MULTINOMIAL LOGISTIC REGRESSION ANALYSIS OF VEHICULAR ACCIDENT IN NIGERIA

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Abstract: Vehicular accidents are major problem in developing countries and Nigeria is no exemption to this worldwide dilemma. In Nigeria, transportation has been largely by road and this means of transportation is largely inefficient and defectives resulting in vehicular accidents. The study was carried out in Akure, Ondo state Nigeria. The data used in the study were collected by collating accident records obtain from the Ondo State specialist hospital for a five-year period from the year 2013 to 2017; the records were analyzed using the multinomial logistic regression model. The findings show that 67% of the accident victims were male having death rate of 12.8%, while 46% of the accident victims are in the ages between 14 to 40 years. The findings also revealed that majority of the accidents occurred between the between the 1st and 3rd quarter of each year while the 2nd quarter generally saw a decline in road traffic accidents. The likelihood ratio test reveals that there is a significant relationship between the nature of accident, gender, and age as they have p value less than 0.05. The study recommends establishment of government policies aimed at improving health care delivery to vehicular accident victims, road network should be provided with roadway infrastructures, improvements in pavement construction and maintenance, enforcement of legislation as related to vehicle speed, pedestrian usage of roads as it is believed when all these are adhered to, vehicular accidents will reduce.

Keywords: Vehicular accidents, transportation, road traffic, vehicle speed, pavement

Introduction

Transportation is vital for all human endeavors and significantly affects a societies operation. Transportation affects the existence and survival of any urban community considering the basis of interaction for commercial, leisure and residential activities of the societies are largely influenced by transportation (Zakaria, 2004). With different modes of transportation offering different levels of mobility under different situations, transportation by road has been the predominant mode of transportation in Nigeria and the deficiencies associated with it such as faulty designs and high levels of deteriorations have resulted in vehicular accidents. Vehicular accidents in developing countries is estimated to account for the death of about 1.24 million people with about 50 million people injured annually (Agbonkhese *et al.*, 2013). In Great Britain, over 230,000 people were either killed or injured in vehicular accidents in 2008 (Department for Transport, 2009) while in the United States, vehicular accident is regarded as the leading cause of death among young people between 14 and 24 years (Thompson, 1996) with about 3,000 people dying daily due to vehicular accident (Bin-Islamand Kanitpong, 2008).

Vehicular accident leads to global economic losses with estimated road traffic injury costs of US$518 billion per year (PAHO, 2004) and these huge economic losses are economic burdens for developing countries such as Nigeria. With 91% of the world's fatalities on roads occurring in low-income and middle-income countries with majority being vulnerable road users such as passengers, pedestrians and cyclists vehicular accidents needs to be prevented. Agbonkhese *et al.* (2013) posits that if vehicular accidents are not prevented, about 1.9 million peoples deaths will be recorded a annually by 2020 as only 7% of the world's population representing about 416 million people from 28 countries have adequate laws that address all five major risk factors which allows for vehicular accidents which are over speeding, drink-driving, helmets, seat belts, and child restraints with Nigeria being one of the countries without the required adequate laws that can help to efficiently mitigate against vehicular accidents.

Vehicular accidents refer to an accident that occurs when a vehicle collides with another vehicle, pedestrian, animal, road barriers or other stationary obstructions which may result in injury, death, vehicle and/or property damage (World Health Organization, 2013). The WHO (2001) posits that injuries resulting from vehicular accidents is the 9th leading cause of injury to individuals worldwide but if left unchecked, it will be the 3rd major cause of injury by the year 2020 as shown in Table 1.

