Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.6, No.1, 2014

The Effect of Driver Behavior Mistakes on Traffic Safety

Mohammad Abojaradeh*, Ph.D., P.E.
Faculty of Engineering, Department of Civil Engineering, Zarqa University
P.O. Box 2000, Zarqa 13110, Jordan Tel: 00962-5-3821100
*E-mail: abojaradeh@yahoo.com
Basim Jrew, Ph.D. Professor
Faculty of Engineering, Department of Civil Engineering, Isra University
Amman, Jordan, Tel 00962-6-4711710 E-mail: basim_jrew@yahoo.com
Hadeel Al-Ababsah, Civil Engineer
Faculty of Engineering, Department of Civil Engineering, Isra University
Amman, Jordan, Tel 00962-6-4711710
Ammar Al-Talafeeh, Civil Engineer
Faculty of Engineering, Department of Civil Engineering, Isra University
Amman, Jordan, Tel 00962-6-4711710

Abstract

The main objectives of this study are: to identify driving behaviors and mistakes that drivers make; based on a questionnaire, which may cause traffic accidents in Jordan and highlight their effect on traffic safety. Also, to develop traffic accidents regression prediction models. Also, to propose effective countermeasures to reduce the frequency and severity of traffic accidents. The analysis is based on the questionnaire by using SPSS software to predict accident rates and compare the results with the model reports developed in Jordan and Amman area.

The data for this study was collected from a survey questionnaire which was distributed to a sample of drivers in Amman Area and in some Jordan Universities. The data from the survey questionnaire were analyzed and used in forming the regression models.

It was found that the drivers' behavior is considered aggressive, according to the first part which represents the participant's opinion weather they listed the behavior as aggressive or not, and the other part which represent weather the participants conducted this behavior or not. Also, there was a strong direct relationship between the driver behaviors and their exposure to accidents. In conclusion, the aggressive behavior increases the chance of exposure to accidents.

From this study, it was concluded the main causes of traffic accidents, injuries, and fatalities that are related to driver behavior. Preventive countermeasures were recommended to enhance traffic safety in Jordan.

Key Words: Traffic Accidents, Traffic Safety, Driver Behavior, Driver Mistakes, Aggressive driving, Countermeasures, Regression Models.

1. Introduction

Motor vehicle accidents are a major cause of death among Jordanians. Roughly 700 people died in 2011 in car accidents according to the Jordan traffic institute out of a total population of about 6 million people (Jordan Traffic Safety Institute 2000-2012).
Many factors contribute to traffic accidents. Some involve planning, design, construction, operation, surface condition, and policing of the roadways. The most deadly factor is human error. This includes unawareness of traffic rules and roadway condition; lack of driving skills; poor judgment; failure to interact and adjust to prevailing roadway conditions; and most importantly, aggressive driving. Preliminary findings of a survey questionnaire conducted in this study show that improper engineering design, inadequate traffic control, lack of traffic management, and traffic congestion are the main factors leading to aggressive driving and road rage on Jordan roadways (Ismeik 2010, TRB 2013, Abojaradeh 2013).
Causes of accidents are of special concern to researchers in traffic safety, since such research would be aimed not only at prevention of accidents but also at reduction of their frequency and severity. Despite the efforts made by law enforcement, transportation agencies, and other organizations concerned with roadway safety, traffic accidents and fatalities continue to grow. Roughly 700 people were killed in 2011 on Jordan roadways. This figure is alarming in comparison to the relatively small population of six million and the number of registered vehicles of about one million. Related research and studies showed that many factors are contributing to traffic accidents and road rage in the Kingdom. These factors include design errors, faulty vehicles, and weather conditions. More importantly, most of the studies identified driving behavior and drivers' attitudes, including

excessive speed, to be the major contributing factors to traffic casualties. Aggressive driving has become the norm on our highways. The traveling public frequently sees incidents of road rage on Jordan roadways (TRB 2013, Abojaradeh 2012, 2013).

1.1 The Importance of Highway Safety

As the number of motor vehicles and vehicles- miles of travel increases throughout the world, the exposure of the population to traffic accidents also increases. Highway safety is a worldwide problem; with over 500 million cars and trucks in use, more than 50,000 people die each year in motor vehicle crashes, and about million are injured (WHO 2007).
In the United States, motor vehicles accidents are the leading cause of death for people between the ages of 1-34 years and rank third as the most significant cause of years of potential life lost, after cardiac dieses and cancer (FHWA 2010, NHTSA 2010).
In the United States, between 1966 and 1992 the number of vehicle miles traveled has increased from about one trillion to 2.1 trillion, whereas fatality rates have declined from 5 per million vehicle miles to less than 2 per million vehicle miles. In 1994, there were fewer than 40,000 fatalities on the nation's highway, as opposed to 55,000 in mid – 1970s (Public Security Directorate 2010, DOT 2007, 2008).

1.2 Issues Involved in Transportations Safety
Several issues are involved in transportations safety. These include weather accident should be referred as crashes, the cause of transportation crashes, and the factors involved in transportation crashes.

1.3 What Causes Transportation Crashes

The occurrence of a transportation crashes presents a challenge to safety investigators. In every instance, the question arises, "What sequence of events or circumstances contributed to the incident that resulted in injury, loss of lives, or property damage?"

In some cases, the answer may be simple one. For example, the causes of a single car crash may be that the driver fell asleep at the wheel, crossed the highway shoulder, and crashed in to a tree. In other cases, the answer may be complex, involving many factors that, acting together, caused the crash to occur.

It is possible to construct a general list of the categories of circumstance that could influence the occurrence of transportation crashes.

If the factors that have contributed to crash event are identified, it is then possible to modify and improve the transportation system. In the future, with the reduction or elimination of the crash-causing factor, a safer transportation system is likely to result.

