

Assessment of Human Errors in Driving Accidents; Analysis of the Causes Based on Aberrant Behaviors

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Abstract: Introduction: Today, mortalities and injuries due to traffic accidents have been confirmed as a global phenomenon. Meanwhile, mistakes and high risk behaviors by drivers, is the most important intervening factor in traffic accidents. This study is to analyze the causes of traffic accidents according to drivers' aberrant behaviors. Methods: This cross-sectional study was conducted on 540 taxi drivers using Manchester Driving Behaviour Questionnaire in 0-5 Likert scale. After being gathered, the data were analyzed by SPSS 11.5 using Pearson Correlation and Logistic Regression. Findings: The mean score of aberrant driving behaviors was obtained 2.06 (± 0.47) and lapse obtained the highest score and driving mistakes did the lowest. As age advanced, the rate of aberrant behaviours declined ($P = 0.006$). Commitment of mistakes and offences was more prevalent in ages under 30 years compared to other age ranges and lapse in the individuals over 50 years was more prevalent compared to other items. The results of logistic regression indicated that all variables of DBQ are important in predicting Iranian drivers' aberrant behaviors ($P < 0.001$), but intentional offences had the highest correlation. There was an inverse correlation between driving history and intentional offences and mistakes ($P < 0.001$). Conclusion: According to the results, it could be said that intentional offences and lapse in driving behaviors are more predictive of self-reported accidents compared to other variables. The drivers in low ages are more willing to practice aberrant behaviors due to lack of adequate skill and experience and having intrinsic excitements. By contrast, as age advances, intentional offenses declines and the rate of lapses ascends. It seems that through provision of regular, periodic training for the drivers by occupation and creating awareness, aberrant behaviors and, by extension, traffic accidents could be effectively decreased.

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1. Introduction

Vehicles, which are characteristics of civilization, have turned into a big problem in different social and public health respects due to increasing the number of the road and city accidents and high mortality rate [1]. The problem of mortality resulting from Road Traffic Crashes (RTCs) has currently been confirmed as a worldwide phenomenon in many countries [2] and this is the third and most important factor behind death of those who are one year to 40 years old [3]. It has been estimated throughout the world, that road traffic crashes were the cause of about 2 million deaths annually [4]. Road mortality in different areas of the world is the main reason for human casualties in respect of potential years missed over 30 years (from 1990 to 2020) [5]. It is predicted that until 2020, the number of road traffic crashes deaths increase up to 65% throughout the world and up to 80% in developing countries. Whereas, till 2020 the rate will decreased by 30% in developed countries

[6]. More than 90% of the casualties of these accidents, about one million people, are in low-income or middle-income countries. Mortality rate due to traffic accidents in low-income and middle-income countries is 20.2 deaths per 100,000 people. Whereas, the rate is 12.6 for high-income countries [7].

Iran has one of the highest rates of road traffic crashes mortality rates in the world; furthermore, road traffic crashes, after cardiovascular diseases, is nationally regarded as the second factor behind death in Iran [8]. The road traffic crashes mortality rate in Iran was 30/100,000 people in 2000 whereas it is 23 and 14 per 100,000 people in the worldwide and Eastern Mediterranean respectively [9]. In a study done aiming at investigating the country population, the number of vehicles, the number of driving accidents, mortality rate, and injury rate due to accidents from 1997 to 2006, it was clarified that mortality rate due to the road traffic crashes during the years had an increasing trend, which is one of the

highest rates in the world and is almost twice the mortality rate in European countries [10]. The total road traffic crashes cases in Iran during three years (2001 to 2004) have almost been doubled and death toll owing to accidents has almost been tripled and such a growth might be a record in the world. Given population growth and increasing the demands in 2014, nearly 200 persons will be killed in road traffic crashes in Iran [11].

