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Analysis of Road Traffic Accidents in Nigeria: A Case Study of Obinze/Nekede/Iheagwa Road in Imo State, Southeastern, Nigeria

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ABSTRACT

The increasing level of road traffic accident in Imo State and the consequent injuries and deaths strengthened the case for its regular analysis. Data on recorded cases of road traffic accidents were collected from the Motor Traffic Division (MTDRTR), the Nigerian Police Force, Divisional Headquarters Umuguma, Owerri West, Imo State Police Command. Using the method of time series decomposition, traffic road accidents were characterized to have an upward trend and significant seasonal influences. Using chi-square test of significance, it was discovered that there were significant differences among the various causes of accidents and accident cases (Minor, fatal and serious) with respect to types of vehicles involved over the years. Out of 5921 accident cases, reckless driving, inexperience and mechanical fault and road defects accounted for 30.3, 21.5 and 21.1%, respectively. Two motorcycles, motorcycle-vehicle and vehicle-vehicle crashes are the lead types and have resulted in 38.9, 37.5 and 14.9% of the total of 855 deaths recorded within the period of study. Furthermore, it was also found that private cars, minibuses and taxis accounted for most of the accidents with 94.7% of the total accidents.

Key words: Road traffic accidents, time series analysis, Chi-square test, marascuillo test procedure, imo state, Nigeria

INTRODUCTION

A Road Traffic Accident (RTA) is when a road vehicle collides with another vehicle, pedestrian, animal or geographical or architectural obstacle. The RTAs can result in injury, property damage and death. RTA results in the deaths of 1.2 m people worldwide each year and injures about 4 times this number (WHO, 2004). In this study, a road traffic accident is defined as accident which took place on the road between two or more objects, one of which must be any kind of a moving vehicle (Jha *et al*., 2004). Road Traffic Accidents (RTAs) are increasing with rapid pace and presently these are one of the leading causes of death in developing countries.

The morbidity and mortality burden in developing countries is rising due to a combination of factors, including rapid motorisation, poor road and traffic infrastructure as well as the behavior of road users (Nantulya and Reich, 2002). This contrasts with technologically advanced countries where the indices are reducing (Oskam *et al*., 1994; O'Neill and Mohan, 2002).

Imo State, a slight heavily motorized country with poor road conditions and transport systems has a high rate of Road Traffic Accidents (RTAs) and the tendency is on the increase. The recognition of RTA as a crisis in Nigeria inspired the establishment of the Federal Road Safety Commission (FRSC).

The FRSC was established by the government of the Federal Republic of Nigeria vide Decree 45 of 1988 as amended by Decree 35 of 1992, with effect from 18th February, 1988. The Commission was charged with responsibilities for, among others, policymaking, organization and administration of road safety in Nigeria.

As can be seen from the trend over a 15-year period (1971-1985) (Asogwa and Obionu, 1986), legislative and other countermeasures such as the establishment of FRSC and the Vehicle Inspection Officials (VIO) have not recorded spectacular achievement. Records still show that RTA in Nigeria requires attention.

For developing measures aimed at reducing the rate of RTA and the consequent injuries and fatalities, there is a need for regular evaluation of the RTA in terms of the trend, major causes, vehicles involved and types among other factors and this is the purpose of this study.

According to AUSTROADS (1994), road accidents occur as a result of one, or more than one of the following factors: Human factors; Vehicle factors; Road and environmental factors. Driving faster or slower than the flow of traffic-which may or may not accord with the posted speed limit-has robustly been demonstrated to increase the likelihood and severity of crashes, as shown by the Solomon Curve (OOIDA, 2003).The factors of traffic accidents are driver, the highway and motor vehicles (Aaron and Strasser, 1990; Balogun and Abereoje, 1992; Luby *et al*., 1997; Mock *et al*., 1999). Most traffic accidents often involve the three elements. Most RTAs involve motor vehicles but Bicycles or Pedestrians accidents can occur without vehicles (Stutts and Hunter, 1999). A high proportion of RTAs can be apportioned to unsafe human acts. The drunken drivers of motor vehicles make the clearest example (Hijar *et al*., 2000). Reckless and dangerous driving, alcoholism, faulty pedestrian attitude, etc constitute the major causes in Nigeria (Ezenwa, 1986; Odero, 1998).

