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Are Professional Drivers more Aggressive than General Drivers? A Case Study from Doha, Qatar

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Abstract

Previous studies have revealed that aggressive and reckless driving can largely affect the occurrence and severity of road crashes. There could be intentional aggressive and unsafe acts, which could significantly affect the safety of all road users. The size of the vehicle and the type of the driver might affect such intentional aggressive and unsafe acts. This study evaluates the aggressive driving behaviors committed by drivers based on the vehicle size and driver type using the data collected from video recordings collected at two intersections in Doha, Qatar. This observational study acquired 743 vehicle observations during the green, yellow and red phases. Results revealed that professional, e.g., heavy vehicle, taxi, bus, and truck, drivers, tend to behave more aggressively compared to general, i.e., sedan and SUV, drivers. Further, the tendency of committing a violation increases with the vehicle size. These findings suggest that aggressive driving behaviors, which can pose a significant safety risk, require interventions such as increased police enforcement, traffic safety campaigns, and improved pavement markings. Moreover, the outcome of this research will be useful for the authorities to understand the relationship between the behavior of professional and heavy vehicle drivers and traffic safety. In addition, policymakers may use such information to establish new fines or update existing schemes.

Keywords: Driver behavior; aggressive driving; traffic violations; safety; driver compliance

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1. Introduction

Injuries due to road crashes are one of the top ten causes of death worldwide [1]. The global status report on road safety published by the World Health Organization specified that road traffic crashes accounted for 1.35 million deaths worldwide in the year 2016 and traffic crashes are the leading cause of death for people in the age group 5-29 [2]. Although the traffic fatalities in Qatar are declining due to the implementation of various measures [3, 4, 5], road traffic injuries are still the major cause of premature death in Qatar [6, 7]. In the state of Qatar, 168 and 683 traffic-related deaths and serious injuries were recorded respectively [4, 5] in 2018. One key goal of the State of Qatar's National Road Safety Strategy (NRSS) is to reduce these numbers even further, with the goal of reaching 130 deaths by 2022.

Although there could be many causes for traffic crashes and severity, driver behavior and driver errors can be identified as the leading cause for the occurrence of crashes. Previous studies have identified that aggressive driving [8, 9, 10], drunk driving [11, 12], and reckless driving [13, 14] can largely affect the occurrence and severity of road crashes. A study conducted in Saudi Arabia concluded that aggressive driving behaviors and speeding could have a significant impact on the likelihood of being involved in an accident [15]. As described in Ma et al. [16] the level of injury at highway and rail grade crossings for young male drivers increased significantly when they drove aggressively.

Driver behavior has been identified as an important factor in preventing road crashes and improving road safety. While it has been proven that human factors, road environment, and vehicle faults are the three main variables in a road crash, driver behavior has been identified as the critical contributing by around 95 percent of total road crashes [17]. Lajunen and Parker [18] studied driver traits, self-reported general aggressiveness, and aggressive driving. This study explained that the aggression was positively correlated with the driver age in men, and annual miles was negatively correlated with aggression in women. Shinar and Compton [19] looked into three types of behavior that are usually referred to as "aggressive driving," including cutting across one or more lanes in front of other vehicles, honking, and passing on the shoulders. The authors found that because men are less motivated to obey traffic laws than women, they are more prone to engage in violent behavior. Björklund [20] also pointed out that male drivers are more likely to act aggressively as compared to female drivers. Aggressive driving proved to be inversely correlated with age, with drivers 45 and older being less likely to drive aggressively than younger drivers [19]. Kaiser et al. [21] also stated that young Australian drivers between the ages of 18 and 24 tend to be more aggressive. Paleti et al. [22] studied the association between aggressive driving behaviors and the injury severity of drivers. They explained that female and older drivers are less likely to display aggressive driving behaviors than male and younger drivers. Sarwar et al. [23] studied the perceived and observed aggressive driving behaviors using the data collected through a driving simulator study and observed that experienced drivers who had the driving license for six or more years showed less aggressive behaviors.

