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Trends and projections of vehicle crash related fatalities and injuries in Northwest Gondar, Ethiopia: A time series analysis

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ABSTRACT

Background: Road traffic crashes are a huge public health and development problem in Ethiopia. Its current situation requires a high level political commitment, immediate decisions and actions in order to curb the growing problem.

Materials and Methods: Data on fatalities, total and partial permanent injuries, and lost workday attributable to vehicle crashes were collected from North Gondar Traffic Offices from 1996 to 2011. Holt and Brown exponential smoothing techniques were used to model the number of fatalities and other injuries due to vehicle crashes.

Results: There were 2300 vehicle crashes that occurred from 1996 to 2011 causing an estimated 968 fatalities, 1665 lost workday and 1185 permanent total and partial injuries, and 1,899,950.60$ losses. Only 7.6% of the vehicles had problems before the crashes occurred while 89.9% had no problems. The mean time of crashes occurred were 12.78 h with a standard deviation of 4.19 h. The highest daily, monthly, seasonal, and yearly crashes occurred were during Friday, January, winter and 2009, respectively. Future forecasts showed that by 2015, there could be 414 fatalities, 1123 lost workdays and 438 permanent total and partial injuries, and 955,249.12$ losses.

Conclusion: The numbers of lives lost and disabilities due to vehicle crashes indicated an upward trend in the last decade showing future burden in terms of societal and economic costs threatening the lives of many individuals. Surveillance systems that could enable to monitor patterns of vehicle crashes with preventive strategies must be established.

Key words: Economic loss, fatal injuries, forecasts, trends, vehicle crash

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INTRODUCTION

Developing countries account for 90% of global road traffic deaths, while accounting for only 20% of cars being driven worldwide.[1] Nearly three-quarters of road deaths occur in developing countries and men comprise a mean 80% of casualties.[2] It threatens to grow exponentially unless swift action is taken to counter it.[1] After the baseline study to estimate the global burden of disease in 1996, WHO

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estimates show the annual number of deaths from road-traffic injuries worldwide rose by 10%. The increase was largely influenced by a pronounced rise in both the numbers and rates of estimated road-traffic injury deaths in low-income and middle-income countries, particularly those in Latin America and the Caribbean, the Middle East, North Africa, and Asia.[3]

In Africa, it has been estimated that 59,000 people lost their lives in road traffic crashes in 1990 and that this figure will be 144,000 people by 2020, a 144% increase.[4]

The number of motor vehicles, volume of road traffic, and utilization of the road by different road users in Africa has grown noticeably.[3,5] About 200,000 people died on African roads in 2002.[3] The highest fatality rates (deaths per 10,000 motor vehicles) worldwide occur in African countries, particularly Ethiopia, Uganda and Malawi.[6]

Although the high burden of road traffic injuries and fatalities in Africa, there is problem of low and negligible resource allocation to road safety in Africa. At the moment, funding for road safety activities in Africa is very limited, a mere drop in the ocean.[5]

In addition, road traffic crash deaths show monthly or seasonal pattern. For example, based on a report on road traffic crash deaths in South Africa indicated that the highest road traffic crash deaths were seen in December and lowest in January and February.[7]

A study showed that research into road safety in developing countries is scarce, especially in Africa.[8] Despite the limited data system, these projections highlight the essential need to address road-traffic injuries as a public-health priority.[9] Road traffic crashes are a huge public health and development problem in Ethiopia. Its current situation requires a high level political commitment, immediate decisions and actions in order to curb the growing problem.[10] Estimating the current problem and forecasting its future magnitude as a public health problem is a primary important step to guide future course of action for describing its economic implications, averting the problem and saving lives.

Few studies have been conducted on trends and projections of road traffic injuries and fatalities in Ethiopia. In addition, the economic implication of vehicle crash related losses as material and human resources have not been researched. Therefore, the study aimed at assessing the trends and projections of vehicle crashes related injuries and deaths as public health problem and economic implications in North Gondar, North West Ethiopia.

MATERIALS AND METHODS

The study was conducted from October 2011 to June 2012 in North Gondar Zone, Northwest Ethiopia. A study with retrospective time series data from 1996 to 2011 on injury and deaths due to vehicle crashes in North Gondar was conducted.

