A Real Case-Based Study Exploring Influence of Human Age and Gender on Drivers' Behavior and Traffic Safety

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Abstract. The demand for understanding the functional relationship between changes in traffic safety level and human-related factors has increased remarkably due to a steady increase in population and traffic volume. Motor vehicle crashes can cause a serious impact on the victims, families, and the community resulting in instability of family and large socio-economic costs to society and healthcare service. Statistical studies of drivers' behavior as a function of some of the human characteristics, in particular, have become increasingly important for establishing an evidence-based framework through which transportation and healthcare authorities can develop innovative solutions to mitigate serious consequences of risky driving. This paper uses a real-world dataset to analyze the relationship between the human characteristics and both the behavior and risk-level. In addition to that, this paper conducts several analytical studies to investigate the extent to which the risky driving behavior may affect the severity of the crash and human injury.

Keywords: Traffic safety · Risky driving behavior · Road crashes · Human factors in traffic safety

1 Introduction

Driving has become an essential part of our day-to-day life. Humans are usually different in nature and have different personalities and behaviors, which can affect the way they drive. Although driving provides ease of movement for people, the different behaviors of the drivers can lead to unfavorable conditions or consequences. Transportation and traffic authorities worldwide have made several endeavors in the direction of mitigating the risky driving behavior through either launching new or modifying existing road traffic regulations. The main purpose of these traffic regulations was to reduce traffic crashes and their severity.

Several publications have been made available over the last years in which the influence of human features such as gender and age on the risky driving behavior was

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investigated. Our investigations in literature have shown that most of these works are essentially based on the police traffic reports as the main source of the research data. However, some of these important research works are reported in this section with detailed description of their data gathering techniques.

Dejoy [1] used a three-part questionnaire to study gender differences in traffic accident risk perception. The first part of the questionnaire was designed for the participants to judge themselves in certain driving characteristics; the second part asked them to rate 15 risky driving behaviors, and the last part collected demographic data. Harré et al. [2] studied gender differences in the driving behaviors and the attitudes of youth. In their study authors relied on the questionnaire as the main tool to collect data relevant to demographics-features, driving status, traffic laws, and crash involvement. Moreover, Özkan and Lajunen [3] used a different questionnaire to understand the effect of gender on driving skills and accident involvement. Authors applied the Bem Sex Role Inventory test and the Driver Skill Inventory test as well as some personal questions. Furthermore, a research published by Jiménez-Mejías et al. [4] developed a questionnaire to carry out an analysis on gender differences. The questionnaire included a demographic section similar to the others. However, the rest of the sections were dissimilar; they focused on collecting data about the frequency of driving, seatbelt usage, and some other selected driving behaviors.

Rhodes and Pivik [5] distributed a questionnaire to establish a clear relationship between age and gender, and twelve driving behaviors. The survey used a scale of five to rate the frequency of displaying twelve different driving behaviors. Moreover, the research also collected responses on the perception of people about the risks involved in doing these risky driving behaviors. Classen et al. [6] tested gender differences in driving behaviors for older drivers. The study was conducted using a questionnaire and other methods such as clinical tests, visual cognition, and motor performance test. The questionnaire collected demographic data, history of the driver, and data about certain driving behaviors.

Another research carried out by Cordellieri et al. [7] studied three aspects as a function of gender and these aspects are: dealing with road safety rules, driving behaviors, and risk perception of male and female drivers. A different questionnaire was designed that collected demographic information and tested each aspect using a scale point. Tao et al. [8] focused on Chinese drivers in investigating three areas: personal characteristics, driving behaviors, and risk of accidents. The research tested the effect of gender and other factors on these areas. A similar research was carried out by Barr et al. [9] who focused on teenagers to study driving behaviors as a function of gender. The research collected responses from male and female teenagers where the teenagers conveyed information about their own driving behaviors.

In addition, some other researchers have analyzed gender differences by collecting data from statistical authorities and police reports or from other researchers who already conducted studies in this field. Welsh and Lenard [10] conducted a research in the UK in which the data used were collected from police records and accident data in the UK. The main aim of the study was to investigate gender differences in collision and injury risk. Lonczak et al. [11] established a study in Washington that endeavored to predict risky and angry driving as a function of gender. In this study, the data were obtained from previous research undertaken in Washington by the Traffic Safety Commission.

In this paper, we aim to explore the gender differences in driving behaviors as well as extend the study to understand age differences in driving behaviors through a case study. Moreover, the correlation of driving behavior at the time crash and the corresponding severity of damage is also studied. Besides, data used was collected from a sample comprising of Qatar University community through an online survey.

