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Effects of Human and External Factors on Traffic Accidents

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Abstract

This work is to investigate traffic accidents in Denizli, in Turkey, to analyze accidents with regard to their causes, human and external factors. To this end, data reported by police were used. The results revealed that human and external factors are significantly effective on the accidents. The analysis showed that the age is an effective parameter on the rate of accident.

Key words: *traffic accident, traffic police data, risk factor, external factor*

Introduction

Traffic accidents causing human injuries, deaths and material losses are some of the negative results of the developing technology in the world. When the traffic density is taken into consideration, it is not surprising to see that Denizli, in Turkey, is one of the cities which have the highest ratio of traffic accidents. Due to this high ratio, it is very crucial to find out the fundamental parameters which affect traffic accidents causing deaths and losses. Traffic accidents are complex mechanisms resulting primarily from human, technical and environmental factors. In this study, we will concentrate on human and external factors rather than technical factors.

Recent years there have been some studies considering the accidents and their causes. Al-Ghamdi (2002) investigated pedestrian-vehicle crashes to analyze pedestrian collisions with regard to their causes, characteristics, location of injury on the victim's body. In a similar way, some characteristics of pedestrian (responsibility, education preventing in accidents) were examined by Harruff et al. (1998). Some researchers considered not only pedestrian characteristics but also human and environmental variables in traffic accidents. For example, the urban road traffic accident risks for Zagreb, in Croatia, were analyzed with the aim of reducing the increasing injury incidence by Vorko-Jovic et al. (2006). Their work attempts to determine circumstances, and human and road traffic variables that most influence fatally and seriously injured urban road users. Furthermore, some studies in the literature specifically concentrated on drivers' behaviors. Kalyoncuoglu et al. (2004) developed a model to analyze the effects of driver characteristics on traffic accidents. Similarly, Gras et al. (2006) used a questionnaire in order to examine drivers' behaviors. Teenage driving and associated accidents were studied by Bayam et al. (2005). Özkan et al. (2006) investigated the applicability of the two-factor structure of the Driver Skill Inventory among British, Dutch, Finnish, Greek, Iranian and

Turkish drivers and examined this asymmetric relationship between perceptual-motor and safety skills in traffic penalties and accident involvement. The relation between different socio-cultural factors, regulations related to traffic safety, and traffic deaths was successfully studied by Melinder (2007). Brenac et al. (2005) showed that the involvement of bus accidents usually is assessed implicitly on the basis of the direct involvement of bus in the collision or in injury production. They deal with the scope and forms of indirect involvement of buses in their study. In addition, predictions about effects of aggregating driver data were tested in a set of data where bus drivers' behavior had been measured repeatedly over three years in a city environment. af Wahlberg (2007) tried to identify dangerous drivers with the consideration of speed changes undertaken by a driver. Golob et al. (2004) presented evidence of strong relationships between the traffic accidents and traffic flow conditions.

The aforementioned studies are very effective regarding to determine the effects of various technical, human and external factors on traffic accidents**.** Some of the human factors (age, sex, education), and of external factors (time of accidents (month, day and hour), weather condition, type of vehicle, type of accident, place of accident) are analyzed in some works but not all. In this study, we considered all variables mentioned above and analyzed the effects of these factors not only one by one but also simultaneously on the number of accidents. 1338 real data during the 2-year period (2004-2005) were analyzed.

Since there is an increase in the number of traffic accidents, it is important to investigate parameters that most influence city road traffic accident. This study considers human and external parameters leading to accidents, and statistical results that help to understand the relationship between these factors.

The traffic accidents are serious problem in modern societies. Therefore, in order to prevent the accidents, various human and external factors have been examined and the main causes of accidents have been analyzed very carefully. The relationships between these factors on the number of accident were analyzed in detail, even though the studies carried out in the literature are not much detailed from the effects of accident point of view. In addition, this study also aims to determine how much these factors affect the number of accident. To the best of authors' knowledge, there is little amount of work clearly analyzing the relation in the literature.