Important factors involved in occurrence of incidents are human, vehicles, road and environment [12], which in 90 to 95 percent of road traffic crashes, man's performance is a main or contributes risk factor [13], also analyzing the road traffic crashes in Iran shows that from the four factors, human is accounted as the most important agent of crashes [14]. Among these factors, drivers' errors, risky behaviors of some professionals in the roads and a large portion of the public are the biggest contributors to the incidents [15]. A great number of vehicle accidents happen more owing to misbehaving or improper driving behavior than the technical defect of the vehicles [16]. Additionally, in the study a positive correlation between road crash and the error of drivers has been reported [17]. Currently it is about two decades that the models of human error have been presented. The models and the approaches of error management have had a significant role in safety in a wide range of domains [18]. Based on studies done upon human error, currently there are three various taxonomies of human error, Norman's error categorization, Reason's error classification, and Rasmussen's error classification [19].

To classify the human error, a majority of studies related to driver's error use the approach of MDBQ adapted from Reason model and the most widespread study upon investigating human errors in road transportation was carried out by using DBQ [18]. This questionnaire was devised by Reason and colleagues in Psychology Department in Manchester University in 1990 [20]. Since devising this English questionnaire till 2010, 174 studies have been done using this questionnaire [21].

In recent years, Iran has been turned into a center of crisis, moreover, recent studies and investigations of World Bank have officially considered the state of Iran traffic safety critical [22]. The outcome of every aberrant action is an accident which leads to death or injury of drivers and passengers. Hence, driver's error is the major agent in accidents; the present study is aimed at evaluating human error through the rate of aberrant behaviors in Iranian drivers.

2. Materials and methods

This cross-sectional study was carried out in the center and west of Iran (Isfahan and Kermanshah)

upon 540 ordinary and taxi drivers who were driving regularly from bus terminals and travel agencies to other cities. Because an overwhelming majority of inter-urban drivers consists of men, therefore, women drivers not consider in this study. To collect data, Manchester Driving Behavior Questionnaire - MDBQ was used. DBQ comprising the following classes of aberrant driver behavior: lapse, errors, aggressive and ordinary violations [20] which have introduced different errors and violations while driving. In this questionnaire, respondents indicate how often each aberration occurred to them during the last year on a Six-point scale of Likert (0 = never, 1 = hardly ever, 2 = occasionally, 3 = quite often, 4 = frequently, and 5 = nearly all the time) and by which aberrant behaviors of drivers have been assessed. All persons also answered the questions related to demographic information including age, educational level, driving experience, accident experience and the like.

Although DBQ were tested for validity and reliability in Iran by Oreyzi et al [23], in the pilot study the reliability assessed. To determine the validity, the approach of expert judgment was used. In other words, the questionnaire was given to 5 senior traffic officers and traffic police chief of Isfahan and the questions were modified concerning the expert comments in the domains of the guidance on transportation, traffic and the Provisions of the traffic regulations. Among the items of the questionnaire, the following question "Drive even though you realize that you may be over the legal blood-alcohol limit" was omitted due to inconsistency with Islamic culture and traffic rules and it was replaced with this item "Drive even though you realize that you aren't good health". In a pilot study, to assess reliability, 30 professional drivers were asked to answer questions and mark the ones which were unclear. Data obtained were analyzed by the SPSS V.20 software to assess the validity and reliability.

In final, data obtained were analyzed by the SPSS V.20 software by using the Pearson Correlation, and Logistic Regression.

3. Results

The mean age of drivers with driving experience of 17.62 ± 12.61 was 41.39 ± 13.21 ; also 15.6% had BSc and upper degree, 55% had diploma degree, and 29.4% had degree under diploma. 51.5% of drivers in the last year had at least one accident and in 47.8% of the accidents occurred, driver had driving offense. 11.5% of these accidents have resulted in physical injuries. From these persons, 1.9% has reported their skill level of driving weak, 45.4% good, 34.4% very good, and 18.3% excellent.

