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Research article

Road rage behaviours among road users in Turkey

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Abstract: One of the human factors that decreases traffic safety is road rage behaviors. Many of the behaviors thought to be indicative of road rage are clearly intended to be aggressive. The purpose of this study was to examine the frequency of road rage incidents experienced by road users both as victims and perpetrators. Furthermore, the goal was to investigate the impact of various socio-demographic and other factors on road rage behaviors in the past year. The questionnaire was completed by 633 individuals who agreed to participate in the study and reside in Istanbul, Izmir, and Ankara. All of the participants were Turkish, aged 19–76 years (M = 37.84 years, SD = 10.10); 57.3% were females, and 42.7% were males. The survey application was started with ethical approval. Using the snowball sampling method, a survey link or paper pencil forms were distributed to participants. Participants were requested to fill out the questionnaire form including socio-demographic information and various forms of road rage. Data were analyzed using the chi-square test and binary logistic regression analysis. Using the SPSS 28 program, all data were statistically analyzed to a significance level of $p < 0.05$. According to our findings, low-level road rage is most common among road users. For perpetration, this rate is 43.6%, while for victimization it is 63.2%. Overall, the results of the analysis suggest that low or high-levels of road rage perpetration and victimization may be influenced by driving a vehicle, carrying a weapon and certain demographic factors like gender, age, education level, and marital status. Numerous factors interact to facilitate road rage's emergence. In our study, various forms of road rage are significantly influenced by factors such as age, gender, education, marital status, driving a vehicle, carrying a weapon. We believe it is crucial to examine this issue from multiple perspectives. Additionally, programs for prevention and intervention that effectively reduce the prevalence of road rage incidents are critical.

Keywords: prevalence, road rage, road users, survey

1 Introduction

Based on crash data from 2016, the World Health Organization (WHO) states in its 2018 Global Status Report on Road Safety that deaths from road traffic crashes have increased to 1.35 million annually and are the eighth leading cause of death worldwide (WHO, 2018a). An estimated 20 175 people died in motor vehicle traffic crashes in the first half of 2022, according to a statistical projection of traffic fatalities in the United States. Compared to the 20 070 fatalities anticipated for the first half of 2021, this indicates a marginal increase of approximately 0.5% (NHTSA, 2022). During the year 2020, there were a total of 983 808 traffic accidents on Turkey's road network. 150 275 accidents resulted in death or injury, and 833 533 accidents resulted in material loss. 2 197 people were killed at the scene of an accident in Turkey in 2020, and 2 699 people who were injured in a traffic accident and

taken to a hospital died within 30 days of the incident due to the related accident and its effects (TSI, 2021).

The incidence of traffic accidents on the roads is influenced in varying degrees by factors connected to vehicles, road geometry, traffic, the environment, and human behavior (Briz-Redón et al., 2019; Papadimitriou, 2019). Identifying factors associated with individual drivers' crash risk has been a primary concern for transportation researchers and policymakers due to the fact that human factors cause the majority of crashes (Guo & Fang, 2013). Therefore, improving traffic safety necessitates identifying high-risk drivers (Joo, 2022). One of the main ways that road accidents can be predicted is aggressive driving (Zhang & Chan, 2016; Herrero-Fernández & Fonseca-Baeza, 2017).

One of the human factors that decreases traffic safety is road rage behaviors. Road rage affects more people than just motorists. It can affect drivers, cyclists, pedestrians, passengers, and others who frequently travel in traffic. Additionally, road users may be either the victims or the perpetrators of an incident of road rage, or they may be both. As a result, the experiences of road users in Turkey's three largest cities regarding road rage were the focus of this study.

1.1 Road rage

The majority of social psychology research on harmful behavior focused on aggression. Although high levels of aggression or inflicting physical harm are sometimes referred as violence, there is no separate basic research area on violence. Research on 'violence on the roads' is difficult to integrate into the larger discourse on violence. This is, on the one hand, because aggressive driving is a situational and temporary behavior that is harder to define than more straightforward physical violence and is clearly less disturbing to society (Kölbel, 2003). Berkowitz (1993) defines aggression as any action with the intention of causing physical or mental harm to another person. Damage caused by aggressive behavior is not the same as damage caused by an accident to the other party, because no such goal was pursued. However, it is possible to discuss aggression at this point if the perpetrator believes that the target will be harmed by the behavior and the target is motivated to avoid it (Bushman & Anderson, 2001). Similarly, any behavior that aims to physically or psychologically harm a driver or other road users is considered driver aggression (Lajunen et al., 1998).

