Analysis of Age As A Risk Factor of Road Accident Fatality in Ghana With Negative Binomial Regression

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ABSTRACT
Road accident in Ghana is known to be among the nine major causes of deaths, WHO (2011). It is reported that there is an average of 1909 people who are killed by road accidents annually. The most dangerous part of it is that about 60% of these people who die through road accidents are within the ages of 16 and 45 years who represent the bigger part of labour force of the country. The ultimate goal of this paper is to use negative binomial regression as an approximation to Poisson regression to fit a model to the secondary data which was obtained from the Building and Road Research Institute of the Council for Scientific and Industrial Research on the number of people killed by road accidents in Ghana from 2001-2010, given the ages of those who were killed as a risk factor in a given time period (in years). The descriptive data analysis of the data was performed using the Microsoft excel and Minitab 14 statistical software, while the model fitting and model selection were done with R statistical package which applies Akaike Information Criterion (AIC) for the best model selection. Maximum likelihood estimation was employed by the R statistical package for the parameter estimates for the model.

It was observed from the results that in general the number of people killed in road accidents gradually increases with time (as the years go by, the number of people killed by road accidents increases). The age of a person involved in road accident could significantly determine as to whether one would be killed in road accident or not. The results also showed that people in the age group of 26-35 were significantly killed most in road accidents in Ghana. This was followed by 16-25 years group and those in the ages of 36-45 were slightly smaller than 16-25 years but those above 60 years were least killed in road accidents.

Keywords: Ghana; road traffic accidents; fatality; Negative Binomial Regression; Poisson Regression.

1. INTRODUCTION
1.1 The State of Road Accidents
Vehicular accident in Ghana has become one of the growing concerns to most Ghanaians in recent times. This is as a result of the tremendous effect of road accidents on human lives, properties and the environment.
Heidi (2006) reported that 1.2 million people in the world lose their lives through road accidents every year. This number has risen to 1.3 million people who lose their lives globally every year and between 20 and 50 million people sustain various forms of injuries annually as a result of road accident. The most affected of these consequences of road accidents is the people in the age bracket of 15 and 29. Road accidents cost the world an amount of US$518 billion annually. It is estimated that if nothing is done globally to curtail the rampant nature of road accidents and most especially the causes of deaths of casualties before they are sent to hospitals then by the year 2020, 1.9 million people will be killed by road accidents in the world annually, (World Health Organisation, 2011).

A research conducted by World Health Organisation also indicated that road accident was the ninth major cause of death in low-middle income countries and predicted that it was going to be the third major cause of deaths in these countries by 2020 if the trend of vehicular accident was to be allowed to continue (Salim and Salimah, 2005).

Media reports reveal that there is a high rate of road accident in Ghana, when compared with other developing countries. In 2001, Ghana was ranked as the second highest road accident-prone nation among six West African countries with 73 deaths per 1000 accidents, (Akongbota, 2011).

According to the road traffic crashes in Ghana statistics for the year 2009 by Building and Road Research Institute, there were 12,299 road accidents for the year 2009 with a total of 18,496 casualties, 2,237 of these casualties lost their lives and 6,242 sustained serious injuries Afukaar et al (2007). This reveals that there is an average of 6 deaths everyday in Ghana through road accidents.

1.2 Causes of Road Accident

Many researchers have come out with the causes and effects of vehicular accidents in Ghana and have provided some recommendations to curtail the problem. For instance, Obeng (2008), identified that the numerous accidents on our road networks have been linked to various causes which include unnecessary speeding, drink driving, wrong over taking, poor road network, corruption and the rickety vehicles which ply on our roads.

Furthermore, the National Road Safety Commission (NRSC) has identified many causes of road accidents in Ghana which include unnecessary speeding, lack of proper judgment of drivers, inadequate experience, carelessness, wrong overtaking, recklessness, intoxication, over loading, machine failure, dazzling and defective light, boredom, unwillingness to alight from motion objects, skid and road surface defect, level crossing and obstruction. Other factors are inadequate enforcement of road laws and traffic regulations, use of mobile phones when driving, failure to buckle the seat belt and corruption, (National Road Safety Commission, 2007).

