Road Traffic Crashes

Subjects: Engineering, Civil | Transportation | Transportation Science & Technology
Contributor: Md. Kamrul Islam, Uneb Gazder, Rocksana Akter, Md. Arifuzzaman

Road traffic crashes (RTCs) are a major problem for authorities and governments worldwide. They incur losses of property, human lives, and productivity. 20 to 50 million people are injured in RTCs every year. The involvement of teenage drivers and road users is alarmingly prevalent in RTCs since traffic injuries unduly impact the working-age group (15–44 years).

Keywords: road traffic crashes ; CART models ; age group

1. Introduction

Road traffic crashes (RTCs) are a source of concern for authorities and governments all over the world. This is because they contribute to losses, both in terms of property and in terms of human lives and productivity [1]. They were reported to be the eighth leading cause of death for all ages in the last decade [2]. In addition, 20 to 50 million people are injured in RTCs every year [3]. This trend has been increasing in recent years, especially in developing countries, and is predicted to continue to increase if appropriate measures are not taken [4]. RTCs are the leading cause of death for young people, accounting for 1.24 million deaths each year [5][6]. Approximately 85 percent of these annual deaths occur in developing countries. The data led researchers to the conclusion that there is one RTC-related death every 4 min and one RTC every minute. Countries spend 1 to 2% of their total national product on dealing with RTCs [5]. Despite the fact that developing countries account for only 52 percent of all vehicles on the road, they account for 80 percent of all road traffic deaths [7]. Pedestrians, passengers, and cyclists account for nearly 90% of road traffic fatalities in developing nations, where most injuries occur in metropolitan areas, and pedestrians in cities account for 55–70 percent of deaths [8][9]. Pedestrian injury rates have been linked to gender, age, population, density, current demographic composition, unemployment, traffic flow, education, and other characteristics, according to a study conducted by La Scala et al. [10]. Mungnimit and Bener [11][12] concluded that reckless driving was the top cause of traffic crashes in Thailand and Qatar in comparable research on the sequence of road traffic incidents and their causes (71%). The bulk of crash casualties (53%) were from society's most productive stratum, those aged 10 to 40. Furthermore, age was a significant influence in all vehicle deaths, accounting for around half of all fatalities [13]. According to the World Health Organization's Global Status Report on Road Safety 2018, issued in December 2018, the number of yearly road traffic deaths has increased to 1.35 million, and road traffic injuries have become the leading cause of death among those aged 5 to 29 years [14].

One of the alarming commonalities in RTCs is the high involvement of young drivers and road users in different countries [15][16]. In developing countries, road traffic injuries disproportionately affect the productive (working) age group (15–44 years) and children. In 1998, the productive age group accounted for 51% of fatalities and 59% of disability-adjusted life years due to road traffic injuries worldwide [17].

Workers below the age of 30 are considered to be healthier and more mobile than those above 30. Workers above the age of 30 become leaders of their families and attain key positions in their organizations. Moreover, their productivity increases till the age of 50 [18]. When the age group and RTC data have been compared, it was found that 55 percent of road traffic crash victims were between the ages of 25 and 65, while the remaining 45 percent of RTC victims were between the ages of 16 and 24 [7]. Moreover, young adults and children are the ones on which the future of a country depends. Evidence has shown that age is a significant factor affecting the involvement of road users in RTCs, with a higher proportion of younger victims [19], which has significant consequences on the future growth and development of a nation due to the reasons mentioned above. Furthermore, RTCs have been a prime cause of death among children and teenagers. Useche et al. [20] attributed this trend to the risky behavior of road users from the young age category.

2. Road Traffic Crashes

There is a body of research pertaining to RTCs that has been carried out to investigate and mitigate the factors related to RTCs. Experts in this field have focused on different aspects related to RTCs, including causal factors [21], severity

analysis [22], and specific road users [23]. RTCs are caused by a variety of factors, including human driver error, vehicle characteristics, and traffic infrastructures, such as engineering design, road maintenance, and traffic regulation [24]. Driver attitude, including road courtesy and behavior; driving while under the influence of drugs, particularly alcohol; gender; seat belt use; and driver age (teenage drivers and elderly drivers) are among the recognized human factors associated with RTCs [24][25]. Touahmia (2018) [26] found that human factors are the prime cause of RTCs in Saudi Arabia, with 67% involvement. Among them, speed limits and seatbelt violations have been commonly reported among drivers involved in these traffic crashes.