The study ethical clearance was obtained from the Institutional Review Board of the University of Gondar. Permission for accessing the data was obtained from North Gondar Zone Traffic Offices.

Data were collected on the number of vehicle crash related fatalities, injuries, and lost workdays and economic losses (in USD) during the crash, vehicle service year, driver service year, problems with the vehicle during the crash, the time and day at which the crash occurred, the month and year at which crash occurred, and the cause of crashes. In this research injury refers to transport injury events which include crashes and other injurious events occurring in the course of transportation.[11,12]

Fatal injury, as most of the countries use the standard definition given by UN/ECE,[13] defined as "any person who was killed outright or who died within 30 days as a result of the crash".

Furthermore, the three key variables used to characterize vehicle crash related injuries and fatalities[14] including:

1. Fatal injury: This is an injury resulting in death from a mishap or from complications arising from the mishap. The length of time between the mishap and a later death has no effect on the assignment of a fatal injury classification.
2. Permanent total and partial disability. Permanent total disabilities are nonfatal injuries that, in the opinion of competent medical authority, permanently and totally incapacitate a person so that he or she cannot follow any gainful occupation. In addition, the loss of, or the loss of use of, both hands, or both feet, or both eyes, or a combination of any of these losses as a result of a single mishap will be considered as a permanent total disability. Permanent partial disabilities: Are injuries that do not result in death or permanent total disability, but, in the opinion of competent medical authority, do result in permanent impairment or loss of any part of the body, loss of the great toe or the thumb, or an unrepairable inguinal hernia.
3. Lost workday injury refers to an injury that does not result in death, permanent total disability, or permanent partial disability, but results in 5 or more lost workdays (not including the day of the injury).

Lost workday level injuries are further divided into major and minor categories.

Questionnaire layout was prepared for collecting the data. Sixteen years of vehicle crash data since 1996-2011 were collected. Ten trained data collectors were recruited. Investigators had checked collected data for completeness during the data collection. Unnecessarily incomplete vehicle crash records were excluded.

Collected data were entered into computer using the Statistical Package for the Social Sciences (SPSS) version

16 software. Summary measures and graphs were used to characterize the distributions of vehicle crash data. Many statistical methods are available to explain crash-related variables, such as log-linear model, generalized linear model and multiple-linear model. Data observed over time usually have strong correlations among neighboring observations. Therefore, the ordinary methods are not appropriate for this analysis because these methods assume that the observations over time are independent.[15] This method has proven to be very useful in the analysis of multivariate time series.[16,17] Box and Jenkins and exponential smoothing are commonly used methods in modeling time series data. After the predictive performance of both modeling techniques were performed using the stationary R^2 which were ranged from 62.5% to 84.5% and below 30% in all the exponential and autoregressive integrated moving-average models, respectively, the analysis suggested to use exponential smoothing with trend components. Exponential smoothing was performed for fitting the time series vehicle crash related injuries and deaths data. In exponential smoothing the current and immediately preceding ("younger") observations are assigned greater weight than the respective older observations. The double exponential smoothing which consisted of simple exponential smoothing and trend factor with no seasonality was performed for the number of deaths, the number of light and heavy body disabilities, economic loss time series data. Holt trend component was added to the simple exponential smoothing models of the number of deaths, the number of heavy and economic loss time series data while Brown trend factor was added to the number of heavy body disabilities time series data. In all the cases, the double exponential models could accomplish exactly such weighting, where exponentially smaller weights are assigned to older observations.

DES = SES + Tend

Trend refers to the smooth upward or downward movement characterizing a time series over a long period of time. Trend movements are attributable to factors such as population change, technological progress, and large-scale shifts in consumer tastes.