In addition to all these factors, Ocansey (2010) observed that poor vision of drivers could also be a major contributory factor to road accidents.
1.3 Causes of death in road accidents

The cause of death of casualties has been associated with many factors such as secondary collision, failure of drivers and vehicle occupants to put on seat belt and riders failing to put on helmet, Afukaar et al (2008). Studies have shown that sleep related accidents tend to be more severe and kill more people than other forms of road accidents. This situation is as a result of the driver’s inability to prevent and stop certain actions such as applying the brakes before collision and steering onto the main road if the vehicle veers off the road. The research identified that in order to reduce the risk of drowsy driving and its related crashes, drivers are advised to have sufficient sleep, drivers are to avoid drinking especially when feeling sleepy and reduce driving between midnight and 6:00 am, Kapur et al (2002).

Home and Reyner (1995) suggested that due to the inactive nature of the sleeping driver to control the vehicle prior to the accident, sleep related accidents have high risk of death as compared with the other forms of road accidents. Furthermore, in a research conducted in the North Carolina, sleep related accidents were found to be the most severe accidents among all other types of road accidents. Also, Home et al (1990) identified that the number of casualties in sleep related road accidents is 50% higher than all accidents. It had three times fatalities and double the seriously injured as compared with non sleeping related road accidents.

The age of the vehicle involved in an accident cannot be eliminated from the factors which contribute to the death of casualties in road accidents. Broughton (2007) identified that when two vehicles collide, the driver and occupants of the older vehicle are usually at more risk of being killed than those in the newer vehicle. In that study, it was estimated that the mean risk of death of drivers of vehicles which were registered in 2000 to 2003 was less than half of the risk for the drivers of vehicles which were registered in 1998 to 1999, Broughton (2007).

The size and mass of a vehicle have also been found to contribute to the death of road users in traffic crashes. From the findings of Broughton (2007) in the study into road accidents data from 2001 to 2005, it was revealed that the driver casualty rate increases with the size and mass of the other vehicle in collision. However, for the past 30 years, the weight and size of vehicles have been improved by 30% yet the number of casualties and deaths in road accidents have not reduced accordingly. The fact still remains that people end up relying so much on the strength of their vehicles and take undue risk especially the youth, (Broughton, 2007). In the study by Broughton (2007), it was revealed that young drivers and young passengers die more in road traffic crashes than their older counterparts.

In a research conducted in Britain and Wales to assess the death pattern of various age groups and their sexes within the period of 2000 to 2002, it was found out that 40% of males and 30% of female drivers who died in road accidents were in the age bracket of 16 and 19 years.

This number had risen to 44% for males and 38% for females by the end of 2005, (Department for Transport, 2006).
However, it is interesting to note that this pattern changes with age, as the road users grow then the number of females who die through accidents become more than that of males. From 1994 to 2004, there were 13% deaths for men above 30 years and 30% for females in that same age group, (Department for Transport, 2007).

Also, Kumar et al (2008) found out in their research in South Delhi that with all the people who were killed in road accidents, 88.2% of them were males. This result actually confirmed the studies by earlier researchers as Shadev (1994) and Henriksson (2001), all of whom proposed and substantiated that more males are killed in road accidents than females.

Drink-driving is another factor which was identified by Clarke et al (2007) as a contributor to death of casualties in road accidents. The reason for this could be link to the inability of the drunk driver to control the vehicle as a result of sleeping, Home et al (1990).

There were 1106 car drivers who were killed in road traffic crashes in 2005 at Britain and Wales and a study into this data by Clarke et al (2007) showed that 40% of those who died worn no seat belts and most of them were people between the age 17 and 29 years. It was further identified that the desire for buckling the seat belt increases as one grows beyond 30 years, Clarke et al (2007).

Broughton and Walter (2007) also found out that drivers and vehicle occupants tend to avoid the use of seat belt in the night and as a result death of victims in road accidents is higher in the night.

One of the commonest thing identified by researchers as the cause of death in road traffic crashes is anoxia – loss of oxygen supply – which may be caused by blockage in the air ways of the casualties and if immediate aid is not given to the casualty, he/she dies after a short while due to inadequate supply of oxygen (British Red Cross, 1997).

Although, there are certain forms of accident which cannot be prevented, it is evidently true that pre-hospital death of road traffic crash victims can be prevented if timely and proper first aid measures are put in place, Hussein & Redmond (1994).

