The result suggested that the risk of driving fault for crash increased with light truck driving license.

The study minimizes bias by eliminating respondents who participate in single-vehicle, three-or-more-vehicle, and two-vehicle crashes with both-at-fault, two vehicle crashes with both-not-at-fault drivers, driver who sustained a fatal or incapacitating injury and required emergent medical treatments.

To determine crash fault driver, this study considers specific hazardous driving behavior (like care-less driving, unsafe speed, failure to yield the right of way, following too closely). The study also avoids non-driving behaviors (like drinking or driving with a suspended/revoked license, unbuckled seatbelt to avoid negative halo effect) in order to avoid inflation risk involvement ratio. Moreover, in this study, driver's citation was issued by traffic police officer judgment. Since, the hand-written crash reports filled by the investigating officers at the crash scene along with sketches plan that was examined and decided in office by the relevant authorities were issued.

This study has a number of limitations. Primarily, the data were collected where the crash victims has been in physical and psychological stress situation that can limit recalling the exact measure of crash event. Secondly, a fatal or severely injury that required emergent medical treatments was not included that may lead to crash proneness bias, which could underestimate the risk involvement for the corresponding driving group. Thirdly, aggressive drivers were not interested to restate the crash event fully that may under estimate crash risks. Lastly the condition of road and vehicle, and drivers' level of fatigue, crash type, driver's drug or alcohol level were unmeasured that may lead to under estimation.

Conclusion

Majority of road traffic crash risk at roundabout were linked manly with being male driver, younger vehicle, the driving fault (moving on illegal path, blocking the other overtaking vehicle path and following another vehicle too closely).

The association of careless driving fault with responsible vehicle crash was modified by the vehicle age 4 -9 years. Young and middle age group are more likely to incur at roundabout crashes during obstructing overtaking vehicle fault than careless driving fault. During incorrect left turn driving fault, roundabout crashes are more likely to happen with light truck driving license drivers than drivers with heavy truck driving license.

Therefore, proper use of road signal at roundabout intersection driving with more visible marking for clear view of location and obeying lane marking are crucial. There should be total enforcement of traffic rules and regulation to correct error of drivers. Moreover, drivers should give more attention for blind spot to proceed cautiously when approaching roundabout to prevent crash. Further extensive and intensive cohort research using relevant technology tool like Camera, Vehicle test and Alcohol test are recommended.

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