There is a significant body of research that has been conducted to explore different aspects of driving behavior of young aged drivers around the world. Jonah [27] examined the evidence for the hypotheses that young (16–25) drivers were (a) more likely than older drivers to be involved in a fatal crash and (b) that this increased risk was mostly due to their proclivity to take risks when driving. Even after correcting for differences in the quantity and quality of road travel and driving experience, epidemiological studies have supported the first theory. Observational and self-report studies of driving behavior have supported the second hypothesis.

Doherty et al. [28] studied the situational dangers that young drivers face, particularly in terms of the passenger effect, using data sources provided by the Ontario Ministry of Transportation, Canada, provided in 1988. They estimated crash involvement rates by the number of passengers, time of day, and weekday. In all conditions studied, the crash participation rates of 16–19-year-old drivers were higher than those of 20–24- and 25–59-year-old drivers. However, they were significantly higher on weekends, at night, and with passengers. The effect of the passenger variable on the results is particularly intriguing since, unlike weekends and nights, passengers had a negative impact on total crash rates for 16–19-year-old drivers. This effect was noticeable in both sexes, with crash involvement rates around twice as high with passengers as without. Crash rates for 16–19-year-olds were also significantly higher for two or more passengers as compared with one passenger. Passengers in this age bracket experienced the greatest rates at night.

Chliaoutakis et al. [29] conducted research in Greece to determine and clarify the (possible) link between young drivers' lifestyles and the likelihood of being involved in a traffic crash. Factor analysis and logistic regression analysis were part of the statistical investigation. According to the logistic regression analysis, young drivers with a dominant lifestyle trait of alcohol use or driving without a destination had a higher crash risk, but those with a prominent lifestyle trait of culture had a lower crash risk. Furthermore, young drivers who were religious in some way appeared to be less likely to be involved in a crash.

To assess crash rates, Chen et al. [30] examined data from passenger vehicle crashes involving drivers aged 17–25, from 1997 to 2007, in New South Wales (NSW), Australia. Age, gender, rurality of location, and socioeconomic position were all taken into account when examining crash patterns over time by the severity of driver injury. From 1997 to 2007, the noninjury and fatality rates for young drivers declined by an average of 4% and 5% per year, respectively. From 2001 to 2004, young driver injury rates climbed by roughly 12% before declining. Males' relative collision risk (independent of driver injury) reduced dramatically over time as compared with that of females. Drivers aged 17 and, in particular, 18 to 20 years old had significantly and continuously greater crash risks than drivers aged 21–25 years old throughout the study period.

Al-Hemoud et al. [31] focused on motorists aged from 25 to 35 years old. The researchers wanted to see if there was a link between a man's style of living and his risk of being involved in a car crash. The findings showed that on Kuwait's countrywide public highways, motorists maintained insufficient space between their vehicles and those ahead of them, indicating dangerous driving behavior. Speeding has been found to be the most important predictor of traffic collisions.

Simons-Morton et al. [32] investigated psychological and personality variables of observed speeding among teenage drivers in the metropolitan area of Virginia in the USA. Speeding was linked to greater g-force event rates ($r = 0.335$, $p<0.05$), which increased with time and were predicted by day vs. night excursions, higher sensation seeking, drug use, deviance tolerance, peer pressure sensitivity, and the number of risk-taking friends. The relationship between speeding and risk-taking friends was significantly mediated by perceived danger.

Carpentier [33] studied to see how much of a role young novice drivers' familial environment had in their driving behavior. A group of young rookie drivers (N = 171) aged 17 to 24 years old who had held their permanent (or temporary) driver's license for less than a year took part in an online survey designed and circulated by the Hasselt University, Belgium. The survey asked about the participants' family climate, three socio-cognitive factors (attitude, locus of control, and social norm), and risky driving habits; both the family environment and socio-cognitive variables were predicted to have a direct

impact on hazardous driving. The findings corroborated the significance of the three socio-cognitive variables, as attitude, locus of control, and social norm all strongly predicted self-reported hazardous driving.