Hussein & Redmond (1994) in their study conducted in Staffordshire in pre-hospital deaths in road accidents, they came out with the result that 39% to 85% are preventable and these deaths are caused by airway obstruction.

Studies have ascertained the medical assertion that for any accident, there is a ‘golden hour’ which exists for casualties after the accident. Within this period, road accident victims have a greater chance of surviving else they lose their lives, British Red Cross (1997). It is therefore imperative that immediate first aid is provided to road accident victims before they are rush to the hospital.

1.4 Road accident models

The fatality rate over the years has been used to compare road accident incidence in a large number of countries. Fatality rate is defined as the number of deaths which occurred through road accidents with
respect to some measure of the use of road system. However, Fatality rate has been defined by several authors to suit the needs of their research. Ghee et al (1997) stated that fatality rate is defined as the number of injury accidents occurring per annum per million vehicle kilometer travelled. But since there is not much reliable accident data base in developing countries and much information required to compute this type of fatality rate, Ghee et al (1997) defined the fatality rate for road accidents in a given country to be measured in respect of the number of persons killed through road accidents per 10,000 licensed vehicles in a country. As population is increasing and the number of licensed vehicles in developing countries is rising rapidly, Rajesh (2006) suggested that fatality rate is defined as number of road accident deaths per 100,000 licensed vehicles.

However, Jacobs & Cutting (1986) suggested that this index cannot be used to compare accident fatality rates of different countries since the countries may vary in terms of population and total vehicles which ply their roads. He then proposed a model which assessed the relationship between fatalities, population and motorization of the country. This model supported the Smeed Formula for international comparisons of accident fatalities, Smeed (1938, 1968). Smeed in 1938 used accident data from different countries and proposed the formula \[ \frac{D}{N} = 0.0003 \left( \frac{N}{P} \right)^{-0.67} \], where D is annual number of fatalities from road accidents, N is number of vehicles in use and P is population. This model was confirmed in 1968, Smeed (1968).

Silyanov (1973) used the idea of Smeed and modeled accident data from different countries and had similar results as that of Smeed except that there were some variations in the constant terms in the models. In all these models none of the researchers made an attempt of using the model to assess the significance of age of the people involved in accident and its effect on the fatality of the accidents in the countries concerned but as basis for only comparison.

Also, this assertion of comparing the accident fatality rate of different countries using deaths via road accidents, population and number of registered vehicles may not be applicable to many countries, Andreassen (1985) such as Ghana because there are vehicles which ply our roads that have foreign registration numbers.

For instance, vehicles from the nearby countries like Burkina Faso and Mali import most of their goods via Ghanaian ports and as a result of the trade relationship among the West Africa Sub-Region, vehicles from these countries ply our roads to convey their goods.

Furthermore, the population of a given country in a particular time is an estimate since census is done mostly at ten year’s intervals and the results of the census is not published in the same year it is conducted. In order to obtain true and accurate model that can fit into accident data for comparison and prediction, other researchers upon the identification of flaws in previous models tried different means by including more factors in the accident data analysis,Andreassen (1985) raised serious objection to the use of death per vehicles licensed in order to make international comparison of road accident fatalities because it was found
out that the two parameters were not linearly related over time. He then came out with a general formula, 
\[ D = \text{constant} \times N^{m_1} \times P^{m_2} \], which could also be used to predict the number of deaths in road accidents.

Where \( D \) is the number of deaths in road accidents, \( N \) is number of vehicles in use, \( P \) is the population of the country and \( m_1, m_2 \) are variables of interest. The difficulty in applying the equation by Andreassen is how to determine the constant term and the indices which might vary from country to country.

Time series analysis was used by Mekky (1985) to study the effect of rapid increase in the motorization levels on the rate of fatalities in some developing countries. Many researchers have dived into the investigation of traffic crash patterns in different countries in order to understand its relationship with the fatality rate of road accident. Among such researchers are Dinesh (1985), who investigated crash patterns in Delhi; Emanalo et al (1987) developed the trend curves for road accidents, casualties and other vital quantities in Zambia; Pramada and Sarkar (1993) who studied the variations in the pattern of road accidents in various States and Union Territories of India; Johnson (1997) studied the change in the number of accidents between before-year and after-year and concluded personal injuries in road accidents increased by 10% after resurfacing of the road but fatality reduced by 26%; Thole'\text{\textsc{n}} (1999) and Velin et al (2002) also compared the variations in the change in the number of accidents in all the control sites of public roads in the Region West Sweden which were not surfaced during the study period and their results also confirmed that road accident fatality decreases with resurfacing of the road networks.