1.4 Factors Involved in Transportation Crashes

While the causes of crashes are usually complex and involve several factors, they can be considered in four separate categories:

1. Action by the driver or operator.
2. Mechanical conditions of the vehicle.
3. Geometric characteristics of the road way.
4. The physical or climatic environment in which the vehicle operates.

2. Study Objectives

The main objectives of this study are:
1. To identify driving behaviors and mistakes that drivers make; based on a questionnaire, which may cause traffic accidents in Jordan and highlight their effect on traffic safety.
2. To study the relationship between the driver behavior and the probability to be exposed to accidents.
3. To increase drivers' awareness of mistakes they might make on the road, and to point out the consequences associated with these actions.

4. To develop traffic accidents regression prediction models. These models relate accident numbers, as a dependent variable, with possible causes of accidents that are related to driver behavior, as independent variables.
5. To propose effective countermeasures to reduce the frequency and severity of traffic accidents.

3. Data Collection and Methodology

This study is based on a questionnaire of two parts: the first part aims to explore and study the aggressive behavior of drivers.
The second part aims to collect data about accidents and its main causes that are related to drivers' behaviors. The collected data will be used to form prediction regression models by using SPSS program (Statistical Package for Social Sciences) to predict accident and accidents rates in Jordan.

3.1 Method used in data collection

Information gathering by surveying, a questionnaire method is used. A questionnaire is a written list of questions, the answers to which are recorded by respondents. In a questionnaire respondents read the questions, interpret what is expected and then write down the answers. In the case of questionnaire, as there is no one to explain the meaning of questions to respondents, it is important that:

1. The questions are clear.
2. Easy to understand.
3. Also, the layout of questionnaire should be such that to be easy to read and pleasant to eye.
4. The sequence of the questions should be easy to follow.

A questionnaire should be developed in an interactive style. This means respondent should feel as if someone is talking to them. In a questionnaire, a sensitive question or a question respondents may feel hesitant about answering should be prefaced by an interactive statement explaining the relevance of the question. It is a good idea to use a different font for these statements to distinguish them from the actual questions.

4. Driver Behavior

4.1 Definition of Aggressive Driving

The following formal definition of aggressive driving is given at the road user safety branch in the Ontario Ministry of Transportation, Canada (Taska 2002):
"A driving behavior is aggressive if it is deliberate, likely to increase the risk of collision and is motivated by impatience, annoyance, hostility and/or an attempt to save time".
This definition is best suited to the Jordanian case where the attempt to buy time is a reality for most Jordanian drivers. Most drivers included in the survey reported that they are often late for work and they are late for appointments most of the time. They gave themselves the unjust priority of being before the others at all times because they thought they were the only ones late and the others all had time at their disposal. Many drivers admitted taking their anger, which is due to road conditions and traffic congestion, out on other drivers. Aggressive driving can refer to any display of aggression by drivers. Moreover, aggressive driving can be defined as the operation of a motor vehicle without regard to others' safety. This aggression can and may lead to extreme acts of physical or mental assault and may cause road rage.
In some cases the drivers are inattentive and would probably be apologetic for their actions. The driver is not considered aggressive in this instance. Aggressive drivers would not feel apologetic because she/he is intentionally ignoring the rights of others on the roadway. That is not saying these actions differ in term of dangerousness. If the victim driver in this case realizes that the act was unintentional, however, she/he would be less likely to retaliate against the inattentive driver. One of the most dangerous consequences of aggressive driving is that it may cause another driver to become angry and retaliate in an extreme manor. This stage of retaliation would be considered road rage.
The specific behaviors which constitute aggressive driving would include:

1. Tailgating
2. Weaving in and out of traffic
3. Improper passing (e.g. cutting in too close in front of vehicle being overtaken)
4. Passing on the road shoulder
5. Improper lane changes (failure to signal)
6. Failure to yield the right of way to other road users

7. Preventing other drivers from passing
8. Unwillingness to extend cooperation to motorists unable to merge or change lanes due to traffic conditions
9. Driving at speeds far in excess of the norm which results in frequent tailgating, frequent and abrupt lane changes
10. Running stop signs
11. Running red lights.

Displays of annoyance or hostility which are not intended to physically harm other road users but likely to intimidate, irritate, anger or provoke them may accompany these behaviors and serve as indicators of the underlying motivation. These behaviors would include:

1. Flashing headlights.
2. Sustained horn-honking.
3. Glaring at another driver to show disapproval.
4. Yelling.
5. Gesturing.

4.2 Definition of Road Rage (Suliman 2009, Wikipedia 2013)

Road rage is considered one of the most extreme detrimental consequences of aggressive driving when a driver becomes angry and retaliates against other aggressive drivers. Road rage can be a result of frustration and anger. The form of road rage may vary from verbal abuse to physical violence. Many cases of deaths and serious injuries have been reported in the US due to road rage (Suliman 2009, Abojaradeh 2012). Jordan is no exception; many traffic accidents involving serious injuries and deaths were a result of road rage. Fist fighting, knives, guns, tools, and other objects were involved in serious disputes that led to casualties on the country's roadways.

5. Review of Literature

5.1 Leo Tasca, Ontario Ministry of Transportation, Canada 2002 (Taska 2002)

There has been relatively little research on aggressive driving behavior. Definitions of aggressive driving have been general and have tended to distinguish themselves from "road rage" (violent exchanges arising from traffic disputes where the intent is to harm another road user). A more precise definition of aggressive driving would focus on deliberate and willful driving behaviors that while not intended to physically harm another road user shows disregard for their safety and well-being. This review suggests the following definition of aggressive driving:

"A driving behavior is aggressive if it is deliberate, likely to increase the risk of collision and is motivated by impatience, annoyance, hostility and/or an attempt to save time".

