Human Injury causing Road Traffic Accident at Debre Markos Town

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Research Article

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Abstract

Objective: A Road traffic accident (RTA) is when in a road Vehicle collides with another Vehicle, pedestrian, animal or geographical or architectural obstacle. The RTAs can result in human injury, property damage and death. RTA result in the deaths of 1.2 million people worldwide each year and injuries about 4 times this number. The objective of this study is to identify the main causing-factors that contribute to road traffic accidents involving human injuries. Literature suggested factors considered for analysis are: Driver's Age, Driver's Education status, Driver's experience, Vehicle type, Driver Vehicle Ownership, Vehicle year of service, Road type, Road division, Road condition, Problem with car, Weather condition, and accident time (day or night).

Results: Among the candidate variables, Pearson Chi-Square method identified weather condition, driver's experience, Vehicle year of service; Road division, Driver Vehicle Ownership, and accident time (day or night) as significantly associated variables. Furthermore, percentage is used to describe the magnitude of associated variable. The result from Poisson regression analyses revealed that low driver experience, high Vehicle year of service (old cars), and Road division (one way road) are the significant contributing factors for increment of human injuries accidents.

Introduction

A Road traffic accident (RTA) is a type of accident occurred at road when a Vehicle collides with another Vehicle, pedestrian, animal or geographical or architectural obstacle. The RTAs can result in injury, property damage and death. RTA is a cause of death for 1.2 million people worldwide each year, and injures about 4 times this number (WHO, 2004). In this study, a road traffic accident is defined as accident which took place on the road between two or more objects, one of which must be any kind of a moving Vehicle [1]. Road Traffic Accidents (RTAs) are increasing with rapid pace and presently these are one of the leading causes of death in developing countries.

The morbidity and mortality burden in developing countries is rising due to a combination of factors, including rapid motorization, poor road and traffic infrastructure as well as the behavior of road users [2]. However, in technologically advanced countries injuries are reducing [3, 4]. Lack of protection, drivers, passengers, and the involved pedestrians are more likely to sustain injury or fatality at the impact of traffic collision [5].

Human factors, including road user behavior and incapacitation, are the most common factors, accounting for more than 85% of all traffic crashes among them, the two key known contributing factors are speeding, and drinking and driving. Other contributing factors are unsafe vehicles, unsafe road design, and the related lack of effective law enforcement and safety regulations [6].

Shankar et al. (1995) explored the frequency of occurrence of highway accidents on the basis of a multivariate analysis (by negative binomial model) of road way geometries (e.g. horizontal and vertical alignments), weather and other seasonal effects. The results of the analysis uncover important determinants of accident frequency.

Karlaftis and Golias (2002) studied the effects of road geometry and traffic volumes on rural roadway accident rates using Generalized linear modeling. The results showed that although the importance of isolated variables differs between two-lane and multilane roads, 'geometric design' variables and 'pavement condition' variables are the two most important factors affecting accident rates. Particularly all accident frequency increased with speed to the power of approximately 2.5.

The literature review shows that pedestrian crashes account for more than 40 percent of crashes in most of Africa countries. For example: pedestrians accounted for 55% of road traffic deaths in Mozambique between 1993 and 2000 [7]. Pedestrians account for 46% of road traffic deaths in Ghana between 1994 and 1998 [8]. Pedestrian and passenger crashes represented 80% of all road traffic deaths in Kenya in 1990 [9].

In a study of motorcycle collisions using hospital data from Nigeria, motor cyclist involved crashes are the second most common cause of road traffic injuries in Nigeria. From the victims more than half are passengers (39.5) and pedestrians (13.8) [5]. Most of car accidents on pedestrian happened on male, with a three to one ratio to female fatalities. The death of the most productive member exerts a devastating impact to the families, pushing many into poverty with long lasting effect to their children and their community at

large [10]. This creates an overwhelming burden to the most vulnerable road users and their families, which tend to be poor and less educated.

RTA and injuries constitute major health, economic, and developmental challenges to developing countries, especially those in Africa. Africa has the highest fatality rate in relation to population (28.3 per 100,000 population after adjusting for underreporting), which is higher than motorized countries in the world, such as those in North America (12.1 to 16.2 per 100,000 population) [11].