To assess reliability of questionnaires, the test of Chronbach's alpha was used, which was equal to 0.913. Out of 4 factors of the questionnaire, lapse and

ordinary violations with the amounts of 0.89 and 0.7 had the most and the least coefficient of internal consistency respectively. (Table1)

Table 1: Alpha reliability coefficients of the Measurement Scales

Type of the aberrant behavior	Alpha reliability coefficients
Lapse	0.89
Errors	0.85
Ordinary violations	0.77
Aggressive violations	0.70

A high correlation was obtained between the items of DBQ questionnaire. In table 2, the presence of correlation between these items was observed.

Table 2: Intercorrelations (Pearson's r) between factors measuring Risk taking (N = 540)

	Lapse	Aggressive violations	Errors	Ordinary violations
Lapse	1			
Aggressive violations	.579**	1		
Errors	.537**	.584**	1	
Ordinary violations	.491**	.498**	.548**	1

** . Correlation is significant at the 0.01 level

The average of the scores related to aberrant behaviors was 2.06(± 0.47) and out of the items in DBQ questionnaire, lapse had the highest score and the errors had the lowest score. The mean and the standard deviation of the items have been indicated in Table 3.

Table 4: Factor loading and items from Driver Behavior Questionnaire (DBQ) arranged in descending order of mean score

Variable	Item	Mean	SD	Factor loading	Behavioral type	Risk category
4	Become impatient with a slow driver in the outer lane and overtake on the inside.	2.71	1.2	.58	AV	C
45	Drive with only "half-an-eye" on the road while looking at a map, changing a cassette or radio channel etc.	2.57	1.14	.76	L	C
2	Check your speedometer and discover that you are unknowingly traveling faster than the legal limit.	2.18	.93	.84	OV	B
14	Miss your exit on a motorway and have to make a lengthy detour.	2.09	.82	.60	L	A
3	Lock yourself out of your car with the keys still inside.	2.05	.93	.79	L	A
41	Fail to check your mirror before pulling out, changing lanes, turning etc.	2.02	.86	.61	L	C
9	Distracted or preoccupied, realize belatedly that the vehicle ahead has slowed and have to slam on the breaks to avoid a collision.	1.96	.85	.69	L	C
7	Drive especially close or "flash" the car in front as a signal for that driver to go faster or get out of your way.	1.93	.98	.81	AV	C
38	Fail to read the signs correctly, and exit from a roundabout on the wrong road.	1.92	.83	.88	L	A
33	Plan your route badly, so that you meet traffic congestion you could have avoided.	1.91	.86	.58	E	A
15	Forget which gear you are currently in and have to check with your hand.	1.87	.77	.92	L	A
20	Try to overtake without first checking your mirror, and then get hooted at by the car behind which has already begun its overtaking maneuver.	1.84	.83	.82	L	C
30	Misjudge speed of oncoming vehicle when overtaking.	1.84	.81	.92	L	C
34	Overtake a single line of stationary or slow-moving vehicles, only to discover that they were queuing to get through a one lane gap or	1.8	.90	.70	E	A

Table 3: Number of items and mean scores for all measures

Measures	Number of item	Mean (range 0-5)	SD
Lapse	21	1.75	.45
Errors	9	1.49	.41
Ordinary violations	3	1.66	.53
Aggressive violations	17	1.63	.48

SD = Standard Deviation

The frequencies of the DBQ responses were, in general, between "never" to "hardly ever" and rarely "occasionally" and five kinds of aberrant behaviors had the highest frequency among Iranian drivers:

1. Become impatient with a slow driver in the outer lane and overtake on the inside. (Mean ± SD = 2.71 ± 1.2)

2. Drive with only "half-an-eye" on the road while looking at a map, changing a cassette or radio channel etc. (Mean ± SD = 2.57 ± 1.14)

3. Check your speedometer and discover that you are unknowingly traveling faster than the legal limit. (Mean ± SD = 2.18 ± 0.93)

4. Miss your exit on a motorway and have to make a lengthy detour. (Mean ± SD = 2.09 ± 0.82)

5. Lock yourself out of your car with the keys still inside. (Mean ± SD = 2.05 ± 0.93)

In Table 4, the other items of the questionnaire are seen with Factor Loading of each item.