In Qatar, a study by Shaaban et al. [24] investigated driver compliance at minor-street stop-controlled crossings. Many factors such as age, gender, vehicle type, presence of an approaching vehicle or a pedestrian during peak and nonpeak hours at residential and commercial land could affect driver behavior near the stop sign. The findings revealed an extremely low rate of compliance with minor-street stop signals. In addition, male, young, and SUV drivers are less likely to come to a complete stop at these places. Liu et al. [25] investigated the effects of an encountered yellow phase on the decisions of 1,123 drivers at six different intersections. Based on their decisions to stop or pass and distances to the stop line, the drivers were classified into three categories: aggressive, conservative, and normal.

All these previous studies have tackled different aspects of aggressive driving. Although the characteristics of the drivers, i.e., age, gender, etc., have been considered, the category of the drivers has not been studied in detail. In addition, classifications of aggressive behaviors are different in different studies. The main objective of this study is to formulate a behavioral model that takes into account the vehicle size and the type of the driver and correlate it with the aggressive driving behaviors committed by drivers using observational study. To the best of the authors' knowledge, this is the first time that 12 aggressive behaviors have been studied and analyzed together at signalized intersections during the green, yellow, and red phases.

This paper is structured as follows: Descriptions of the two selected sites, the list of considered aggressive behaviors, and the analysis methods are presented in Section 2. This is followed by Section 3 that discusses the results. Finally, conclusions and recommendations for further research are presented.

2. Methodology

2.1. Site description

This research is based on the data on aggressive and risky driving behaviors extracted from video recordings taken at two intersections in Doha, Qatar. The videos have been collected during the daytimes of several weekdays in March and April 2017. In total, 96 video recordings collected at two locations were used to extract data on aggressive and risky driving behaviors. Each video recording was approximately 13 minutes long. Fig. 1 shows snapshots taken at the studied two intersections during the video playbacks.
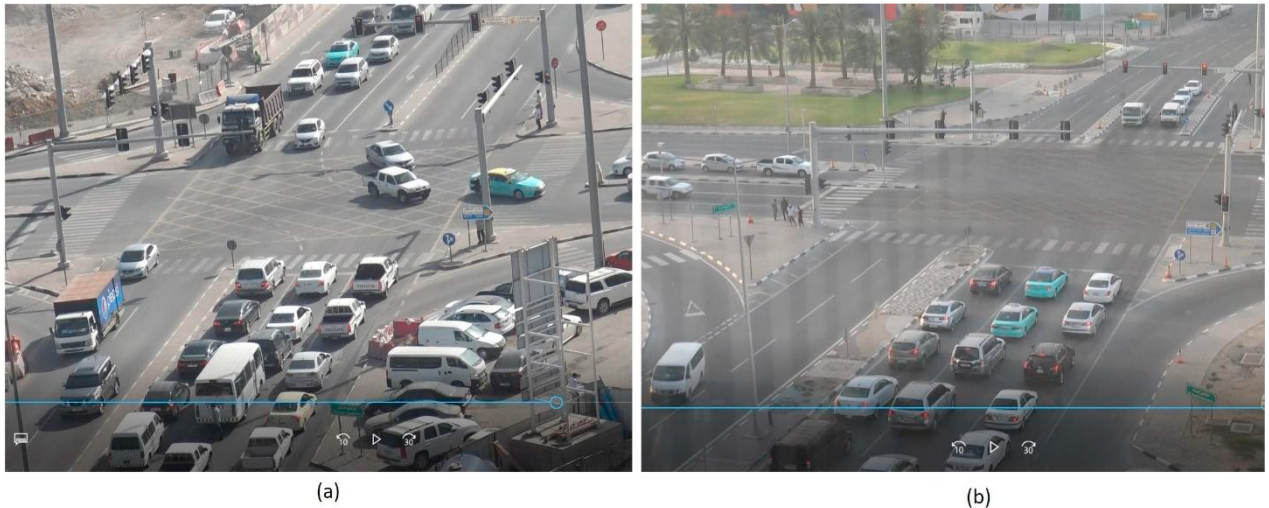

(a)

(b)

Fig. 1. Intersections considered in the study; (a) Sana intersection; (b) Al-Meena intersection.