Survey research indicates that most drivers report engaging in aggressive driving behaviors, but there is some evidence that survey responses reflect a tendency to provide socially desirable responses. It is unclear if the lower incidence of certain behaviors associated with higher collision risks such as tailgating is due to this tendency rather than to an actual low incidence of such behavior.

Factors which seem to increase the likelihood of aggressive driving behavior are:

1. being relatively young
2. being male
3. being in a traffic situation which confers anonymity and/or where escape is highly likely
4. being generally disposed to sensation-seeking or aggressiveness in other social situations
5. being in an angry mood (likely due to events unrelated to traffic situation)
6. belief that one possesses superior driving skills
7. traffic congestion, but only if drivers do not expect it

5.2 Traffic Accidents in Jordan study: by Hashem R. Al-Masaeid, Jordan 2007

Based on the results of this study and analyzing accident for the years (1989-2007), the main conclusions are as follows (Al-Masaeid 2007):

1. Jordan faces a serious and alarming traffic accident problem. Compared with developed and a number of developing countries, Jordan has experienced excessive human and economic losses as well as social and emotional impacts as a result of this problem.

2. Child age group (5-10) years and elderly age group (over 60) years are exposed to the highest level of pedestrian accident risk.
3. Young drivers of ages less than 25 years and elderly of over 60 years are overrepresented in traffic accident involvement.
4. While the first single cause of accidents in Jordan is carelessness, aggressive driving behavior is believed to be the major contributory factor in traffic accidents.
5. Public transport means, including buses and minibuses, are over-involved in traffic accidents.
6. Forecasting exponential models, using motorization level as an independent variable, successfully explains the variations in traffic accidents and fatalities.
7. Intensification of traffic enforcement accompanied by implementation of traffic law with stiff penalty levels would have a great positive influence on traffic safety.
8. Although political will and commitment to reduce the problem of traffic accidents exist, Jordan shall implement a comprehensive strategy with a clear vision and rational policies to curb this problem.

5.3 Development of driver behaviors accident prediction models: the Jordan experience study: by Muhannad Ismeik, Basim K. Jrew, Nithal K. Abbas, Jordan 2010 (Ismeik 2010)

The 2004 and 2005 accident data of 43 intersections in Amman street network was collected. The data of 1578 accidents was linked to 17 independent variables. Based on statistical analysis of the data, 14 models were developed to identify the relationship between traffic accidents frequency and key behavioral characteristics of drivers. Statistical accident prediction models were developed for Amman and the appropriateness of the models to predict accidents is examined as an important tool for comparison. The statistical technique of regression is used to find relationships (models) between a dependent variable (number of accidents) and independent variables (driver behaviors). The significance of the models was assessed by using the F-test. There were no large discrepancies between the estimated and observed accident numbers as the models provided adequate fit for the accident data used.

The most critical influencing variables that affect the accident frequency in Amman intersections were X1 (the short distances between vehicles), X2 (lane changing), and X9 (not obeying the right way of movement). The accident prediction models can be used to predict the probability of an accident to occur at an intersection based on the critical variables listed.

The program proposed for the analysis of intersections within Amman street network, and the determination of the hazardous locations within its various locations is found very active for the predication of those locations. Further study or detailed analysis of the most hazard locations identified on the street network is needed to identify the nature and type of countermeasures.

The accident prediction models developed in this study will aid in decision making with regard to Highway Safety Improvement Program (HSIP) and to Urban Transportation Planning Process (UTPP), and can be used as the basis for establishment of priority orders for alternative protection schemes.

Further research is required to develop prediction accident models for the intersections based on environmental factors, roadway conditions at the time of the accident occurrence, and technical characteristics of the vehicle itself. Additional research is also required to develop prediction models for Amman's streets.

5.4 Aggressive driving is a major cause of traffic accidents and road rage in Jordan, by: Mohd R. Suliman and Wa'el H. Awad, Jordan 2009 (Suliman 2009)

The attempt to evaluate and assess driving aggression and road rage in Jordan should include drivers' attitudes, roadway conditions, traffic conditions and personal circumstances. This task is very difficult when trying to use quantitative measures in the process. The amount of research conducted in this field worldwide and particularly in Jordan is limited to field surveys using small portions of the population. This study is the first of its kind to address aggressive driving issues in Jordan. Saving time, territorial behavior, and traffic congestion are some of the main factors contributing to aggressive driving in Jordan.

The main findings of this study can be summarized as follows:

1. Aggressive driving is believed to contribute to the high accident rate and traffic casualties in Jordan.

2. Aggressive driving leads to retaliatory actions, and therefore, causes road rage.
3. Most respondents admitted that their aggressiveness was a temporary measure used to retaliate against other drivers' aggression.
4. Self-assertion and territorial attitude among Jordanians leads to aggressive driving on the Kingdom's roadways.
5. The rate of aggressive driving is much higher than in western countries.
6. Road conditions and traffic factors contribute to aggressive driving in Jordan.
7. Forcing a car off the roadway, deliberate obstruction of passing vehicles, excessive speed, running red lights, and tailgating are ranked highest as aggressive driving behaviors by Jordanians.
8. Beeping the horn and flashing headlights are not considered by Jordanians to be aggressive driving behaviors.