The rest of this paper is organized as follows: Sect. 2 explains the methodology used to collect the data. Section 3 highlights the findings of the survey results. In Sect. 4, we discuss in details the results of our analysis. Finally, we summarize the implications of the study and draw conclusions in Sect. 5.

2 Proposed Methodology

We dedicate this section to introduce the methodology followed to achieve the work objectives. In this paper, we designed a questionnaire consisting of two different main sections. The first section is about introducing the survey objectives and identifying the targeted population. The second section of the questionnaire is dedicated to collect data relevant to age, gender, driving behaviors and road crashes history of participants.

The "driving behaviors" section explores how drivers frequently behave. The participants use a scale of 1 to 5 to rate each behavior in which 5 = always, 4 = often, 3 = sometimes, 2 = rarely, and 1 = never, and zero = not applicable. In this study, several behaviors were selected and rated including:

- Not wearing the car seatbelt (DB1)
- Exceeding the speed limit (DB2)
- Driving in the emergency lane (DB3)
- Overtaking from the right side (DB4)
- Changing lanes without using the signs (DB5)
- Not keeping safe distance from the front vehicle (DB6)
- Eating or drinking while driving (DB7)
- Making or accepting phone calls (DB8)
- Reading or sending emails and text messages (DB9)

Furthermore, the "road crashes" section collected information to understand the relationship between car crashes and driving behaviors. The questions asked in this section included the number of crashes that participants were involved in within the last three years, the type of injury that occurred in the two most recent crashes, the type of damage that occurred to the car in the two most recent crashes, and the person who caused the crash. In addition, this section asked the drivers to report the driving behaviors that they were doing when the crash occurred.

3 Survey Results Description

This section describes the data collected for the study as part of a "Driving Behaviors" survey conducted at Qatar University during the month of February of the spring 2017 term. E-mails with the link to participate in a web-based survey were sent to 14,000+

students and 2,000+ faculty and staff. The total number of participants who completed the questionnaire was 500, that is, the sample size was 3.13%. The sample was chosen to be from Qatar University since it represented the diversity of Qatar with regard to gender, age, occupation, and driver characteristics.

3.1 Demographics of Participants

Female (51.89%) respondents for the survey were slightly more than males (48.11%). Besides, the majority of the participants were of the age group 18–22 (43.9%) which reflected the occupation (student) of more than half of the participants (55.7%). Additionally, the driving experience for most of the participants (38%) was less than 2 years. A major percentage of the sample (45.1%) said they drove 1–2 h each day, which reveals both their dependency and affinity towards driving. It is also worth mentioning that 99.5% of the participants graduated from high school. For further detailed information, see Table 1.

Table 1. Summary of selected variables explaining socio-economic demographics of individual participants

Gender	Male	48.1%
	Female	51.9%
Age (years)	18–22	43.9%
	23–30	24.9%
	31–45	20.9%
	46–65	10.3%
Occupation	Student	55.7%
	Working full-time	39.0%
	Temporarily unemployed	2.8%
	Other	2.6%
Driving experience in Qatar (years)	<2	38.0%
	2–5	33.4%
	6–10	14.1%
	>10	14.5%
Hours driven per day	<1	16.3%
	1–2	45.1%
	3–4	32.6%
	>5	6.0%

3.2 Driving Behaviors Analysis

Participants rated how often they practiced the driving behaviors mentioned in Sect. 2. In all cases, the majority of them said they never or rarely practiced risky behaviors such as not wearing car seatbelt. Around 23.0%–29.5% of the participants admitted that

they would sometimes make/accept calls using mobile, not keep a safe distance from the front vehicle, move from one lane to another without using signs, eat/drink while driving or exceed the speed limit. 14.7% reported often using mobile phone followed by 14.5% exceeding the speed limit followed by 11.6% changing lanes without a sign and 10.9% not keeping a safe distance. See Fig. 1 for more details.