The specific formula for the simple exponential smoothing is:

$$S_t = \alpha^* X_t + (1-\alpha)\,^* S_{t-1} \quad (1)$$

When applied recursively to each successive observation in the series, each new smoothed value (forecast) is computed as the weighted average of the current observation and the previous smoothed observation; the previous smoothed observation was computed in turn from the previous observed value and the smoothed value before the previous observation, and so on. Thus, in effect, each smoothed value is the weighted average of the previous observations, where the weights decrease exponentially depending on the value of parameter α (alpha). If α is equal to 1 (one) then the previous observations are ignored entirely; if α is equal to 0 (zero), then the current observation is ignored entirely, and the smoothed value consists entirely of the previous smoothed value (which in turn is computed from the smoothed observation before it, and so on; thus all smoothed values will be equal to the initial smoothed value S_0).

In practice, the smoothing parameter is chosen by a *grid search* of the parameter space, that is, different solutions for α are tried starting for example with α = 0.1-0.9, with increments of 0.1. Then α is chosen so as to produce the smallest sums of squares (or mean squares) for the residuals (i.e., observed values minus one-step-ahead forecasts; this mean squared error (MSE) is also referred to as *ex post* MSE, *ex post* MSE for short).

The formula for the double exponential smoothing is:

$$S_t = \alpha Y_{t-1} + (1-\alpha)(S_{t-1} + T_{t-1}),\ 0 \le \alpha \le 1 \quad (2)$$
$$T_t = \gamma + (S_t - S_{t-1}) + (1-\gamma)\, T_{t-1},\ 0 \le \gamma \le 1 \quad (3)$$

Trend term is the expected increase or decrease per unit time period in the current level (mean level). The first smoothing equation adjusts *St* directly for the trend of the previous period T_{t-1} by adding it to the last smoothed value S_{t-1}. This helps to bring S_t to the appropriate base of the current value. The second smoothing equation updates the trend which is expressed as the difference between last two values. α (the smoothing parameter) and γ (trend coefficient) are the two parameters. Hence, the *h*-step ahead forecast at time *t* is:

$$\hat{Y}_t(h) = S_t + hT_t \quad (4)$$

Trend prediction is added in the *h*-step ahead forecast. α and γ can be chosen by minimizing the MSE as in single exponential smoothing. These steps involved plotting the data, identifying the dependence orders of the model, parameter estimation, diagnostics, and model choice.[16]

RESULTS

Vehicle crash burdens

There were 2300 vehicle crashes that occurred from 1996 to 2011 causing an estimated 968 fatalities, 1665 lost workdays, 1185 total and partial permanent injuries and 1,899,950.60 USD economic losses [Table 1].

Vehicle crash characteristics

The mean time of crash was 12.78 h with a standard deviation of 4.19 h. Most of the vehicle crashes were occurred on private vehicles which made up 1,858 (81.2%) of the crashes. The rest 420 (18.4%) were owned by government while nine (0.4%) of the vehicles had unknown owners. When the crash occurred, 7.6% of the vehicles had problems before the crash, 89.9% had no problems while 2.5% of the crashes had unknown problems. Only one (1.89 * 10-5%) had no vehicle damage, 754 (33.0%) caused crashes on humans and animals, 800 (35.0%) had caused damage on the vehicles, 732 (32.0%) had caused crashes on humans and vehicles. Regarding the driver service years, 168 (7.3%) had no driving experience, 845 (36.9%) had <5 years of services, 588 (25.7%) had 5-10 years of services, 631 (27.6%) had >10 years services and 55 (2.4%) had unknown service years. When vehicle years of services considered, 838 (36.7%) had served <5 years, 541 (23.7%) had served 5-10 years, 888 (38.9%) had served >10 years while 18 (0.8%) of the vehicles had unknown years of services [Table 2].

Daily, monthly, seasonal and annual characteristics of vehicle crash injuries time series data

The pattern of vehicle crashes by days indicated that the crashes tend to increase starting from Monday. The highest crashes occurred on Friday which was followed by Saturday. The number of total and partial permanent disability injuries and fatalities were the highest on Friday while the number of lost workdays reached its maximum on Saturday. The findings support the fact that, in Ethiopia, many people drink alcohol, travel and perform most funeral activities during weekends which could raise the level of road crashes during these days [Figure 1].