Eke *et al*. (2000) using data collected form University of Port Harcourt Teaching Hospital (UPTH) from January 1986 to December 1995 found that 70% of total accidents in Port Harcourt, Nigeria occurred during the rainy seasons and that most accidents occurred during the weekends. They went further to recommend that the roles of road users and agents responsible for keeping the roads safe should be defined so that responsibility for mishaps can be apportioned.

This study follows the same path and analyses data on the reported number of RTAs for the period 2000-2008 along (Obinze/Ihegwa/Nekede) road in Owerri West Local Government Area (LGA), Imo State, Southeast Nigeria, collected from the Motor Traffic Division (MTDRTR), of the Nigerian Police Force, Divisional Headquarters Umuguma Owerri West Imo State Police Command.

The Obinze/Ihegwa/Nekede road is approximately a 26 km road that leads to Federal University of Technology, Owerri (FUTO), Federal Polytechnic, Nekede and Imo State Polythecnic (former College of Agriculture) from Owerri, the capital city of Imo State and as a result is very busy and hugely important to Imo State and Federal Governments. Considering the importance of the road and the increased level of RTAs in recent years along the road, there is need for this study aimed at characterizing the RTA to provide an enabling base for the development of countermeasures by the Government and the Traffic control agents to reduce the incidences of RTA.

MATERIALS AND METHODS

Data for the study were collected on monthly basis from the Motor Traffic Division (MTDRTR), the Nigerian Police Force, Divisional Headquarters Umuguma, Owerri West, Imo State Police Command for the period January 2001 December 2008. The data were classified into types (minor, serious and fatal), cause, types of vehicles and number of persons involved.

Considering that the data is a time-sequence data collected at regular interval (monthly), we would adopt the technique of time series analysis in analyzing the data. Descriptive statistics would also be used to summarize the data.

Time series analysis refers to that body of principles and techniques, which deal with analysis of the observed data X_t , t = 1, 2, ...n. Usually the data are analyzed in order to gain an understanding of the underlying generating mechanism of the process, X_t, $t \in Z$ (Delurgio, 1998; Priestley, 1981). Since the emphasis on time series analysis is on model building, the following model are always considered.

$$\text{Additive: } X_t = T_t + S_t + C_t + I_t \tag{1}$$

$$\text{Multiplicative: } X_t = T_t * S_t * C_t * I_t \tag{2}$$

Or the Multiplicative model with additive error (irregular) component given by:

$$X_t = T_t * S_t * C_t + I_t \tag{3}$$

where for time t, X_t denotes the observed value of the series, T_t is the trend, S_t the seasonal component, Ct the cyclical component and I_t, the irregular component of the series (Chatfield, 2004; Kendall and Ord, 1990). Model (3) may also be grouped under mixed models. Considering the short period of time involved in this study, the cyclical component is superimposed into the trend and we obtain a trend-cycle component denoted by M_t (simply referred as trend). In this case Eq. 1-3, respectively become,

$$X_t = M_t + S_t + I_t, t = 1, 2, ..., n \tag{4}$$

$$X_t = M_t * S_t * I_t, t = 1, 2, ..., n \tag{5}$$

$$X_t = M_t * S_t + I_t, t = 1, 2, ..., n \tag{6}$$

For our choice of model, the data would speak for itself.

The data on monthly RTAs is presented in a two dimensional table (Buys-Ballot Table (Buy-Ballot, 1847) accessed in Wei 1989 in Table 1. A time series plot of the data is shown in Fig. 1, while the plots of the yearly mean and standard deviations are shown in Table 1.

From Table 1, the series is can be seen to have seasonal effects with a slight upward trend. There is an upsurge of the series, though of varying magnitude in the months of January and December. In Table 1, it is seen that the standard deviation is not stable and mimics the mean. It increases with the mean suggesting a multiplicative model. Minitab was used to decompose the data into its components namely; the trend, seasonal and irregular (residuals) components as well as