Accidents and injuries due to RTAs is the second most common & accounted for 22.8% of all such incidents in Ethiopia. RTAs contributed to 43.8% of all fatalities next to other accidents and injuries. Among RTA causalities, 21.9% were drivers, 35.0% were passenger vehicle occupants and 36.0% were vulnerable road users including: motorcyclists (21.0%), pedestrians (12.1%) and cyclists (2.9%) [12].

Recent studies on RTA in Ethiopia have shown the escalation of the problem at the national level, at least 70 people die for every 10,000 vehicle accidents annually. Particularly Amhara region accounted for 27.3% of the total road traffic accident related deaths in Ethiopia during the year 2008/9, it takes the highest share among all regions. This indicates the need to examine the cause of accidents on the region [13].

Pedestrians and passengers of commercial vehicles are the most vulnerable in Ethiopia. Factors like poor road network, absence of knowledge on road traffic safety, mixed traffic flow system, poor legislation and failure of enforcement, poor conditions of vehicles, poor emergency medical services, and absence of traffic accident compulsory insurance law have been identified as key determinants of the problem [14].

Road traffic accident in Amara region indicates that freight vehicles (51%) and passenger vehicles (34.5) are the main causes of accidents. And interstate highways takes 54.8% of the accidents occurred. Mainly pedestrians passengers were accounted for the largest part of road traffic deaths victims in the urban areas. This accident is mainly due to drivers problem of failure to give priority to pedestrians, failure to stay on the right side of the road, speeding, failure to maintain distance between vehicles and failure to yield the right of way for other vehicles [13].

Recent report on Debre Markos town traffic accident indicated that there is an increase in accident and huge loss due to many factors. This enhances socio-economic instability in addition to physiological and physical damage. In response to this, road and transport authority office plan to work with other organizations, to have good behaved and well trained human resources, and based on information and studies developing awareness and work with the society, to achieve a gole of creating stable accident free transportation system. The approach is based on developing awareness of society on rules of road and transportation system, which helps the society to know and respect rules for the purpose of reducing car accident. In addition creating good behaved and well trained human resources is another input. It known that to reduce level and number of accident the influence of diver and related factors are unrepeatable hence much concern should have to give. However, the quality of drivers, cars, and road standard does not considered. As a result, this study attempts to investigate factors those contribute to road traffic accident involving human injuries, by considering literature suggested factors which are recorded by traffic police officers.

Materials And Methods

Data Source

The Cross-sectional study is applied for the number of human injuries per Vehicle accident at Debre Markos town in a year from 2014 to 2019(1615 consecutive days). The data is taken from the record and report book of Debre Markos town traffic police. Accidents were recorded by the traffic police on daily basis for the purpose of reports and public service.

Missing Value Treatment

The data set is extracted from recorded document, and some values were incomplete or missed. So in ordered to treat such problem I preferred to use median value for categorical variable and exception maximization method for continuous variable.

Variables of the study

The response variable is number of human injuries per accident over a day. This includes the number of people dead, lightly injured or heavily injured due to a traffic accident. The considered predictors are Driver's Age, Driver's Education status, Driver's experience, Vehicle type, Driver Vehicle Ownership, Vehicle year of service, Road type, Road division, Road condition, Problem with car, Weather condition, and accident time (day or night) [See Table S1].

Methods of data analysis

Variable selection

The analyses were started by considering the whole explanatory variables, and a significantly associated factor with a dependent variable is taken to check the causal effect on a response. Pearson chi-square is used to select which variable should be entered into reduced model. Finally, the log-likelihood of the full model and reduced model were compare to select the variables which stayed in the model.

Poisson Regression Model

In statistical analysis of the count of rare event, it is often assumed that the dependent variable follows a Poisson distribution, with the assumption of the mean (expected) count equal to its variance. In practice, the variance is much larger than the mean. This is often referred to as "over dispersion" with respect to the Poisson distribution.