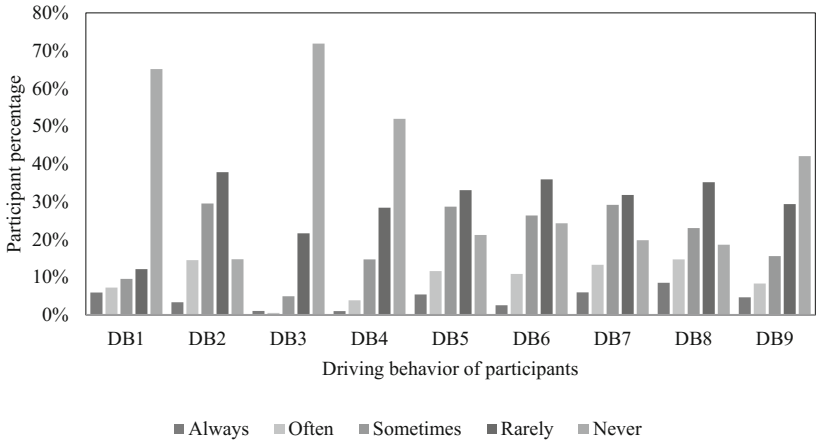

Fig. 1. Distribution of participants' response to driving behavior practices

In addition, around 10.9%–13.3% stated they often would not keep a safe distance, eat/drink, or change lanes without a sign. Among the small percentage who said they always practiced a behavior, the highest percentage was using a mobile phone (8.5%). Small percentages (3.4%–6%) of them would always exceed the speed limit, read/send emails/text messages, change lanes without a sign, not wear a seatbelt, or eat/drink.

3.3 Crash History Analysis

The participants reported how many crashes they were involved in the last three years. Participants involved in a crash identified their driving behavior at the time of the crash. Moreover, they also rated the severity of the crash in terms of injury and car damage.

Frequency of Crash. Out of 500 participants, 34.2% reported being involved in at least one crash in the last three years. Around 37.1% of the male participants said they were in an accident; while a lower percentage (31.5%) of the female participants said they had a crash. Similarly, the males had a higher mean number of crashes (2.39) than the females (1.81). On the other hand, the highest percentage (49.2%) of crashes reported was by the age group 23–30. However, the age group 18 – 22 had the highest mean crashes (2.25) followed by the age group 46–65 (2.09). See Table 2 for the detailed summary.

Table 2. Summary of participants involved in crash in the last three years

		≥ 1 crash	Mean crashes	Std. dev.
Gender	Male	37.1%	2.39	3.15
	Female	31.5%	1.81	0.99
Age (years)	18–22	31.4%	2.25	3.22
	23–30	49.2%	2.00	1.41
	31–45	28.8%	2.03	1.99
	46–65	21.2%	2.09	1.51

Driving Behavior During Crash. Moreover, the majority of the participants (36.5%) involved in their most recent crash reported not keeping a safe distance from the front vehicle at the time of the crash (see Fig. 2). 17.5% of them said they were not wearing the car seatbelt. Around 8%–9.5% stated that they were exceeding the speed limit, changing lanes without using signs, or reading/sending emails and text messages. Also, about 7% were either making/accepting phone calls or overtaking from the right side. Whereas, small percentages (1.5%–3.5%) of them were either driving on the emergency lane or eating/drinking while driving.

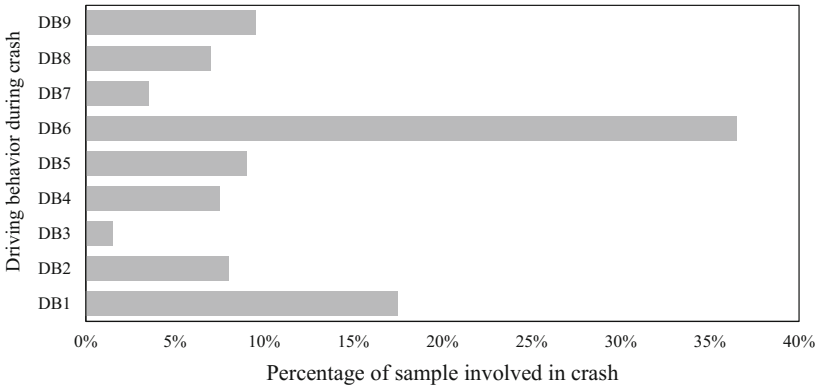

Fig. 2. Driving behavior of participants at the time of their most recent crash

Severity of Crash. The majority of the participants (94%) involved in the crash reported no injury to the driver and the passengers (see Table 3). Only 6% reported slight injury; whereas, none of them reported any severe or fatal injury. Likewise, high car damage was incurred by only a small percentage (6.9%) compared to low car damage sustained by the majority of them.