The monthly patterns of vehicle crash injuries started to increase from September of each year and reached its monthly maximum on January. This pattern started to die out beyond January till August of each year. In all of the cases the number of fatalities, lost workdays, and total and partial permanent injuries reached their maximum during January. During the months June, July and August, the rainy season in Ethiopia, people become less moveable and as most of the population (85%) is rural dwelling, during these months they become busy with their traditional agricultural activities. From September to March, the people start harvesting their agricultural products and moving from place to place to marketing the products and it increases their exposure to road crashes [Figure 2].

During winter season of each year, i.e., during December, January and February months, injuries become more pronounced. As it could be seen in Figure 3, the number of fatalities, lost workdays, and total and partial permanent disability reached their maximum during winter season and started to decline and reached their minimum during

Table 1: Number of fatalities, lost workdays, total and partial permanent injuries and economic loss (USD) due to vehicle crashes in North Gondar Zone, Northwest Ethiopia, from 1996 to 2011

Variables	Total
Fatalities	968
Lost workdays	1665
Total and partial permanent injuries	1185
Economic loss ($)	1899950.60

Table 2: Characteristics of crashed vehicles in North Gondar Zone, Northwest Ethiopia, from 1996 to 2011

Variable	Category	Count *N* (%)
Driver service year	No experience	168 (7.35)
	<5 years	845 (36.95)
	5-10 years	588 (25.71)
	>10 years	631 (27.59)
	Unknown	55 (2.40)
Vehicle service year	Unknown	18 (0.79)
	<5 years	838 (36.67)
	5-10 years	541 (23.68)
	>10 years	888 (38.86)
Owner of the vehicle	Unknown	9 (0.39)
	Private	1858 (81.24)
	Government	420 (18.36)
Vehicle problem during the crash	No problem with the vehicle	2057 (89.94)
	Vehicle is with problem	173 (7.56)
	Unknown	57 (2.49)
Crash happened to the vehicle	No vehicle damage	1 (0.04)
	Crash on humans and animals	754 (32.97)
	Damage on vehicle	800 (34.98)
	Both humans and vehicles	732 (32.01)

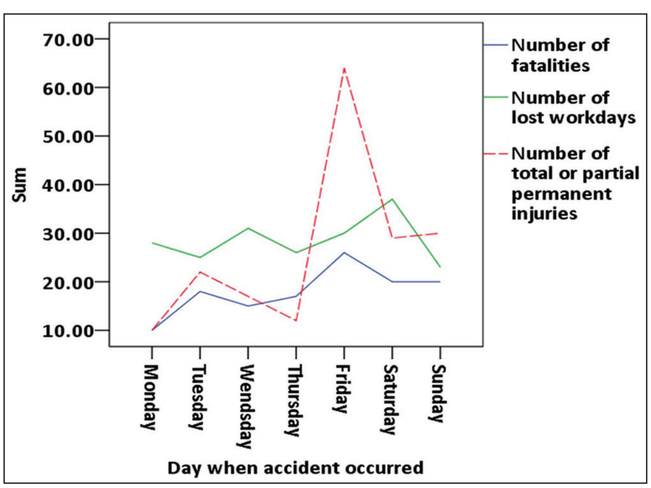

Figure 1: Daily pattern of vehicle crash fatalities, injuries and lost workdays during 1996-2011 in North Gondar Zone

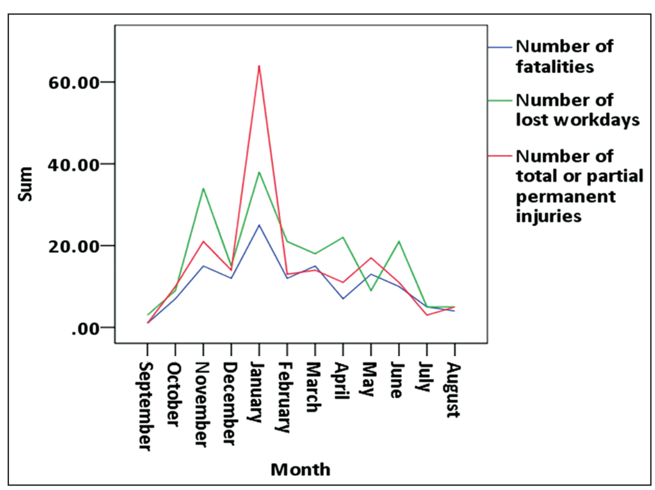

Figure 2: Monthly patterns of vehicle crash fatalities, injuries and lost workdays during 1996-2011 in North Gondar Zone

summer and the burdens would start to increase during autumn [Figure 3].