Lajunen et al. (1998)'s classification of driving behaviors into three categories provides a more precise definition of aggressive driving: violations, errors, and lapses. Examples of lapses include switching on one control when trying to turn on another or pulling away from the curb in third gear. Errors include not seeing a sign, estimating the distance incorrectly, and so on. Violations are linked to aggressive driving and intentional acts. Also, three aspects of driving behavior have been identified as aggressive in the field of research: (*a*) deliberate acts of physical, verbal, or figurative aggression; (*b*) negative feelings while driving, such as anger or frustration; and (*c*) taking risks (Dula & Ballard, 2003). In addition to the concept of aggressive driving, driving anger is also an important issue. Driving anger is characterized by having more frequent and intense anger (Deffenbacher et al., 1994). Driving anger does not always have a negative effect on one's behavior, and there have been reports of drivers finding positive ways to deal with their anger (Sullman et al., 2013). However, just as anger is frequently associated with aggression (Anderson & Bushman, 2002), driving aggression is occasionally, but not always, associated with anger (Sullman et al., 2013; Deffenbacher et al., 2016; Zhang & Chan, 2016).

The media in the United States coined the term 'road rage' in the late 1980s, and the United Kingdom adopted it in the 1990s (Shinar, 1998; Fong et al., 2001). Road rage was simply defined as hostile/aggressive behaviors against other people in the traffic environment (Shinar, 1998). Road rage, according to Brewer (2000), it is a forceful way of behaving of drivers on highways (Brewer, 2000). Britt & Garrity (2003) state that road rage encompasses not only minor behaviors but also serious and risky ones (Britt & Garrity, 2003). The Automobile Association (AA) argued that the term 'road rage' covers a wide range of intensely negative feelings and behaviors. This idea is closely related to intense feelings of frustration when confronted with particular circumstances, events, and individuals (Joint, 1995). This concept, according to some researchers, refers to actions that are motivated by anger with an aggressive intent (Asbridge et al., 2006; Bjureberg & Gross, 2021). In the road rage category, many of the behaviors thought to be indicative of road rage are clearly intended to be aggressive (Sarkar, 2000). In addition, in the event of a perceived threat or response to a specific provocation while driving, road rage can be defined

as a system of emotions, thoughts, and behaviors that intentionally endanger or threaten others (Carpenter, 2020).

When a road user is not the one causing the incident, they are called 'road rage victims'. It is possible for victims to experience low (such as shouting, cursing or making rude gestures) or high-level (such as threat to hurt someone or damage their vehicle) of road rage behavior. In addition, the person who was responsible for the incident is known as the road rage perpetrator. Sometimes a person can be both the perpetrator and the victim (Fong et al., 2001; Fierro et al., 2011; Benavidez, 2013).

In reports of aggression while driving, both academics and laypeople have used the terms 'road rage' and 'aggressive driving' interchangeably, sometimes as synonyms (Dula & Geller, 2003). However, Rathbone & Huckabee (1999) pointed out that road rage and aggressive driving are not the same thing, and that definitions of road rage vary and frequently go unstated. They said that '*an angry or impatient motorist or passenger intentionally injures or kills another motorist, passenger, or pedestrian, or attempts or threatens to injure or kill another motorist, passenger, or pedestrian*' is an example of road rage. Uncontrollable anger that leads to violence or the threat of violence while driving is known as road rage. It is illegal conduct. Tailgating, sudden lane changes, and speeding are all examples of aggressive driving. These potentially hazardous actions are traffic violations, but they are not illegal (Rathbone & Huckabee, 1999). According to another study (Dukes, 2001); obscene gestures, verbal remarks, and intentionally chasing or blocking other vehicles are all examples of road rage. However, rather than being provoked by other drivers, aggressive driving may be the result of the driver's own impatience and frustration (Dukes, 2001). Driving at an excessive speed, weaving in and out of lanes, running red lights or stop signs, and so on are all examples of aggressive behaviors (Yu et al., 2004).

1.2 Risk Factors

Road rage behaviors are also influenced by sociodemographic characteristics, according to some previous studies. The majority of these previous studies focus on being young and male (Lajunen et al., 1999; Krahé & Fenske, 2002; Miller et al., 2002; Wells-Parker et al., 2002; Mann et al., 2004; Smart et al., 2007). Studies are demonstrating that known as the 'weapons effect' (Berkowitz, 1974) in social psychology can have an impact on road rage behaviors in addition to sociodemographic factors (Dukes, 2001; Miller et al., 2002; Hemenway et al., 2006; Pfeiffer et al., 2016; Bushman et al., 2017). These findings suggest that riding with a weapon in the vehicle poses a risk of aggressive behavior.

Previous studies have demonstrated a significant link between road rage and the risk of collisions (Wells-Parker et al., 2002; Mann et al., 2007). Additionally, driving anger has also been linked to a variety of crash-related conditions, including: near-misses, disorientation, following too closely, and losing control of the vehicle (Deffenbacher et al., 2002, 2003; Underwood et al., 1999; Sullman et al., 2007). Furthermore, simulator research shows that angry drivers are more likely to collide (Deffenbacher et al., 2003; Stephens & Groeger, 2011). The primary factors fall into four categories: social (the presence of passengers in the car), psychological (aggressive personality, the search for adrenaline, hostility, competitiveness, and gender), as well as temporal (time pressure and the time of day) or environmental factors (the state of the road, the density of traffic, and the conditions of the weather).