Table 1: Top ten leading causes of disease/injury in 1998 and 2020

S/N	1998 Disease or Injury	2020 Disease or Injury
1	Lower respiratory infections	Ischaemic heart disease
2	HIV/AIDS	Unipolar major depression
3	Perinatal conditions	**Road traffic injuries**
4	Diarrhoeal diseases	Cerebrovascular disease
5	Unipolar major depression	Chronic obstructive pulmonary disease
6	Ischaemic heart disease	Lower respiratory infections
7	Cerebrovascular disease	Tuberculosis
8	Malaria	War
9	**Road traffic injuries**	Diarrhoeal diseases
10	Chronic obstructive pulmonary disease	HIV/AIDS

Source: WHO, Evidence, Information and Policy (2001)

Vehicular accidents are caused by four main factors namely: driver, vehicular, road pavement and environmental factors and the accidents can be caused by a single factor or a combination of these factors. Studies from countries such as Saudi Arabia has shown that in year 2013, 91% of all accidents involved driver factors, 7% accounted for vehicle factors, and 2% were associated with roadway/environments (Yazan, 2016). Hendriks *et al.* (1999) revealed that vehicular accident causation factors can be categorized into driver behavior, vehicle condition, environment condition, and roadway condition among others and that driver behavior caused or contributed to 99% of the crashes investigated, with the six causal factors that accounted for most of the problem behavior in decreasing order of frequency, being driver inattention, vehicle speed, alcohol impairment, perceptual errors, decision errors and incapacitation.

Certain pedestrian behaviors such as walking along the roadway, crossing a roadway at a point other than the intersection, non-availability of pedestrian bridges have been found to be causes of vehicular accidents. Mechanical failures of vehicles such as tyre burst, brake failure and other vehicle factors significantly contributes to vehicular accidents. Road pavement factors such as pavement quality, shoulder availability, absence of traffic control devices and intersections, design speed and sight distances, roadway super elevations, ramps, medians and pavement markings have been found to contribute to vehicular accidents due to the absence or improper designs. Environmental related conditions such as fog, sunrays, mist and rain immensely contribute to vehicular accidents. During rainy season for example, wet pavements reduces friction between the vehicle tyres and the pavement surface, stagnant waters can lead to hydroplaning while environmental conditions such as smoke, fog or glare can greatly reduce visibility (Aworemi *et al.*, 2010) thereby causing vehicular accidents.

Nigeria is rated to have the second highest rate of road accidents among 193 ranked countries of the world with deaths from reckless driving being the third leading cause of death in Nigeria. Vehicular accidents are very prevalent in Nigeria such that (Ukoji, 2014) stated that apart from Boko Haram crisis, vehicular accident is a leading cause of violent deaths in the country. Injuries associated with vehicles as a mode of transport is growing at an alarming rate and constitutes a vital but neglected problem in developing countries such as Nigeria (Peden *et al.*, 2002).Thus, in this paper vehicular accident in Akure and its environs is analyzed while pragmatic approach that will reduce the menace is proposed.

Materials and Methods

The study was carried out in Akure which is a traditional Nigerian city, located within Ondo State in the South-Western part of Nigeria. The natural pattern of development is linear along its main roads viz Oyemekun-Oba Adesida road and Arakale-Oda road. The existing land use is characterized by a medium density of structure within the inner core areas.

Five years accident data used in the study were extracted from accident records of the Ondo State Specialist Hospital Akure from the year 2013 to 2017 giving a study sample size of four thousand and twenty-five (4025) victims and this was used to formulate a multinomial logistic regression model using Statistical Packages for Social Sciences (SPSS) version 22. The dependent variable (Nature of accident) has more than two categories while Gender, Age and Time of the year were the independent variables.

Results and Discussion

A total of four thousand and twenty-five (4,025) vehicular victims were discovered as shown in Table 2. There were 816 (20.3%) vehicular accident victims in 2013, 801 (19.8%) victims in 2014, 767 (19.1%) victims in 2015, 820(20.4%) victims in 2016 while, 821 (20.4%) cases were recorded in 2017. The decrease in the accident rates from 2013 to 2014 could be as a result of increase in road safety operations by government agencies charged with ensuring safety on the roads such as the Federal Road Safety Agency, improved road pavement conditions and favorable weather conditions in the year. The increase in accident rates from the year 2015 to 2016 and 2017 is attributed to non-adherence to traffic rules, over-speeding, and conflicting use of road by car/taxis and motorcycle operators. Fig. 2 shows the gender distribution of the vehicular victims while Fig. 3 is the nature of accident distribution of vehicular accident victims.