	roadwork lights.					
21	Deliberately disregard the speed limits late at night or very early in the morning.	1.79	1.0	.82	AV	C
44	Disregard red lights when driving late at night along empty roads.	1.77	1.07	.67	AV	C
17	Intending to drive to destination A, you "wake up" to find yourself en route to B, where the latter is the more usual journey.	1.77	.78	.49	L	A
18	Take a chance and cross on lights that have turned red.	1.75	.81	.68	AV	C
13	"Wake up" to realize that you have no clear recollection of the road along which you have just traveled.	1.74	.77	.82	L	A
1	Attempt to drive away from traffic lights in third gear.	1.69	.93	.36	L	A
8	Forget where you left your car in a multi-level car park.	1.65	.81	.65	L	A
40	Ignore "give way" signs, and narrowly avoid colliding with traffic having right of way.	1.62	.86	.73	AV	C
42	Attempt to overtake a vehicle that you had not noticed was signaling its intention to turn left (right).	1.62	.77	.41	L	C
27	Have an aversion to a particular class of road user and indicate your hostility by whatever means you can	1.61	.87	.49	AV	B
35	Overtake a slow-moving vehicle on the inside lane or hard shoulder of a motorway.	1.59	.89	.76	AV	C
10	Intend to switch on the windscreen wipers, but switch on the lights instead or vice versa.	1.59	.77	.74	L	A
39	Fail to give way when a bus is signaling its intention to pull out.	1.58	1.08	.69	AV	B
16	Stuck behind a slow-moving vehicle on a two-lane highway, you are driven by frustration to try to overtake in risky circumstances.	1.53	.83	.72	AV	C
46	Fail to notice pedestrians crossing when turning into a side-street from a main road.	1.51	.80	.52	L	C
29	Park on a double-yellow line and risk a fine.	1.51	.73	.79	AV	A
11	Turn left on to a main road into the path of an oncoming vehicle that you had not seen, or whose speed you had misjudged.	1.51	.72	.44	E	B
19	Angered by another driver's behavior, you give chase with the intention of giving him/her a piece of your mind.	1.5	.78	.43	AV	C
23	Lost in thought, you forget that your lights are in full beam until "flashed" by other motorists.	1.5	.69	.59	L	B
32	Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late.	1.48	.44	.39	L	C
28	Lost in thought or distracted, you fail to notice someone waiting at a zebra crossing, or a pelican crossing light that has just turned red.	1.46	.67	.86	OV	C
36	Cut the corner on a left (right) - hand turn and have to swerve violently to avoid an oncoming vehicle.	1.44	.76	.68	AV	C
47	Get involved in unofficial "races" with other car drivers.	1.43	.81	.71	AV	C
12	Misjudge your gap in a car park and nearly (or actually) hit adjoining vehicle.	1.43	.67	.65	E	B
50	Misjudge your crossing interval when turning left and narrowly miss collision.	1.41	.70	.62	E	C
31	Hit something when reversing that you had not previously seen.	1.39	.67	.60	E	C
49	Brake too quickly on a slippery road and/or steer the wrong way in a skid.	1.39	.62	.68	E	C
26	Drive even though you realize that you aren't good health.	1.37	.70	.58	AV	C
22	Forget when your road tax/insurance expires and discover that you are driving illegally.	1.34	.64	.76	OV	A
6	Attempt to drive away without first having switched on the ignition.	1.33	.64	.71	L	A
25	In a queue of vehicles turning right (left) on to a main road, pay such close attention to the traffic approaching from the left (right) that you nearly hit the car in front.	1.33	.63	.70	L	B
37	Get into the wrong lane at a roundabout or approaching a road junction	1.33	.63	.73	E	A
24	On turning right (left), nearly hit a cyclist who has come up on your inside.	1.32	.67	.47	L	C
48	"Race" oncoming vehicle for a one-car gap on a narrow or obstructed road.	1.31	.67	.79	AV	C
43	Deliberately drive the wrong way down a deserted one-way street.	1.26	.60	.41	AV	C
5	Drive as fast along country roads at night on dipped lights as on full beam.	1.22	.62	.53	E	B