Numerous studies on aggressive driving have sought to determine how it interacts with personal, sociocultural, and situational variables, according to the literature (Berdoulat et al., 2021). The most well-known proximal reasons for road rage are deterring one's advancement, being seriously jeopardized by other drivers' wild driving, and being dealt with inconsiderately by others (Deffenbacher et al., 2016). Warm temperatures (Kenrick & MacFarlane, 1986), lack of time, daily and work stressors (Wickens & Wiesenthal, 2007), and traffic congestion (Shinar, 1998; Lupton, 2002; Zhang et al., 2015) are more distant causes of road rage. A driver's sense of anonymity in traffic can also be effective, which is one of the situational factors (Ellison et al., 1995; Ellison-Potter et al., 2001). Other risk factors for road rage include psychological factors, depression (Yu et al., 2004), a tendency to attribute blame to another person (external attribution) (Lawton & Nutter, 2002), and a high perceived level of general negative stress (Lupton, 2002). In addition, numerous studies show a link between personality traits and aggressive driving (Sümer et al., 2005; Jovanović et al., 2011; Hussain et al., 2020). As a result, individual characteristics and situational factors interact, and

this interaction may result in traffic-related violent behavior (Indermaur, 1998).

1.3 Current Study

Driver samples have only been used in many previous studies. It has been suggested in these studies (Fong et al., 2001; Asbridge et al., 2003; Smart et al., 2005a; Møller & Haustein, 2018) that drivers experience road rage quite frequently. On the other hand, other road users may also experience road rage, depending on how much time they spend in traffic. There are relatively few studies (Rosenbloom et al., 2004; Papadimitriou et al., 2013; Deb et al., 2017; Solmazer et al., 2020; Öztürk & Öz, 2021) on this topic that focus on non-driver road users. As a result, not only were the road rage behaviors of motorists examined in this study, but also the experiences of others.

In Turkey, there are studies on driver anger and aggression (Özkan et al., 2011; Akşar & Alavci, 2018; Güngör et al., 2020; Öztürk et al., 2021). However, there are few studies on road rage in the national literature (Aktaş & Akgür, 2022b,a; Aktaş, 2021). The purpose of this study was to examine the frequency of road rage incidents experienced by road users both as victims and perpetrators. Furthermore, the goal was to investigate the impact of various socio-demographic and other factors on road rage behaviors in the past year.

2 Method

2.1 Participants and procedure

After receiving ethical approval (Protocol No: 21-10.1T/12) from the Izmir Ege University Committee of Medical Research Ethics, participants were reached using snowball sampling method, and shared with them a survey link or paper pencil forms of the survey. Participants were requested to fill out the Questionnaire Form including socio-demographic information and various forms of road rage. The volunteer participants were reached from disparate social media pages (urban life, automobile forum, cyclists forum, etc.) and public places (bus stop, cafe, shopping center, etc.). The researcher waited for the participants to complete the questionnaire in the face-to-face application.

Two inclusion criteria were identified in the study: participants had to be over 18 years old and living in Izmir, Istanbul, or Ankara. All of the participants were put into groups based on how often they used each type of transportation. Therefore, each participant could be designated to more than one group depending on using the transportation types. The participants stated which role they were in the traffic environment the most. Concerning role in traffic, they were categorized into two groups as motor vehicle drivers (including motorcyclists) and non-drivers (cyclists, pedestrians and passengers).

A total of 651 participants concurred to take part in the study and 633 participants completed the questionnaire, either the online version or pencil paper version. The online version of the questionnaire was filled out by 610 participants. The pencil paper version was filled out by 41 participants. All participants were Turkish, aged 19–76 years (M = 37.84 years, SD = 10.10); 57.3% were females, and 42.7% were males. Based on the frequency of driving at least once a week, on average, drivers spent approximately 14.86 (SD = 13.90) years per year actively driving. In the previous year, the average number of miles driven was 18 735 (SD = 30 647).

2.2 Measures and outcome variables

The Questionnaire Form was including questions related to sociodemographic characteristics, road users' characteristics and road rage behavior. Road rage behavior was measured adapted from a taxonomic study developed by (Smart & Mann, 2002). Four questions were used to assess road rage behavior over the course of the previous year. These questions were included being a victim and a perpetrator of road rage. Being a victim of road rage items:

'*During the past 12 months, how many times has someone (i.e. a driver in another vehicle, a cyclist, a pedestrian, a passenger) in traffic cursed, shouted, or made rude gestures at you or others with you*?'

'*During the past 12 months, how many times has someone (i.e. a driver in another vehicle, a cyclist, a pedestrian, a passenger) in traffic threatened to hurt you or others with you, or threatened to damage the vehicle you were in*?'

Being a perpetrator of road rage items:

'*During the past 12 months, how many times have you cursed, shouted, or made rude gestures at a driver or other road users in traffic?*'

'*During the past 12 months, how many times have you threatened to hurt a driver or other road users in traffic,*

or threatened to damage their vehicle?'