Method

Data Collection

From 2004 through 2005, 1338 traffic accidents were analyzed in Denizli. Traffic police have the responsibility of collecting and analyzing accident data, and the most complete information about causalties in road traffic accidents can be obtained from the police department. So, we used traffic police records in determining human and external factors. According to the reports, the following personal characteristics and external variables have been investigated: age, sex, time of accidents (month, day and hour), weather condition, type of vehicle, type of accident, place of accident, education.

Variables Studied

Characteristic features of the people in the accidents' and the information related to other factors are given in Table 1 through Table 9. For those variables shown in the table, the frequencies were sufficiently large to perform analysis. Chi square test was used to find significant relation among considered factors on traffic accidents. We assumed that the expected number of accidents is proportional to the ratio of corresponding groups in population.

Age and Sex

The effects of age and sex in the number of accident are two important subjects that are more frequently examined in the literature. First we investigate the effect of the age on traffic accident. Table 1 shows observed and expected number of accidents. The chi square test shows that there is a significant relationship between the age and the number of accidents. From Table 1, the largest proportion of drivers was 30-39 years old. The age group of 20-29 is following these age groups. The accident rates of the young are more than the rest of the examinees.

Furthermore, the age groups of 20-29 and 30-39 in the traffic are more than other age groups. We also see that as the age increases from the group of 40-49 age to the group of 60-69 age, the rates of accidents decreases.

Table 2 shows observed and expected number of accidents for sex. In Denizli, the chi square test indicates that there is a significant relationship between the sex and the number of accidents. According to Table 2, men are seen in accidents dominantly comparison to women. The characteristic differences between male and female drivers are effective in accident occurences. Female drivers are more careful and responsible in traffic so the rates of their accident are less than that of men. Similarly, McKenna et al. (1991) reported that male drivers, for instance, consistently overestimated their driving skills as compared to female drivers. An analysis done by Mannering (1993) also pointed out that there have been important differences in the relationship between male and female driver characteristics and their respective accident risks.

Time of Accident

In this study the "time" parameter was examined as month, day and hour in detail. The statistical result demonstrates that the month of the year has no significant effect on the number of accident. As can be seen from Table 3, each month has almost the same rate of accident. But, when day is considered, the results show that it is an effective factor on the number of accident. Table 4 reveals that the number of accidents increases towards the weekends, even though the increase in the number of accidents on Fridays is slightly low. Sunday has the lowest accident number while the most traffic accidents take place on Saturday. In a similar vein, it is clear from Table 5 that the time of the day is an effective parameter for accidents. Two period of peak traffic hours: 06:00–09:59 (the beginning of the working day) and 16:00–19:59 (the end of the working day) demonstrates that time period of 16:00–19:59 is riskier than the other one for traffic accidents.

Education

Education is a very important parameter for traffic safety as is the case in most fields**.** Table 6 shows observed and expected number of accidents. The results indicate that there is a significant relationship between the education and the number of accidents. Table 6 shows that the highest risk group for accident is people who are graduated from primary school. When you considered the people graduated from high school, this risk of accident decreases a bit. It can be clearly understood from the table that in university graduations the risk of accident decreases more. These results show that as the education level increase, the accident rate decreases. This situation indicates that education is an important factor to prevent accidents. Thus it can be realized that understanding, interpreting and obeying to the regulations are parallel to the education and behaving more logical.

Place of Accident

According to the presented results, place of accident is another important factor in accident occurrences. As can be seen in Table 7, accidents mostly took place on main roads and streets have the second-highest risk of accidents. It should be noted that main roads are typically busy with traffic volume so this situation gives rise to increase in the number of accidents. The

accidents happening on the main roads can be related to the urbanization and city planning. Similarly, Al-Ghamdi (2002) studied in Saudi Arabia and reported that the same observation. It is clear from Table 7 that highways have the lowest risk of accident occurrences in Denizli.