Table 1: Number of accidents by months

	Year								
Months	2001	2002	2003	2004	2005	2006	2007	2008	Total
Jan.	62	50	78	186	207	301	304	287	1475
Feb.	7	6	8	49	51	47	74	62	304
Mar.	5	2	8	27	48	27	23	26	166
Apr.	8	4	5	15	27	36	28	24	147
May.	5	12	14	38	46	85	82	67	349
June	10	23	12	16	86	64	58	46	315
Jul.	7	18	20	17	27	23	26	22	160
Aug.	19	27	11	74	22	19	27	27	226
Sept.	7	35	16	62	28	12	19	14	193
Oct.	32	39	28	81	60	80	40	60	420
Nov.	27	15	30	22	58	69	63	71	355
Dec.	76	74	167	332	225	315	375	247	1811
Total	265	305	397	919	885	1078	1119	953	GT = 5921
Mean	22.8	25.4	33.1	76.6	73.7	89.8	93.3	79.4	GM = 61.7
SD	23.8	21.3	46.5	93.5	69.0	104.8	117.9	90.2	

Note: GT: Grand total, GM: Grand mean

Table 2: Type of accident cases by type

	Fatal		Serious		Minor		Total	
Type. of Acc1	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	P_t
McMc	333	38.9	935	45.0	1412	47.2	2680	0.45
McV	321	37.5	597	28.7	1212	40.5	2130	0.36
VV	127	14.9	474	22.8	365	12.2	966	0.16
VP	38	4.4	57	2.7	0	0.0	95	0.02
McP	20	2.3	14	0.7	0	0.0	34	0.00
VByc	16	1.9	0	0.0	0	0.0	16	0.00
Total	855		2077		2989		5921	

χ^2_{value}= 359.81 and $\chi^2_{6, 0.05}$ = 12.59, Note: For the Chi-square test to be performed, the rows-VP, McP, VBcy were pooled to VV

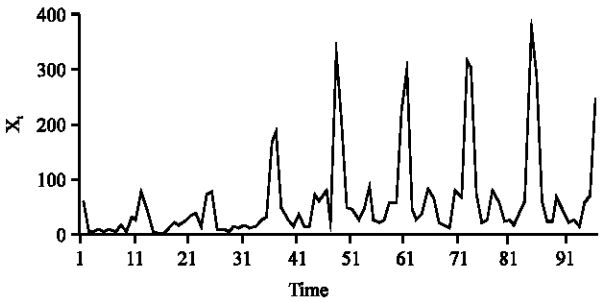
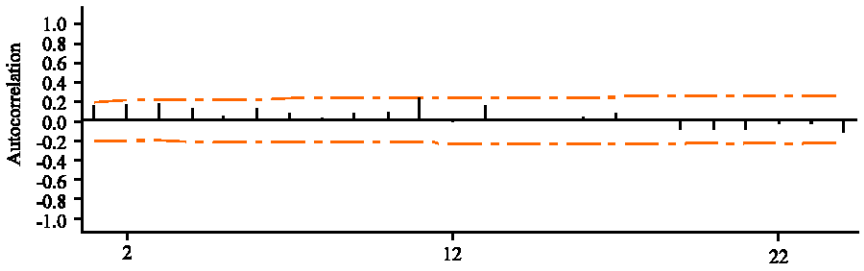


Fig. 1: A time series plot the road accident data (X_t)

plotting the ACF of the residual series. In order to ascertain the adequacy of the fitted model, we assessed the (ACF) of the residual series I_t (X_t -(M_t *S_t)) (Table 2). For model adequacy at 5% level of significance, the autocorrelation coefficients are all expected to lie in the interval:



Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ
1	0.16	1.58	2.57	8	0.02	0.20	12.12	15	0.00	0.03	22.94	22	-0.05	-0.37	27.78
2	0.18	1.70	5.73	9	0.07	0.63	12.67	16	0.01	0.11	22.96	23	-0.05	-0.38	28.07
3	0.17	1.57	8.60	10	0.10	0.88	13.77	17	0.08	0.68	23.79	24	-0.14	-1.10	30.57
4	0.12	1.06	10.00	11	0.24	2.05	19.93	18	-0.00	-0.01	23.79				
5	0.03	0.28	10.10	12	-0.02	-0.18	19.98	19	-0.10	-0.82	25.02				
6	0.11	0.95	11.28	13	0.16	1.34	22.93	20	-0.10	-0.79	26.21				
7	0.09	0.77	12.07	14	-0.01	-0.01	22.93	21	-0.10	-0.82	27.52				

Fig. 2: ACF of the residual series

$$\pm\frac{1.96}{\sqrt{n}}=0.20$$

where, n is the number of observations. The ACF of the residual series with the autocorrelation coefficients at various lags are shown in Fig. 2. It is clear from Fig. 2 that all the coefficients lie within the interval except at lag 11 whose value is 0.24. However, there is not enough evidence to reject the model at 5% level of significance since there is only one value and did not occur at the seasonal lag or multiples of it. For detailed discussion of residual analysis (Ljung and Box, 1978; Box *et al.*, 1994).