Table 3. Summary of severity of crashes

Injury	No injury	94.0%
	Slight injury	6.0%
Car damage	Low	72.7%
	Moderate	20.4%
	High	6.9%

4 Results and Discussion

4.1 Driving Behavior Versus Gender

This section uses a non-parametric test called Wilcoxon test. The purpose is to test the difference in terms of seatbelt usage and speeding between two groups: male and female. In this study, we examined the null hypothesis H_0: The two samples follow the same distribution versus H_1: The distributions of the two samples are different. However, the two hypotheses were tested using the Minitab software at level of significance $\alpha = 0.05$. The next sections were dedicated to understand the relationship between the human features, age and gender, and the rate of how frequently the the participants practice the corresponding list of risky driving behaviors.

Not Wearing Car Seatbelt. After applying the Wilcoxon test, the result showed that the p-value is <0.001. Since the computed p-value is lower than the significance level $\alpha = 0.05$, one should reject the null hypothesis H_0, and accept the alternative hypothesis H_1. This shows that there is a significant difference between males and females in terms of car seatbelt usage. Moreover, the mean and standard deviation of the two groups were calculated in order to extract which group wears the car seatbelt more frequent. The male group has higher mean showing that they wear the seatbelt less often than females. The values are shown in Table 4.

Table 4. Seatbelt usage according to gender

Gender	Mean	Std. deviation
Male	2.728	1.062
Female	2.429	0.872

Exceeding the Speed Limit. The results of the Wilcoxon showed that the p-value is <0.001. This reveals that males and females significantly behave differently in terms of exceeding the speed limit. Here as well, the mean of the two groups show that males have higher value illustrating that males exceed the speed limit more often than females. See Table 5 for details.

Table 5. Speeding according to gender

Gender	Mean	Std. deviation
Male	1.870	1.265
Female	1.690	1.190

4.2 Driving Behavior Versus Age

This section uses a test called Kruskal-Wallis test, which is also a non-parametric test. The test will verify if the four age groups behave similarly or differently in terms of seatbelt usage and exceeding the speed limit. We examined the null hypothesis H_0: The two samples follow the same distribution versus H_1: The distributions of the two samples are different. The two hypotheses were examined using the Minitab software at level of significance $\alpha = 0.05$.

Not Wearing Car Seatbelt. The results of the Kruskal-Wallis test provided a *p*-value that is <0.001. According to the level of significance, the null hypothesis will be rejected. This concludes that there is a significant difference between the four age groups in terms of seatbelt usage. From the mean calculations, it can be observed that the age group between 23 and 30 years do not wear the car seatbelt more often than the other age groups. Table 6 shows each group with their corresponding mean and standard deviation.

Table 6. Seatbelt usage according to age

Age	Mean	Std. deviation
18–22	1.642	1.188
23–30	2.127	1.376
31–45	1.870	1.207
46–65	1.237	0.820

Exceeding the Speed Limit. Likewise, the Kruskal-Wallis test gives a *p*-value that is <0.001. It is noted that the difference between the four age groups is significant according to the significance level. Table 7 shows the calculated mean and standard deviation for all age groups. The age group that is between 23 and 30 has the highest mean showing that this age group usually exceeds the speed limits more than the other groups.

Table 7. Speeding according to age

Age	Mean	Std. deviation
18–22	2.617	1.046
23–30	2.804	1.005
31–45	2.403	0.936
46–65	1.921	0.712

4.3 Correlation Analysis: Driving Behavior Versus Injury Severity

Pearson Correlation is used to identify the interrelationship between the severity of an injury caused by a car crash and the different driving behaviors that existed during the crash. The results of the correlation test are shown in Table 8. However, the results obtained from the correlation test show that DB2 and DB1 have the highest values. This proves that seatbelt usage and speeding are the two behaviors that mostly affect the type of injury that can occur to a driver.

Table 8. Correlation between injury severity and driving behaviors

Variables	DB1	DB2	DB3	DB4	DB5	DB6	DB7	DB8	DB9
Injury severity	0.064	0.097	−0.035	0.012	−0.004	0.045	−0.054	0.018	0.075

It is also clear from the results that although DB2 and DB1 have the highest values; their values are still small and not close to 1. This is according to the responses obtained where all crashes were either a crash with no injury or a crash with a slight injury.

4.4 Correlation Analysis: Driving Behavior Versus Car Damage Severity

The interrelationship between the severity of car damage caused by a car crash and the driving behavior that was done during the crash was also tested using *Pearson Correlation*. In this analysis, DB1 was removed because obviously, seatbelt usage has no relation with the car damage severity. Meanwhile, DB2 shows the highest value among all other behaviors. The value represents that the higher the speed, the more severe the car damage. See Table 9 for the summary of the correlation.