Hassan [34] used structural equation modeling (SEM) to investigate the driving behavior of 18- to 24-year-old male Saudi motorists in Riyadh, the capital city of Saudi Arabia. The study looked at the factors that influence the involvement of young Saudi motorists in traffic crashes. The findings revealed that exceeding the stated speed limit was the most common reason for young Saudi motorists receiving traffic penalties (73%). In addition, ”being late” was the leading cause of risky driving (62%).

Ramisetty-Mikler and Almakadma [35] conducted a survey on the attitudes of teenage motorists in Riyadh, as well as their risky driving behavior. Approximately 40% of respondents admitted to engaging in unsafe driving behavior known as “drifting”. A total of 70% of drivers thought of “drifting” as a unique ability or a popular action. It was found that motorists were happy about engaging in risky behavior even though they knew it was dangerous.

According to a study conducted by (Issa) [36] in Tabuk city, Saudi Arabia, motorists under the age of 30 were involved in almost 60% of all RTCs, and more than 80% of all RTCs were caused by human factors. Drivers with advanced driving experience and scholastic achievements were involved in more traffic crashes than drivers without advanced driving and educational expertise.

Mohamed and Bromfield [37] used structural equation modeling (SEM) to investigate the links between road traffic crashes, driving behavior, and underdeveloped male motorists’ views of road traffic safety in the Eastern Province of Saudi Arabia. A total of 287 drivers between the ages of 18 and 24 were included in the study. The findings revealed that the driving behavior of young Saudi male drivers could be divided into three categories: error-making, aggression, and neglect. Aggressive and negligent actions, unlike errors (violations), were both heavily influenced by drivers’ attitudes toward road traffic safety, and both enhanced the probability of road traffic collisions.

Weston and Hellier [38] investigated the impact of peer influence on young drivers. They looked at the link between peer influence vulnerability and unsafe driving behavior among teenage drivers. According to their findings, young drivers who were persuaded by their peers to gain social status and who had peers intervene in their decisions committed more driving offenses.

Zeyin et al. [39] looked at the effect of a safe driving environment among friends on prosocial and aggressive driving behaviors among young Chinese drivers and concluded that traffic locus of control had a moderating function. A total of 352 young Chinese drivers, ranging in age from 18 to 25, volunteered to take part in the study and filled out a questionnaire that included questions about safe driving atmosphere among peers, traffic locus of control, and prosocial and aggressive driving behaviors. Prosocial and aggressive driving habits were directly influenced by the driving atmosphere among friends and the traffic locus of control. A comparative summary of papers on young drivers’ behaviors is shown below in **Table 1**.

Table 1. Comparative summary of papers on young drivers’ behaviors.

References	Focus Group	City/Country	Comments
Brian A. Jonah [27]	**16–25 years**	**Canada**	**Successfully tested two hypotheses: (a) young drivers are more likely to be involved in a fatal crash than older drivers and (b) that this higher risk is mostly due to their tendency to take risks when driving.**
Sean T. Doherty et al. [28]	**16–19 years, 20–24 years, 25–59 years**	**Ontario, Canada**	**Studied the situational dangers that young drivers of different age groups face. Crash rate for the 16–19-year-old age group was higher than other age groups. The rate of traffic crashes was even higher on weekends and nights.**
Joannes El. Chliaoutakis et al. [29]	**18–24 years**	**Greece**	**Investigated the potential relationship between the lifestyle of teenage drivers and their chances of becoming involved in a traffic crash using factor analysis and logistic regression analysis.**
H. Y. Chen et al. [30]	**17–25 years**	**NSW, Australia**	**Examined passenger vehicle crash pattern over time by severity of driver injury considering age, gender, rurality of location, and socioeconomic position. Drives aged 17–20 years had significantly and continuously greater risk than drivers aged 21–25 years old.**
Al-Hemoud et al. [31]	**25–35 years**	**Kuwait**	**Examined the relation between living style and crash risk-taking behavior of drivers.**