The speed limits for the roads of both sites were 80 km/h. Both sites were characterized by relatively shorter green times compared to longer red times. Based on the video recordings, average green and red times for the Sana intersection were approximately 42 s and 150 s, respectively. For the Al-Meena intersection, average green and red times were roughly 25 s and 220 s, respectively.

2.2. Data extraction

The data were extracted for the intersection approach shown in Fig. 1. Traffic signals were visible for the approaches in videos of both sites. Each signal cycle of all videos was carefully observed and aggressive behaviors were manually extracted for different vehicle types, i.e., sedans, SUVs, professional (e.g., taxi, 6-seater vans), and heavy vehicles (e.g., trucks, trailers, busses). In total, 12 types of aggressive behaviors were considered in this study as follows:

- Harsh acceleration at the onset of green
- Cut-in (forced lane change)
- Changing lanes during departure
- Speeding during flashing green/ yellow/ red
- Not keeping safe distance
- Stop beyond the stop line
- Stop on the yellow square
- Changing lanes during stopping
- Driver crossing stop line and then coming back

- Harsh breaking
- Driving over curbs/median
- Did not give priority to pedestrians

In addition to the aggressive behaviors, traffic volumes and signal timings (green, red, yellow times) were also collected for each signal cycle. The traffic volume data were used to estimate the percentage of vehicles in each category (sedans, SUVs, professional vehicles, heavy vehicles) that show aggressive behaviors during each signal cycle.

2.3. Data analysis

Initially, descriptive analyses were performed to identify the relationship (if available) between vehicle size, driver type, and different types of aggressive behaviors. ANOVA test was performed to compare the aggressive behaviors committed by different sized vehicles and different types of drivers. Further, the post-hoc analysis was performed using Kolmogorov-Smirnov test. In addition, Chi-squared test was performed to explore the overall association between vehicle type and aggressive behaviors.

3. Results and discussion

3.1. Summary of aggressive behaviors

Fig. 2 shows the pie charts for the different aggressive behaviors that were obtained after a thorough examination of the videos.
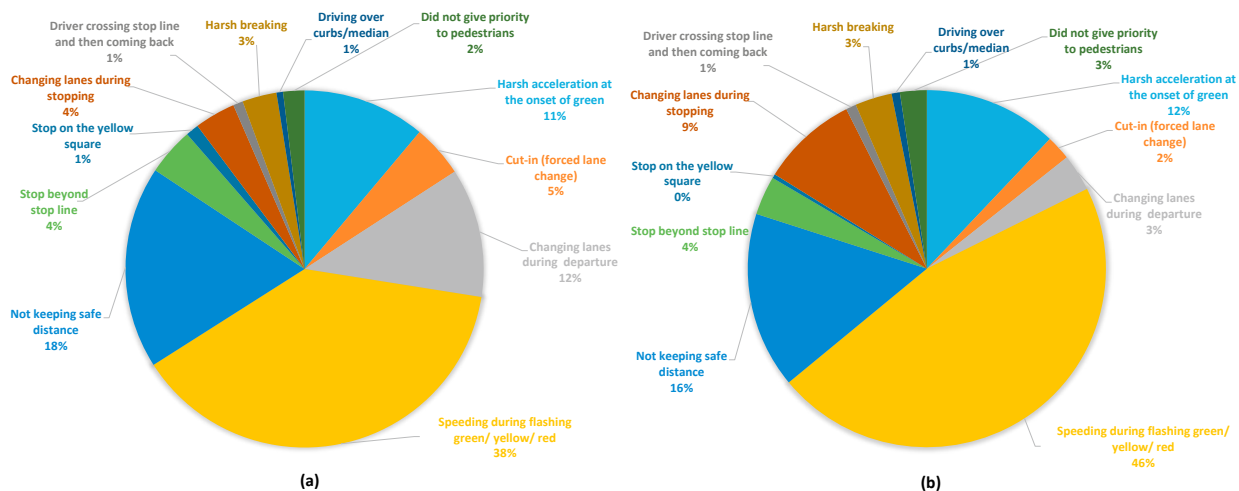

Fig. 2. Summary of violations and unsafe behaviors at (a) Sana intersection; (b) Al-Meena intersection.