Table 9. Correlation between car damage severity and driving behaviors

Variables	DB2	DB3	DB4	DB5	DB6	DB7	DB8	DB9
Car damage severity	0.233	−0.078	−0.063	0.032	−0.139	0.034	0.049	0.086

5 Implications and Conclusion

This study investigates the effect of human characteristics on several driving behaviors that are familiar to most drivers. The analysis of the survey results mainly focused on two famous driving behaviors, which are seatbelt usage and speeding.

The survey results suggest that majority of the drivers in the Qatar University sample were young (18–22 years), had less than 2 years of driving experience in Qatar, and drove 1–2 h per day. Although the sample had almost equal number of males and females, males were found to be reporting more accidents than females with the age group 23–30 being the most vulnerable. On a positive note, the majority of them were involved in no injury and low car damage crashes. In addition, most of them were

rarely practicing unsafe driving behaviors. However, at the time of the reported crashes, most of them were either driving too closely to the vehicle in front, not wearing Seatbelts, or reading/sending text messages/emails. In addition, a small percentage of the sample were found to be always or often involved in unsafe driving practices.

The study concluded that male drivers speed more and wear seatbelt less than female drivers. The other part of the study focused on the effect of several driving behaviors on the injury severity and the car damage severity caused by a car crash. The results analysis revealed that seatbelt usage and speeding have an interrelationship with the injury severity among all other behaviors. Meanwhile, the severity of car damage had the highest interrelationship with speeding.

References

1. DeJoy, D.: Gender differences in traffic accident risk perception. Proc. Hum. Factors Ergon. Soc. Annu. Meet. **34**(14), 1032–1036 (1990). http://dx.doi.org/10.1177/154193129003401416
2. Harré, N., Field, J., Kirkwood, B.: Gender differences and areas of common concern in the driving behaviors and attitudes of adolescents. J. Safe. Res. **27**(3), 163–173 (1996). http://dx.doi.org/10.1016/0022-4375(96)00013-8
3. Özkan, T., Lajunen, T.: What causes the differences in driving between young men and women? The effects of gender roles and sex on young drivers' driving behaviour and self-assessment of skills. Transp. Res. Part F Traffic Psychol. Behav. **9**(4), 269–277 (2006). http://dx.doi.org/10.1016/j.trf.2006.01.005
4. Jiménez-Mejías, E., Prieto, C., Martínez-Ruiz, V., Castillo, J., Lardelli-Claret, P., Jiménez-Moleón, J.: Gender-related differences in distances traveled, driving behaviour and traffic accidents among university students. Transp. Res. Part F Traffic Psychol. Behav. **27**, 81–89 (2014). http://dx.doi.org/10.1016/j.trf.2014.09.008
5. Rhodes, N., Pivik, K.: Age and gender differences in risky driving: the roles of positive affect and risk perception. Accid. Anal. Prev. **43**(3), 923–931 (2011). http://dx.doi.org/10.1016/j.aap.2010.11.015
6. Classen, S., Wang, Y., Crizzle, A., Winter, S., Lanford, D.: Gender differences among older drivers in a comprehensive driving evaluation. Accid. Anal. Prev. **61**, 146–152 (2013). http://dx.doi.org/10.1016/j.aap.2012.10.010
7. Cordellieri, P., Baralla, F., Ferlazzo, F., Sgalla, R., Piccardi, L., Giannini, A.: Gender effects in young road users on road safety attitudes, behaviors and risk perception. Front. Psychol. **7** (2016). http://dx.doi.org/10.3389/fpsyg.2016.01412
8. Tao, D., Zhang, R., Qu, X.: The role of personality traits and driving experience in self-reported risky driving behaviors and accident risk among Chinese drivers. Accid. Anal. Prev. **99**, 228–235 (2017). http://dx.doi.org/10.1016/j.aap.2016.12.009
9. Barr, G., Kane, K., Barraco, R., Rayburg, T., Demers, L., Kraus, C., et al.: Gender differences in perceptions and self-reported driving behaviors among teenagers. J. Emergency Med. **48**(3), 366.e3–370.e3 (2015). http://dx.doi.org/10.1016/j.jemermed.2014.09.055
10. Welsh, R., Lenard, J.: Male and female car drivers - difference in collision and injury risks. In: Proceedings of the 45th Annual AAAM Conference, 24–26 September, Texas (2001)
11. Lonczak, H., Neighbors, C., Donovan, D.: Predicting risky and angry driving as a function of gender. Accid. Anal. Prev. **39**(3), 536–545 (2007). http://dx.doi.org/10.1016/j.aap.2006.09.010