The categories (Fatal, Serious and Minor) of RTAs by types are shown in Table 2. Using Chi-square test, it was established that there is a significance difference between the various categories of RTA by types since the test statistic (80.53) exceeds the critical value of χ^2 with 42 degrees of freedom at 5% level of significance ($\chi^2_{42,\ 0.05}$ = 58.14). It is obvious from Table 2 that out of the 5921 incidences of RTAs, two-Motorcycle-crash (McMc) came across the other types of RTA with 45.3%, followed by Motorcycle-Vehicle (McV) and vehicle-Vehicle (VV) with 36.0 and16.3%, respectively. In terms of fatality McMc and McV came on top with 38.9 and 37.5%, respectively followed by VV with 14.9%.

Data on causes of RTAs by types are presented in Table 3 while that of vehicles involved is presented in Table 4. Using Chi-square test, it was established that there is a significance difference between the various causes of RTA over the years since the test statistic (80.53) exceeds the critical value of χ^2 with 35 degrees of freedom at 5% level of significance ($\chi^2_{35,\ 0.05}$ = 49.73). Using Marascuillo test procedure (SEMATECH, 2003) to compare the various proportions of the RTA by causes, significant differences were discovered between the proportion caused by reckless driving (P_1) and those of inexperience (P_2), Mechanical fault and bad road (P_3) and unknown causes (P_5) and also between P_2 Vs P_5 and P_3 and P_5 (Table 6). From Table 3, reckless driving accounted for greater number of the RTAs with 30.3% followed by inexperience and mechanical fault and bad road accounting for 21.5 and 21.1%, respectively. There is no significant difference between the proportions caused by inexperience and mechanical fault and bad road as shown in Table 6.

Table 3: Number of accidents by cause

	Year									
Causes	2001	2002	2003	2004	2005	2006	2007	2008	Total	P_t
Reckless driving	50	74	123	257	296	430	281	284	1795	0.30
Inexperience	63	31	90	148	150	220	350	223	1275	0.22
Mechanical fault and bad road	54	78	98	113	104	300	233	269	1249	0.21
Pedestrian crossing	10	7	8	65	18	11	19	46	184	0.03
Unknown cause	56	52	31	210	184	100	224	320	925	0.16
Other causes	32	81	47	126	133	17	12	45	493	0.08

$\chi^2_{value} = 917.85$ and $\chi^2_{42, 0.05} = 49.73$, P_t: Proportion

Table 4: Number and type of motor vehicles involved in RTA

	Year									
Type of vehicle	2001	2002	2003	2004	2005	2006	2007	2008	Total	P_t
Taxis	81	76	73	43	51	44	39	32	439	0.17
Private car	105	101	82	121	103	125	108	103	848	0.33
Motorcycle	48	42	44	52	45	43	32	23	329	0.13
Motor lorries	53	51	35	51	42	42	33	44	351	0.14
Pedal bicycle	7	6	4	6	4	4	3	1	35	0.01
Mini bus	56	65	61	74	58	59	54	48	475	0.18
Others	10	9	15	18	18	20	4	7	101	0.04

$\chi^2_{value} = 80.53$ and $\chi^2_{42, 0.05} = 85.14$

Table 5: Monthly seasonal indices

Months	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Seasonal variation	3.33	0.60	0.31	0.27	0.60	0.65	0.35	0.31	0.37	0.91	0.72	3.58

Table 6: Marascuillo test procedure for types of vehicle involved in RTA

Contrsast	Value	Critical range	Significant
$\lvert p_1-p_2 \rvert$	0.08	0.044	Yes
$\lvert p_1-p_3 \rvert$	0.09	0.044	Yes
$\lvert p_1-p_5 \rvert$	0.14	0.045	Yes
$\lvert p_2-p_3 \rvert$	0.01	0.046	No
$\lvert p_2-p_5 \rvert$	0.06	0.047	Yes
$\lvert p_3-p_5 \rvert$	0.05	0.047	Yes

