ROAD TRAFFIC ACCIDENTS;
PREDICTION IN PAKISTAN

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ABSTRACT... Objective: To determine the trend of road traffic accidents (RTAs) and forecasting their incidence is an emerging to take safety measures so that general public health related morbidity and mortality can be minimized. **Setting:** The data for present study has been taken from Pakistan bureau of statistics (statistics House). **Period:** January 2002-2003 to December 2011-2012. **Methods:** A set of eleven curve fitting models namely linear, quadratic, cubic, logarithmic, inverse, exponential growth model, logistics-curve ,and compound models were carried out for prediction. **Results:** Under the descriptive analysis, the annual average number of fatal and non-fatal accidents is 43.3% and 56.7% respectively. In provinces Punjab contributes to a high rate of total number of accidents, while Khyber Pakhtunkhwa, Sindh and Baluchistan placed second, third and fourth respectively. Under the curve fitting estimation, the cubic model was selected for predicting the annual traffic road accident for all categories i.e. (i) Total Number of Accident (ii) Fatal Accident (iii) Non-Fatal Accident (iv) Killed People (v) Injured People and (vi) The Number of Vehicle Involved. Rising trend in all categories are expected in Pakistan. **Conclusions:** The traffic road accident is expected to rise in Pakistan.

Key words: Curve fitting models; Forecasting; Pakistan; Traffic road accidents

INTRODUCTION

Every year more than a million people lost their lives on the world's roads while the non-fatality injuries between 20 to 50 million.[1] Traffic road fatalities vary in region by region and country by countries, Africa has the higher rate (24.1/100000) and the European region has the lower rate(10.3/100000) while south Asia placed on fourth (18.5/100000).[1] The globally annual road traffic fatality rate for overall, middle-income, low-income and high-income countries are 18/100000, 20.1/100000, 18.3/100000 and 8.7/100000 respectively, while over 80% road fatalities took place in low and middle income countries.[1] Globally the death rate is much higher in Pedestrians, motorcyclists, cyclists and the passenger use public transport including Asia.[2-5]. However the progress of any country is much depending on the mobility of transportation. The increasing tendency to the road transportation is maximizing the chances of traffic road crashes. RTAs have become a noteworthy health problem not only in developing countries but also in the developed nations and will become a fifth leading cause of death in 2030.[6] The poor road condition, traffic infrastructure, rapid motorization and the behavior of road users caused an increment in RTAs fatalities and injuries in developing countries and continue to rise.[7] The major and the mutual causes of traffic road accident in throughout the globe are vehicle related factors, human related factors and environmental related factor.[8] The major factors that caused for RTAs in developing countries that contributes to the high rate of crashes are , lack of safety belt and helmet use, a large number of old vehicles on roads that often carry more people than their capacity and design, poor road design and maintenance and the traffic mix on roads.[9]

RTAs in Pakistan

Pakistan is a developing country and ranked as a 6th most populous country in the globe. The RTAs fatalities and disabilities in low- and middle income countries are more than 85% and 90% respectively.[10] In Pakistan, the pedestrians and the

rider of motorized (2 or 3 wheelers) at on greater risk and the leading cause of RTAs fatalities 41% and 39% respectively.[1] The main reason of traffic road accident is lack of awareness about traffic sense codes and orders, driver related factor, overloading over speed use of cell phone during driving and vehicle related factor.[11] In a survey based analysis in Islamabad the capital of Pakistan, was found the overall deficient about road safety awareness, while the data taken from the hospital showed that 87% RTAs cases due to negligence of traffic law.[12] The poor enforcement of traffic laws on seat-build and helmet wearing in Pakistan.[13] The enforcement of the new road laws plays a vital role in the reduction of RTAs and mortality.[14] The impact of traffic road accident is significantly associated with the victim and their families and the national economy particularly for developing.[2,15] The roughly estimated cost related to traffic crashes is 1%, 1.5% and 2% of Gross national product in lower middle and high income countries respectively.[2] For Pakistan that cost is estimated to be 2% of the Pakistan's GDP.[16]

