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A Moving Average Analysis of the Age Distribution and the Pattern of Road Traffic Fatalities in Ghana, From 2001 - 2010

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Abstract
Road traffic fatalities (RTF) in Ghana have adverse effect on the dependency ratio and economic growth in the formal sector of the economy. To analyse the pattern of road traffic deaths in Ghana, fatalities for road traffic accidents by age groups from 2001 – 2010 were obtained. Using published road traffic accident statistics from the National Road Safety Commission, the pattern of RTF with respect to age was obtained, using moving average analysis. The pattern of the series data displays 8 distinct yearly cycles over a 10-year period, with the underlying trend showing a steady increase overall, as well as in each particular age group. Based entirely on the trend of the past data, the values of the number of RTFs are projected for each of the 8 age groups. The number of road traffic fatalities in Ghana is predicted to rise from 1 987 in the year 2010 to 3 677 in the year 2030, an increase of about 85%.
Key Words: Age, Fatality, Trend and Forecast

1. Introduction

The first study of global patterns of death among people aged between 10 – 24 years of age has found that road traffic accidents, complications during pregnancy and child birth, suicide, violence, HIV/AIDS and tuberculosis (TB) are the major causes of mortality. Most causes of death of young people are preventable and treatable. The study, which was supported by the World Health Organization (WHO) and published in The Lancet medical journal (Lozano, R. et al. 2012), found that 2.6 million young people are dying each year, with 97% of these deaths taking place in low- and middle-income countries.

According to the National Road Safety Commission (NRSC) of Ghana, 2011 report, road traffic fatality occurs when a person involved in a road traffic accident dies within thirty (30) days of the accident. Fatality rate refers to fatalities per 10 000 vehicles while population risk refers to fatalities per 100 000 persons. In some countries, a road traffic fatality is recorded only if the victim dies at the site or is dead upon arrival at a hospital. In order to make comparison of accident statistics between countries reasonable, figures obtained from countries which have not adopted the 30-day fatality definition, should be properly adjusted. No adjustment is required for figures from countries such as Ghana, U.S.A and Great Britain, which have adopted the standard fatality definition.

Fatalities of road traffic accidents in Ghana by age group, from 2001 – 2010, are given in Table 1, on the next page. Unlike many fatal diseases, traffic accidents kill people from all age groups including young and middle-aged people in their active years. A cumulative total of 17 436 fatalities is recorded over the 10-year period. The highest fatalities during the period were in the 26 – 35 year old. Table 1 also shows that the active age group, 16 – 45 years, was the most vulnerable in road traffic fatalities, representing 60.2% of the total fatalities in the 10-year period.

Table 1: Annual Distribution of Road Traffic Fatalities in Ghana by Age Group

Year	0 - 5	6 - 15	16 - 25	26 - 35	36 - 45	46 - 55	56 - 65	Over 65	Total
2001	80	179	259	298	282	137	105	65	1405
2002	85	200	230	337	237	149	96	76	1410
2003	113	203	264	359	241	422	99	61	1462
2004	116	272	357	444	280	191	132	83	1875
2005	120	184	276	375	273	138	101	82	1549
2006	124	201	260	363	266	146	108	69	1537
2007	109	214	369	579	379	191	120	81	2042
2008	136	218	310	528	329	177	138	102	1938
2009	130	250	388	609	383	222	141	109	2232
2010	136	217	269	577	379	184	129	95	1986
Total	1149	2138	2982	4469	3049	1957	1169	823	17436

Data provided by the NRSC showed that, in Ghana, road traffic accidents are responsible for a far higher rate of death among men, by an approximate ratio of 3:1. Similar proportions practically apply for all the years. Over the 10-year period, over 70% of the road traffic accident fatalities were male and 30% were female. Considering the fact that the national population split is slightly in favour of females, point to the claim that male fatalities are highly over-represented. Perhaps, putting the at-risk age-group and sex together, the picture that emerges underscores a dominant socio-economic role that is reflected in higher traffic crash involvement for the male gender. Furthermore, these males are mostly workers who are married.

Male dominant in road traffic fatalities in Ghana may be due to the fact that men spend substantially more time in moving vehicles than women. Moreover, Gender role socialization and the association of masculinity with risk-taking behaviour, a greater acceptance of risk and a disregard of pain and injury may be factors leading to hazardous actions on the part of men. Men are also more likely to be employed as drivers and mechanics in cars and trucks, including drivers of long haul vehicles which may mean spending several days and nights in the vehicle. Males, therefore, have a higher exposure to the risk of traffic injuries.