5.5 Traffic Accidents Prediction Models in Amman Area. The study, by Dr. Mohammad Abojaradeh and Dr. Basim Jrew, 2009 (Abojaradeh 2013, 2009), and Analysis of accident prediction model for Marka area in Amman, by Dr. Basim Jrew and Eng. Muneer Abo Aloosh, 2008 (Jrew 2008)

Statistical accident models were developed for Amman Area and Marka region. The appropriateness of the models to predict accidents is examined as an important tool for comparison. Prediction models of the study shows that the independent variables following closely (X_1), lane violation (X_2), and wrong passing (X_3), was the most causes of accident. Accident data were collected from the General Security Directorate and from the Jordan Traffic Institute. These data were analyzed and used in the regression models. Several regression prediction models were formed and the best models were chosen. The intersections and road segments, under this study, were arranged according to the traffic accidents severity. The most dangerous and hazardous streets and intersections were located in the study areas. Proper treatments and improvements are needed to reduce the number and severity of accidents in these areas. Preventive countermeasures were recommended to enhance traffic safety in Jordan specially Amman Area.

6. Results and Analysis

6.1 Study Questionnaire

The data were collected from a survey questionnaire of two parts, where the number of distributed questionnaire was 700. The number of respondent was 582, 492 males and 90 females. The Study included a sample from Amman Area and a sample from Jordan public and private universities. Statistical data of the participants in the questionnaire are shown in Table 1.

1. The first part of the questionnaire represents aggressive driver behaviors. This questionnaire depends on a study by Mohd R. Suliman and Wa'el H. Awad in 2009 as shown in Table 2, and a review of the literature on aggressive driving research (Tasca, 2002) at the road user safety branch in Ontario Ministry of Transportation, Canada.
2. The second questionnaire represents driver's mistakes and number of accidents and causes of these accidents. It depends on the study done by Dr. Mohammad Abojaradeh and Dr. Basim Jrew, 2009 and Dr. Basim Jrew and Eng. Muneer Abu Aloosh for Amman Area and Marka Region, 2008. SPSS (Statistical Package for Social Sciences) software was used in forming the Regression Models. SPSS is considered one of the most frequently used program for researchers in many fields such as engineering, science, art, and education.

6.1.1 Analysis of the first part of the Questionnaire

Table 3 shows the ranking of Driver behavior according to the percent of respondents. Table 3 contains two parts: The first part is % of respondent which represent the participants' opinion on whether they listed the behavior as aggressive or not. In our sample the most top causes of accidents according to the participant opinion, and by % of respondents, where as follows:

1. Forcing a car off the road way, 79.38%.
2. Forcing a car to pull over, pursuing a vehicle, braking suddenly, Failure to yield the right of way to others, 78.35 %.
3. Driving slowly on the left lane on multilane roads, 77.84 %.
4. Deliberate obstruction such, 77.32 %.

Table 1: Statistical Data about the Participants in the Questionnaire

		All	Male	Female
Gender	Participant	582	492	90
Age	18-24	261	201	60
	25-31	168	150	18
	32-38	66	57	9
	39-45	36	36	0
	46-52	27	27	0
	53-59	24	21	3
Vehicle ownership	Personal	312	279	33
	Family	270	213	57
Work	Public Employee	87	72	15
	Private Employee	264	255	9
	University student	231	165	66
Amman Area	West	93	72	21
	East	87	45	42
	North	288	273	15
	South	114	102	12

The second part of the table, represents the particepents real application for thes behaviours, for example 78 of participant said that they always do the behaviur Unwillingness to extend cooperation to others in severe traffic conditions, on the conterrary, 375 of them said that they never forced a car to pull ovre, and so on.

By comparing the results of our sample, with the study of Mohd R. Suliman and Wa'el H. Awad shown in Table 2 were ranked also according to the % of respondent as follows:

According to Table 3, the most top causes of accidents according to the participant opinion, and by % of respondents, where as follows:

1. Forcing a car off the roadway, 95%.
2. Deliberate obstruction such as preventing other drivers from passing, forcing a car to pull over, 93%.
3. Pursuing a vehicle, 92%.
4. Excessive high speed, 91%.

From another point of view, Our sample where analyzed by calculating the weighted average for the second part of the table shown below Table 4, which represent weighted average and a new rank has been set according the weighted average also.

By calculating the weighted average, the most top causes of accidents are:
1. Running yellow light.
2. Collective aggression (e.g., wedding caravans).
3. Excessive high speed.
4. Unwillingness to extend cooperation to others in severe traffic conditions.

The driver behaviors are considered aggressive, according to the first part which represents the participant's opinion whether they listed the behavior as aggressive or not, and the second part which represent the weather the participants conducted this behavior or not, we can see that:

The highest aggressive behaviors according to the percent of respondent are:

1. Forcing a car off roadway.
2. Failure to yield the right of way to others.
3. Breaking suddenly.
4. Pursuing a vehicle.
5. Forcing a car to pull over.

The highest aggressive behaviors according to the weighted average are:

1. Running yellow light
2. Collective aggression (e.g., wedding caravans)
3. Excessive high speed
4. Unwillingness to extend cooperation to others in severe traffic conditions
5. Tailgating

Since there are no common behaviors, then it is considered aggressive.

Table 2: Aggressive behavior as judged by Jordanian drivers by Mohd R. Suliman and Wa'el H. Awad, (Suliman 2009)

Rank	Aggressive Behavior	% of respondents			Have you ever conducted this behavior?				
		Yes	NA	No	Never	Seldom	Sometimes	often	Always
1	Forcing a car off the roadway	95	5		186	10	4		
2	Deliberate obstruction such as preventing other drivers from passing	93	2	5	86	78	36		
3	Forcing a car to pull over	93	3	4	150	46	4		
4	Pursuing a vehicle	92	7	1	100	70	29	1	
5	Excessive high speed	91	4	6	10	106	50	19	15
6	Unwillingness to extend cooperation to others in severe traffic conditions	90	8	2	170	29	1		
7	Running red lights	90	6	4	180	18	2		
8	Tailgating(flowing closely)	90	7	3	60	120	16	3	1
9	Yelling and verbal abuse	88	10	2	10	60	80	35	15
10	Improper lane change (e.g., without signaling)	85	10	5	20	75	80	15	10
11	Braking suddenly	84	15	1	30	90	50	21	9
12	Collective aggression (e.g., weddings caravans*)	82	7	11	5	105	80	8	2
13	Cutting off or swerving in front of through traffic from left-turn lanes	75	5	20	4	50	70	50	26
14	Driving slow on the left lane on multilane roads	74	6	20	21	91	59	25	4
15	Weaving in and out of traffic	73	20	7	10	59	91	35	5
16	Excessive low speed	69	21	10	33	141	11	9	6
17	Failure to yield the right of way to others	67	30	3	29	150	21		
18	Glaring	61	27	12	7	116	54	18	5
19	Running stop signs	55	40	5	3	24	56	90	27
20	Parking on traffic lanes	54	38	8	25	95	80		

Table 3: The Behaviors rank according to the % of respondent.