References	Focus Group	City/Country	Comments
Bruce G.Simons-Morton et al. [32]	Teen ages	Virginia Metropolitan Area, USA	Investigated psychological and personality variables of observed speeding. The relationship between speeding and risk-taking friends was significantly mediated by perceived danger.
Aline Carpentier [33]	17–24 years	Hasselt, Belgium	Studied the influence of family environment and socio-cognitive elements on driving behavior on young novice drivers; both family environment and socio-cognitive variables were predicted to have a direct impact on hazardous driving.
Hassan [34]	18–24 years	Riyadh, Saudi Arabia	Studied the factors that affect the involvement of young Saudi motorists in traffic crashes, where findings revealed that more than 70% of penalties and 60% of risky driving were due to exceeding the posted speed limit and “being late”, respectively.
Ramisetty-Mikler and Almakadma [35]	Teen age	Riyadh, Saudi Arabia	Conducted a survey on teenage drivers, where it was found that 40% of drivers “drift” cars as an act of adventure despite knowing that it is a hazardous action.
Issa [36]	Below 30 years	Tabuk, Saudi Arabia	Showed that experienced and educated drivers were more involved in RTCs than less experienced and educated drivers.
Mohamed and Bromfield [37]	18–24 years	Eastern Province, Saudi Arabia	Young Saudi male drivers were divided into three categories: (i) error-making, (ii) aggressive, and (iii) negligent.
Lauren Weston and Elizabeth Hellier [38]	Teen age	USA	Studied the relationship between peer influence vulnerability and unsafe driving behavior and suggested peer education tools for safe driving.
Yang Zeyin et al. [39]	18–25 years	China	Investigated the influence of a safe driving environment among friends on prosocial and aggressive driving behavior.

In recent years, there has been an increase in research on RTCs involving vulnerable road users (VRUs). RTCs have been the leading cause of death in the productive (working) age group (15–44 years), and the present study focused on this age group [7]. This category includes all road users including VRUs, such as drivers, pedestrians, passengers, and cyclists. In developing countries, road traffic injuries primarily affect pedestrians, passengers, and cyclists, as opposed to drivers, who account for the most deaths and disabilities in the developed world. In the United States, for instance, drivers account for more than 60% of road traffic crash fatalities, whilst drivers account for less than 10% of mortalities caused by traffic injury issues in the least-motorized countries [8][9].

However, most previous research on pedestrian safety and traffic crashes have been crash-based studies, and researchers have looked into the characteristics of older pedestrians, the living and traveling environment, and roadway features associated with pedestrian crashes. The authors in [40], for example, used various data-mining algorithms, including the classification and regression tree (CART) model, gradient boosting (GB) model, random forest (RF) model, artificial neural network (ANN) model, and support vector machine (SVM) model, to ascertain the most important factors that contribute to death and severe vehicle–pedestrian crashes at intersections. In another study, the component-wise, model-based, gradient-boosting algorithm was used to estimate the nature and effects of socioeconomic, land use, road network, and traffic features on pedestrian crashes in Broward and Miami-Dade Counties in Florida [41]. The XGBoost machine learning tool was used to simulate the problem of classifying three categories in older pedestrian traffic crashes [42]. Another study provided a framework for using machine learning Bayesian neural network (BNN) approaches to reduce pedestrian deaths due to traffic crashes [43]. Pour et al. [44] used decision tree (DT) and kernel density estimation (KDE) to investigate the effects of temporal, geographical, and personal variables on the severity of vehicle–pedestrian collisions. Ding et al. [45] used multiple additive poisson regression trees (MAPRT) to provide a different perspective on the effects of pedestrian collisions and SVM, as well as multinomial logit (MNL) were used to forecast the severity of injuries in pedestrian collisions [32][46]. Zou [47] proposed a model for predicting vehicle acceleration based on machine learning and driving behavior analysis. Two different groups were considered. The first group consisted of 10 homogeneous drivers, whereas the second group consisted of 20 heterogeneous drivers. The driving behavior semantics were divided using a finite mixture of the hidden Markov model (MHMM). The Kolmogorov–Smirnov test was used to assess the similarity of distinct behavioral semantic chunks, and both groups employed long short-term memory (LSTM) and the gate recurrent unit (GRU) to forecast vehicle acceleration.

It can be seen that various machine learning algorithms and models have been applied for various aspects of crash severity analysis. There is, however, a significant research gap. First, no studies with comparative analysis of predictive age group crash severity using machine learning modeling were found. Second, in existing machine-learning-based crash

severity modeling, a confined number of road traffic crash variables were considered as input features. As a result, it would be worthwhile to conduct a thorough analysis and compare various road traffic crash parameters based on machine learning modeling for the productive age group.