Figure 1 shows the graph of the age distribution of road traffic fatality values on the vertical axis against the eight (8) independent age groups on the horizontal axis in the 10-year period, 1991 to 2009. The trend of the graph over the interval of time displays 8 distinct yearly cycles over a 10-year period, with the underlying trend showing a steady increase overall, as well as in each particular age group. The graph appears to follow almost identical patterns, parabolic in shape, in the corresponding age groups over the successive 10-year cycles. The 8 independent age groups in Table 1 represent the seasonal variations in a yearly cycle. The data shows a significant seasonal effect with the cycle peak over the age group 26 – 35 years and trough in the last age group (above 65 years). Since a definite periodicity for the occurrence of road traffic fatality among the 8 age groups can be established from the above data, it follows that the change in conditions of road traffic fatality can be anticipated to some degree of precision.

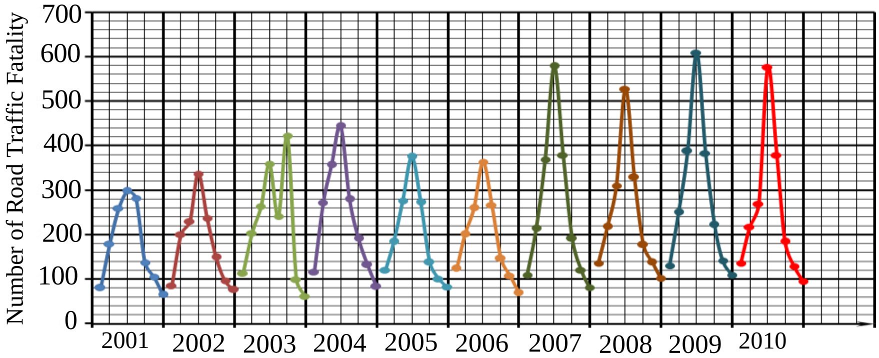

Figure 1: Graph of the distribution of the data in Table 1

2. Method

The model

There are two main types of model which can be used to analyze the data. These are the additive component model and the multiplicative component model. For the purpose of this analysis, the additive component model is adopted.

In the additive component model, the variation of the values of the data over the age distribution can best be described by adding the relevant components within a cycle.

The actual value of the variable, Y, can be modelled by:

Actual value = Trend + Age variation + Irregular

or $Y = T + A + I.$ ………………………………………………………………………………..(1)

If we assume that irregular variations are not included, then we have

$Y = T + A.$

The trend

Since the data have a significant age variation effect, the moving average technique is preferred in extracting the trend. It depicts the true nature of the trend as to whether it is linear or non-linear. In this section, the procedure for obtaining a trend, using the moving average is demonstrated.

The data is distinctly 8 independent age groups over yearly cycle. We therefore need a (centered) 8-value moving average trend. Table 2 shows the standard columnar layout of the calculation.

The data is road traffic fatalities in distinctly 8 independent age groups over yearly cycle. We therefore need an 8-value moving average trend. Table 2 shows the 8-value centred moving average (t) together with the corresponding actual data values (y).

Table 2: Centered 8-value moving averages of data in Table 1

n	*y*	*t*	***n***	*y*	*t*	***n***	*y*	*t*	***n***	*y*	*t*
1	80		**21**	241	220.4	**41**	124	192.3	**61**	329	241.9
2	179		**22**	422	224.9	**42**	201	192.4	**62**	177	243.5
3	259		**23**	99	235.1	**43**	260	193.3	**63**	138	250.4
4	298		**24**	61	246.2	**44**	363	192.9	**64**	102	260.3
5	282	175.9	**25**	116	253.9	**45**	266	191.2	**65**	130	268.8
6	137	177.6	**26**	272	241.9	**46**	146	191.1	**66**	250	274.9
7	105	177.1	**27**	357	229.6	**47**	108	198.7	**67**	388	277.9
8	65	177.7	**28**	444	233.0	**48**	69	219.0	**68**	609	278.6
9	85	177.3	**29**	280	234.6	**49**	109	239.6	**69**	383	279.4
10	200	175.3	**30**	191	229.4	**50**	214	249.4	**70**	222	277.7
11	230	175.4	**31**	132	218.8	**51**	369	253.0	**71**	141	268.2
12	337	175.6	**32**	83	209.4	**52**	579	254.5	**72**	109	258.8
13	237	178.0	**33**	120	204.7	**53**	379	256.9	**73**	136	256.5
14	149	179.9	**34**	184	200.9	**54**	191	258.9	**74**	217	253.9
15	96	182.3	**35**	276	195.7	**55**	120	255.4	**75**	269	250.8
16	76	185.8	**36**	375	193.7	**56**	81	248.6	**76**	577	249.1
17	113	187.4	**37**	273	193.9	**57**	136	242.3	**77**	379	
18	203	204.7	**38**	138	195.2	**58**	218	238.3	**78**	184	
19	264	221.9	**39**	101	195.3	**59**	310	238.5	**79**	129	
20	359	221.2	**40**	82	193.5	**60**	528	240.9	**80**	95	

Figure 2 shows a graph of the original data with the trend superimposed. We note, from Fig. 2, that there is approximately constant increase in the trend values. This means that the trend values are approximately linear.