A study was conducted to find the effects of speed limits on road accidents by Fieldwick (1987) who identified that speed limits have significant impact on road safety and severity in both rural and urban roads. Pramada and Sarkar (1997) used road length as an additional parameter and established a model for road accidents with the length of road covered by the vehicle as a factor. Jamal and Jamil (2001) presented a general model to predict road accident fatalities in Yemen. Pramada (2005) used road accident data to compare the models developed by Smeed and Andreassen and confirmed that the two models worked well. Researchers have been modeling vehicular accidents with crash prevention models in various parts of the world. However, it is extremely difficult to just apply models which have worked somewhere to data obtained from different country due to the variations in the various factors pertaining in different countries, Fletcher et al (2006).

In Ghana much work has not been done to model road accident fatality but Salifu (2004) developed a forecasting model for traffic crashes for unsignalised urban junction, Afukaar & Debrah (2007) also modeled traffic crashes for signalized urban junction in Ghana and Ackaah (2011) modeled traffic crashes on rural highways in the Ashanti region. However, none of these models were used to verify the significance of the ages of casualties involved in the accident as one of the risk factors of the fatality of the accident.

This study then attempts to ascertain the significance of age as one of the risk factors in road accidents fatality in Ghana using the Negative binomial regression model.
2. MATERIALS AND METHODS

The data for this research was secondary data obtained from the Building and Road Research Institute of the Council for Scientific and Industrial Research, Ghana. The data was originally collected using accident report form by the Motor Traffic and Transport Unit of the Ghana Police Service. This study considered accident data for ten year period from 2001 to 2010 as shown in Table 2.1. It consists of the number of people who were killed by road accidents annually which is treated as the response variable, the year and the age grouping of casualties who died in the accident as the explanatory variables. Descriptive analysis of the data was done using Minitab 14 statistical software and Microsoft excel whiles the further analysis was done with the R statistical package. The initial analysis to assess the nature of the data showed overdispersion in the count data, hence the use of the Negative binomial regression model.

Table 2.1 The Road Accident Fatality in Ghana with Age Distribution from 2001 to 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>Age grouping</th>
<th>People killed</th>
<th>Year</th>
<th>Age grouping</th>
<th>People killed</th>
<th>Year</th>
<th>Age grouping</th>
<th>People killed</th>
<th>Year</th>
<th>Age grouping</th>
<th>People killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>36-45</td>
<td>282</td>
<td>2004</td>
<td>0-5</td>
<td>116</td>
<td>2006</td>
<td>36-45</td>
<td>266</td>
<td>2009</td>
<td>0-5</td>
<td>130</td>
</tr>
<tr>
<td>2002</td>
<td>36-45</td>
<td>237</td>
<td>2005</td>
<td>0-5</td>
<td>120</td>
<td>2007</td>
<td>36-45</td>
<td>379</td>
<td>2010</td>
<td>0-5</td>
<td>136</td>
</tr>
<tr>
<td>2003</td>
<td>26-35</td>
<td>359</td>
<td>2005</td>
<td>Over 65</td>
<td>82</td>
<td>2008</td>
<td>26-35</td>
<td>528</td>
<td>2010</td>
<td>Over 65</td>
<td>95</td>
</tr>
</tbody>
</table>

Source: Building and Road Research Institute of the Council for Scientific and Industrial Research, Ghana.

2.1 Model Specification and Estimation

To ascertain the significance of age as one of the risk factors of road accident fatality in Ghana, the study specifies a Negative Binomial regression for the data. The Negative Binomial regression model is a special form of the generalized linear model frame work for count data (Agresti, 2007). The negative binomial regression model is an extended form of the Poisson regression model to cater for over/under dispersion which is very common in count data such as road accidents. The Poisson model assumes that the mean of the count data equates the variance (Agresti, 2007). This assumption is mostly violated by accident data due
to the presence of spatial clusters or other sources of autocorrelation (Cameron and Trivedi, 1998). The negative binomial model is therefore applied since it has an extra parameter which accounts for the extra-Poisson Variation in the data (Dean and Lawless, 1998). Also, Miaou (1994) conducted a research into the relationship between truck accident and geometric design of the road section to compare Poisson and Negative Binomial regression models and concluded that Negative Binomial regression model fit well into the accident data. The model selection procedure was performed with R statistical package the result is presented in Table 2.2.