First, participants were asked if they thought the aforementioned questions were relevant. The number of times was required of those who said yes. In addition, the following questions were asked participants: '*Has someone made complain about you due to a road rage incident*?' and '*Have you made complain about someone due to a road rage incident?*'

2.3 Design and data analysis

These items were included between October and November 2021. The road rage experiences of the participants were analyzed in two different ways. First, data for road rage items were recorded (no = 0, yes = 1). Respondents who reported at least one experience of road rage victimization or perpetration were coded as 1. Those who perform an action only once and those who perform it multiple times fall under the same category because the data set is dichotomously coded. Based on having at least once experienced road rage behaviors. Second, the participants' responses to the questions regarding the number of incidents of road rage were analyzed.

However, due to limited data, we believed that it would not provide a reliable assessment.

The analysis results include only valid responses. Those left blank or giving different responses were evaluated missing data and were not included in the analysis. Data were analyzed using the chi-square test and binary logistic regression analysis. Using the SPSS 28 program, all data were statistically analyzed to a significance level of $p < 0.05$. Averages for each participant's road rage experiences are presented in Table 1. The low and high-levels of road rage victimization and perpetration had average scores of 10.58, 0.85, 8.81, and 0.50 respectively.

Table 1 Averages on the victims and perpetrators of road rage

	Victimization		Perpetration	
level	low	high	low	high
Mean	10.58	0.85	8.81	0.50
Median	2.00	0.00	0.00	0.00
SD	50.940	7.396	65.766	5.906
Min	0	0	0	0
Max	1000	150	1000	100

2.4 Independent variables

Sociodemographic variables included gender (0 = female, 1 = male), age (0 = 19–25, 1 = 25–35, 2 = 35–45, 3 ≥ 45), marital status (0 = never married, 1 = married or previously married), education (0 = less than university degree, 1 = university degree and more than university degree) and city (0 = Izmir, 1 = Istanbul, 2 = Ankara). Other variables included road user (0 = non-driver, 1 = driver), weapons presence (0 = no, 1 = yes). Due to the low frequency of the education and marital status variables at levels, the categories were combined for data analysis.

3 Results

3.1 Findings on analyses of road rage frequency in road users

Actions like shouting, swearing, honking, and making gestures that are not intended to physically harm the other party are referred to as 'low-level road rage'. Threatening or causing harm are examples of high-level road rage behaviors. Some previous studies (Mann et al., 2004; Wickens et al., 2012; Benavidez, 2013) have utilized this distinction. Table 2 and Table 3 show data on the frequency of road rage in the last 12 months by socio-demographic and the other factors. The frequency rates at least once in the past year are 63.2% for lower levels and 14.5% for higher levels of road rage victimization (Table 2), and 43.6% for lower levels and 3.5% for higher levels of road rage perpetration (Table 3). 2.2% of participants reported having a forensic problem as a victim due to serious road rage behaviors involving physical assault, while 0.9% reported was a perpetrator of the incident.

According to the results of the chi-square test (Table 2), road users' age ($\chi^2(1) = 4.24$, $p = .039$), driving a motor vehicle ($\chi^2(1) = 6.64$, $p = .010$), and carrying weapons in their vehicle or pocket ($\chi^2(1) = 4.58$, $p = .032$) were all found to be associated lower levels of road rage victimization. However, there was no statistically significant difference by gender and the other variables. For threats of hurting or vehicle damage, a statistically significant relationship was found by gender ($\chi^2(1) = 17.54$, $p = .0001$), age ($\chi^2(3) = 10.41$, $p = .015$), marital status ($\chi^2(1) = 12.08$, $p = .001$), and weapons presence ($\chi^2(1) = 16.98$, $p = .0001$).

Table 3 displays the chi-square test analysis results for road rage perpetration. Perpetration of road rage

Table 2 Frequency of road rage victimization by sociodemographic and other variables

	sample characteristics n (%)	low-level victimization (yes) n (%)	high-level victimization (yes) n (%)
Total sample	633 (100)	400 (63.2)	92 (14.5)
Gender			***
Male	270 (42.7)	175 (65.3)	58 (21.6)
Female	363 (57.3)	225 (63.7)	34 (9.6)
Age		*	*
19–25	65 (10.3)	50 (76.9)	17 (26.2)
25–35	219 (34.6)	142 (65.7)	33 (15.2)
35–45	205 (32.4)	123 (61.2)	20 (10.0)
45+	140 (22.1)	83 (61.5)	21 (15.4)
Missing	4 (0.6)		
Education			
< University degree	117 (18.5)	69 (61.1)	23 (20.2)
≥ University degree	513 (81.0)	329 (65.1)	69 (13.7)
Missing	3 (0.5)		
Marital status			***
Never married	239 (37.8)	159 (67.1)	50 (21.1)
Married/previously married	394 (62.2)	241 (62.8)	42 (10.9)
Income			
≤ 6000₺	186 (29.4)	116 (64.1)	34 (18.8)
6000–12000₺	225 (35.5)	147 (65.6)	30 (13.3)
> 12000₺	169 (26.7)	108 (64.3)	23 (13.9)
Missing	53 (8.4)		
Employed			
Yes	499 (78.8)	322 (65.4)	69 (14.0)
No	129 (20.4)	74 (59.2)	22 (17.6)
Missing	5 (0.8)		
City			
Izmir	336 (53.1)	220 (66.5)	53 (16.0)
Istanbul	202 (31.9)	121 (62.1)	27 (13.8)
Ankara	95 (15.0)	59 (62.1)	12 (12.6)
Road user		*	
Driver	404 (63.8)	273 (68.1)	63 (15.7)
Non-driver (pedestrians, passengers, cyclists)	229 (36.2)	127 (57.7)	29 (13.1)
Weapons presence		*	***
Yes	61 (9.6)	47 (77.0)	20 (32.8)
No	558 (88.2)	351 (63.2)	72 (13.0)
Missing	14 (2.2)		