The pattern of vehicle crashes was relatively low with a staggering pattern to increase between the years 1996 and 2004. Beyond 2004, the crash pattern started to increase and continued increasing. The highest numbers of fatalities and total and partial permanent injuries were recorded during 2009 while the highest for lost workdays was recorded in 2011. The increasing trend in crashes and the resulting fatalities, workdays lost and injuries in recent years may be attributable to the increased volume of old vehicles as well as vehicular population in the country[18] [Figure 4].

Economic loss due to vehicle crashes

The pattern of amount lost (USD) due to vehicle crashes showed a relatively small increase in the years between 1996 and 2007. Beyond 2007, the amount of loss (USD) due to crash continued to increase. The highest amount of loss (USD) was recorded during 2009 [Figure 5].

Time series models and forecasts

The model building started with the examinations of the models performance in predicting crash related burdens such as fatalities, lost workdays, total and partial permanent injuries and amount lost (in USD) due to vehicle crashes. SPSS version 20 Expert Modeler indicated that fatalities, lost workdays, total and partial permanent injuries and amount lost due to crashes are best described by exponential smoothing with Holt and Brown model types. Holt model for number of fatalities, total and partial permanent injuries and amount lost (in USD) due to crashes while Brown model is best fit for the number of lost workdays. In this analysis model fit was assessed using the stationary R^2 model fit statistics which indicates the proportion of the total variation in the series that was explained by the model. The closer this statistics to one means the model does an excellent job of explaining the observed variation in the series. The stationary R^2 model fit statistics were 76.4%, 62.5%, 82.8 and 84.4% for the number fatalities, lost workdays, total and partial permanent injuries and amount lost (in USD) due to crashes, respectively, showing relatively good models in fitting the time series data [Table 3].

As it could be seen in the forecasts table, it could be expected 97, 101, 106 and 110 fatalities in the years 2012, 2013, 2014 and 2015, respectively. Future forecast also showed that there would be 132 deaths in the year 2020. Similarly, it could be expected 251 and 105, 270 and 108, 290 and 111, 310 and 114 lost workdays and total and partial permanent body disabilities in the years 2012, 2013, 2014 and 2015, respectively. Forecasts for amount of loss due to crashes showed that there would be 222,543.46, 233,389.34, 244,235.22 and 255,081.10 economic losses ($), in the years 2012, 2013, 2014 and 2015, respectively.

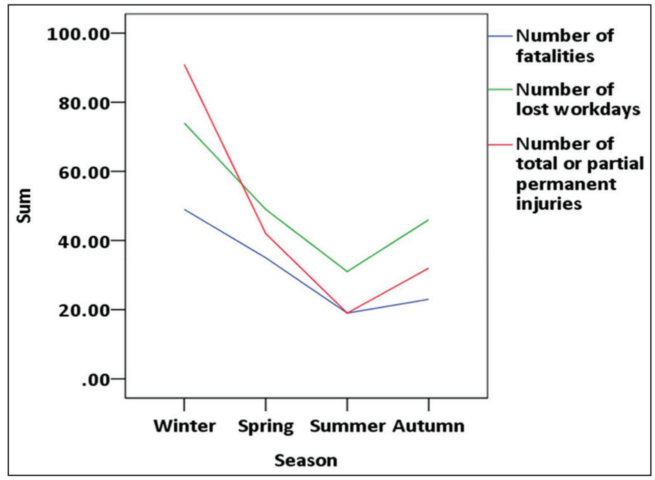

Figure 3: Seasonal patterns of vehicle crash fatalities, injuries and lost workdays during 1996-2011 in North Gondar Zone