The results show that 2,697 (67%) of the victims were male while 1,328 (33%) were female. This shows that there were more of male accident victims in the study area as shown in Fig. 1.

The distribution of the accident victims according to the nature of accident indicate that 1,566 (38.9%) had laceration, 1,545 (38.4%) had injury, 398 (9.9%) had dislocation while 516 (12.8%) died as a result of the vehicular accident. Fig. 4 shows the age distribution of vehicular accident victims.

Table 2: Distribution of vehicular accident victims

Year		2013	2014	2015	2016	2017	Total
Variable		**F (%)**	**F (%)**	**F (%)**	**F (%)**	**F (%)**	**F (%)**
Gender	**Male**	535 (65.6)	542 (67.7)	527 (68.7)	563 (68.7)	530 (64.6)	**2697 (67.0)**
	Female	281 (34.4)	259 (32.3)	240 (31.3)	257 (31.3)	291 (35.4)	**1328(33.0)**
Nature of Accident	**Laceration**	357 (43.8)	331 (41.3)	360 (47.0)	272 (33.2)	246 (30.0)	**1566(38.9)**
	Injury	369 (45.2)	263 (32.3)	285 (37.2)	310 (37.8)	318 (38.7)	**1545(38.4)**
	Dislocation	32 (3.9)	83 (10.4)	52 (6.8)	100 (12.2)	131 (16.0)	**398(9.9)**
	Death	58 (7.1)	124 (15.5)	70 (9.1)	138 (16.8)	126 (15.3)	**516(12.8)**
Age	**0-15**	147 (18.0)	129 (16.1)	227 (29.6)	250 (30.5)	153 (18.6)	**906(22.5)**
	16-40	420(51.5)	420 (52.4)	287 (37.4)	304(37.1)	419 (51.0)	**1850(46.0)**
	40 and above	249 (30.5)	252 (31.5)	253 (33.0)	266 (32.4)	249 (30.3)	**1269(31.5)**
Total		**816 (20.3)**	**801 (19.8)**	**767 (19.1)**	**820 (20.4)**	**821 (20.4)**	**4025**