* p < .05 ; ** p < .01 ; *** p < .001

'low-level of road rage': shouting, cursing or making rude gestures

'high- level of road rage': threat to hurt someone or damage their vehicle

'₺': Turkish Lira

Table 3 Frequency of road rage perpetration by sociodemographic and other variables

	sample characteristics n (%)	low-level perpetration (yes) n (%)	high-level perpetration (yes) n (%)
Total sample	633 (100)	276 (43.6)	22 (3.5)
Gender		***	*
Male	270 (42.7)	145 (53.9)	15 (5.6)
Female	363 (57.3)	131 (37.1)	7 (2.0)
Age			***
19–25	65 (10.3)	32 (49.2)	6 (9.4)
25–35	219 (34.6)	93 (42.9)	10 (4.6)
35–45	205 (32.4)	91 (45.3)	6 (3.0)
45+	140 (22.1)	58 (43.0)	0 (0.0)
Missing	4 (0.6)		
Education			
< University degree	117 (18.5)	42 (37.5)	7 (6.1)
≥ University degree	513 (81.0)	232 (45.8)	15 (3.0)
Missing	3 (0.5)		
Marital status			*
Never married	239 (37.8)	108 (45.8)	14 (6.0)
Married/previously married	394 (62.2)	168 (43.5)	8 (2.1)
Income			
≤ 6000₺	186 (29.4)	77 (43.0)	9 (5.0)
6000–12000₺	225 (35.5)	97 (43.3)	7 (3.1)
> 12000₺	169 (26.7)	84 (49.7)	6 (3.6)
Missing	53 (8.4)		
Employed		*	
Yes	499 (78.8)	231 (46.7)	17 (3.5)
No	129 (20.4)	42 (34.1)	5 (4.0)
Missing	5 (0.8)		
City			
Izmir	336 (53.1)	148 (44.7)	14 (4.2)
Istanbul	202 (31.9)	84 (42.9)	5 (2.5)
Ankara	95 (15.0)	44 (46.3)	3 (3.2)
Road user		***	
Driver	404 (63.8)	221 (54.8)	18 (4.5)
Non-driver (pedestrians, passengers, cyclists)	229 (36.2)	55 (25.1)	4 (1.8)
Weapons presence		***	***
Yes	61 (9.6)	46 (75.4)	11 (18.0)
No	558 (88.2)	229 (41.3)	11 (2.0)
Missing	14 (2.2)		

* $p < .05$; ** $p < .01$; *** $p < .001$

'low-level of road rage': shouting, cursing or making rude gestures

'high- level of road rage': threat to hurt someone or damage their vehicle

'₺': Turkish Lira

by to cursing, shouting, or making rude gestures at someone was related to road users' gender ($\chi^2(1) = 17.44$, $p = .0001$), employment state ($\chi^2(1) = 6.26$, $p = .012$), driving a motor vehicle ($\chi^2(1) = 50.79$, $p = .0001$) and carrying weapons in their vehicle or pocket ($\chi^2(1) = 25.93$, $p = .0001$). Being a perpetrator of higher levels of road rage behavior, a statistically significant relationship was found by gender ($\chi^2(1) = 5.82$, $p = .016$), age ($\chi^2(3) = 12.19$, $p = .007$), marital status ($\chi^2(1) = 6.54$, $p = .011$) and weapons presence ($\chi^2(1) = 41.02$, $p = .0001$).

3.2 Findings on logistic regression analyses of road rage behaviors in road users

Logistic regression analysis was employed to examine the impact of potential risk factors on both being a victim of road rage and engaging in road rage behavior. For all analysis models, the Hosmer and Lemeshow test was not significant, indicating good fit of the model. The developed four models are statistically significant ($p < 0.05$). Logistic regression analyses were performed with sociodemographic (age, gender, marital status, education level and city) and other factors (driving a motor vehicle and weapons presence) as independent variables. The dependent variables were road rage behaviors.