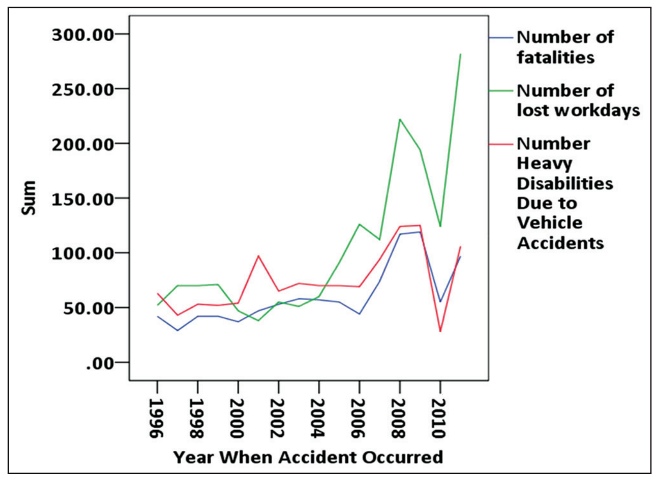

Figure 4: Yearly Patterns of Vehicle Crash fatalities, injuries and lost workdays During 1996-2011 in North Gondar Zone

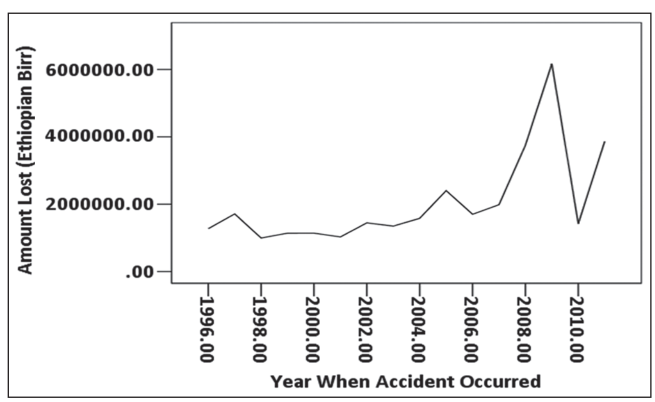

Figure 5: Yearly pattern of economic losses ($) due to vehicle crashes during 1996-2011 in North Gondar Zone, Northwest Ethiopia

To sum up, future forecasts showed that by 2015, there could be 414 fatalities, 1123 lost workdays and 438 permanent total and partial injuries, and 955,249.12$ economic losses [Table 4].

The forecast graphs showed the resulting plots of both the observed values and the fit values, and the forecast values for the estimation periods and the forecast periods, respectively [Figure 6]. As plots showed there were discrepancies between the observed lines and fitted lines in all the plots suggesting the need to include predictors of crashes related deaths, disabilities and losses in the models so that the variations in the observed time series data could be efficiently explained by the fitted models. In addition, these findings were supported by the stationary R^2 values in the model statistics table [Table 3], in which only 76.4%, 62.5%, 82.8 and 84.4% of the variations within the number of fatalities, number of lost workdays, total and partial permanent injuries, and economic lost due to vehicle crashes times series data were explained by the models, respectively.

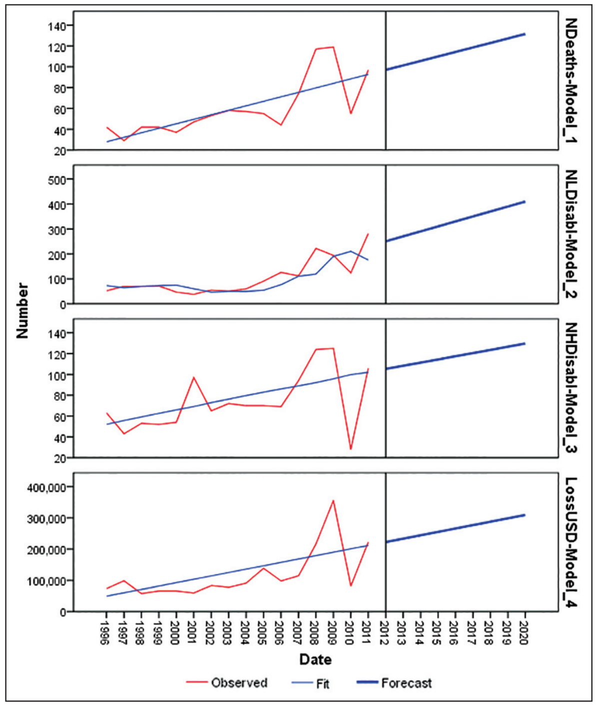

Figure 6: Yearly estimation and forecast patterns of fatalities, lost workdays, total and partial permanent injuries and economic losses (USD) due to vehicle crashes