<table>
<thead>
<tr>
<th>Assessment parameter</th>
<th>Poisson Regression Model</th>
<th>Negative Binomial Regression Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Deviance</td>
<td>5352.66</td>
<td>2688.92</td>
</tr>
<tr>
<td>Degree of Freedom</td>
<td>79.00</td>
<td>79.00</td>
</tr>
<tr>
<td>Residual Deviance</td>
<td>155.09</td>
<td>72.75</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>63.00</td>
<td>63.00</td>
</tr>
<tr>
<td>Dispersion Parameter</td>
<td>2.46</td>
<td>1.15</td>
</tr>
<tr>
<td>AIC</td>
<td>753.77</td>
<td>724.51</td>
</tr>
</tbody>
</table>

Table 2.2 shows that the dispersion parameter for the Poison model is 2.46 that is far more that 1 but that of Negative Binomial is 1.15 which is approximately equal to 1. It is therefore obvious that negative binomial regression model will best fit the accident data used for the study.

2.2 The Negative Binomial Distribution and Regression Model

Let the annual road accidents’ fatality in Ghana be denoted by $Y_1, Y_2, ..., Y_t$. The conditional set of predictors (age grouping of casualties) is denoted by $X_{1,t}, X_{2,t}, ..., X_{p,t}$ of road accidents. Road accidents fatality is assumed to follow negative binomial distribution with a probability mass function given as

$$P(Y = y) = \frac{\Gamma (y + 1/\alpha)}{\Gamma (y + 1) \Gamma (1/\alpha)} \left( \frac{1}{1 + \alpha \lambda} \right)^{1/\alpha} \left( \frac{\alpha \lambda}{1 + \alpha \lambda} \right)^y, t = 1, 2, ...$$

(1)

where $\Gamma$ is gamma function.

The conditional mean $\lambda$ of road accident fatality given the age groupings of casualties involved is defined as

$$\lambda = E(Y|X) = \exp (\beta_0 + \beta_1 X_{1,t} + \beta_2 X_{2,t} + \cdots + \beta_p X_{p,t})$$

(2)

$$= \exp (\beta_0 \sum_{i=1}^p \beta_i X_{i,t})$$

(3)

Which can be expressed in matrix notation as

$$\lambda = \exp (X \beta^T)$$

(4)

Hence the expected value of the response variable $Y$ of the negative binomial regression model converges to

$$\log(\lambda) = X \beta$$

(6)

where $X$ and $\beta$ are vectors of predictors and their coefficients respectively

The conditional variance $\sigma^2 = \lambda + \alpha \lambda^2$

(7)
where $\alpha$ is referred to as the dispersion parameter. The negative binomial distribution approximates to Poisson distribution when $\alpha = 0$.

Thus, $\lim_{\alpha \to 0} (\lambda + \alpha \lambda^2) = \lambda$.  

(8)

In the negative binomial regression model as in any generalized linear model, the model selection can be performed using an information criterion such as the Akaike Information Criterion. The coefficients of the predictors in the model are estimated by the maximum likelihood method and the evaluation of the model follows the usual generalized linear models.

3. RESULTS AND DISCUSSION

There were 114,770 road accidents which occurred in Ghana from 2001 to 2010 which killed 19,088 people. This shows that on the average, 11,477 road accidents occurred every year and 1,909 lives are lost through these accidents every year.

3.1 Annual Distribution of Road Accidents Fatality in Ghana.

![Figure 3.1 Annual Distribution of Road Accident Fatality in Ghana from 2001-2010](image)

The Figure 3.1 shows the annual distribution of road accidents fatality in Ghana from 2001-2010. It is obvious that the annual distribution of road accidents in Ghana increased gradually from 1,660 in 2001 to 1,734 in 2003 and increased sharply to 2,184 in 2004. The number of people killed by road accidents in 2004 reduced enormously to 1,784 in 2005. The number started rising again and by the end of 2007, the number had risen to 2,043. It then dropped again to 1,937 in 2008 and by the end of 2009; the number of people killed by road accident in Ghana had rose to 2,239 which fell by the close of 2010 to 1,986. Despite the fluctuating nature of the annual distribution of road accidents’ fatality in Ghana for the years under review, it is clear that in general, there is rising trend in the number of people killed by road accidents in

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Ghana as the years go by. This observation supports what Obeng-Odoom (2010) stated in his publication that as years go by, the number of vehicle in Ghana will be increasing and the number of traffic accident will increase accordingly and therefore the number of people who are likely to be killed in road accidents will also increase.