According to the results presented in Table 4, age and driving a motor vehicle were identified as significant factors in the logistic regression analysis when considering individuals who were subjected to curses, shouts, or rude gestures while on the road. Drivers were more likely than non-drivers to be the target of lower levels of road rage (OR = 0.52). The probability of young road users, aged between 19–25, being victims of road rage is found to be higher compared to individuals aged between 35–45 (OR = 0.41) and those above 45 years old (OR = 0.38). Moreover, explained total variance value (Nagelkerke's R square) is 5%.

According to Table 5, gender, marital status and carrying a weapons were found to be significant factors in the logistic regression analysis for high-level of road rage victimization. Males (OR = 2.42), married individuals (OR = 0.48) and road users carrying weapons in their vehicle or pocket (OR = 2.73) experienced less victimization of higher levels of road rage. Moreover, explained total variance value (Nagelkerke's R square) is 12%.

Table 6 shows that gender, education, driving a motor vehicle and carrying a weapon were found to be significant factors in the logistic regression analysis for low-level of road rage perpetration. Females (OR = 1.47), individuals with an education lower level of university degree (OR = 1.72), road users carrying weapons in their vehicle or pocket (OR = 3.68) and drivers (OR = 3.15) experienced more frequent perpetration of lower levels of road rage. Moreover, explained total variance value (Nagelkerke's R square) is 17%.

Table 7 shows that age and carrying weapons were found to be significant factors in the logistic regression analysis for high-level of road rage perpetration. Individuals between the ages of 19–25 (OR = 0.93) and road users carrying weapons in their vehicle or pocket (OR = 8.54) experienced more frequent perpetration of higher levels of road rage. Moreover, explained total variance value (Nagelkerke's R square) is 26%.

4 Discussion

The purpose of this cross-sectional study is to investigate the frequency of road rage behaviors among Turkish drivers and non-drivers, as well as the impact of sociodemographic and other factors on victimization and perpetration of road rage. The frequency of road users' experiences, occurring at least once in the previous year, was considered in the study. Low-level road rage is most common among road users, according to our findings. For perpetration, this rate is 43.6%, while for victimization, it is 63.2%. Overall, the results of the analysis suggest that low or high-levels of road rage perpetration and victimization may be influenced by driving a vehicle, carrying a weapon and certain demographic factors like gender, age, education level, and marital status.

4.1 Frequency of road rage victimization

'Road rage victims' are people who were not at fault for the incident. These victims may have been the victims of incidents of road rage, whether at a lower or higher level. The rate of being the victim of lower levels of road rage behaviors like shouting, swearing, and making gestures was 63.2%, according to our study. Also, higher levels of road rage behaviors like threats and harm was a rate of 14.5%. The results of the chi-square analysis also indicated that being younger, male and single, driving, and possessing a weapon were all associated with being a victim of road rage. The victims

Table 4 Logistic regression analyses on low-level of road rage victimization

Predictor	Estimate	SE	Z	p	OR	Lower 95% CI	Upper 95% CI
Intercept	0.8744	0.354	2.4717	0.013	2.397	1.198	4.796
Gender (ref.= female)							
male–female	-0.1585	0.192	-0.8262	0.409	0.853	0.586	1.243
Age (ref.=19–25)							
25–35 against 19–25	-0.6365	0.370	-1.7183	0.086	0.529	0.256	1.094
35–45 against 19–25	-0.886	0.379	-2.3395	**0.019**	0.412	0.196	0.866
> 45 against 19–25	-0.9601	0.390	-2.4650	**0.014**	0.383	0.178	0.821
Education (ref. ≥ university degree)							
≥ university against < university	0.2499	0.239	1.0462	0.295	1.284	0.804	2.051
Marital status (ref. = never married)							
married/previously–never married	0.0130	0.198	0.0656	0.948	1.013	0.687	1.495
City (ref. = Izmir)							
Istanbul–Izmir	-0.1130	0.201	-0.5616	0.574	0.893	0.602	1.325
Ankara–Izmir	-0.1815	0.253	-0.7176	0.473	0.834	0.508	1.369
Road user (ref. = non-driver)							
driver against non-driver	0.5231	0.195	2.6776	**0.007**	1.687	1.151	2.474
Weapons presence (ref. = no)							
yes–no	0.5315	0.327	1.6256	0.104	1.701	0.896	3.229

Estimates represent the log odds of road rage ('yes = 1', 'no = 0'); ref. = reference category
Model Fit Measures: $\chi^2 = 20.1$ (10df), p = .03, R^2_N (Nagelkerke R Square) = 0.05