Rank	Aggressive Behavior	% of respondents		Have you ever conducted this behavior?				
		Yes	No	Never	Seldom	Sometimes	often	Always
1	Forcing a car off the roadway	79.381	20.619	276	186	90	12	18
2	Forcing a car to pull over	78.351	21.649	375	120	66	15	6
3	Pursuing a vehicle	78.351	21.649	276	168	108	15	15
4	Braking suddenly	78.351	21.649	210	231	93	36	12
5	Failure to yield the right of way to others	78.351	21.649	231	186	111	39	15
6	Driving slow on the left lane on multilane roads	77.835	22.165	312	147	90	21	12
7	Deliberate obstruction such as preventing other drivers from passing	77.320	22.680	282	150	96	27	27
8	Running red lights	77.320	22.680	306	165	75	24	12
9	Unwillingness to extend cooperation to others in severe traffic conditions	76.289	23.711	189	150	129	36	78
10	Tailgating	75.773	24.227	150	162	180	54	36
11	Excessive high speed	74.742	25.258	147	132	192	78	33
12	Cutting off or swerving in front of through traffic from left-turn lane	74.742	25.258	216	204	111	24	27
13	Yelling and verbal abuse	74.227	25.773	282	132	108	30	30
14	Parking on traffic lanes	72.680	27.320	276	144	99	39	24
15	Glaring	70.103	29.897	204	156	156	51	15
16	Running stop signs	69.588	30.412	252	168	105	39	18
17	improper lane change(without signaling)	69.072	30.928	192	162	177	24	27
18	passing vehicles from right to left	68.557	31.443	204	186	117	51	24
19	Weaving in and out of traffic	67.010	32.990	213	162	126	54	27
20	Excessive low speed	66.495	33.505	213	192	120	33	24
21	Running yellow light	51.031	48.969	126	153	174	69	60
22	Collective aggression (e.g., wedding caravans)	46.392	53.608	159	144	141	87	51

Table 4: The Behaviors rank according to the weighted average

Rank	Aggressive Behavior	% of respondents		Have you ever conducted this behavior?					Wt. Ave.
		Yes	No	Never	Seldom	Sometimes	often	Always	
1	Running yellow light	51.03	48.97	126	153	174	69	60	2.63
2	Collective aggression (e.g., wedding caravans)	46.39	53.61	159	144	141	87	51	2.53
3	Excessive high speed	74.74	25.26	147	132	192	78	33	2.52
4	Unwillingness to extend cooperation to others in severe traffic conditions	76.29	23.71	189	150	129	36	78	2.42
5	Tailgating	75.77	24.23	150	162	180	54	36	2.42
6	Improper lane change (without signaling)	69.07	30.93	192	162	177	24	27	2.20
7	Weaving in and out of traffic	67.01	32.99	213	162	126	54	27	2.18
8	Glaring	70.10	29.90	204	156	156	51	15	2.17
9	passing vehicles from right to left	68.56	31.44	204	186	117	51	24	2.15
10	Excessive low speed	66.49	33.51	213	192	120	33	24	2.08
11	Cutting off or swerving in front of through traffic from left-turn lane	74.74	25.26	216	204	111	24	27	2.04
12	Failure to yield the right of way to others	78.35	21.65	231	186	111	39	15	2.01
13	Braking suddenly	78.35	21.65	210	231	93	36	12	1.98
14	Running stop signs	69.59	30.41	252	168	105	39	18	1.97
15	Yelling and verbal abuse	74.23	25.77	282	132	108	30	30	1.96
16	Parking on traffic lanes	72.68	27.32	276	144	99	39	24	1.95
17	Deliberate obstruction such as preventing other drivers from passing	77.32	22.68	282	150	96	27	27	1.91
18	Pursuing a vehicle	78.35	21.65	276	168	108	15	15	1.84
19	Forcing a car off the roadway	79.38	20.62	276	186	90	12	18	1.81
20	Driving slow on the left lane on multilane roads	77.84	22.16	312	147	90	21	12	1.75
21	Running red lights	77.32	22.68	306	165	75	24	12	1.75
22	Forcing a car to pull over	78.35	21.65	375	120	66	15	6	1.55

6.1.1.1 The relation between driver behavior and their exposure to accidents

It is normal that the driver behavior is the main reason for exposure to accidents, 22 driver behaviors were included in the first part of the questionnaire. A specific question was about the number of accidents to those who had an accident, the participants were grouped into 4 groups depending on how many accidents each participant had faced in his/her driving life. The first group contains only one accident, and so on for the rest of 2, 3, and 4 accidents.

The objective is to get the relation between the driver behaviors and their exposure to accidents. After descriptively analyzing each group separately and after finding

The weighted average, it was found that there is a direct relationship between driver behavior and the exposed accidents. As the aggressive behavior increases the chance of exposure to accidents increases as shown in Table 5 and Table 6. Keeping in mind that there is behaviors that are not effected by number of accidents, our conclusion was based on the behaviors of the majority as shown in Table 5 and Table 6.