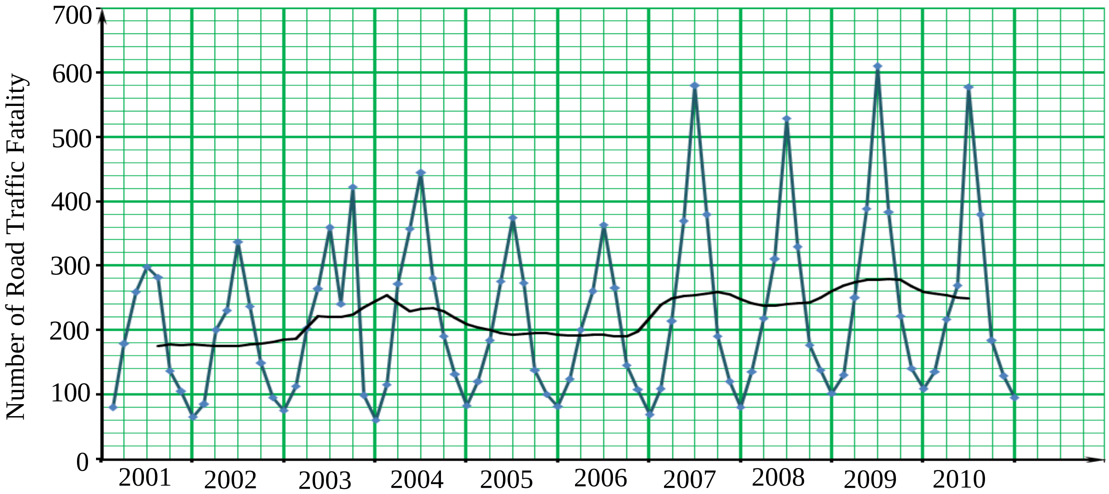

Figure 2: Trend superimposed on the graph of the data

In order to obtain a formula for the estimation of trend values for future number of occurrence of road traffic fatalities, we use the least square regression model of the form

$$t_n = \beta_0 + \beta_1 n + \varepsilon_n, \quad n = 5, 6, \ldots, 76 \quad \ldots\ldots\ldots(2)$$

where t_n is the trend value for the n^{th} observation and the error terms $\varepsilon_5, \varepsilon_6, \ldots, \varepsilon_{76}$ are assumed to be normally and independently distributed with mean 0 and variance σ^2. β_0 and β_1 are parameters to be determined. It can be shown that the least square estimates of β_0 and β_1 are given by (see Ofosu et al., 2013)

$$\hat{\beta}_0 = \bar{t} - \hat{\beta}_1 \bar{n}, \quad \ldots (3)$$

where

$$\hat{\beta}_1 = \frac{\sum_{n=5}^{76} nt_n - \frac{1}{72}\left(\sum_{n=5}^{76} t_n\right)\left(\sum_{n=5}^{76} n\right)}{\sum_{n=5}^{76} n^2 - \frac{1}{72}\left(\sum_{n=5}^{76} n\right)^2} \quad \ldots (4)$$

$$= \frac{S_{nt}}{S_{nn}}, \quad \ldots (5)$$

$$\bar{n} = \frac{1}{72}\left(\sum_{n=5}^{76} n\right), \quad \bar{t} = \frac{1}{72}\left(\sum_{n=5}^{76} t_n\right),$$

$$S_{nt} = \sum_{n=5}^{76} nt_n - \frac{1}{72}\left(\sum_{n=5}^{76} n\right)\left(\sum_{n=5}^{76} t_n\right), \quad \ldots (6)$$

and $$S_{nn} = \sum_{n=5}^{76} n^2 - \frac{1}{72}\left(\sum_{n=5}^{76} n\right)^2. \quad \ldots (7)$$

The fitted or estimated regression line is

$$\hat{t}_n = \hat{\beta}_0 + \hat{\beta}_1 n. \quad \ldots (8)$$

The $\hat{t}_n$ values are the predicted trend values. Thus, based on the data in Table 2 and the given equations, the maximum likelihood estimates of β_0 and β_1 are $\hat{\beta}_0 = 174.179$ and $\hat{\beta}_1 = 1.207$, respectively.