Type of Vehicle

Type of vehicle is a quite important parameter for traffic and accident occurence. Table 8 indicates observed and expected number of accidents. The distribution of vehicle type was estimated based on the data collected in different locations in the city. When we consider the result of chi square test in Table 8, it demonstrates that type of vehicle is one of the most effective parameters on the number of accidents. It is seen in Table 8 that bicycles have the highest risk for accidents and motorcycles follow this vehicle type. When van, bus, minibus and lorry are considered, it is clearly seen from the table that number of accident decreases. In addition, the table indicates that contrary to common belief, cars have the lowest risk for traffic and accident occurrence in Denizli.

Weather Condition

One of the important parameters for traffic accidents is weather condition. Table 9 shows observed and expected number of accidents. The result of chi square test indicates that there is a significant relationship between the weather condition and the number of accidents. As can be seen in Table 9, most of the accidents happen in sunny days. Since winters are not very cold and usually not snowy, especially summers are very hot and not much rainy; most of the years are mild in Denizli, these results are very usual. On the other hand it shouldn't be misleading by suggesting that these circumstances are the most dangerous.

Risk Combinations

In this work, with the help of the real data, two factors are examined such as month-hour, type of accident-visibility condition and weather condition-type of vehicle. An analysis is performed to examine the association among some variables of interest selected. Table 10, Table 11 and Table 12 were developed and chi square test technique was used to determine if there is a relationship among the examined variables in accidents.

When we look at Table 10, at the same period of hour there is a similarity between the number of accidents in each month. The result of chi square test confirms that there is not a significant effect of month and hour on the number of accident simultaneously.

It is shown from the result in Table 11 that visibility condition - accident type is a significant combination affecting the number of accident. As can be seen from the table, hitting an immobile object or parked vehicle at overnight is more often than daytime. It is obvious that one of the reasons for this situation is that the visibility distance is inadequate at overnight. So, it can be seen that visibility condition affects the type of accident and therefore number of accident**.**

It is obvious that the movements of vehicles in the traffic also depend on weather conditions among many parameters. Moreover, some vehicles such as motorcycles, bicycles etc. enter into traffic depending on the weather conditions. The result of chi square test confirms that there is significant effect between vehicle type involved in the accident and the weather conditions on the number of accidents. It can be seen from Table 12, when the weather is rainy, the motorcycles and bicycles have a low possibility of having an accident since they usually do not enter into traffic in rainy weather.

Until now, we discussed effects of some factors on the number of accident. In addition, we also analyzed some risks for the result of accident (dead, injured) with the choice of some factors and examine their combinations.

In this part of the study, we used the statistical analysis included odds ratio (OR) and confidence interval (CI) of 95% for potential risks. Table 13 presents some risk combinations that show statistically significant differences between dead and injured people. The table shows the following risk combinations: There is a high dying risk for accidents which take place on main road with multi-vehicles (OR=2.025; 95% CI, 2.208-19.715), and male driver who is older than 35 years, has a high dying risk (OR=2.138; 95% CI, 0.425-10.754). The car user who is older than 35 years, has a higher risk of dying (OR=1.295; 95% CI, 0.179-9.379). People graduated from primary school who are younger than 35 years, have a higher risk of dying (OR=2.447; 95% CI, 0.250-23.920). There is a high dying risk for people driving on dry road, who is older than 35 years, (OR=1.442 %95 CI, 0.287-7.239). Furthermore, accidents took place on street at daytime have a high dying risk (OR=1.071; 95% CI, 0.096-11.984) and there is a high dying risk for male driving car (OR=1.232; 95% CI, 0.135-11.249).