Table 5: Weighted average for the whole sample

No. of Accident	Weighted Average
One Accident	45.62
Tow Accident	46.40
Three Accident	48.82
Four Accident	58.25

Table 6: Weighted average for accident groups.

	Aggressive Behavior	Weighted Average for 1 acc.	Weighted Average for 2 acc	Weighted Average for 3 acc.	Weighted Average for 4 acc.
1	Excessive high speed	2.87	2.30	2.91	3.75
2	Tailgating	2.57	2.65	3.09	3.38
3	Collective aggression (e.g., weddings caravans*)	2.53	2.55	2.73	3.25
4	Running yellow light	2.49	3.05	3.18	3.13
5	Unwillingness to extend cooperation to others in severe traffic conditions	2.43	2.45	2.00	2.63
6	Weaving in and out of traffic	2.21	2.10	2.64	2.38
7	Glaring	2.19	2.30	2.45	2.75
8	Improper lane change (e.g., without signaling)	2.15	2.10	2.55	2.88
9	Cutting off or swerving in front of through traffic from left-turn lanes	2.11	1.85	2.27	2.38
10	Yelling and verbal abuse	2.09	1.55	1.91	2.50
11	Failure to yield the right of way to others	2.04	1.80	2.00	2.13
12	Excessive low speed	2.02	2.15	2.00	1.75
13	Running stop signs	2.00	2.05	2.36	2.75
14	Parking on traffic lanes	1.98	2.50	1.91	2.50
15	passing vehicles from right to left	1.94	2.25	2.09	2.88
16	Forcing a car off the roadway	1.85	1.95	1.73	2.75
17	Deliberate obstruction such as preventing other drivers from passing	1.85	1.95	2.09	2.50
18	Braking suddenly	1.83	2.00	2.18	2.88
19	Pursuing a vehicle	1.77	1.70	1.73	2.88
20	Driving slow on the left lane on multilane roads	1.62	1.90	1.64	2.38
21	Running red lights	1.60	1.60	1.82	2.13
22	Forcing a car to pull over	1.49	1.65	1.55	1.75

6.1.2 Results and Analysis of the second part of the Questionnaire

The second part of the questionnaire represents participant's accidents and the related driver's mistakes. SPSS (Statistical Package for Social Sciences) software was used in forming the Regression Models in this study (SPSS 2009). SPSS is considered one of the most frequently used program for researchers in many fields such as engineering, science, art, education, and psychology.

The method of least squares that leads to the best fitting line of a postulated form to a set of data is used to form Regression Models between the dependent variable Yi, and independent variables Xi. In this study, the dependent variable Yi includes accident frequency, injuries, and fatalities. On the other hand, the independent variable Xi includes the drivers' behavior mistakes which caused traffic accidents. The detailed drivers' mistakes are shown in Table 5. A relationship between the dependent and the independent variables of the form:

$$Y_i = ß_0 + ß_1X_1 + ß_2X_2 + \ldots + ß_n X_n$$

It was calibrated by the method of least squares. This relationship is known as a multiple linear regression model. Stepwise calibration procedure was used to form the Multiple Linear Regression Model. The selections of explanatory variables follow the following four guidelines to decide which explanatory (independent) variables to include in the linear regression model. The selected independent variable has to follow the following four rules (Montgomery 2010, Garber 2010, Papacostas 2008, Abojaradeh 2013, Abojaradeh and Jrew 2014, Abojaradeh and Jrew 2013):

1. Must be linearly related to the dependent variable.
2. Must be highly correlated with the dependent variable.
3. Must not be highly correlated between themselves.
4. Must lend themselves to relatively easy projection

The selected regression model has to have maximum 3 to 5 variables in order to have an easy projection and application, and in order to have a lower cost. Also, the selected regression model should have strong coefficient of determination R^2 value. The coefficient of determination R^2, quantifies the fact that the goodness of fit of a regression line increases with the proportion of the total variation that is explained by the regression line. R^2 ranges from zero when none of the total variation is explained by the regression line to unity when all of the variation is explained by the line (Montgomery 2010, Garber 2010, Papacostas 2008, Abojaradeh 2013, Abojaradeh and Jrew 2014, Abojaradeh and Jrew 2013).
Table 7 contains 26 variables. New independent variables were added to the original 19 independent variables. These new variables were concluded during the study as high reasons for participant's accidents.
Prediction regression models were formed for all accidents and drivers mistakes in the study area with the following situations:
1. The relation between No. of accidents and driver mistakes in general.
2. The relation between No. of accidents and driver mistakes at intersection.
3. The relation between No. of accidents and driver mistakes at streets.
4. The relation between No. of accidents and driver mistakes which causes injuries.
5. The relation between No. of accidents and driver mistakes which causes property damages.
6. The relation between No. of accidents and driver mistakes by male drivers
7. The relation between No. of accidents and driver mistakes by female drivers

Table 7: Independent Variables and Driver Mistakes.

X Variable	Drivers Mistakes
1	following closely
2	lanes violation
3	wrong passing
4	wrong turning
5	Sudden turning
6	wrong u - turning
7	wrong backing (reversing)
8	Distraction and not taking enough precautions
9	Yield violation (Not respecting priorities of vehicles)
10	Pedestrian yield violation (Not respecting the rights of way for pedestrians)
11	Wrong way driving (opposite of the traffic)
12	Passing Speed limits
13	passing the red light
14	violation of stop sign
15	Violation of traffic signs
16	Not securing the car when stopping
17	Illegal Parking or stopping
18	Brake system failure

19	Not securing the vehicle loads
20	Eating and drinking while driving
21	Using cell phones while driving
22	using radio and music while driving
23	Fault of the other
24	Not slow down at intersections
25	tire squeal
26	Drinking alcohol

The details of the regression models which relate number of accidents and driver mistakes are as follows:
1. Prediction regression models for all accidents and drivers mistakes in general in the study area. The resulting models included variables that were shown to significantly affect accident frequency. The best Model along with the coefficient of correlation is provided below:
$Y = 0.335 + 1.389\ X_8 + 3.074\ X_{16} + 2.041\ X_{22} + 1.079\ X_{25} + 2.199\ X_{20}$ $R^2 = 0.67$

In the model the driver mistakes are (Distraction and not taking enough precautions, not securing the car when stopping, using radio and music while driving, tire squeal, Eating and drinking while driving). The previous mistakes are the most causes of accidents.