The significance of the regression relationship can be assessed by using analysis of variance techniques to test the null hypothesis $H_0: \beta_1 = 0$ against the alternative hypothesis $H_1: \beta_1 \neq 0$. The sum of squares due to linear regression is given by

$$SSR = \frac{S_{nt}^2}{S_{nn}} = \frac{(37\,537.469)^2}{31\,098} = 45\,310.36.$$

The total corrected sum of squares is given by

$$SST = S_{tt} = \sum_{i=5}^{76} t_i^2 - \frac{1}{72}\left(\sum_{i=5}^{76} t_i\right)^2 = 75\,379.45.$$

Therefore, the residual sum of squares is $SSE = SST - SSR = 30\,069.09$. The calculations can be summarized in the following ANOVA table.

Table 3: Analysis of Variance table

Source of variation	Sum of squares	Degrees of freedom	Mean square	*F*
Linear regression	45 310.36	1	45 310.36	105.48
Residual	30 069.09	70	429.56	
Total	75 379.45	71		

The test statistic for testing H_0 against H_1 is $F = \frac{\text{regression mean square}}{\text{residual mean square}}$. When H_0 is true, *F* has the *F*-distribution with 1 and 70 degrees of freedom. We reject H_0 at significance level 0.05 if the computed value of *F* is greater than $F_{0.05,1,70} \approx 4.00$. Since 105.48, the calculated value of *F*, is greater than 4.00, the test is significant at the 5% level. We conclude that there is a linear relationship between the expected value of t and n. Thus, the least squares regression equation for estimating the trend values of road traffic fatalities in Ghana is given by

$$\hat{t}_n = 174.179 + 1.207n, \quad n = 1, 2, 3, \ldots (9)$$

Table 4 shows the estimated trend values from Equation (9). The residuals from the regression trend are $e_i = y_i - \hat{y}_i$ and the standardized residual $d_i = e_i \big/ \sqrt{\hat{\sigma}^2}$, $i = 5, 6, \ldots, 76$.

Table 4: Estimated trend, residual and standardize residual values

$\hat{t}$	e_i	d_i	$\hat{t}$	e_i	d_i	$\hat{t}$	e_i	d_i	$\hat{t}$	e_i	d_i
180.2	-4.3	-0.2	204.4	49.5	2.4	228.5	-37.3	-1.8	252.6	16.2	0.8
181.4	-3.8	-0.2	205.6	36.3	1.8	229.7	-38.6	-1.9	253.9	21.0	1.0
182.6	-5.5	-0.3	206.8	22.8	1.1	230.9	-32.2	-1.6	255.1	22.8	1.1
183.8	-6.1	-0.3	208.0	25.0	1.2	232.1	-13.1	-0.6	256.3	22.3	1.1
185.0	-7.7	-0.4	209.2	25.4	1.2	233.3	6.3	0.3	257.5	21.9	1.1
186.3	-11.0	-0.5	210.4	19.0	0.9	234.5	14.9	0.7	258.7	19.0	0.9
187.5	-12.1	-0.6	211.6	7.2	0.3	235.7	17.3	0.8	259.9	8.3	0.4
188.7	-13.1	-0.6	212.8	-3.4	-0.2	237.0	17.5	0.9	261.1	-2.3	-0.1
189.9	-11.9	-0.6	214.0	-9.3	-0.5	238.2	18.7	0.9	262.3	-5.8	-0.3
191.1	-11.2	-0.5	215.2	-14.3	-0.7	239.4	19.5	0.9	263.5	-9.6	-0.5
192.3	-10.0	-0.5	216.4	-20.7	-1.0	240.6	14.8	0.7	264.7	-13.9	-0.7
193.5	-7.7	-0.4	217.6	-23.9	-1.2	241.8	6.8	0.3	265.9	-16.8	-0.8
194.7	-7.3	-0.4	218.8	-24.9	-1.2	243.0	-0.7	0.0			
195.9	8.8	0.4	220.1	-24.9	-1.2	244.2	-5.9	-0.3			
197.1	24.8	1.2	221.3	-26.0	-1.3	245.4	-6.9	-0.3			
198.3	22.9	1.1	222.5	-29.0	-1.4	246.6	-5.7	-0.3			
199.5	20.9	1.0	223.7	-31.4	-1.5	247.8	-5.9	-0.3			
200.7	24.2	1.2	224.9	-32.5	-1.6	249.0	-5.5	-0.3			
201.9	33.2	1.6	226.1	-32.8	-1.6	250.2	0.2	0.0			
203.2	43.0	2.1	227.3	-34.4	-1.7	251.4	8.9	0.4			

It can be seen that only two of the computed standardized residuals fall outside the interval $(-1.96, 1.96)$. Thus, based on the given data, more than 95% of the standardized residuals fall in this interval. There is therefore a strong evidence to conclude that the errors are normally distributed.