Table 5 Logistic regression analyses on high-level of road rage victimization

Predictor	Estimate	SE	Z	p	OR	Lower 95% CI	Upper 95% CI
Intercept	-1.7207	0.411	-4.1881	< .001	0.179	0.0800	0.400
Gender (ref. = female)							
male – female	0.8824	0.266	3.3198	**< .001**	2.417	1.4354	4.069
Age (ref. = 19–25)							
25–35 against 19–25	0.0398	0.412	0.0965	0.923	1.041	0.4637	2.335
35–45 against 19–25	-0.4392	0.444	-0.9900	0.322	0.645	0.2702	1.538
> 45 against 19–25	0.0527	0.444	0.1188	0.905	1.054	0.4419	2.515
Education (ref. ≥ university degree)							
≥ university against < university	-0.1154	0.317	-0.3641	0.716	0.891	0.4788	1.658
Marital status (ref. = never married)							
married/previously–never married	-0.7438	0.269	-2.7643	**0.006**	0.475	0.2805	0.805
City (ref. = Izmir)							
Istanbul–Izmir	0.3276	0.282	1.1635	0.245	1.388	0.7991	2.410
Ankara–Izmir	-0.3949	0.361	-1.0954	0.273	0.674	0.3324	1.366
Road user (ref. = non-driver)							
driver against non-driver	-0.0799	0.278	-0.2871	0.774	0.923	0.5351	1.593
Weapons presence (ref. = no)							
yes–no	1.0058	0.326	3.0871	**0.002**	2.734	1.4438	5.178

Estimates represent the log odds of road rage ('yes = 1', 'no = 0'); ref. = reference category
Model Fit Measures: $\chi^2 = 43.1$ (10df), p < .001, R^2_N (Nagelkerke R Square) = 0.12

Table 6 Logistic regression analyses on low-level of road rage perpetration

Predictor	Estimate	SE	Z	p	OR	Lower 95% CI	Upper 95% CI
Intercept	-1.4053	0.353	-3.981	< .001	0.245	0.123	0.490
Gender (ref. = female)							
male – female	0.3857	0.190	2.025	**0.043**	1.471	1.012	2.136
Age (ref. = 19-25)							
25–35 against 19–25	-0.3705	0.355	-1.042	0.297	0.690	0.344	1.385
35–45 against 19–25	-0.3555	0.367	-0.969	0.333	0.701	0.341	1.438
>45 against 19–25	-0.5785	0.379	-1.528	0.126	0.561	0.267	1.178
Education (ref. ≥ university degree)							
≥ university against < university	0.5439	0.259	2.104	**0.035**	1.723	1.038	2.860
Marital status (ref. = never married)							
married/previously–never married	-0.0581	0.202	-0.288	0.774	0.944	0.635	1.401
City (ref. = Izmir)							
Istanbul–Izmir	0.1879	0.205	0.918	0.359	1.207	0.808	1.803
Ankara–Izmir	0.1259	0.258	0.488	0.625	1.134	0.684	1.880
Road user (ref. = non-driver)							
driver against non-driver	1.1471	0.205	5.583	**< .001**	3.149	2.105	4.711
Weapons presence (ref. = no)							
yes–no	1.3040	0.326	4.000	**< .001**	3.684	1.945	6.980

Estimates represent the log odds of road rage ('yes = 1', 'no = 0'); ref. = reference category
Model Fit Measures: $\chi^2 = 80.6$ (10df), $p < .001$, R^2_N (Nagelkerke R Square) = 0.17

Table 7 Logistic regression analyses on high-level of road rage perpetration

Predictor	Estimate	SE	Z	p	OR	Lower 95% CI	Upper 95% CI
Intercept	-3.7938	0.828	-4.5794	< .001	0.0225	0.00444	0.114
Gender (ref. = female)							
male–female	0.4109	0.548	0.7499	0.453	1.5082	0.51525	4.415
Age (ref. = 19-25)							
25–35 against 19–25	0.3713	0.721	0.5151	0.607	1.4497	0.35287	5.956
35–45 against 19–25	-0.0314	0.791	-0.0397	0.968	0.9691	0.20553	4.569
>45 against 19–25	-0.0724	0.0320	-2.260	**0.024**	0.930	0.8735	0.990
Education (ref. ≥ university degree)							
≥ university against < university	-0.1992	0.615	-0.3241	0.746	0.8194	0.24564	2.733
Marital status (ref. = never married)							
married/previously–never married	-1.0668	0.574	-1.8599	0.063	0.3441	0.11180	1.059
City (ref. = Izmir)							
Istanbul–Izmir	-0.1813	0.573	-0.3162	0.752	0.8342	0.27116	2.566
Ankara–Izmir	-0.6914	0.707	-0.9784	0.328	0.5009	0.12537	2.001
Road user (ref. = non-driver)							
driver against non-driver	0.9192	0.617	1.4894	0.136	2.5073	0.74793	8.405
Weapons presence (ref. = no)							
yes–no	2.1445	0.505	4.2458	**< .001**	8.5380	3.17266	22.977

Estimates represent the log odds of road rage ('yes = 1', 'no = 0'); ref. = reference category
Model Fit Measures: $\chi^2 = 44.6$ (10df), $p < .001$, R^2_N (Nagelkerke R Square) = 0.26

of road rage incidents are the focus of some studies in the literature. Results of a study in 2005 showed that in the previous year, victims of road rage were reported to be 47.5% in 2001 and 40.6% in 2003, a decline. It was reported that 28% of participants had been victim in the previous five years (Fong et al., 2001). A study found that 46% of drivers reported being the victims of obscene gestures, 46% of drivers reported being followed aggressively, and 27% reported being the victims of both behaviors (Hemenway et al., 2006). In the last ten years, it has been reported that threats, shouting, and yelling in traffic have increased (Møller & Haustein, 2018).