P_i is the proportion by cause, P_1: Reckless driving, P_2: Inexperience, P_3: Mechanical fault and bad road, P_5: Unknown causes; the proportions due to pedestrian crossing and other causes were ignored since they are of negligible magnitude

Similarly, Chi-square test suggested significant difference between the types of accident over the years since the test statistic (917.85) exceeds the critical value of χ^2 with 42 degrees of freedom at 5% level of significance ($\chi^2_{42, 0.05}$). Also using Marascuillo test procedure to compare the various proportions of the RTA by vehicle types, significant differences were discovered between the proportions involving Private cars (P_2) and those of Taxis (P_1), Motorcycle (P_3) Motor Lorries (P_4) and Mini buses (P_6) and also between P_2 Vs P_3, P_2 Vs P_4 and P_2 Vs P_6 (Table 7). On the number of vehicles involved, out of a total of 2578 motor vehicles involved over the period, Private cars accounted for 32.9% (Note that there were no significant differences among all other contrasts not involving Private cars (P_2).

Table 7: Marascuillo test procedure for causes of RTA

Contrsast	Value	Critical range	Significant
$\|p_1-p_2\|$	0.16	0.074	Yes
$\|p_1-p_3\|$	0.04	0.079	No
$\|p_1-p_4\|$	0.03	0.079	No
$\|p_1-p_6\|$	0.01	0.077	No
$\|p_2-p_3\|$	0.20	0.076	Yes
$\|p_2-p_4\|$	0.19	0.076	Yes
$\|p_2-p_6\|$	0.15	0.074	Yes
$\|p_3-p_4\|$	0.01	0.081	No
$\|p_3-p_6\|$	0.05	0.079	No
$\|p_4-p_6\|$	0.04	0.079	No

P_t: Taxis, P_2: Private cars,P_3: Motorcycles, P_4: Motor lorries, P_6: Mini buses; the proportions due to pedal bicycles and other types of Vehicles were ignored since they are of negligible magnitude

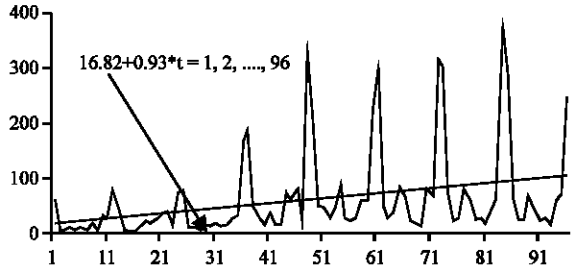


Fig. 3: A plot of the data and its trend line

Finally, a plot of the data with its trend line is given in Fig. 3 while the monthly seasonal indices are given in Table 5. By the trend line, it is clear that the RTA increased by a factor of approximately 1 over the constant level of 16 cases over the period of study. It is also seen from Table 5 that the months of December and January topped the indices with 3.58 and 3.33, respectively followed by October, November and June with 0.91, 0.72 and 0.65, respectively.

DISCUSSION

From the results of the study, it is clear that the incidences of the RTA are on the increase and characterized by seasonal factors as can be seen from the high values of the seasonal indices in Table 5 for the months of January, February, May, June, October, November and December. This study is in line with previous studies in developing countries which suggest that RTA has been on the increase. It also agrees with the results of the study by Eke *et al.* (2000) that there are seasonal variations in RTA cases. However, it is at variance with it with respect to the period where it occurs most. Eke *et al.* (2000) found that RTAs occur most during the rainy season (June, July and August) while ours are in the first and second quarters precisely in the months of January and December which are dry season period. Considering the fact that heavy road traffics lead to more RTAs, the difference may be explained by the following facts;

- Universities and Polytechnics close for Christmas holidays and students go home in the month of December and to return in the month of January on re-opening

- The heavy traffic on all Nigerian roads of which the Obinze/Iheagwa/Nekede road is no exemption as a result of the Christmas festival spanning through 1st and 2nd quarters (1st quarter-January, February and March; 2nd quarter-October, November and December) of the year in Igbo land, Southeastern Nigeria
- The months of May and June are very rainy periods and RTA is expected to occur more during this period as a result of bad road and reduced visibility whenever it is raining

It also agrees with Ezenwa (1986) and Odero (1998) that reckless driving is a lead cause of RTA in Nigeria.