The last trend value (Year 10 at series point 4) is $t_{76} = 249.1$. From Equation (9), the estimated trend value for Year 10 at series point 5 is approximately

$$\hat{t}_{77} = 174.179 + 1.207 \times 77 = 267.1.$$

Similarly, $\hat{t}_{78} = 268.3$, $\hat{t}_{79} = 269.5$ and $\hat{t}_{80} = 270.7$.

Variation due to age groups

The purpose of analysing these data is not the determination of the trend. Interest is centered on forecasting, or the ability to estimate future road traffic fatality values using variation due to the 8 independent age groups. The determination of the trend is merely a stage in the process of measuring and analysing the age variation.

In the additive component model, the age variation factors are individually expressed as deviation from the trend. Given the original road traffic fatality values (y) and with the corresponding trend values (t), the procedure for calculating the age variation is as follows.

1. For each point n, calculate the difference between the original values (y_n) and the trend (t_n). That is, the value of $a_n = y_n - t_n$. The calculations to find the variations due to age groups (a_n) are shown in Table 5. The additive model is described as

$$y_n = t_n + a_n.$$

Table 5: Variation due to age groups together with the trend values

		y_n	t_n	a_n			y_n	t_n	a_n			y_n	t_n	a_n
2010	1	136	256.5	–120.5	2004	1	116	253.9	–137.9	2007	1	109	239.6	–130.6
	2	217	253.9	–36.9		2	272	241.9	30.1		2	214	249.4	–35.4
	3	269	250.8	18.3		3	357	229.6	127.4		3	369	253.0	116.0
	4	577	249.1	327.9		4	444	233.0	211.0		4	579	254.5	324.5
2001	5	282	175.9	106.1		5	280	234.6	45.4		5	379	256.9	122.1
	6	137	177.6	–40.6		6	191	229.4	–38.4		6	191	258.9	–67.9
	7	105	177.1	–72.1		7	132	218.8	–86.8		7	120	255.4	–135.4
	8	65	177.7	–112.7		8	83	209.4	–126.4		8	81	248.6	–167.6
2002	1	85	177.3	–92.3	2005	1	120	204.7	–84.7	2008	1	136	242.3	–106.3
	2	200	175.3	24.8		2	184	200.9	–16.9		2	218	238.3	–20.3
	3	230	175.4	54.6		3	276	195.7	80.3		3	310	238.5	71.5
	4	337	175.6	161.4		4	375	193.7	181.3		4	528	240.9	287.1
	5	237	178.0	59.0		5	273	193.9	79.1		5	329	241.9	87.1
	6	149	179.9	–30.9		6	138	195.2	–57.2		6	177	243.5	–66.5
	7	96	182.3	–86.3		7	101	195.3	–94.3		7	138	250.4	–112.4
	8	76	185.8	–109.8		8	82	193.5	–111.5		8	102	260.3	–158.3
2003	1	113	187.4	–74.4	2006	1	124	192.3	–68.3	2009	1	130	268.8	–138.8
	2	203	204.7	–1.7		2	201	192.4	8.6		2	250	274.9	–24.9
	3	264	221.9	42.1		3	260	193.3	66.7		3	388	277.9	110.1
	4	359	221.2	137.8		4	363	192.9	170.1		4	609	278.6	330.4
	5	241	220.4	20.6		5	266	191.2	74.8		5	383	279.4	103.6
	6	422	224.9	197.1		6	146	191.1	–45.1		6	222	277.7	–55.7
	7	99	235.1	–136.1		7	108	198.7	–90.7		7	141	268.2	–127.2
	8	61	246.2	–185.2		8	69	219.0	–150.0		8	109	258.8	–149.8

2. For each season, find the arithmetic mean of all the seasonal values, that is, the average estimated seasonal component.
3. The total of the average estimated seasonal component is expected to be zero. Since the sum of average age variation components is 8.0 and not zero, it is necessary to adjust them by subtracting 1 from each of the values to obtain the adjusted age variation components. The 8 age groups (i.e. 0 – 5, 6 – 15, 16 – 25, 26 – 35, 36 – 45, 46 – 55, 56 – 65 and over 65) are coded 1, 2, 3, 4, 5, 6, 7 and 8, respectively.