The number of accidents occurred in a day follow a Poisson distribution with parameter λ, and for a given independent variables (x_1, x_2, ..., x_m) the probability of an event occurred is modeled as:

$$p(y = k/x\,1, x2, \ldots, xm) = e^{-\lambda}\frac{\lambda^k}{k!}, where; k = 1,2,3\ldots,$$

Where the log of the mean occurrence (λ) is assumed to be a linear function of the independent variables. Which implies that λ is the exponential function of independent variables:

$$\lambda = e^{(\beta_0+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_m X_m)}; log(\lambda) = \beta_0 + \sum_{i=1}^{m}\beta_i x_i$$

Results And Discussion

Descriptive Statistics

Descriptive statistics is used to compare and describe the magnitude of significantly associated factors using percentile. The result in Table S3 indicates that, explanatory variables which have significant association with number of human injure in road traffic accident are: weather condition, driver's experience, Vehicle year of service; Road division, Driver Vehicle Ownership, and accident time (day or night).

As the result indicated in Table S3, most of the accident were occurred in road type asphalt 78.8% comparing to the accident occurred on sandy road (10%) and cobble road (11.2%). Higher accident were encountered by Small Vehicles (Minibus, Bajaj, taxi and Toyota) (43.75%), followed by auto track (27.5%), Wagon and related (12.5%), Motorbike (8.75%), and Buses (7.5%). Most of the accident were occurred at day (85%) than at night (15%); during coldest season (47.5%) than hot season (46.25%) and rainy season (6.25%).

Frequently, higher accident were occurred in one way road (55%) than two way road; straight road (50%) than curved (16.2%) & slopping (33.3%); on suitable/comfortable road (72.5%) than not suitable road (27.5%), this result is supported by previous studies [3, 7, & 15].

The influence of education on car accident indicated that, a diver educated preparatory school takes the largest portion (28.75%), followed by educated with secondary school (23.75), MSc (15%), elementary education (12.5%), BSc (10%), & basic education (10%). The accident occurred by diver problem (56.2%) takes the larger proportion compared to technical problem (43.8%), this result is supported by previous studies [7 & 14]. Vehicle owner ship were also considered as a source of accident and it indicates that, employed diver takes the larger portion of accident (58.8%) than owners (41.2%).

Inferential Statistics

Poisson Regression is fitted for the full model, and the reduced model by using only significantly associated explanatory variables (six variables). The result in Table S4 indicates that, even if the full model is significant, only two variables from 13 are significant. Where as the result in Table 1 indicates that, from six significantly associated variables 3 variables (with one additional variable) have statistically significant causal effect on Vehicle accident.

Hence, fitting by using significantly associated 6 variables gave a better model comparing to the full model. As a result the Poisson model for Vehicle accident is as follow:

$$\text{Log}(\lambda) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 = 0.818 + 0.091X_1 - 0.022X_2 + 0.102X_3$$

Where X_1 is Vehicle year of service, X_2 is driver experience, X_3 is road division.

Based on the fitted model above: The odds of number of vehicle accident for one year older vehicle is 1.095 times higher. So as a vehicle becoming older the accident will increase. Older vehicles are more likely to cause an accident comparing to a new one. The odds of number of vehicle accident for one more year experienced drivers is 0.022 times lower. Un-experienced drivers are more likely to cause an accident comparing to a experienced drivers. The odds of vehicle accident is higher for one directional road (1.107 times) as compared to odds of two directional road.

Table 1: Poisson Regression Model using significantly associated variable

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	P-value		Lower	Upper
Intercept	0.818	0.3080	0.214	1.421	7.051	1	0.008	2.261	1.239	4.143
Driver experience	-0.022	0.0321	-0.085	0.041	0.481	1	0.047	0.978	0.919	1.042
Weather condition = 0	0.016	0.2790	-0.531	0.563	0.003	1	0.953	1.1016	0.588	1.756
Weather condition =1	-0.099	0.2727	-0.634	0.435	0.132	1	0.716	0.906	0.531	1.545
Weather condition=2	0							1		
Vehicle year of service	0.091	0.0349	0.023	0.159	6.837	1	0.009	1.095	1.023	1.173
Road division=0	0.102	0.1377	-0.168	0.371	0.544	1	0.031	1.107	0.845	1.450
Road division=1	0							1		
light condition=0	0.108	0.1676	-0.220	0.436	0.416	1	0.519	1.114	0.802	1.547
Light condition=1	0							1		
Vehicle driver relation=0	0.058	0.1317	-0.201	0.316	0.191	1	0.662	1.069	0.818	1.371
Vehicle driver relation=1	0							1		
Scale	1									
Likelihood Ratio Chi-Square	9.761					7	.003			
Deviance	12.698		.			72	176			
Pearson chi square	12.227					72	.170			

Conclusions

Among the candidate variables, Pearson Chi-Square method identified weather condition, driver's experience, light condition, vehicle year of service, road division, and deriver-vehicle relationship as significantly associated variables. Furthermore, the percentile of associated variable indicated that, coldest season (47.5%), high year of driver's experience, low Vehicle year of service, one way Road division (55%), employed diver (58.8%), and day accident time (85%) takes the larger portion of accident.