E = Errors L = Lapse AV = Aggressive violations OV = Ordinary violations

Among the behaviors that may cause risk for other drivers, two kinds of them had the highest percentages a) the behaviors without risk possibility for other road drivers, which cause just lack of comfort (low risk possibility) with 34.5% and b) behaviors which certainly create risk for other drivers (high risk possibility) with 33.7%. Moreover, the behaviors which may cause risk for others (average risk possibility) were rated next.

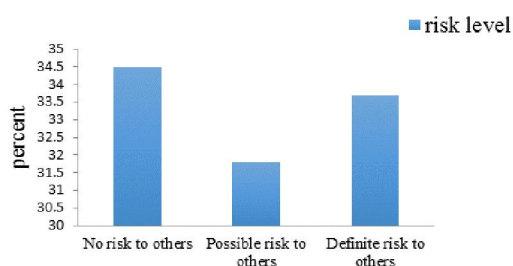


Chart 1: Percent of risk level at type of the behavior

By aging, the amount of aberrant behaviors has been reduced ($P = 0.006$). Errors and violations in those who were under 30 were more than that in other age ranges and lapses in those above 50 were observed more than that in other ages (Chart 2).

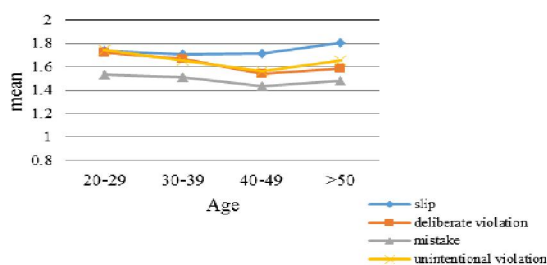


Chart 2: Average rate of aberrant behaviors at different age ranges

Table 5: The aberrant behavior and self report accident predictors

Variables	Aberrant behaviors			Self report accident		
	R ²	β	P	R ²	β	P
Lapse	.88	.42	< 0.001	.13	.31	0.002
Errors	.75	.18	< 0.001	.16	.29	< 0.001
Ordinary violations	.64	.06	< 0.001	.62	.12	0.153
Aggressive violations	.87	.34	< 0.001	.13	.41	0.002

There was a positive correlation between the number of accidents and the variables of the questionnaire; in addition, the correlation between the number of accidents and aggressive violations was higher than that between other variables. Furthermore, high number of accidents is predictive for aberrant behaviors and self reported accidents.

The findings obtained showed that there is an inverse correlation between educational level and the amount of aberrant behaviors ($P = 0.001$). In other words, by increasing the educational level, the amount of aberrant behaviors in the occurrence of the road crashes decreases. Moreover, education had a greater role in reducing the lapses and errors than in violations.

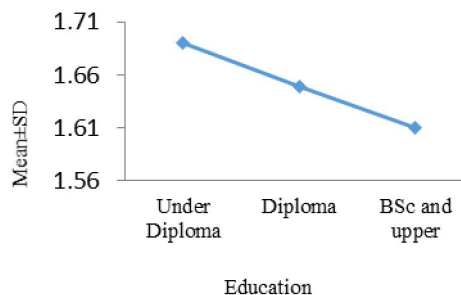


Chart 3: Correlation between aberrant behaviors and educational level

Out of the variables of DBQ questionnaire, there was an inverse correlation between driving experience and aggressive violations as well as errors ($P < 0.001$). Self-reported accidents had a positive correlation with errors ($P < 0.001$), aggressive violations and lapse ($P = 0.002$).

The results of Logistic Regression test showed that all the variables of DBQ questionnaire are important in predicting the aberrant behaviors of Iranian drivers ($P < 0.001$). However, aggressive violations had the highest regression coefficient. The test also showed that aggressive violations, lapse, and errors respectively are predictive for self-reported accidents of drivers. (Table 5).