Table 6: Arithmetic mean of all the age variations

Age groups	0 – 5 1	6–15 2	16–25 3	26–35 4	36–45 5	46–55 6	56–65 7	Over 65 8	
Total	–953.7	–72.7	686.9	2131.5	697.8	–205.1	–941.1	–1271.2	
Average age variations	–106.0	–8.1	76.3	236.8	77.5	–22.8	–104.6	–141.2	8.0
Adjusted age variations	–107.0	–9.1	75.3	235.8	76.5	–23.8	–105.6	–142.2	0

The interpretation of the figures is that for the fourth age group (i.e. 26 – 35), for instance, the value of the data is about 235.8 above the trend and that for the sixth age group (i.e. 46 – 55) is 23.8 below the trend.

3. Results

Forecasting

So far, we have made use of the Road Traffic Fatality (RTF) data, in Table 1, to study what has happened in the past in order to better understand the underlying structure of the data. This understanding provides the means necessary for predicting future occurrences of fatalities. Forecasting involves projecting the values of a variable based entirely on the past and present observations of the variable. Forecasting values for future RTF is demonstrated below. The trend values (*t*), calculated in Table 4, and the average adjusted age variation components (*a*), calculated in Table 6, are given in Table 7 for Years 9 and 10.

Table 7: The trend values and the average age variation components for the year 2009 to 2010

	2009 (Year 9)							
	0 – 5 1	6–15 2	16–25 3	26–35 4	36–45 5	46–55 6	56–65 7	Over 65 8
y	130	250	388	609	383	222	141	109
t	268.8	274.9	277.9	278.6	279.4	277.7	268.2	258.8
a	–107.0	–9.1	75.3	235.8	76.5	–23.8	–105.6	–142.2
	2010 (Year 10)							
	0 – 5 1	6–15 2	16–25 3	26–35 4	36–45 5	46–55 6	56–65 7	Over 65 8
y	136	217	269	577	379	184	129	95
t	256.5	253.9	250.8	249.1				
a	–107.0	–9.1	75.3	235.8	76.5	–23.8	–105.6	–142.2

Assuming that the trend in Year 11 follows the same pattern as in years 1 to 10, and an additive model is appropriate, the forecast for the eight yearly values for year 11 (i.e. the year 2011) are determined using the following procedure.

1. Estimate the trend values for the series points of Year 11. From Equation (9), the least squares regression estimate of the trend values for Year 11 at series point 1 is approximately

$$\hat{t}_{81} = 174.179 + 1.207 \times 81 = 271.9.$$

Similarly, $\hat{t}_{82} = 273.2,\ \hat{t}_{83} = 274.4,\ \hat{t}_{84} = 275.6,\ \hat{t}_{85} = 276.8,\ \hat{t}_{86} = 278.0,\ \hat{t}_{87} = 279.2$ and $\hat{t}_{88} = 280.4.$

2. Corresponding to each of the estimated trend values for Year 11, is the age factor. These values are given as $s_1 = -107.0,\ s_2 = -9.1,\ s_3 = 75.3,\ s_4 = 235.8,\ s_5 = 76.5,\ s_6 = -23.8,\ s_7 = -105.6$ and $s_8 = -142.2.$

3. Add the estimated trend values to the corresponding seasonal factors to obtain the forecast values. Let $y_{p,n}$ denote the forecast for Year *p* at series point *n*, where *n* = 1, 2, …, 8. The forecast for Year 11 at series point 1 is then given by

$$y_{11,1} = t_{81} + s_1 = 271.9 - 107.0 = 164.9.$$

This means that in the year 2011, about 165 children between the ages of 0 to 5 years are expected to die as a result of Road Traffic Fatalities. The other forecast values for the remaining 7 age groups for the year 2011, are as follows:

$$y_{11,2} = t_{82} + s_2 = 273.2 - 9.1 = 264.1,$$
$$y_{11,3} = t_{83} + s_3 = 274.4 + 75.3 = 349.7,$$
$$y_{11,4} = t_{84} + s_4 = 275.6 + 235.8 = 511.4,$$
$$y_{11,5} = t_{85} + s_5 = 276.8 + 76.5 = 353.3,$$
$$y_{11,6} = t_{86} + s_6 = 278.0 - 23.8 = 254.2,$$
$$y_{11,7} = t_{87} + s_7 = 279.2 - 105.6 = 173.6,$$
$$y_{11,8} = t_{88} + s_8 = 280.4 - 142.2 = 138.2.$$

Table 8 gives the age distribution of the expected road traffic fatalities together with the estimated totals as computed by the analysis from the year 2010 to 2030. For instance, out of a total of 2 132 estimated road traffic deaths expected to occur in the year 2010, about 502 of these victims are between the ages 26 to 35 years while 254 of them are children in the age group 6 – 15 years.