2. Studying the relation between No. of accidents and driver mistakes which causes accidents at intersections. The best Model along with the coefficient of correlation is provided below:
$Y = 1.39 + 1.745\ X_9 + 1.079\ X_8 + 0.98\ X_3 + 4.51\ X_{24}$ $R^2 = 0.70$

In the model above, the mistakes (Yield violation (Not respecting priorities of vehicles), Distraction and not taking enough precautions, wrong passing, Not slow down at intersections) explains 70% the change of no. of accidents at intersection.

3. Studying the relation between No. of accidents and driver mistakes which causes accidents at streets. The best Model along with the coefficient of correlation is provided below:
$Y = 1.196 + 1.49X_9 + 0.986X_{12} + 1.279X_3 + 0.733X_8 + 1.283X_{13} + 1.102X_2$ $R^2 = 0.61$
Yield violation (Not respecting priorities of vehicles), Passing Speed limits, wrong passing, Distraction and not taking enough precautions, passing the red light, lanes violation, explains 61.0% of accidents at streets.

4. Studying the relation between No. of accidents and the driver mistakes which causes property damages. The best Model along with the coefficient of correlation is provided below:
$Y_5 = 0.335 + 1.389\ X_8 + 3.074\ X_{16} + 2.041\ X_{22} + 1.079\ X_{25} + 2.199\ X_{20}$ $R^2 = 0.67$

Distraction and not taking enough precautions, not securing the car when stopping, using radio and music while driving, tire squeal, Eating and drinking while driving, explains 66.5% of accidents at intersections.

5. Studying the relation between No. of accidents and the driver mistakes which causes injuries. The best Model along with the coefficient of correlation is provided below:
$Y = 1.284 + 6.037X_{21} + 1.539X_{25} + 2.716X_3 + 1.013X_8$ $R^2 = 0.91$

Using cell phones while driving, Tire squeal, wrong passing, Distraction and not taking enough precautions, explains 91% of injuries caused by accidents.

6. Studying the relation between No. of accidents and the male drivers mistakes which causes accidents. The best Model along with the coefficient of correlation is provided below:
$Y = 0.334 + 1.395X_8 + 3.297X_{22} + 4.409X_{16} + 2.2X_{25} + 1.023X_1$ $R^2 = 0.70$
Distraction and not taking enough precautions, Using radio and music while driving, Not securing the car when stopping, Tire squeal, following closely, explains 70.3% of accidents made by male drivers.

7. Studying the relation between No. of accidents and the female drivers mistakes which causes accidents. The best Model along with the coefficient of correlation is provided below:
$Y = 0.337 + 3.596X_5 + 2.07X_1 + 1.663X_{21}$ $R^2 = 0.76$

The mistakes (Sudden turning, following closely, Using cell phones while driving), explains 75.9% of accidents made by female drivers.

7. Summary and Conclusions

1- It was found that the drivers' behavior is considered aggressive, according to the first part which represents the participant's opinion weather they listed the behavior as aggressive or not, and the second part which represent weather the participants conducted this behavior or not. It was found that the highest aggressive behaviors are as follows:

1. Tailgating (close following)
2. Running yellow light
3. Running red lights
4. Running stop signs
5. Excessive high speed

2- There was a strong direct relationship between the driver behaviors and their exposure to accidents. In conclusion, the aggressive behavior increases the chance of exposure to accidents.

3- The main causes of traffic accidents, injuries, and fatalities that are related to driver behavior are:

1. Close following and tailgating
2. Lane violations and zigzag driving or passing
3. Being unfocused, and distraction
4. Yield violations for other vehicles and pedestrians
5. Sudden turning and stopping
6. Wrong u-turning and backing
7. Speeding over the speed limit
8. Violations of traffic signs and signals including running on red light

8. Recommendations

The following recommendations are needed to improve traffic safety in Jordan:

1. It is recommended to improve the driver behavior through the following:
    1. Increase enforcement
    2. Education and awareness for drivers and pedestrians
    3. Increase the role of the Police Friends and the Secret Police
    4. Use high technology surveillance of driver behavior such as using stationary and moving radars and cameras.
    5. To have a daily news report through the T.V. and Radio stations about the daily traffic accidents, and to show the human losses and the injuries caused by these accidents, also to talk about the social and financial losses that can result.
    6. To force drivers who repeat traffic violations to suspend their driving license and to attend training courses concerning traffic laws and regulations.
    7. To increase the penalties for speeding, close following, running red light eating, drinking, smoking, using cell phones, zigzag driving, and yield violations.
    8. To start educating our children in schools about traffic safety rules and regulations. Also, encourage the students at university level to take traffic safety course.
    9. To encourage drivers to drive defensively and to obey traffic rules and regulations in all circumstances.
    10. To increase the number of traffic police patrols on the most hazardous and dangerous streets and intersections.
2. Widen the study area to include most areas inside Greater Amman Municipality, and to include more variables in the regression models such as road geometric features and Traffic characteristics.

3. Train all the traffic personnel to deal with the statistics programs such as SPSS software and keep them updated with the recent studies and researches regarding traffic safety issues.