3.2 Age Distribution of Road Accident Fatality in Ghana from 2001-2010.

The number of people who were killed through road accidents and their age groupings for the period under consideration is presented in Table 3.1 and the graphical nature of the data is illustrated in Figure 3.2 which depicts the actual distribution of the road accident fatality in Ghana given the age groupings of the victims. The total number of deaths for all the age grouping (17337) is slightly different from the total number people died through road accidents (19088) for the ten year period because the ages of some people who died through road accidents could not be identified and recorded.

![Figure 3.2](image-url)  
**Figure 3.2** A bar graph illustrating the average number of people killed by road accident in Ghana from 2001 to 2010 for various age groupings.

Figure 3.2 shows the distribution of the number of people who were killed by road accidents and their age groupings. It is clear from the figure that the youth is the most vulnerable to road accident. The age group 26-35 recorded 4469 casualties representing 25.78% of total deaths from 2001-2010, the highest number of deaths. This was followed by 16-25 which recorded 2982 (17.20%), a little above those killed in the age group 36-45 which had 2949 (17.01%). This result is not surprising since research has shown that most people who are at risk in road accidents are in the ages between 15 and 44 years, Margie et al (2002). The age group which recorded the least number of deaths is that of over 65 years which recorded 824 (4.75%) people who died in road accidents within the ten year period. It should be noted however that people of over 65 years are pensioners and are mostly not in active service and therefore do not normally travel regularly.

It is interesting to note from the graph of Figure 3.2 that the risk of one getting killed by road accident in Ghana increases from infancy till one gets to the early adulthood. Thus, at the age of 26 to 35 one is at the
peak of the risk of dying through road accident but as one grows past the 35 years, the risk level begins to reduce gradually till 65 years where the risk of dying in road accident decreases drastically. In fact, the count distribution from Figure 3.1 could be assumed to be following the normal distribution since almost half of the data lies to right of the age group 26-35 and the other half of the data lies to the left of the age group 26-35.

### 3.3 Negative Binomial Model Specification

The negative binomial regression model was fitted into the data using R statistical package which applies the Akaike information criterion (AIC) for the best model selection. The best model was selected based AICs of the various models and the dispersion parameters as illustrated in Table 3.1.

<table>
<thead>
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<tbody>
<tr>
<td>Null Deviance</td>
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</tr>
<tr>
<td>Dispersion Parameter</td>
<td>1.15</td>
</tr>
<tr>
<td>AIC</td>
<td>724.51</td>
</tr>
</tbody>
</table>

From the Table 3.1 it is observed that the dispersion parameter for the negative binomial regression model is 1.15 which is approximately equal to 1, an indication of a good sign of reduced over dispersion in the data if not totally eliminated. It is therefore appropriate to fit a model to the data using the negative binomial regression.

Table 3.2 summarizes the maximum likelihood estimates of the parameters in the model after the R statistical model was applied to the data using the negative binomial regression model as presented in equation (6). The coefficients for all the variables are estimated in relation to the base levels, in which case age group, 1-5 years and 2001. To ascertain the significance of the various variables in the model, likelihood ratio test was conducted and based on their P-value as shown in the last column of Table 3.3 the significance of each variable present in the model was assessed.