For both sites, the most frequent aggressive act was 'speed during flashing green/ yellow/ red' followed by 'not keeping safe distance'. For Sana intersection, 'changing lanes during departure' and 'harsh acceleration at the onset of green' were also frequently observed aggressive behaviors. Whereas, for Al-Meena intersection, 'harsh acceleration at the onset of green' and 'changing lanes during stopping' were also quite commonly observed.

The figure clearly shows that around 80% of the aggressive driving behavior are mainly due to four top different behavior at both intersections. Speeding during flashing green/yellow/red, not keeping safe distance, changing lanes during departure and harsh acceleration at the onset green constitute 79% of the wrong behaviors at Sana intersections. Whereas at Al-Meena intersection, speeding during flashing green/yellow/red, not keeping safe distance, harsh acceleration at the onset green, and changing lanes during stopping constitute 83% of the aggressive behavior. It is

worth mentioning here that the intersection geometry has a direct impact on some behavior such as changing lanes during stopping. Drivers at Al-Meena intersection tend to commit this type of behavior more than the drivers at Sana intersections because the first intersection has only one dedicated lane for the through movement and on the contrary, the second intersection has two dedicated lanes.

Proportions of vehicles showing the key five aggressive behaviors, which were commonly observed for both intersections, are plotted in Figure 3 for different vehicle categories. Although the proportion of heavy vehicles that display aggressive behaviors are higher in general, some aggressive behaviors, e.g., changing lanes during stopping and changing lanes during departure, are not frequently observed for this vehicle category. This is mainly because of the large size of the vehicle, which makes it difficult to maneuver. It is also worth noting that, for the five primary forms of aggressive behaviors, the proportions of vehicles driven aggressively by professional drivers are higher than those for general drivers.
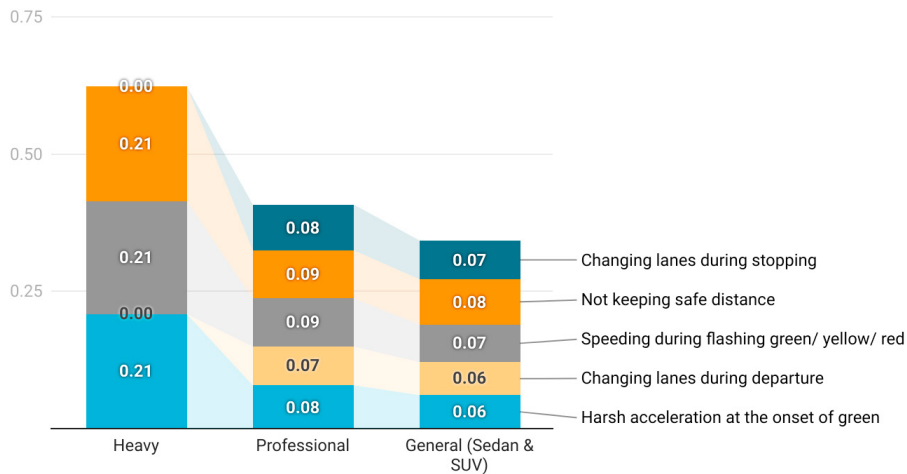

Fig. 3. Proportions of vehicles displaying the five main aggressive behaviors.