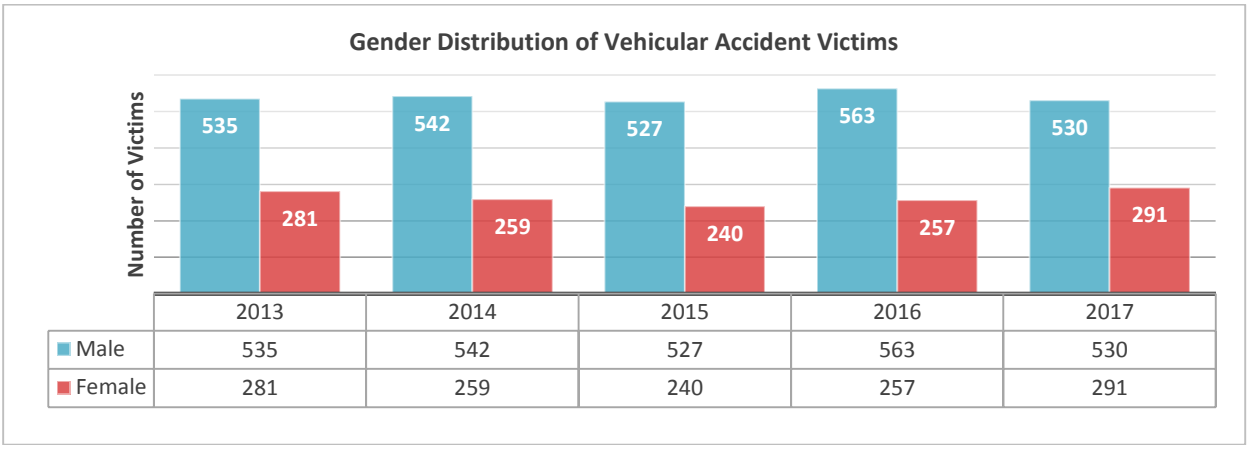

Fig. 2: Gender distribution of vehicular accident victims

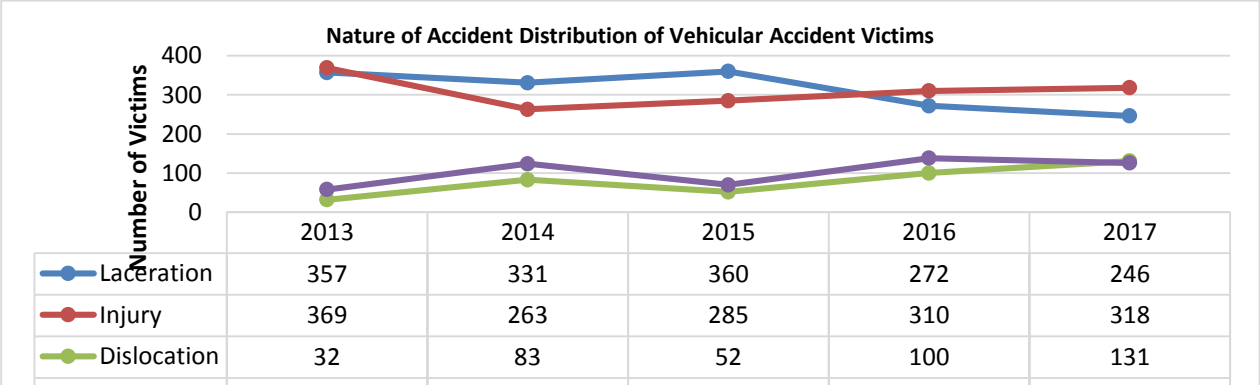

Fig. 3: Nature of accident distribution of vehicular accident victims

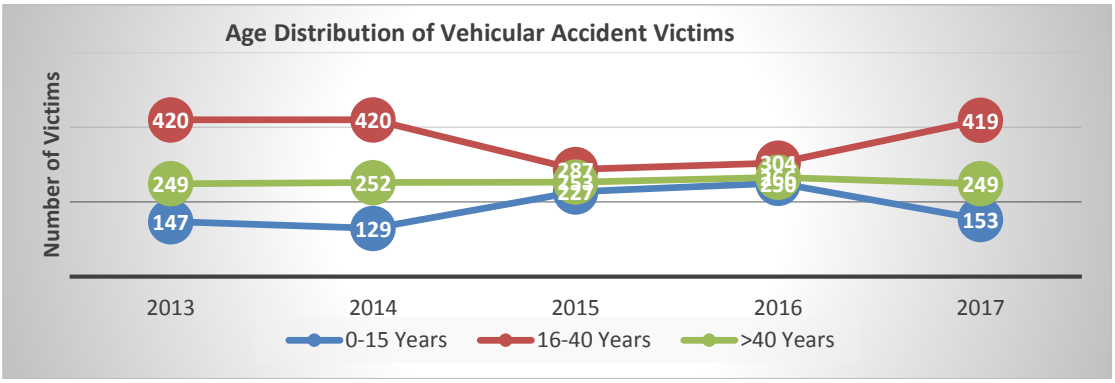

Fig. 4: Age distribution of vehicular accident victims

The distribution of the vehicular accident victims according to age shows that 905 (22.5%) victims were between the age 0-15 years, 1,850 (46%) of the victim were between the age of 16-40 years while 1,269 (31.5%) of the victims were 40 years old and above.