Table 8: Expected distribution of Road Traffic Fatalities in Ghana from 2010 to 2030

	Age Groups								
Year	**0 – 5**	**6–15**	**16–25**	**26–35**	**36–45**	**46–55**	**56–65**	**Over 65**	**Total**
2010	155	254	340	502	344	245	164	129	**2132**
2011	165	264	350	511	353	254	174	138	**2209**
2012	175	274	359	521	363	264	183	148	**2287**
2013	184	283	369	531	373	273	193	158	**2364**
2014	194	293	379	540	382	283	203	167	**2441**
2015	204	303	388	550	392	293	212	177	**2518**
2016	213	312	398	560	402	302	222	186	**2596**
2017	223	322	408	569	411	312	232	196	**2673**
2018	233	332	417	579	421	322	241	206	**2750**
2019	242	341	427	589	431	331	251	215	**2827**
2020	252	351	437	598	440	341	260	225	**2904**
2021	262	361	446	608	450	351	270	235	**2982**
2022	271	370	456	618	459	360	280	244	**3059**
2023	281	380	466	627	469	370	289	254	**3136**
2024	290	390	475	637	479	380	299	264	**3213**
2025	300	399	485	647	488	389	309	273	**3291**
2026	310	409	495	656	498	399	318	283	**3368**
2027	319	419	504	666	508	409	328	293	**3445**
2028	329	428	514	676	517	418	338	302	**3522**
2029	339	438	523	685	527	428	347	312	**3600**
2030	348	448	533	695	537	438	357	322	**3677**

From Table 1, it can be seen that, the number of fatal accidents and their resulting fatalities in 2009 were the highest ever recorded in Ghana as at the year 2010. From the analysis, a total of 2 132 deaths were estimated to occur in 2010 as a result of road traffic accidents. This represents a decrease of 4.5% over the 2009 observed figures. However, the actual number of fatalities as observed from the 2010 data decreased by 11% over the 2009 observed figures. The result shows that the expected road traffic fatalities as estimated by the analysis for the year 2010 exceeded the total observed fatalities for that same year by 7.3%.

Table 9 gives the breakdown of the actual age distribution of road traffic fatalities together with the corresponding estimated fatalities from the analysis for the year 2011. It can be seen that the total estimated number of road traffic fatalities, from the analysis, is within 0.5% of the observed national figure for 2011.

Table 9: The estimated and the observed road traffic fatalities for 2011 by age groups

	0 – 5	**6–15**	**16–25**	**26–35**	**36–45**	**46–55**	**56–65**	**Over 65**	**National**
Observed fatalities	126	212	365	658	400	209	126	103	**2199**
Estimated fatalities	165	264	350	511	353	254	174	138	**2209**
% change	31.0	24.5	4.1	22.3	11.8	21.5	38.1	34.0	**0.5**

The observed number of road traffic fatalities together with the number of fatalities estimated from the analysis (from 2001 to 2011) are given in Table 10. The absolute percentage differences between the estimated and observed values are also given in Table 10.

From Table 10, it can be seen that, of the 11 calculated figures, 9 are within 10% of the actual figure, 10 are within 20% and one is in error by 23.6% of its actual value.

Table 10: Comparison of observed fatalities and fatalities estimated from the analysis

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Observed fatalities	1660	1665	1716	2185	1784	1856	2043	1938	2237	1986	2199
Estimated fatalities	1437	1514	1591	1669	1746	1823	1900	1978	2055	2132	2209
Error	223	151	125	516	38	33	143	-40	182	-146	-10
Error percentage	13.4	9.1	7.3	23.6	2.1	1.8	7.0	2.1	8.1	7.4	0.5

4. Discussion

The number of road traffic fatalities has continued to increase in Ghana, expecially in many of the low-income and middle-income countries. The number of road traffic fatalities in Ghana are predicted to rise from 1 986 in the year 2010 to 3 677 in the year 2030, an increase of about 85%. There are notable differences in the way different road users are affected by road traffic collisions. As can be seen in Table 1, more than half of all road traffic deaths in Ghana occur among young adults between 15 and 44 years of age.

One of the key findings on global trends and projections, presented in the World report on road traffic injury prevention revealed, that road traffic deaths are predicted to increase by 83% in low-income and middle-income countries (if no major action is taken), and to decrease by 27% in high-income countries. The overall global increase is predicted to be 67% by 2020 if an appropriate action is not taken.