The result from Poisson regression reveals that driver experience, road division, and Vehicle year of service are the significantly causing factors which affect the number of human injuries. In order to reduce the number injury in Debre Markos Town, for effective and safe traffic management, the concerned transportation authorities can consider the above mentioned predictors as potential causes of accidents in their order of importance in order to take preventive measures. Specifically, controlling new driver, removing old Vehicles, and controlling one way road (or building two-way road) can help to reduce human injuries Vehicle accidents.

Limitation

This study is a cross-sectional study which does not consider the spatial and temporal analysis od the accident so further study on this aspect is advisable.

Abbreviations

RTA	Road traffic accident
WHO	World Health Organization
RTI	Road traffic injuries
GLM	Generalized Linear Model

Declarations

Ethics approval and consent to participate

The data is secondary data design for public use and report by Debre Markos town traffic police office, and any researcher can take and do a research. And formal ethical ethical approval is not required.

Consent for Publication

Author proves consent of publication for this research.

Availability of data and material

All important data and material are available. It is a free access data any researcher can take and make a study for the improvement of public service.

Competing interests

- The author declare no competing interests regarding this paper.

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Authors' contributions

The research is performed by Wubetie, H.T. The author read and approved the final manuscript.

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Appendix

Appendix:

Table S1: List of Variables

No.	Variables	Codes
1	Age of driver	Continuous
2	Driver educational background	0=basic education, 1=elementary education, 2=secondary school, 3=preparatory school, 4=BSc, 5=MSc and above
3	Driver experience	continues
4	Type of vehicle	0=buses, 1=mini buses, Taxi, Bajaj, and Toyota, 2=auto track, 3=motorbike, 4=wagon and others
5	Light condition (Accident time day or night.).	1= day light, 0 = dark
6	Weather condition	0 = cold, 1= sunny, 2 = rainy
7	Vehicles _driver relation	1 = owner, 0 = employee
8	Vehicle's year of service	
9	Problem with car	1= technique problem ,0= driver problem
10	Road Type	0= sandy , 1=asphalt ,2= cobble
11	Location of road	1=straight , 2=slopping, 0=curve
12	Road division	0=one direction ,1= two direction
13	Condition of road	1= suitable, 0= non suitable

Table S2: Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation	Variance
Dependent Variable	number of injuries per accident	80	1	5	3.61	1.92	3.70
Covariate	age of driver	80	18	67	29.46	8.19	67.04
	Driver experience	80	0	9	3.02	1.99	3.968
	Vehicle age (year of service)	80	0	10	3.53	1.95	3.79

Table S3: Summary of Descriptive Statistics and Chi-square

Variables	Categories	Frequency	Percent (%)	Cumulative Percent	P-value (Pearson chi-square)
Road Type	Sandy	8	10	10	0.506
	Asphalt	63	78.8	88.8	
	Cobble	9	11.2	100	
Type Of Vehicle	Buses	6	7.5	7.5	0.841
	Minibus, Bajaj, Taxi, and Toyota	35	43.75	51.25	
	Auto track	22	27.5	78.75	
	Motorbike	7	8.75	87.5	
	Wagon and others	10	12.5	100	
Accident time	Dark or night	12	15	15	0.006
	Daylight	68	85	100	
Weather Condition	Cold	38	47.5	47.5	0.023
	Sunny	37	46.25	93.75	
	Rainy	5	6.25	100	
Road Division	One Direction Road	44	55	55	0.019
	Two Direction Road	36	45	100	
Location Of Road	Curve	13	16.2	16.2	0.421
	Straight Line	40	50	66.2	
	Slopping	27	33.8	100	
Condition Of Road	Not Suitable	22	27.5	27.5	0.906
	Suitable	58	72.5	100	
Educational Background Of Driver	Basic Education	8	10	10	0.498
	Elementary Education	10	12.5	22.5	
	Secondary School	19	23.75	46.25	
	Preparatory School	23	28.75	75	
	Bsc	8	10	85	
	Msc And Above	12	15	100	
Problem With Car	Driver Problem	45	56.2	56.2	0.693
	Technical Problem	35	43.8	100	
Driver Vehicle Ownership	Employee	47	58.8	58.8	0.017
	Owner	33	41.2	100	
Driver experience					0.010
Vehicle year of service					≤ 0.001
Age of driver					0.621