3.2. Aggressive and risky driving behaviors based on driver type

For this analysis, sedans and SUVs were considered as one category named as general drivers, i.e., those who drive for general purposes. As mentioned earlier, professional drivers consisted of the drivers of taxis, pick-ups, and 6-seater vans. Fig. 4 shows the percentage of drivers who engage in aggressive behaviors grouped by driver category. As illustrated, heavy vehicle drivers tend to behave more aggressively as compared to other types of drivers. Overall heavy vehicle drivers showed a higher mean proportion (29.16%) of aggressive behaviors per signal cycle compared to 10.53% and 4.11% for professional and general (Sedan and SUV together) drivers, respectively. The results of Chi-squared test showed that there was a significant difference between the number of aggressive behaviors between general, professional, and heavy vehicle drivers ($\chi2$=77.834, df=2, p<0.001) with later having the highest proportion (21%) of drivers showing aggressive behaviors. ANOVA test was conducted to see if the differences in aggressive behavior are significant in each cycle for different driver types. The results showed statistically different percentage of drivers showing aggressive behavior (K-W=219.536, df=2, p<0.001). The results of post-hoc tests confirmed statistically significant difference between mean percentage of general and heavy vehicle drivers undertaking aggressive behaviors (Z=7.056, p=0.001), general and professional drivers (Z=8.258, p=0.001), and professional and heavy vehicle drivers (Z=4.215, p=0.001).
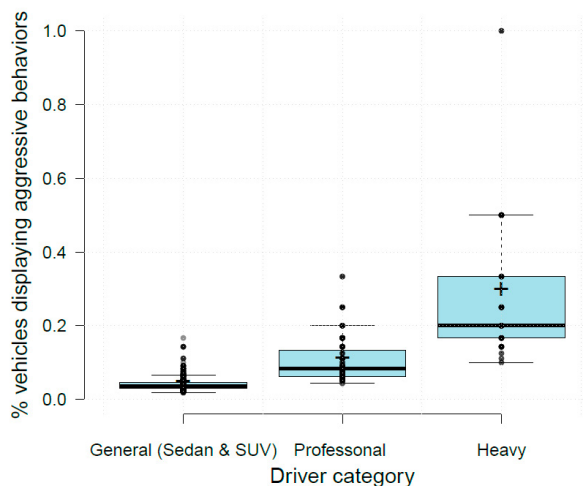
Fig. 4. Boxplot of the percentage of vehicles displaying aggressive behaviors based on the driver type ("+" represents the sample mean; whiskers are based on Tukey's definition, i.e., 1.5 × Inter-quartile-range from 1st and 3rd quartiles or the maximum/minimum point).

Several previous studies have also highlighted that pick-up drivers and taxi drivers are most likely to behave aggressively [22, 26]. Findings of the current study are in line with such previous studies.

It should be noted that in addition to taxis, pick-ups and 6-seater vans were also categorized as professional vehicles in this study as they are driven by professional drivers to transport workers and staff. Future studies may consider such different vehicle types separately to better understand the relationship between different driver categories and aggressive behaviors.

3.3. Aggressive and risky driving behaviors based on vehicle size

In this analysis, sedans and SUVs were considered as two different categories based on the size of the vehicles. Professional vehicles (taxis, pick-ups, vans) were not included in the analysis. Fig. 5 presents the percentage of drivers showing aggressive behaviors based on the size of the vehicle.
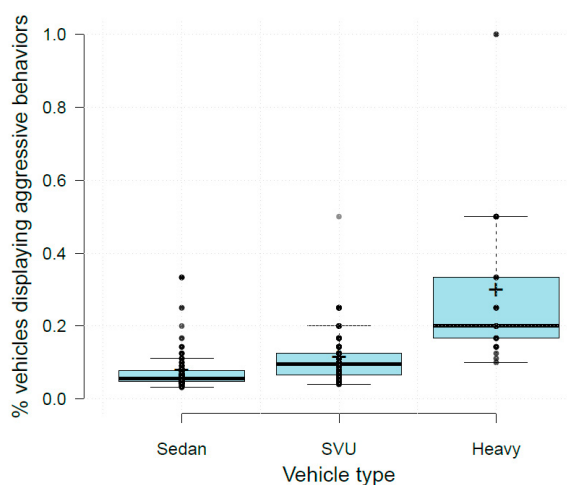

Fig. 5. Boxplot of the percentage of vehicles displaying aggressive behaviors based on the vehicle category and size ("+" represents the sample mean; whiskers are based on Tukey's definition, i.e., 1.5 × Inter-quartile-range from 1st and 3rd quartiles or the maximum/minimum point).

As can be understood from this figure, the likelihood of displaying aggressive behavior increases with the size of the vehicle. Paleti et al. [22] also explained that young adult drivers, who drive SUVs, tend to drive more aggressively than sedan drivers and that is consistent with the findings of this study. Thomas and Walton [27] explained that drivers' perception of safety is directly linked with vehicle size. That is, the drivers of smaller vehicles, e.g., sedans, tend to behave conservatively and less aggressively as compared to the drivers of bigger vehicles, e.g., trucks.