4. Discussion

User behavior is one important key parameter in road traffic crashes [24] and has been identified as main factor in road accidents [25], whereas based on the reports of the Legal Medical Organization and Road Maintenance and Transportation Organization of Iran, 241240 of people have been killed on roads over 80s Shamsi. The most losses were related to “drivers,”

and the highest mortality rate in vehicle accidents was related to motorcars [26]. Therefore, in the present study an attempt was done to use the same approach to investigate the aberrant behavior of Iranian drivers and to compare the results with other countries.

DBQ questionnaire has been mainly used as a predictive for road self reported accidents [27] and in the present study it was clarified that the Manchester Driving Behavior Questionnaire can properly predict the self reported accidents in Iranian drivers ($P < 0.001$). The results obtained from the present study showed that out of driving behaviors, aggressive violations and lapse, more than other variables, are predictive for self reported accidents. In 2007, in a study done by Bener in two countries: Qatar and United Arab Emirates to investigate the drivers' behaviors, after controlling the impact of demographic variables, the errors and lapses perform as predictive for accidents in Qatar [28]. The result has been also reported in other studies [22, 29, 30]. Like a most number of studies done, the responses were between *never* and *nearly all the time* [28] and overtaking the person who drives slowly had the highest frequency that in a study done by Ozkan et al in 6 different countries including Iran by using DBQ questionnaire [29], similar results were reported. Other items which had the highest scores have been reported in a study done by Ketabi et al in Yazd to investigate the aberrant behaviors and road accidents among Iranian truck drivers [31]. Given the fact that in Iran almost all professional drivers are men, there was no possibility of having a woman sample in the present study. Nevertheless, some studies have reported that frequently risky driving behaviors are mainly behaviors [32]. There was an inverse correlation between age and aberrant behaviors. In addition, errors and violations in persons under 30 were less than that in other ages. But lapse in persons above 50 was more than that in other ages. 33. Parker et al figured out that drivers above 50 have more tendency to lapse and errors while driving. Whereas, the rate of violating the rules in young drivers was more than that in other ages [32]. In a study done by Ozkan et al, it has been reported that driving skills among Iranian drivers increase by aging and accident risks are higher in young people [29]. Other studies done in this field like the study of Clinton et al as well as Tronsmoen also have pointed to the same result [34,35] and some studies have reported that by aging, inattention to violations increases systematically [36]. When drivers are young, they are willing to speed and do aberrant behaviors due to lack of sufficient skills and internal excitement. Educational level is an effective agent upon drivers' perception in traffic trends while driving. If individuals have high educational level, their perception from environmental conditions and

dangerous factors would grow, and they would pay more attention to road signs and barriers. In the present study, there is an inverse correlation between aberrant behaviors and education and it was clarified that by increasing the education, the aberrant behaviors have been reduced, which is in line with the results obtained from a study done by Shams in 2011 upon the behavior of taxi drivers in Tehran [37].

In the present study, there is also a significant relationship between aberrant behaviors and number of accidents. In other words, those who had more accidents have obtained a higher aberrant behaviors scores. These results are consistent with the findings of Ozkan et al study [38]. It also has been proved that more experienced persons totally have lower aberrant behaviors than the others, high experience decreases aggressive violations and errors in driving. In fact, more experience in driving increases skill and causes people to avoid aberrant behaviors. This matter has been approved in other studies [39].

5. Conclusion

However, statistics show that in Iran more attention should be paid to travels by land. But unfortunately in spite of this matter, traffic safety and transporting vehicles in Iran are not regarded as a national preference. In the driving test in Iran, attention is paid to the driver's celerity more than any other factors. In the countries whose driving rules are more organized, more attention is paid to observing the rules as well as driver's behavior and instructions needed in this field are presented. Therefore, in this area necessary training must be provided. Obtaining the driving license need to be modified in Iran. To increase the amount of the risk aversion and need to be arranged, according to the driver's character and records.

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