DISCUSSION

The incidence of fatalities and injuries as a result of vehicle crashes found to be very significant showing an increasing

Table 3: Table of model fit types for the number of fatalities, number of lost workdays and heavy disabilities and economic lost (in USD) associated with vehicle crashes during 1996-2011 in North Gondar Zone, Northwest Ethiopia

Variables	Model type	Stationary R^2	Model parameters	Estimate	SE	*P* value
Fatalities	Holt	0.764	Alpha (level)	0.001	0.3	0.997
			Gamma (trend)	0.000	940.9	1.000
Lost workdays	Brown	0.625	Alpha (level and trend)	0.306	0.1	0.008
Total and partial permanent injuries	Holt	0.828	Alpha (level)	0.009	0.1	0.942
			Gamma (trend)	0.999	16.2	0.952
Economic loss in USD	Holt	0.844	Alpha (level)	0.001	0.1	0.986
			Gamma (trend)	0.000	29.6	1.000

SE: Standard error

Table 4: Forecasts table for the number of deaths, number of light and heavy disabilities and economic loss ($) associated to vehicle crashes during 1996-2011 in North Gondar Zone, Northwest Ethiopia

	Forecast								
Model	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fatalities									
Forecast	97.01	101.32	105.63	109.95	114.26	118.58	122.89	127.21	131.52
UCL	137.40	141.71	146.03	150.34	154.66	158.97	163.29	167.60	171.92
LCL	56.61	60.93	65.24	69.56	73.87	78.19	82.50	86.81	91.13
Lost workdays									
Forecast	250.56	270.48	290.40	310.32	330.24	350.16	370.08	390.00	409.92
UCL	353.54	391.17	431.22	473.36	517.34	562.97	610.11	658.64	708.48
LCL	147.59	149.80	149.58	147.28	143.14	137.34	130.04	121.35	111.35
Injuries									
Forecast	105.22	108.27	111.33	114.38	117.43	120.49	123.54	126.60	129.65
UCL	159.74	162.80	165.88	168.97	172.08	175.21	178.37	181.57	184.80
LCL	50.70	53.75	56.78	59.80	62.79	65.77	68.71	71.62	74.50
Economic losses in $									
Forecast	222543	233389	244235	255081	265927	276773	287619	298465	309310
UCL	363002	373848	384694	395540	406386	417232	428078	438924	449770
LCL	82084	92930	103776	114622	125468	136314	147160	158005	168851

For each model, forecasts start after the last non-missing in the range of the requested estimation period, and end at the last period for which non-missing values of all the predictors are available or at the end date of the requested forecast period, whichever is earlier. UCL: Upper confidence limit, LCL: Lower confidence limit, Economic loss is rounded to the nearest 0 digit trend, especially in recent years. The finding supports the report of the 65th road safety congress which indicated that road traffic deaths and injuries are a global phenomenon virtually in all countries of the world.[3,6,19] In the study area alone, there were 2300 vehicle crashes that occurred from 1996 to 2011 causing an estimated 968 fatalities, 1665 lost workdays, 1185 total and partial permanent disabilities and 1,899,950.60$. A study in Pakistan also indicated a corroborating findings which showed road crashes are very critical not only because they result in harm and eventual disability or death of people, but also because they result in waste of resources such as those hospital services that could be used for other purposes, and loss of savings and working days of the crash victims which may impact the future lifestyle of their families.[20]

The highest number of crashes occurred on Friday which was followed by Saturday. This is due to the fact that, in Ethiopia, many people drink alcohol, travel and perform most funeral activities during weekends, which could raise the level of road crashes during these days. According to United Nations Economic Commission for Africa (UN/ECA), the major causes of traffic accidents are failure to give way for pedestrians, followed by over speeding and failure to give way for other vehicles. However, the major causes of fatal accidents in order of importance are failure to give way for pedestrians, over speeding, and failure to respect right hand rule. The causes of driver errors are many which include inadequate training, driving under the influence of alcohol, drug or chat, and others. It is important to note here that, chat used to be one of the critical problems in the Eastern part of the country. However, its influence is currently expanding throughout the country. The traffic accident statistics in 2007/8 also indicate that over 5% of the fatal accidents and the total accidents occur when driving without having a driving license.[10,18]