The results of Chi-squared test showed that there was a significant difference between the number of aggressive behaviors and vehicle type, classified based on the size as Sedan, SUV, and Heavy vehicles ($\chi 2$=98.565, df= 2, p<0.001) with later having the highest proportion (21%) of aggressive behaviors. Further, the ANOVA test that was conducted to assess differences in the percentage of vehicles showing aggressive behavior and vehicle type showed statistically significant differences (K-W=219.536, df=2, p<0.001). In addition, the post-hoc tests revealed statistically significant differences between mean percentages of aggressive behaviors for Sedan and SUV vehicles (Z=5.154, p=0.001), Sedan and Heavy vehicles (Z=6.058, p=0.001), and SVU and heavy vehicles (Z=4.397, p=0.001). The mean proportion of Sedan, SUV, and heavy vehicles exhibiting aggressive behaviors per cycle was 7.08%, 10.82%, and 29.16%, respectively.

4. Conclusions

Aggressive driving behaviors have been identified as a key cause for the occurrence and severity of crashes. This study investigated the aggressive driving behaviors at signalized intersections in terms of vehicle size and driver type using the video data collected at two signalized intersections in Doha, Qatar. Results indicated that speeding during flashing green/yellow/red, not keeping safe distance, and harsh acceleration at the onset green constitute were the most commonly observed aggressive behaviors at both intersections.

Outcomes of this study further revealed that not only the type of driver but also the type of vehicle have an influence on aggressive and unsafe driving behaviors. In particular, professional drivers (taxi, pick-up, and van) tend to behave more aggressively as compared to general drivers (sedan and SUV) and heavy vehicle (e.g., truck, bus) drivers tend to behave more aggressively as compared to lighter vehicle types. Further, the likelihood of displaying aggressive behavior could increase with the size of the vehicle. In addition, it was identified that the intersection geometry may affect driver behavior such as lane changes while stopping.

Moreover, the findings of this study could be useful to understand the common types of aggressive behaviors at signalized intersections by different types of drivers in terms of the driver as well as vehicle categories. Based on such understanding, countermeasures, e.g., police enforcement, better geometric designs for intersections, driver training and awareness campaigns, could be proposed to mitigate aggressive behaviors.

This study considered 12 possible aggressive behaviors that can be observed at signalized intersections together. Different driver categories and vehicle types might display different aggressive behaviors. Therefore, future studies may study the aggressive behaviors separately. Further, this study used the video data collected only at two intersections. Aggressive behaviors could be different for different geometrical settings, e.g., lane configurations, traffic volumes, signal settings, etc., Therefore, such factors should also be considered in future studies.

Acknowledgements

References

[1]   World Health Organization, The top 10 causes of death, https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death, Accessed on 10th November 2019.

[2]   World Health Organization, 2018, Global status report on road safety 2018, https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/ , Accessed on 10th November 2019.

[3]   Qatar records sharp decline in road deaths, https://www.gulf-times.com/story/621810/Qatar-records-sharp-decline-in-road-deaths, Gulf Times, Accessed on 10th of November, 2019.

[4]   National Road Safety Strategy 2013-2022, Ashghal, http://www.ashghal.gov.qa/en/Services/Lists/ServicesLibrary/NRSS_Eng.pdf, Accessed on 10th November, 2019.

[5]   Traffic death rate in Qatar falls below global average, https://thepeninsulaqatar.com/article/11/02/2019/Traffic-death-rate-in-Qatar-falls-below-global-average, The Peninsula, Accessed on 10th November 2019.

[6]   Road Safety – Ministry of Public Health, https://phs.moph.gov.qa/data/road-safety/, Accessed on 10th November 2019.

[7]   GBD PROFILE: QATAR, http://www.healthdata.org/sites/default/files/files/country_profiles/GBD/ihme_gbd_country_report_qatar.pdf, Accessed on 10th November 2019.

[8]   AAA Foundation for Traffic Safety, 2009. Aggressive Driving: Research Update. AAA Foundation for Traffic Safety, Washington, http://www.aaafoundation.org/pdf/AggressiveDrivingResearchUpdate2009.pdf, Accessed on 10th November 2019.