Table 3: Distribution of vehicular accidents according to the time of the year

Year		2013	2014	2015	2016	2017	Total
Variable		F (%)	F (%)	F (%)	F (%)	F (%)	F (%)
1st Quarter	January – April	319 (39.1)	266 (33.2)	303 (39.5)	250 (30.5)	310 (37.8)	**1448 (36.0)**
2nd Quarter	May – August	203 (24.9)	255 (31.8)	200 (26.1)	244 (29.8)	203 (24.7)	**1105 (27.4)**
3rd Quarter	Sept. – December	294 (36.0)	280 (35.0)	264 (34.4)	326 (39.7)	308 (37.5)	**1472 (36.6)**
Total		**816 (20.3)**	**801 (19.9)**	**767 (19.1)**	**820 (20.4)**	**821 (20.4)**	**4025**

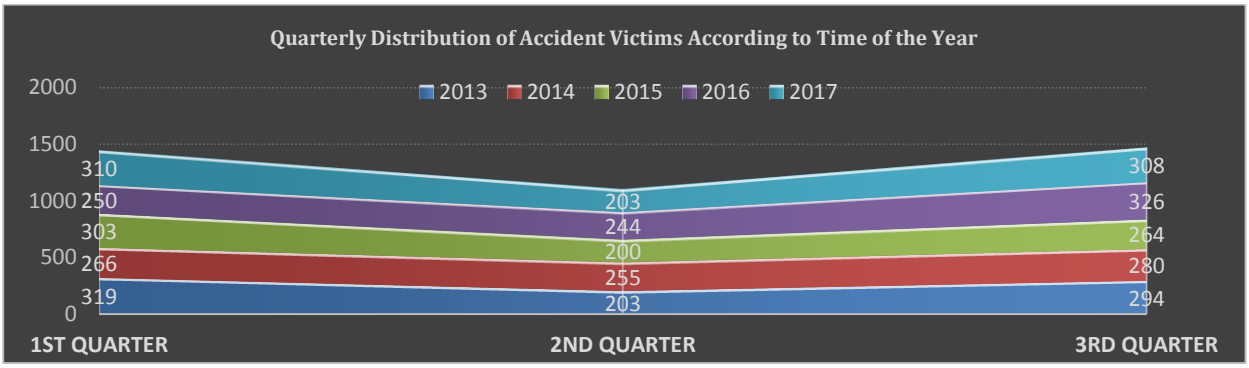

Fig. 5: Quarterly distribution of accident victims according to time of the year

As shown in Table 3 and Fig. 5, there were more accidents in the 1st quarter of year 2013 (319 victims), year 2014 had more accident victims in the 3rd quarter (280 victims), year 2015 had more victims in the 1st quarter (303 victims), year 2016 had more victims in the 3rd quarter (326 victims) while year 2017 had more victims in the 1st quarter. Generally, there was a decline of accident victims in the 2nd quarters for all the years. Increased accidents in the 1st and 3rd quarter could be as a result of it being a festive and seasonal period which leads to increased road traffic and higher tendency for drivers to over speed so as to engage in more journeys and therefore make more money. Within these periods, people travel to celebrate with their loved ones. Also, environmental factors play a dominant role in accidents during these periods as it witnesses the harmattan and raining seasons which reduces visibility of the drivers on the roads.

Summary of regression model

Table 4 is the summary of the model fitting for the accident data from 2013 to 2017 in the study area.

From Table 4, the "-2log Likelihood" is a product of -2 and the log likelihood of the null and fitted final model. It tells whether the variables added significantly improve the model compare to the intercept alone. Since we have a sig. value 0.00 which is less than 0.05, the independent variable is shown to significantly affect the dependent variable. This means the final model predicts the dependent variable better than the intercept only model.

The likelihood ratio test

Table 5 shows which of the variables had a significant effect on the dependent variable. It is shown that both sex and age have an effect on the nature of accident (dependent variable) because they have a p value less than 0.05.