RTAs Modeling

As road traffic injuries has become a major public health concern, but preventable. It needs effective implementations of mathematical and statistical models that allow better understanding the level, trend and predicting its development. Time series analysis and regression analysis is excessively used for prediction of TRAs. In Nigeria curve fitting estimation was used for predicting the traffic road accident related fatalities and injuries.[17] A study made in Qatar, and found that regression models estimate was better as compared to smeed's model in traffic road fatalities.[18] A regression analysis and modeling was used in Turkey to find out significant factor that caused for accident.[19] Box-Jenkins model was developed for predicting the trend of road traffic accidents in Ghana and Kuwait.[20,21] The logistic regression, the multiple linear regression models, Bayesian approach and Poisson regression models are often used to analyze and develop the model to understand the pattern and magnitude of the road traffic injuries.[22-26]

METHODS AND MATERIAL

The data for current study has been taken from Pakistan bureau of statistics from January 2002-2003 to December 2011-2012. The register data on traffic road accident with the police authorities relates to road accident only. Railway accidents air crashes electrocutions are not included. Fatal accidents refer to those where the death occurred on the spot or where the victim succumbed to injuries later on. Non-fatal accidents refer to those in which no person was killed but in which one or more persons were seriously or slightly injured or property damaged.

Methods

Eleven different curves estimation models have been carried out by taking "y_i"= dependent variable, where $i = 1, 2, \cdots\cdots, 6$. Let y_1 represent the number of total registered accident, y_2 represent the number of registered fatal accident, y_3 represent the number of registered non-fatal accident, y_4 represent the number of registered killed person's, y_5 represent the number of registered injured person's and y_6 represent the number of registered vehicle involved in an accident. The independent variable is "t" (2002-03=1, 2003-04=2 and so on 2011-12=10). Among the various models namely linear, quadratic, cubic, logarithmic, inverse, exponential growth model, logistics-curve, and compound models, cubic model is selected due to higher value of coefficients of determination.

CUBIC MODEL

This model is define by the following equation

$$y = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 + e \qquad (1)$$

While $\beta_0, \beta_1, \beta_2$ and β_3 are the regression coefficients, "e" represents regression residual.
F-test was used to choose the statistically significant regression coefficients.[27]

Coefficient of Determination

$$R^2 = 1 - \frac{\sum e^2}{\sum y^2} \qquad (2)$$

Statistical package for social sciences (SPSS) 16 was used for the execution of various curve fitting models.

RESULTS AND DISCUSSION

On the basis of given registered data the annually average numbers of fatal and non-fatal accidents is 43.3% and 56.7% respectively. While in a single accident the average causalities and wounds are 31% and 69% in Pakistan respectively. In a 100 accidents the number of vehicles involved is 109. Detail of descriptive statistics for RTAs from 2002-2003 to 2011-12 is given in Table I. Trend analysis is given in figure1 for various categories. The total member of RTAs in 2006-07 was high 10466 a similar level was observed in 2007-08. There is an overall gradual trend toward a declining for all categories in last couple of years. Graphically illustrations are shown in Figure 1.

	Min	Max	Mean	Std. Deviation
Total accident	9140	10466	9811.1	467.11
Fatal	3966	4610	4250.8	206.66
Non-fatal	5174	6124	5560.3	312.53
Killed	4758	5615	5128.8	289.09
Injured	10145	12927	11609.5	936.11
Vehicle involved	9986	11481	10699.2	509.57

Table-I. Descriptive Statistics for various categories of RTAs (annually)
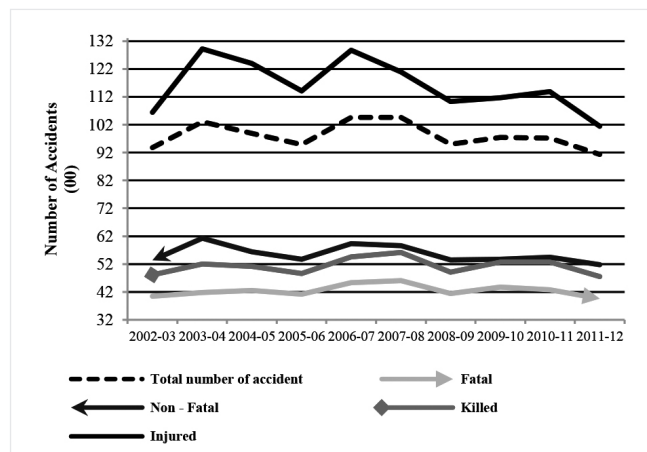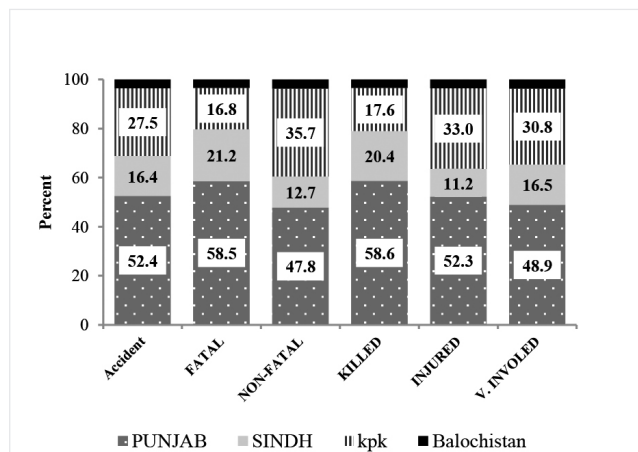