[9]   Paleti, R., Eluru, N. and Bhat, C.R., 2010. Examining the influence of aggressive driving behavior on driver injury severity in traffic crashes. Accident Analysis & Prevention, 42(6), pp.1839-1854.

[10]   Tasca, L., 2000. A review of the literature on aggressive driving research. Aggressive Driving Issues Conference, Sponsored by the Ministry of Transportation of Ontario, Canada, in cooperation with the Transportation Research Board. Available at: http://www.aggressive.drivers.com/papers/tasca/tasca.pdf, Accessed on 10th November 2019.

[11]   Taylor, C. and Kleinke, C.L., 1992. Effects of Severity of Accident, History of Drunk Driving, Intent, and Remorse on Judgments of a Drunk Driver. Journal of Applied Social Psychology, 22(21), pp.1641-1655.

[12]   Hubicka, B., Laurell, H. and Bergman, H., 2010. Psychosocial characteristics of drunk drivers assessed by the Addiction Severity Index, prediction of relapse. Scandinavian journal of public health, 38(1), pp.71-77.

[13]   Arnett, J.J., Offer, D. and Fine, M.A., 1997. Reckless driving in adolescence:'State'and 'trait'factors. Accident Analysis & Prevention, 29(1), pp.57-63.

[14]   Yang, B.M. and Kim, J., 2003. Road traffic accidents and policy interventions in Korea. Injury control and safety promotion, 10(1-2), pp.89-94.

[15]   Mohamed, M., & Bromfield, N. F. (2017). Attitudes, driving behavior, and accident involvement among young male drivers in Saudi Arabia. Transportation research part F: traffic psychology and behaviour, 47, 59-71.

[16]   Ma, C., Hao, W., Xiang, W., & Yan, W. (2018). The impact of aggressive driving behavior on driver-injury severity at highway-rail grade crossings accidents. Journal of Advanced Transportation, 2018.

[17]   Singh, S. (2015). Critical reasons for crashes investigated in the national motor vehicle crash causation survey (No. DOT HS 812 115).

[18]   Lajunen, T., & Parker, D. (2001). Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving. Accident Analysis & Prevention, 33(2), 243-255.

[19]   Shinar, D., & Compton, R. (2004). Aggressive driving: an observational study of driver, vehicle, and situational variables. Accident analysis & prevention, 36(3), 429-437.

[20]   Björklund, G. M. (2008). Driver irritation and aggressive behaviour. Accident Analysis & Prevention, 40(3), 1069-1077.

[21]   Kaiser, S., Furian, G., & Schlembach, C. (2016). Aggressive behaviour in road traffic–findings from Austria. Transportation research procedia, 14, 4384-4392.

[22]   Paleti, R., Eluru, N., & Bhat, C. R. (2010). Examining the influence of aggressive driving behavior on driver injury severity in traffic crashes. Accident Analysis & Prevention, 42(6), 1839-1854.

[23]   Sarwar, M. T., Anastasopoulos, P. C., Golshani, N., & Hulme, K. F. (2017). Grouped random parameters bivariate probit analysis of perceived and observed aggressive driving behavior: a driving simulation study. Analytic methods in accident research, 13, 52-64.

[24]   Shaaban, K., Wood, J. S., & Gayah, V. V. (2017). Investigating driver behavior at minor-street stop-controlled intersections in Qatar. Transportation research record, 2663(1), 109-116.

[25]   Liu, Y., Chang, G. L., & Yu, J. (2012). Empirical study of driver responses during the yellow signal phase at six Maryland intersections. Journal of transportation engineering, 138(1), 31-42.

[26]   Zahid, M., Chen, Y., Khan, S., Jamal, A., Ijaz, M., & Ahmed, T. (2020). Predicting risky and aggressive driving behavior among taxi drivers: do spatio-temporal attributes matter?. International journal of environmental research and public health, 17(11), 3937.

[27]   Thomas, J. A., & Walton, D. (2008). Vehicle size and driver perceptions of safety. International Journal of Sustainable Transportation, 2(4), 260-273.