Table 4: Model fitting information

Model	Model Fitting Criteria -2 Log Likelihood	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept Only	151.202			
Final	114.869	36.333	9	.000

Table 5: Likelihood ratio tests

Effect	Model Fitting Criteria -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept	114.869[a]	.000	0	.
Sex	123.264	8.395	3	.039
Age	142.639	27.770	6	.000

Table 6: Parameter estimates test

Nature of accident		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
Laceration (Intercept)		.922	.148	38.563	1	.000			
Gender:	Male	-.383	.141	7.339	1	.007	.682	.517	.900
	Female	0[b]	.	.	0[b]	.	.	.	.
Age:	0-15 Years	.642	.165	15.166	1	.000	1.900	1.376	2.625
	16-40 Years	.310	.153	4.121	1	0.042	1.363	1.011	1.839
	>40 Years	0[b]	.	.	0[b]	.	.	.	.
Injury (Intercept)		.976	.147	43.966	1	.000			
Gender:	Male	-.212	.141	2.250	1	.134	.809	.613	1.067
	Female	0[b]	.	.	0[b]	.	.	.	.
Age:	0-15 Years	.214	.166	1.667	1	.197	1.239	.895	1.714
	16-40 Years	.318	.149	4.576	1	.032	1.375	1.027	1.841
>40 Years		0[b]	.	.	0[b]	.	.	.	.
Dislocation (Intercept)		-.251	.188	1.791	1	.181			
Gender:	Male	-.178	.177	1.015	1	.314	.837	.592	1.183
	Female	0	.	.	0	.	.	.	.
Age:	0-15 Years	.290	.210	1.896	1	.169	1.336	.885	2.018
	16-40 Years	.349	.190	3.385	1	.066	1.418	.977	2.056
>40 Years		0[b]	.	.	0[b]	.	.	.	.

a = The reference category is: death; **b** = This parameter is set to zero because it is redundant.

Parameter estimate test

This table (Table 6) shows how each of the different categories of the independent variable affects the dependent variable. Parameters with negative values in the beta (B) column decreases the likelihood of that category compared to the reference group while positive values increase the likelihood. For the variables, nature of accident (NOA) has four categories: laceration, injury, dislocation and death. Sex has two categories: male is 1, female is 2. Age has three categories: low, medium and high. The fifth column tells us about the significance of each category with respect to the reference group. The next column which is the Exp(B) tells us about the odds ratio. The second column; the beta B, tells us about the odds of selecting a category compared to another.

The three equations that can be gotten from the above output are written below. Kindly keep in mind that the reference group for the dependent variable is "nature of accident" or NOA.

$$In\left(\frac{P(NOA = laceration}{P(NOA = death}\right) = 0.922 - 0.383(Gender) + 0.642(Age) + 0.310(Age)$$

$$In\left(\frac{P(NOA = injury}{P(NOA = death}\right) = 0.976 - 0.212(Gender) + 0.214(Age) + 0.318(Age)$$

$$In\left(\frac{P(NOA = dislocation}{P(NOA = death}\right) = -0.251 - 0.178(Gender) + 0.290(Age) + 0.349(Age)$$

Conclusion and Recommendations

The study in conclusion has shown the variables (gender, age, time of the year) have significant relationships with accidents in the city. The study shows that majority of the accident victims were male, with a death rate 12.8%, with majority of the vehicular accident victims between the ages of 14-40 years and majority of the accidents occurred between the 1st and 3rd quarter of each year while the 2nd quarter generally saw a decline in road traffic accidents.

The study recommends establishment of government policies aimed at ensuring treatment of accident victims immediately in hospitals even when they are without cash through the establishment of a road accident relief scheme. Also, the road network should be provided with roadway infrastructures such as medians, pavement markings, bus stops, street lightings, traffic control devices as this will help ensure safety on the roads. The road pavement condition should be enhanced and free from pavement distresses with appropriate maintenance being carried out immediately a pavement distress is observed. Finally, constant awareness on the dangers of non-adherence to traffic rules and other vehicular/road safety measures should be carried out by all relevant bodies with checks to ensure compliance carried out as it is believed when all these factors, rules and practices are adhered to, vehicular accidents is bound to reduce.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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