In a study of injury-related mortality among adolescents, Ohene et al. (2010) discovered that drowning and road traffic accidents are the leading causes of injury-related, mortality based on data collected from Korle-Bu teaching hospital. According to the report, road traffic accidents contribute 33% of the total causes of injury related deaths among adolescents between 10 to 19 years of age. They recommended appropriate injury reducing interventions to facilitate a decrease in these preventable deaths.

According to Odero et al. (1997), road traffic accident victims tend to stay longer in a hospital than average patients. The total number of disability days, is one way of qualifying the overall societal burden due to non-fatal injuries, caused by various modes of transport. Research has shown that mortality among the seriously injured, increased from 35% in the US to 55% in middle-income Mexico, to 63% in low-income Ghana (Mock et al., 1998).

It can be seen from these statistics that RTAs have adverse impact on the resources of governments. This is aggravated by the fact that most fatal accident victims are bread winners of their families and their sudden departure throws their dependants into hardships. The death of male breadwinners, through a road traffic accident, creates widows and female-headed households. In the same vein, the loss of female caretakers, of households, leaves the men alone to take care of children. Such children, who are denied the precious motherly love in their formative years, are not likely to grow up to become well-balanced members of society. In situations whereby both parents die, the onus is on family members to take care of the children. Dependants of road accident victims usually become school dropouts, social destitutes and eventual delinquents.

5. Conclusion

Road traffic fatality is a major but neglected challenge that requires concerted efforts for effective and sustainable prevention. In Ghana, a cumulative total of 17 436 fatalities were recorded in the 10-year period from 2001 to 2010. The highest fatalities during the period were in the 26 – 35 year old age group. Projections indicate that the number of road traffic fatalities in Ghana will increase by about 47% in the period 2010 to 2020 unless there is a new commitment of prevention. Nevertheless, the tragedy behind these figures attracts less mass media attention than other less frequent types of tragedy.

In Table 8, we compared the expected number of fatalities per age group from the year 2011 to 2020. The distribution remains broadly the same, with the highest fatalities for those between 26 and 35 years of age.

Table 9 shows the distribution of the relative expected increase in road traffic fatalities in 2020 over that of 2010 among the 8 age groups in the study. The expected percentage increase in road traffic fatalities in the year 2020 over that of 2010 is highest for those in the older age groups (over 56 years), with increase of over 100%. The increase is expected to be less than 5% within the age group 26 – 35.

Table 9: Expected percentage increase in fatalities

Year	0 – 5	6–15	16–25	26–35	36–45	46–55	56–65	Over 65	Total
2020	252	351	437	598	440	341	260	225	2904
2010	136	217	269	577	379	184	129	95	1986
Expected percentage increase	85.29	61.75	62.45	3.64	16.09	85.33	101.6	136.8	46.22

An increase in the number of vehicles and the population size should not lead to an increase in road traffic fatality if vehicles on our roads are crashworthy. Crashworthiness is the ability of a vehicle to protect its occupants during an impact. It is a measure of how well a vehicle performs during a collision. The crashworthiness of a vehicle is not simply how little damage it experiences, but how well it holds up to its intended design. Crashworthiness in highway vehicles can be divided into two categories: the effectiveness of the vehicle structure, and the effectiveness of the safety components within the vehicle.

Most vehicles plying the roads of Ghana lack the necessary modern safety mechanisms and equipments to minimize the occurrences and consequences of automobile accidents. Most modern vehicles have some kind of mechanism with which you can put a lock on windows and doors which are designed to keep children safe. Many vehicles have sensor systems that allow you to determine if a child or an object is behind or near to the car and wheels. Modern cars have air bags to protect the driver and the passenger riding in the front seat. Air bags are usually inside the steering wheel and dashboard in front of the passenger seat. It is speculated that an increase in automobile safety in Ghana will go a long way in reducing road traffic fatalities.

The Northern Ireland Department of The Environment (DOE) reports that the number of people killed on Northern Ireland's (NI's) roads in 2010 was the lowest since records began in 1931. The figures reported show the number of people killed in accidents in NI fell from 115 in 2009 to 55 in 2010, representing a 50% fall in fatalities and a 20% reduction in serious injuries. Of the 55 people killed in 2010, 10 were pedestrians, 10 on motorcycles and the rest in other vehicles. This success, among other things, was attributed to road safety mechanisms in cars such as anti-lock braking systems (ABS), air bags, better design of cars and increased wearing of seatbelts. People were surviving accidents at 60 mph when previously they were dying.

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