| Coefficients | Estimate | Std. Error | z value | Pr(>|z|) |
|--------------|----------|------------|---------|---------|
| (Intercept)  | 4.544991 | 0.050543   | 89.923  | < 2e-16 |
| 6-15 years   | 0.622941 | 0.047270   | 13.178  | < 2e-16 |
| 16-25 years  | 0.951368 | 0.045862   | 20.744  | < 2e-16 |
| 26-35 years  | 1.347528 | 0.044641   | 30.186  | < 2e-16 |
36-45 years        0.941337    0.045899    20.509    < 2e-16
46-55 years        0.362424    0.048720    7.439    1.02e-13
56-65 years        0.016055    0.051231    0.313    0.7540
Over 65 years      -0.334953    0.054632   -6.131    8.73e-10
2002              0.005785    0.051913    0.111    0.9113
2003              0.034622    0.051711    0.670    0.5032
2004              0.287376    0.050125    5.733    9.85e-09
2005              0.097097    0.051287    1.893    0.0583
2006              0.094011    0.051308    1.832    0.0669
2007              0.339428    0.049837    6.811    9.71e-12
2008              0.314554    0.049973    6.294    3.08e-10
2009              0.444804    0.049292    9.024    < 2e-16
2010              0.280971    0.050161    5.601    2.13e-08

By default, R statistical package takes the first category in a data as the base level and therefore people from 0-5 years and the year 2001 were picked as the base levels for comparison in the analysis of the parameter estimates in the model as shown in Table 3.2. The intercept was found to be 4.544991 with p-value of <2e-16 which is far less than 5% significant level indicating that apart from age of people, other factors could also contribute to the death of casualties in road accident. With the exception of people from 56-65 years group which was not significantly different from the number people of killed in road accidents within the ages of 0-5 years in the model, the rest were all significantly different from the base level in the model at 5% \( \alpha \)-level. It is observed that people above 65 years who were killed via road accidents was significantly smaller by -0.334953 in logarithmic count than those younger than 65years. The most significant age group in the model was found to be 26-35 years with parameter estimate of 1.347528. This means that the expected number of people killed through accident in the age group of 26-35 is \( e^{1.347528} = 3.847902 \) times more than that of 0-5 years for every year. It could also be seen from the model that those in the age bracket of 16-25 years are the second most affected in death through road accidents in Ghana. The parameter estimate for 16-25 was found to be 0.951368 which implies that people who are killed by road accidents and are in the ages from 16-25 years are \( e^{0.951368} = 2.589249 \) times more than those who were killed and are in the age group from 0-5 years for every year. 36-45 years who were killed via road accidents was 0.941337 more than 0-5 years in logarithmic counts for every year.

Table 3.2 further reveals that the years 2002, 2003, 2005 and 2006 were not significant in the model giving that the year 2001 is the base level. 2009 was significantly found to be the year which had most people killed by road accident for all ages in Ghana. It was found that 2009 had \( e^{-0.444804} = 1.560184 \) times more people killed than 2001 for all age groups in Ghana. It is obvious from the results in the Tables 3.2 and 3.3 that the age of a person involved in an accident can significantly contribute to the fatality of the accidents in any given year provided all other things remain constant.
4. CONCLUSION

Road accidents have been a lifelong phenomenon which leads to the loss of lives of many Ghanaians. This paper tries to ascertain the significance of the ages of people involved in road accident in Ghana as one of the risk factors of the fatality of the road accident using Negative binomial regression model.

Within the year period from 2001 to 2010, there were a total of 114,770 road accidents which killed 19,088 people in Ghana. Also it was found that road accident fatality increases with time in that there was 53% logarithmic increase from 2001 to 2010.

In the investigation of age as one of the risk factors of road accident fatality, it was found that age was one of the significant risk factors in road accident fatality in Ghana.

The results also revealed that the most significantly affected people who die through road accidents in Ghana are the youth. Out of 1909 people who are killed via road accidents annually, 447 (25.75%) of them are people in the age group of 26-35, 298 (17.20%) are in 16-25 and 295 (17.01%) are those of the ages from 36-45. This shows that 59.96% of all those who die through road accidents are within the age bracket of 16 and 45 years.

The initial result was confirmed by the model which indicated that the expected number of people who are killed in road accident and are in the ages from 26-35 is approximately four times that of the base level for every year. Those in the age groups of 16-25 and 36-45 have expected number killed to be three times that of the base level for every year. This gives us a cause to worry since the work force of the country is being killed through road accidents.

Education on road accidents should be intensified especially among the youth and hence it will help the country to save more lives from road accidents if road accidents will be introduced as a topic, if not a subject on its own, in social studies.

Finally, institutions that enforce road traffic regulations should do well to enforce the law to the later so that all perpetrators of traffic offences shall be brought to book to deter others from repeating such offences.

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