The present study is based upon RTC data from Saudi Arabia, which is a car-dependent country, which has caused it to suffer problems associated with RTCs. Despite the harsh penalties enforced by the General Traffic Department for lawbreakers, road traffic crashes cause a considerable number of deaths each year in Saudi Arabia. A study reported an 8% increase in RTC-related mortalities in Saudi Arabia between 2005 and 2010 [48]. Traffic crashes are one of the most serious challenges that society and its stakeholders face due to various variables and contributing factors. Because it is a sophisticated behavioral problem of young drivers, it involves many stakeholders. To the authors' best knowledge, a study of this nature is not found in the literature for Saudi Arabia and other countries in the region. It is expected that the outcomes of this research will help researchers to improve their understanding of the involvement of young people in RTCs. It will also help traffic management authorities, especially in Saudi Arabia, to minimize RTCs, especially those involving young and productive people, thereby mitigating their impacts on the country's future. In 2018, Saudi Arabia allowed female citizens to have a license, which increased the number of young drivers in the country. Car ownership and RTCs are also expected to increase [49]. Hence, it is crucial to proactively mitigate RTCs involving young road users in Saudi Arabia.

References

1. Ackaah, W.; Adonteng, D.O. Analysis of Fatal Road Traffic Crashes in Ghana. Int. J. Inj. Control Saf. Promot. 2011, 18, 21–27.
2. Factor, R. The Effect of Traffic Tickets on Road Traffic Crashes. Accid. Anal. Prev. 2014, 64, 86–91.
3. Ang, J.Y.; Gabbe, B.; Cameron, P.; Beck, B. Animal–Vehicle Collisions in Victoria, Australia: An under-Recognised Cause of Road Traffic Crashes. EMA Emerg. Med. Australas. 2019, 31, 851–855.
4. Basu, S.; Saha, P. Regression Models of Highway Traffic Crashes: A Review of Recent Research and Future Research Needs. Procedia Eng. 2017, 187, 59–66.
5. Elvik, R. Risk of Road Accident Associated with the Use of Drugs: A Systematic Review and Meta-Analysis Of Evidence from Epidemiological Studies. Accid. Anal. Prev. 2013, 60, 254–267.
6. Kaygisiz, Ö.; Yildiz, A.; Düzgün, Ş. Spatio-Temporal Pedestrian Accident Analysis to Improve Urban Pedestrian Safety: The Case of the Eskişehir Motorway. Gazi Univ. J. Sci. 2015, 28, 623–630.
7. MORT&H. Road Accidents Data. 2010. Available online: https://morth.nic.in/sites/default/files/Road_Accidents_in_India_2010.pdf (accessed on 5 May 2022).
8. Nantuly, V.M.; Muli-Musiime, F. Kenya: Uncovering the Social Determinants of Road Traffic Accidents. In Challenging Inequities in Health: From Ethics to Action; Oxford University Press: Oxford, UK, 2009.
9. Hijaar, M.C. Traffic Injuries in Latin American and the Caribbean Countries. 1999. Available online: www.globalforumhealth.org/Non_compliant_pages/forum3/Forum3doc962.htm (accessed on 20 June 2006).
10. LaScala, E.A.; Gerber, D.; Gruenewald, P.J. Demographic and Environmental Correlates of Pedestrian Injury Collisions: A Spatial Analysis. Accid. Anal. Prev. 2000, 32, 651–658.
11. Mungnimit, S. Road Traffic Accident Losses; Transport and Communications Policy and Planning Bureau, Ministry of Transport and Communications: Bangkok, Thailand, 2001.
12. Bener, A. The Neglected Epidemic: Road Traffic Accidents in a Developing Country, State of Qatar. Int. J. Inj. Control Saf. Promot. 2005, 12, 45–47.
13. Wedagama, D.M.P.; Dissanayake, D. The Influence of Accident Related Factors on Road Fatalities Considering Bali Province in Indonesia as a Case Study. J. East. Asia Soc. Transp. Stud. 2010, 8, 905–1917.
14. Ishrat, R. Global Status Report on Road Safety 2018: Summary; World Health Organization: Geneva, Switzerland, 2018.
15. Scholes, S.; Wardlaw, M.; Anciaes, P.; Heydecker, B.; Mindell, J.S. Fatality Rates Associated with Driving and Cycling for All Road Users in Great Britain 2005–2013. J. Transp. Health 2018, 8, 321–333.
16. Abegaz, T.; Gebremedhin, S. Magnitude of Road Traffic Accident Related Injuries and Fatalities in Ethiopia. PLoS ONE 2019, 14, e0202240.