Table 1. Chi square test for age and number of accidents *

Age	Number of accidents	
	Observed number	Expected number
9 –	9	190.7
10 – 19	120	372.3
20 – 29	688	456.3
30 – 39	658	399.7
40 – 49	420	325.2
50 – 59	192	217.4
60 – 69	43	104
70 +	12	76.3

* $\chi^2 = 749.212$, $\chi^2_\alpha = 14.076$, $\alpha = 0.05$

Table 2. Chi square test for sex and number of accidents *

Sex	Number of accidents	
	Observed number	Expected number
Male	2038	1080
Female	114	1072

* $\chi^2 = 1705.905$, $\chi^2_\alpha = 3.841$, $\alpha = 0.05$

Table 3. Chi square test for the months of the year and number of accidents *

Months	Number of accidents	
	Observed number	Expected number
January	103	111,5
February	79	111,5
March	117	111,5
April	118	111,5
May	116	111,5
June	106	111,5
July	103	111,5
August	132	111,5
September	122	111,5
October	111	111,5
November	121	111,5
December	110	111,5

* $\chi^2 = 17.462$, $\chi^2_\alpha = 19.675$, $\alpha = 0.05$

Table 4. Chi square test for days and number of accidents *

Days	Number of accidents	
	Observed number	Expected number
Monday	169	191,1
Tuesday	170	191,1
Wednesday	201	191,1
Thursday	216	191,1
Friday	205	191,1
Saturday	225	191,1
Sunday	152	191,1

* $\chi^2 = 23.662$, $\chi^2_\alpha = 12.592$, $\alpha = 0.05$

Table 5. Chi square test for time intervals and number of accidents *

Time intervals	Number of accidents	
	Observed number	Expected number
06:00 – 09:59	180	266
16:00 – 19:59	352	266

* $\chi^2 = 55.609$, $\chi^2_\alpha = 3.841$, $\alpha = 0.05$

Table 6. Chi square test for education and number of accidents *

Education levels	Number of accidents	
	Observed number	Expected number
Primary School	590	377
Secondary School	168	428
High School	330	264
University	169	188

* $\chi^2 = 296.706$, $\chi^2_\alpha = 7.815$, $\alpha = 0.05$

Table 7. Place of accidents and number of accidents

Place of accidents	Number of accidents
Main Road	854
Street	276
Highway	155

Table 8. Chi square test for type of vehicle and number of accidents *

Type of vehicle	Number of accidents	
	Observed number	Expected number
Bicycle	37	2
Motorcycle	127	27
Car	685	848
Minibus	96	96
Van	229	281
Lorry	62	31
Bus	91	42

* $\chi^2 = 1111.991$, $\chi^2_\alpha = 12.592$, $\alpha = 0.05$

Table 9. Chi square test for weather condition and number of accidents *

Weather condition	Number of accidents	
	Observed number	Expected number
Sunny	1122	713
Rainy	126	535

* $\chi^2 = 547.290$, $\chi^2_\alpha = 3.841$, $\alpha = 0.05$

Table 10. Distribution of months and time intervals*

Months	Time intervals		
	00:00 - 07:59	08:00 - 15:59	16:00 - 23:59
January	19	47	20
February	6	27	19
March	10	35	29
April	12	35	39
May	24	50	43
June	17	43	40
July	37	53	50
August	32	55	66
September	34	67	53
October	26	52	51
Novenber	22	50	57
December	20	52	39

* $\chi^2 = 27.424$, $\chi^2_\alpha = 33.924$, $\alpha = 0.05$

Table 11. Distribution of type of accidents and time of the day *

Type of the accidents	Time of the day	
	Daytime	Night
Mutually collision	31	24
Hitting in the back	79	31
Hitting in the sides or collision	417	171
Hitting a parked vehicle	19	21
Hitting an immobile object	33	45
Hitting pedestrian	279	76
Falling over	18	14
Run off the road	17	10

* $\chi^2 = 58.687$, $\chi^2_\alpha = 14.067$, $\alpha = 0.05$

Table 12. Distribution of weather condition and type of vehicle *

Type of vehicle	Weather Condition	
	Sunny	Rainy
Bicycle	33	4
Motorcycle	116	9
Car	565	117
Minibus	8	14
Van	189	37
Lorry	49	13
Bus	66	6