Table S4: Parameter Estimates using all explanatory variables.

Parameter	B	Std.	95% Wald Confidence	Hypothesis Test	Exp(B)	95% Wald

		Error	Interval						Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	Df	P-value		Lower	Upper
Intercept	.720	.9026	-1.049	2.489	.636	1	.425	2.054	.350	12.049
light_con=0	.107	.1935	-.272	.486	.305	1	.581	1.113	.762	1.626
light_con=1	0	.	.	.	.	.	.	1	.	.
wea_con=0	.099	.3041	-.497	.695	.105	1	.746	1.104	.608	2.003
wea_con=1	-.008	.2884	-.573	.557	.001	1	.977	.992	.564	1.746
wea_con=2	0[a]	.	.	.	.	.	.	1	.	.
driver_relation=0	.049	.1421	-.230	.327	.118	1	.731	1.050	.795	1.387
driver_relation=1	0[a]	.	.	.	.	.	.	1	.	.
road _division=0	.117	.1519	-.181	.414	.590	1	.443	1.124	.834	1.514
road_division=1	0	.	.	.	.	.	.	1	.	.
driving_exp	-.021	.0376	-.095	.052	.326	1	.018	.979	.909	1.054
year_service	.091	.0430	.007	.176	4.521	1	.033	1.096	1.007	1.192
type_vechicle=0	.031	.5531	-1.053	1.115	.003	1	.956	1.031	.349	3.049
type_vechicle=1	-.022	.5393	-1.079	1.034	.002	1	.967	.978	.340	2.814
type_vechicle=2	-.122	.5601	-1.219	.976	.047	1	.828	.886	.295	2.655
type_vechicle=3	-.230	.6743	-1.551	1.092	.116	1	.734	.795	.212	2.980
type_vechicle=4	0[a]	.	.	.	.	.	.	1	.	.
pro_car=0	-.068	.1596	-.381	.245	.182	1	.670	.934	.683	1.277
pro_car=1	0[a]	.	.	.	.	.	.	1	.	.
road_type=0	-.070	.3037	-.665	.525	.053	1	.818	.933	.514	1.691
road_type=1	-.111	.2566	-.614	.392	.187	1	.665	.895	.541	1.480
road_type=2	0[a]	.	.	.	.	.	.	1	.	.
condition_road=0	.107	.1771	-.240	.454	.367	1	.545	1.113	.787	1.575
condition_road=1	0[a]	.	.	.	.	.	.	1	.	.
location_road=0	.016	.2111	-.398	.429	.005	1	.941	1.016	.672	1.536
location_road=1	.074	.1731	-.266	.413	.181	1	.671	1.076	.767	1.511
location_road=2	0[a]	.	.	.	.	.	.	1	.	.
education=0	-.154	.6454	-1.420	1.111	.057	1	.811	.857	.242	3.036
education=1	.081	.5089	-.917	1.078	.025	1	.874	1.084	.400	2.940
education=2	.052	.5137	-.955	1.059	.010	1	.919	1.054	.385	2.884
education=3	.206	.5173	-.808	1.220	.158	1	.691	1.228	.446	3.386
education=4	0[a]	.	.	.	.	.	.	1	.	.
Age	.001	.0103	-.019	.021	.007	1	.935	1.001	.981	1.021

Scale	1[b]		
Omnibus Tests of Model Coefficients			
Likelihood Ratio Chi-Square	12.36	22	≤ 0.001
Goodness of Fit			
Deviance	10.82	57	.177
Pearson Chi-Square	9.797	57	.172