17. Peden, M. Injury: A Leading Cause of the Global Burden of Disease, 2000; Department of Injuries and Violence Prevention Noncommunicable Diseases and Mental Health Cluster World Health Organization: Geneva, Switzerland, 2002. Available online: http://www.worldcat.org/title/injury-a-leading-cause-of-the-global-burden-of-disease-2000/oclc/52416791?tab=details (accessed on 21 September 2011).
18. Cataldi, A.; Kampelmann, S.; Rycx, F. Does It Pay to be Productive? The Case of Age Groups. Int. J. Manpow. 2012, 33, 264–283.
19. Sanyang, E.; Peek-Asa, C.; Bass, P.; Young, T.L.; Daffeh, B.; Fuortes, L.J. Risk Factors for Road Traffic Injuries among Different Road Users in the Gambia. J. Environ. Public Health 2017, 2017, 8612953.
20. Useche, S.A.; Montoro, L.; Sanmartin, J.; Alonso, F. Healthy but Risky: A Descriptive Study on Cyclists' Encouraging and Discouraging Factors for Using Bicycles, Habits and Safety Outcomes. Transp. Res. Part F Traffic Psychol. Behav. 2019, 62, 587–598.
21. Lee, J.; Abdel-Aty, A.; Park, J. Investigation of Associations between Marijuana Law Changes and Marijuana-Involved Fatal Traffic Crashes: A State-Level Analysis. J. Transp. Health 2018, 10, 194–202.
22. Wang, D.; Liu, Q.; Ma, L.; Zhang, Y.; Cong, H. Road Traffic Accident Severity Analysis: A Census-Based Study in China. J. Saf. Res. 2019, 70, 135–147.
23. Damsere-Derry, J.; Palk, G.; King, M. Road accident Fatality Risks for 'Vulnerable' Versus 'Protected' Road Users in Northern Ghana. Traffic Inj. Prev. 2017, 18, 736–743.
24. Bjerre, J.; Kirkebjerg, P.G.; Larsen, L.B. Prevention of Traffic Deaths in Accidents Involving Motor Vehicles. Ugeskr Laeger 2006, 168, 1764–1768.
25. Smart, R.G.; Mann, R.E. Deaths and Injuries from Road Rage: Cases in Canadian Newspapers. Can. Med. Assoc. J. 2002, 167, 761–762.
26. Touahmia, M. Identification of Risk Factors Influencing Road Traffic Accidents. Eng. Technol. Appl. Sci. Res. 2018, 8, 2417–2421.
27. Jonah, B.A. Accident Risk and Risk-Taking Behaviour Among Young Drivers. Accid. Anal. Prev. 1986, 18, 255–271.
28. Doherty, S.T.; Andrey, J.C.; Macgregor, C. The Situational Risks of Young Drivers: The Influence of Passengers, Time of Day and Day of Week on Accident Rates. Accid. Anal. Prev. 1998, 30, 45–52.
29. Chliaoutakis, J.E.; Darviri, C.; Demakakos, P.T. The Impact of Young Drivers ' Lifestyle on Their Road Traffic Accident Risk in Greater Athens Area. Accid. Anal. Prev. 1999, 31, 771–780.
30. Chen, H.Y.; Senserrick, T.; Chang, H.Y.; Ivers, R.Q.; Martiniuk, A.; Boufous, S.; Norton, R. Road Crash Trends for Young Drivers in New South Wales, Australia, from 1997 to 2007. Traffic Inj. Prev. 2010, 11, 8–15.
31. Al-hemoud, A.M.; Simmons, R.J.; Al-asfoor, M.M. Behavior and Lifestyle Characteristics of Male Kuwaiti Drivers. J. Saf. Res. 2010, 41, 307–313.
32. Simons-Morton, B.G.; Ouimet, M.C.; Chen, R.; Klauer, S.G.; Lee, S.E.; Wang, J.; Dingus, T.A. Peer Influence Predicts Speeding Prevalence among Teenage Drivers. J. Saf. Res. 2012, 43, 397–403.
33. Carpentier, A.; Brijs, K.; Declercq, K.; Brijs, T.; Daniels, S. The Effect of Family Climate on Risky Driving of Young Novices: The Moderating Role of Attitude and Locus of Control. Accid. Anal. Prev. 2014, 73, 53–64.
34. Hassan, H.M. Investigation of the Self-Reported Aberrant Driving Behavior of Young Male Saudi Drivers: A Survey-Based Study. J. Transp. Saf. Secur. 2016, 8, 113–128.
35. Ramisetty-Mikler, S.; Almakadma, A. Attitudes and Behaviors Towards Risky Driving among Adolescents in Saudi Arabia. Int. J. Pediatr. Adolesc. Med. 2016, 3, 55–63.
36. Issa, Y. Effect of Driver's Personal Characteristics on Traffic Accidents in Tabuk city in Saudi Arabia. J. Transp. Lit. 2016, 10, 25–29.
37. Mohamed, M.; Bromfield, N.F. Attitudes, Driving Behavior, and Accident Involvement among Young Male Drivers in Saudi Arabia. Transp. Res. Part F Psychol. Behav. 2017, 47, 59–71.
38. Weston, L.; Hellier, E. Designing Road Safety Interventions for Young Drivers: The Power of Peer Influence. Transp. Res. Part F Traffic Psychol. Behav. 2018, 55, 262–271.
39. Zeyin, Y.; Long, S.; Gaoxiao, R. Effects of Safe Driving Climate among Friends on Prosocial and Aggressive Driving Behaviors of Young Drivers: The Moderating Role of Traffic Locus of Control. J. Saf. Res. 2022, 81, 297–304.
40. Zhu, S. Analyse Vehicle–Pedestrian Crash Severity at Intersection with Data Mining Techniques. Int. J. Crashworthiness 2021, 1–9.