Figure-1. RTAs trend in Pakistan

Figure-2. RTAs by Province

RTAs by Provinces

Punjab and Baluchistan contributes a high and low percent of total number of accidents, fatal, non-fatal accidents, and number of deaths, wounds and vehicle involved as compared to Khyber pakhtunkhwa and Sindh respectively.

Meanwhile the Khyber pakhtunkhwa (27.5%) has higher total number of accident as compared to Sindh (16.4%), but the number of fatal accidents and the deaths are more in Sindh. Graphically illustrations of the total number of road traffic accidents by type the number of causalities and injuries person with involved vehicles are shown in Figure 2.

To uncover the trend of RTAs that is a major objective of that study. Among the various models the final efficient model is a cubic model for all categories by taking into account the ANOVA approach with p=0.000 and higher the value of coefficient of determination for different categories.[28] In all the models by including the constant term the p-value become greater than the level of significance (5%), the regression coefficients becomes insignificant, while excluding the constant term the models becomes significant i.e. p-value < level of significance.[27] Forecasts summery along with expected percent change is given in Table II. Under cubic model the rising trend in all categories. The expected

percent increment in total number of accident which is 43.49% in 2012-2013 as compared to 2011-2012. If 100 accidents occur in 2011-2012 the 143 accident are expected in 2012-2013. Cubic model equations of total number of accident, fatal accident, Non- fatal accident, killed, injured and number of vehicle involved in an accident is shown in equation 3 to equation 8 respectively.

For Total Number of Accident:
R^2 = 0.97, P-value =0.000

$$y_1 = 6850.96t - 1269.75t^2 + 68.67t^3 \qquad (3)$$

For Fatal Accident:
R^2 = 0.98, P-value =0.000

$$y_2 = 2847.26t - 513.657t^2 + 27.308t^3 \qquad (4)$$

For Non-Fatal Accident:
R^2 = 0.98, P-value =0.000

$$y_3 = 4003.699t - 756.095t^2 + 41.358t^3 \qquad (5)$$

For Killed:
R^2 = 0.98, P-value =0.000

$$y_4 = 3441.178t - 622.507t^2 + 33.193t^3 \qquad (6)$$

For Injured:
R^2 = 0.98, P-value =0.000

$$y_5 = 8446.294t - 1581.599t^2 + 85.239t^3 \qquad (7)$$

For Vehicle Involved:
R^2 = 0.97, P-value =0.000

$$y_6 = 1.1229t - 1369.204t^2 + 73.843t^3 \qquad (8)$$

Entity	Actual (2011-12)	Forecast (2012-13)	% change
Total accident	9140	13114.68	43.49
Fatal	3966	5514.31	39.04
Non-fatal	5174	7600.37	46.90
Killed	4758	6709.15	41.01
Injured	10145	14989.12	47.75
Vehicle involved	9986	14257.2	42.77

Table-II. Expected percent change summery

CONCLUSION

This statistical modeling will serve as a guide to the policy maker and the government in the formulation of a solid preventative measures and a comprehensive legislation and enforcement of road traffic safety laws. One of the major causes of road traffic accidents in Pakistan is lack of traffic rules and regulation among general public. Mortality and morbidity due to RTAs can be decline by improving the awareness level about traffic road safety laws among the general public[29] it is suggested that government ought to be launched comprehensive general public awareness companion about road safety. It needs to develop an intelligent transport system as well as the application of information and communication technologies will enhance the road safety.[30] A rising trend in road traffic accidents is an alarming situation as far as human's lives and the national economy of Pakistan concerned.
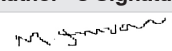
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