* $\chi^2 = 49.211$, $\chi^2_\alpha = 12.592$, $\alpha = 0.05$

Table 13. Risk combinations for some factors: fatal versus injured

Risk combinations	Outcomes	OR	95 % CI
Male & >35 Age vs. Male &<35 Age	Dead vs. Injured	2.138	0.425-10.754
Male & Car vs. Male & Motorcycle	Dead vs. Injured	1.232	0.135-11.249
>35 Age & Car vs. <35 Age & Car	Dead vs. Injured	1.295	0.179-9.379
Main road & Multi-vehicles vs. Main road & Single vehicle	Dead vs. Injured	2.025	0.208-19.715
Street & Daytime vs. Main road & Daytime	Dead vs. Injured	1.071	0.096-11.984
Primary school & <35 Age vs. Primary school & >35 Age	Dead vs. Injured	2.447	0.250-23.920
Dry road & >35 Age vs. Dry road & <35 Age	Dead vs. Injured	1.442	0.287-7.239

Discussion and Conclusion

This study provided insight into traffic accidents, in Denizli, Turkey. The analysis in this paper pertains to searching the significant factors and investigating the effects of these factors. On the basis of linked road traffic accident data of traffic police reports, a total of 1338 traffic accidents were analytically investigated and it was understood that people's characteristics and some external factors affect the number of accidents. With respect to cause of accidents, the people bear the responsibility for traffic accidents.

Chi square test has been used for interpreting the data. The relationship among the factors of interest and the effect of corresponding relationship on the number of accident was analyzed in detail. Apart from these factors, this work also successfully determined how much the factors affect the number of accident.

This work showed that the highest risk ages are between 30-39 and the age group of 20-29 is following these ages**.** As the age increases from the group of 40-49 age to the group of 60-69 age, the rates of accidents decreases. Moreover, male drivers are seen in accidents dominantly comparison to women.

The highest risk for accidents takes place towards the weekends, even though the increasing in the accidents on Fridays is slightly slow. Saturday has the highest accident number. Moreover, possibility of occurence of the traffic accident is dependent on the corresponding time periods. It was seen that the highest risk time is the period of 16:00–19:59 (the end of the working day) for accidents.

The bicycles are the vehicles which involve in accidents most and secondly motorcycles. Furthermore, buses and minibuses play an essential role in public transportation and accidents. Contrary to common belief, cars have the lowest risk for accidents.

People graduated from primary school involve in accident most. As the education level increases accident level decreases. This indicates that education is a considerable factor to prevent road traffic accidents.

The possible use of the current work in terms of human and external factors may be: i) some features of the individuals which can represent the society can be built for direction of coming drivers ii) some features of the environment can be taken into consideration for a safe life. Possibility of individuals' involvement into traffic accidents can be determined before the risk of accident becomes real in traffic and they will be warned according to the results obtained.

Consequently, the current study provides a better understanding of some of the risks and problems related to human and external factors namely**;** age, education, time of accidents, place of accidents and type of vehicles. This work could also help in targeting certain age groups in population with better designed educational programs to improve traffic safety. The current results can help the police to make new traffic safety laws more effective. These results will also influence the traffic police controls, which will decrease the number of accidents and protect the least experienced road users.

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Efecte ale factorilor umani şi externi asupra accidentelor rutiere

Rezumat

Această lucrare îşi propune să investigheze accidentele rutiere în Denizli, Turcia, şi să le analizeze din perspectiva cauzelor lor, factori umani şi externi. În acest scop au fost folosite date raportate de poliția rutieră. Rezultatele au arătat că factorii umani şi externi au o importanță semnificativă asupra producerii accidentelor. Analiza a demonstrat că vârsta este un parametru esențial în rata producerii accidentelor.