41. Saha, D.; Dumbaugh, E. Use of a Model-Based Gradient Boosting Framework to Assess Spatial and Non-Linear Effects of Variables on Pedestrian Crash Frequency at Macro-Level. J. Transp. Saf. Secur. 2021, 1–32.
42. Guo, M.; Yuan, Z.; Janson, B.; Peng, Y.; Yang, Y.; Wang, W. Older Pedestrian Traffic Crashes Severity Analysis Based on an Emerging Machine Learning Xgboost. Sustainability 2021, 13, 926.
43. Tao, W.; Aghaabbasi, M.; Almaliki, A.H.; Zainol, R.; Almaliki, A.A.; Hussein, E.E. An Advanced Machine Learning Approach to Predicting Pedestrian Fatality Caused by Road Crashes: A Step toward Sustainable Pedestrian Safety. Sustainability 2022, 14, 2436.
44. Pour, A.T.; Moridpour, S.; Rajabifard, A.; Tay, R. Spatial and temporal Distribution of Pedestrian Crashes in Melbourne Metropolitan Area. Road Transp. Res. 2017, 26, 4–20.
45. Ding, C.; Chen, P.; Jiao, J. Non-Linear Effects of the Built Environment on Automobile-Involved Pedestrian Crash Frequency: A Machine Learning Approach. Accid. Anal. Prev. 2018, 112, 116–126.
46. Mokhtarimousavi, S. A Time of Day Analysis of Pedestrian-Involved Crashes in California: Investigation of Injury Severity, A Logistic Regression and Machine Learning Approach using HSIS data. ITE J.-Inst. Transp. Eng. 2019, 89, 25–33.
47. Zou, Y.; Ding, L.; Zhang, H.; Zhu, T.; Wu, L. Vehicle Acceleration Prediction Based on Machine Learning Models and Driving Behavior Analysis. Appl. Sci. 2022, 12, 5259.
48. Mansuri, F.A.; Al-Zalabani, A.H.; Zalat, M.M.; Qabshawi, R.I. Road Safety and Road Traffic Accidents in Saudi Arabia: A Systematic Review of Existing Evidence. Saudi Med. J. 2015, 36, 418–424.
49. Al-Garawi, N.; Dalhat, M.A.; Aga, O. Assessing the road Traffic Crashes among Novice Female Drivers in Saudi Arabia. Sustainability 2021, 13, 8613.