4. Update the traffic police personnel with the most common mistakes drivers make, and to give them monthly classes on dealing with traffic safety and congested traffic.
5. To have more collaboration and coordination between all traffic and transportation agencies to improve traffic safety and achieve the goal of reducing traffic accidents frequency and severity.
6. The urgent need to adopt and implement a practical traffic safety strategy that has clear targets, objectives, action plans, time frame, and legislations.
7. The time has come to establish the Jordan National Traffic Safety Council to take its role in handling all the traffic safety issues in Jordan.

ACKNOWLEDGEMENT

The author of this paper would like to acknowledge for my beloved wife Hanaa Abdelhadi and my beloved daughters, Engineer Dua Abojaradeh, Engineer Eman Abojaradeh, Engineer Lina Abojaradeh, and Dr. Alaa Abojaradeh and my beloved son Engineer Ahmad Abojaradeh for their valuable help in this research. Their work is highly appreciated.

REFERNCES

Abojaradeh M., (2013). "Evaluation of Pedestrian Bridges and Pedestrian Safety in Jordan" Journal of Civil and Environment Research issued from IISTE USA. Volume 3, No. 1, 2013. pp 66-78.

Abojaradeh M., (2013). "Traffic Accidents Prediction Models to Improve Traffic Safety in Greater Amman Area". Journal of Civil and Environment Research issued from IISTE USA. Volume 3, No. 2, 2013. pp 87-101.

Abojaradeh M., (2013). "Travel Time and Delay Study to Improve Public Transit Systems in Jordan". (2013) Journal of Environment and Earth Science issued from IISTE USA. Volume 3, No. 4, 2013. pp 85-97.

Abojaradeh M., and Jrew B., (2013). "Development of Statistical Prediction Models to Reduce Fatal and Injury Traffic Accidents". Journal of Environment and Earth Science issued from IISTE USA. Volume 3, No. 11, 2013. pp 54-65.

Abojaradeh M., and Jrew B., (2014). "Evaluation and Improvement of Signalized Intersections in Amman City in Jordan". Accepted for publication at Journal of Environment and Earth Science issued from IISTE USA.

Abojaradeh M., Jrew K., and Abojaradeh D., (2009). Traffic Accidents Regression Prediction Models in Amman Area. The 4th conference of the Jordan Society for Scientific Research, Jordan 2009.

Abojaradeh, M., Jrew B., and Abojaradeh A. (2012). " The Effect of Driver Behavior Mistakes on Traffic Safety in Jordan" published and presented in the 6th Traffic Safety in Jordan by the Jordan Traffic Institute, Jordan 19-20 November 2012.

Al-Masaeid H., (2007), Traffic Accidents in Jordan study. Civil Engineering Dept., Jordan University of Science and Technology, Irbid, Jordan.

Department of Transportation DOT (2007), Federal highway Administration FHA, Highway Statistics, Annual Issues, Washington, D.C., USA 2007.

Department of Transportation DOT (2008), National Highway Traffic Safety Administration NHTSA, National Center for Statistics and Analysis, Fatality Analysis Reporting System FARS Database, USA 2008.

Garber, N.J., Hoel, L.A. (2010) Traffic and Highway Engineering, 4th SI Edition, USA.

Highway Administration FHWA (2010), the Highway Safety Improvement Program (HSIP), USA.

Ismeik M., Jrew B., and Nithal A., (2010), Development of driver behavior accident prediction model. International Journal of Natural & Engineering Science.

Jordan Traffic Safety Institute (2000-2012), Traffic Accidents in Jordan, Annual Reports 2000-2012.

Jrew B. and Abo-Aloush M., (2008), Analysis of accident prediction model for Marka area in Amman. Proceeding of the fifth Jordanian Traffic Safety conference, Jordan 2008.

Montgomery D., Runger G. (2010) Applied Statistics and Probability for Engineers Fifth Edition, USA.

National Highway Traffic Safety Administration NHTSA (2010), USA 2010.

Papacostas C., Prevedonros P. (2008) Transportation Engineering and Planning, Fourth Edition, USA.

Public Security Directorate (2000-2012), Annual Reports, Jordan 2000-2012.

Statistical Package for Social Sciences software (SPSS) (2009), version 17.

Suliman M. and Awad W., (2009). Aggressive driving is a major cause of traffic accidents and road rage in Jordan, Jordan

Tasca L., (2002), A Review of the literature on aggressive driving research, Ontario Ministry of Transportation,Canada 2002.

Transportation Research Record (TRR 2013) Journal

Wikipedia (2013), http://en.wikipedia.org/wiki/

World Health Organization WHO (2007), Report 2007.

Dr. Mohammad Abojaradeh

Dr. Mohammad Abojaradeh Ph.D., P.E., is an associate professor in the Faculty of Engineering Technology, Department of Civil Engineering, Zarqa University. He is a Ph.D. graduate of Arizona State University USA in 2003, and his Master degree from Jordan University in 1997, and his bachelor degree from Kuwait University in 1985. He is a registered Professional Engineer Registration # 40201 Arizona USA October 2003. Dr. Abojaradeh has over 25 years of experience in civil engineering consultation and management and over 10 years in academic teaching and research in the fields of transportation, highway, and traffic. His areas of expertise include pavement materials design, advanced laboratory testing, field performance evaluation, the performance and improvement of pavement materials, traffic studies and traffic and pedestrian safety, highway engineering studies, and in transportation engineering studies. He has over 20 publications in his field. Dr. Abojaradeh is a member of several professional organizations such as the ASCE American Society of Civil Engineers USA, ITE Institute of Transportation Engineers USA, JEA Jordan Engineer Association Jordan, and KES Kuwait Engineers Society Kuwait.