The reason for the high level of RTA involving Motorcycles (McMc and McV) is not far fetched. As a result of the high level of unemployment in Nigeria, a lot of the unemployed youths took to Motor-cycle-riding popularly known in Nigeria as Okada- riding (Okada-riding is the use of Motorcycle as a means of transportation) as a means of livelihood without being well grounded in good-road-using capabilities such as ability to read signs and obey traffic rules and regulations. No wonder the Imo State Government has now started banning Okada riding in most of the major cities.

It is not uncommon that reckless driving, a human factor (AUSTROADS, 1994) caused a greater percentage of the RTA. This may be attributed to the fact that many of the students who ply the road with their parents or relatives vehicles are bound to be reckless in driving with a view of impressing their fellow students and most of them are also inexperienced in driving. This factor also partly explained why larger numbers of vehicles, involved in RTAs along the road are private cars. More so, most of the staff of the Institutions live in Owerri, the capital city of Imo State and are frequent users of the road with their private vehicles to and fro.

Mechanical fault and road defects (MRD) which can be grouped under Vehicle and road and environments factors respectively are also significant cause of RTA. This is in agreement with AUSTROADS (1994) that says that one or more of human, Vehicle and road and environment factors must be involved for RTA to occur. This may be attributed to the fact that the conditions of most Nigerian roads are generally poor and majority of the vehicles are fairly used, imported from Europe and Asia (These imported fairly used cars are locally called Belgium) and majority of them have been used for over 15 years in Nigeria.

On the part of inexperience which is a human factor, there are too many I-Can-Drive (ICD) drivers (ICD means just the ability to move vehicles without knowing the rules and regulations guiding road use) using the road of which a good number of the students belong to this class.

On the part of Mini-buses and Taxis being significantly involved in RTAs is due to the fact that they are the major means of transport for the students to and fro. This finding is in agreements with Eke *et al.* (2000) and Thanni and Kehinde (2006). While the former have observed that cars and buses are commonly involved in the casualties of RTAs in Nigeria followed by motorcycles and Lorries, the latter found that minibuses, the popular mode of commercial transportation was involved in 63.9% of RTAs, while cars were involved in 14.8% of cases. Motorcycles and pedal bicycles were involved in 6.2 and 0.6% of cases, respectively while Lorries and trailers were involved in 1.1% of cases each.

Based on the results of the study, the following preventive measures are suggested:

- Training of drivers should be made a very serious affair and must be properly supervised by qualified personnel and traffic road control agents

- Drivers' licenses should only be issued to those who have passed through a series of Driver and Traffic Safety Tests (DTST)
- Motor vehicles should be thoroughly inspected for roadworthiness before registration. Inspection checklist should include the number of years the vehicle has been used, rear and side view mirrors, windscreen wipers, speedometer, brakes and brake lights, trafficators, reverse and parking lights and so on (Nwokoro, 2005)
- The FRSC, VIO and other Traffic wardens should step up to their responsibilities and should go extra miles during the traffic heavy periods (festive and rainy periods) of high RTA level
- Driver and Traffic Safety Education (DTSE) should be offered as a pre-requisite to the issuance of driving licenses. DTSE should also be offered in Primary and Post-primary schools and Tertiary Institutions

CONCLUSIONS

The fundamental finds of this study are that RTAs in Imo State, Nigeria are characterized by an upward trend and seasonal effect of an appreciable magnitude. Crashes-Motorcycles-Motorcycle (McMc), Motorcycles-Vehicle (McV) and Vehicle-Vehicle (VV) are the lead types and accounted for the greater number of deaths. Reckless driving, inexperience and mechanical fault and bad roads are the major causes while Private cars, Minibuses and Taxis were predominantly involved in RTA.

The increasing toll of RTA in Imo State, Nigeria and consequent deaths and injuries constitute a public health problem which requires a serious attention since these deaths and injuries may be preventable.

Though the data used in the study were collected only on Obinze/Iheagwa/Nekede road, however the finds provides an insight into the trend and characteristics of RTAs in Nigeria.

Finally, it is our utmost belief that the preventive measures proffered in this paper will yield spectacular results in Imo State and Nigeria in general if properly and honestly adopted.

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