The highest numbers of fatalities and total and partial permanent injuries were recorded during 2009 while the highest for lost workdays was recorded in 2011. According to the case study of UN/ECA on road safety, Ethiopia is one of the African countries with the least vehicle-ownership. According to the available yearly inspected and registered national vehicle-fleet data, motorization per 10,000 populations has increased from 15 to 22 in 10 years (1994/5-2004/5), which is nearly 4%/year. The vehicle fleet sharply increased at annual rate of 10% in the period 2001/2-2004/5. The increase in station wagons and trailers contributed much to the high growth rate of vehicle population. The number of private cars has increased 8%/year. In 2004/5, the vehicle fleet was composed of 37% private cars, 7% station wagons, 9% taxis, 9% buses, 21% small trucks, and 17% trucks, and truck-trailers. Accordingly, the vehicle fleet in Ethiopia was estimated to be 250,000 in 2008, which brought the country's motorization level to 32 vehicles/10,000 inhabitants. Like many developing countries, the vehicle fleet in Ethiopia generally consists of very old vehicles and without adequate maintenance.[18] Hence, the increasing trend in crashes and the resulting fatalities, lost workdays and injuries in recent years may be attributable to the increased and old volume of vehicles in the country.

Future forecasts showed that by 2015, there could be 110 deaths, 310 light and 114 heavy body disabilities, and 255,081.10$ losses. According to UN/ECA, in the 2007/8 fiscal year, police reported 15,086 accidents. The number of lives lost and estimated money lost due to the accident were 2161 people and US$ 7.3 million respectively. These findings are also in line with the future forecasts which say road traffic injuries will become the third leading cause of death and disability worldwide by 2020.[19,21,22] The study in India, for instance indicated that, the country will have 150,000-175,000 road traffic fatalities in the year 2015.[23]

Another study pointed out that in Africa, there were an estimated 59,000 people who lost their lives in road traffic crashes in 1990 and that this figure will be 144,000 people by 2020, a 144% increase.[4] This study highlights a need to address road-traffic injuries as a public-health priority. This recommendation is supported by Ameratunga *et al*.[9] Beside that the overall implications of the study indicate there still remain huge works in order to minimize deaths, disability and economic losses due to road traffic accidents.

CONCLUSION

In conclusion, the numbers of lives lost and disabilities due to vehicle crashes indicated an increasing trend in the last decade showing future burden in terms of societal and economic costs which would rise substantially threatening the lives of many individuals. It would be impossible to attach a value to each case of human sacrifice and suffering, add up the values and produce a figure that captures the national social cost of road crashes and injuries.[18] A sustainable commitment at different levels to mitigate and avert the burdens is required by not only road traffic workers nationwide, but also stakeholders from several disciplinary areas. In addition, the design and establishment of a population-based traffic injury surveillance system which complements police and hospital-derived crash and collision events is required.

Surveillance systems that could enable to monitor patterns of road crashes and preventive strategies must be established. Such systems must track not only deaths but also non-fatal vehicle crash outcomes which could threaten both the lives and economic conditions of families, communities and the country.

Limitations

Lack of uniformity in definitions

There are differences in defining road crashes across different countries[12] making international comparisons difficult. No objective systematic criteria for classifying the injury severity were applied by the police.

The study is entirely based on secondary source of data

As the study is based on police records under-reporting presents a serious problem in the calculation of the present magnitude of crash and future forecasts.

Reporting bias

Regarding the completeness, the police records are known to be biased. Deaths and severe injuries are more likely to be reported than minor injuries; drivers and passengers also have a greater likelihood of being recorded by traffic police than pedestrians, cyclists and other non-motorized road users becoming recognized sources of reporting bias. Crash-related morbidity and mortality statistics based on routinely collected data therefore represent an unknown proportion of the true values.

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