4.2 Frequency of road rage perpetration

The person who was responsible for the incident is known as the road rage perpetrator. It was reported that 12% of participants had been perpetrator in the previous five years. Additionally, 10% of participants have been both the victims and perpetrators (mix group) of road rage (Fong et al., 2001). The most common behaviors were reported to be purposefully tailgating another vehicle (50.8%), yelling at another driver (46.6%), and honking their horn 'to show annoyance or anger' (44.5%). 11.9% of these drivers admitted to having obstructed another vehicle's path (AAA_Foundation, 2014). One study showed that 17% of participants aggressively followed other motorists and made obsence gestures (Hemenway et al., 2006). In a study, the prevalence of being a perpetrator of road rage was 33.6% (Smart et al., 2005b). The lower levels of road rage, like shouting, cursing, etc. were the most frequently displayed behaviors by drivers (Wickens et al., 2012). According to the findings of one study, 70% of drivers in Australia engaged in minor acts of aggressive road behaviors, such as chasing someone with their vehicle (Stephens & Fitzharris, 2019). In a Chinese study, 51.3% of drivers become enraged when cars traveling in the opposite direction turn their high beams, and 34.1% use their own high beams to respond (Wu et al., 2018). The rate of being the perpetrator of lower levels of road rage behaviors like shouting, swearing, and making gestures was 43.6%, according to our study. Also, higher levels of road rage behaviors like threats and harm was a rate of 3.5%. The results of the chi-square analysis also indicated that being younger, male, single and employed, driving, and possessing a weapon were all associated with being a perpetrator of road rage.

4.3 Sociodemographic and other risk factors

Which characteristics are most frequently associated with road rage? Is there a connection between sociodemographic factors and road rage behaviors? What other factors can affect road rage? These and other similar questions have been the subject of numerous studies in the literature. These studies (Blanchard et al., 2000; Asbridge et al., 2003; Smart et al., 2003; Vanlaar et al., 2008; Lee & Bonfiglio, 2013; Smart et al., 2007, 2005a; Aktaş & Akgür, 2022a) are evaluating demographic and other variables, particularly drivers. Smart et al. found that males and younger people are more likely to experience victimization of road rage. Also, it is reported that women are exposed to serious road rage as much as men (Smart et al., 2007). Men are more likely to get involved in situations that suggest physical aggression (Blanchard et al., 2000). According to a study of Turkish drivers, female drivers are more likely than male drivers to be the victims of road rage (Aktaş & Akgür, 2022a) . On the other hand, another studies are reporting that victimization does not differ by gender (Asbridge et al., 2003). While some studies find no correlation, others indicate a higher male prevalence of aggressive driving (Vanlaar et al., 2008) or contrast concerning trigger occasions (Lee & Bonfiglio, 2013).

According to our findings, age and driving a vehicle (for low-level road rage), as well as gender, marital status and carrying a weapon (for high-level road rage), are contributing factors of road rage victimization. In a previous study, it is reported that the amount of road rage victimization is slightly affected by vehicle type (Smart et al., 2004). Studies in the past have shown that road rage significantly increases the likelihood of collisions (Wells-Parker et al., 2002; Deffenbacher et al., 2003; Mann et al., 2007; Stephens & Groeger, 2011).

Youth (Evans, 2004) and male gender were found to be significant risk factors for driver aggression in other studies: (Ellison-Potter et al., 2001; Krahé & Fenske, 2002; Miller et al., 2002; Evans, 2004; AAA_Foundation, 2014). In Turkey, males between the ages of 21 and 35 are thought to be at higher risk for driver aggression (Eşiyok et al., 2007). Similarly, it has been reported that younger drivers (18 to 34 years old) are more likely than older drivers (55 and older) to engage in road rage Wickens et al. (2011, 2012). On the other hand, different results have been reported in other studies. For example, a study conducted in Canada

by (Wickens et al., 2012) found that gender was not a significant predictor of driver aggression. According to our findings, females, individuals with an education lower level of university degree, drivers and road users carrying a weapon (for low-level road rage), and youth and road users carrying a weapon (for high-level road rage) reported being more perpetrators of road rage.

Each of these potential causes of road rage will need to be examined in greater detail in future research. We believe that specific consideration should be given to the risk factors associated with road rage. For instance, the most dangerous form of road rage can occur when a driver has immediate access to a firearm or other weapon. In many societies, firearms are readily available. For instance, it is remarkable that Americans own approximately 31% of all weapons, despite having only 4% of the world's population (Benjamin & Bushman, 2016). According to 2017 data from the Ministry of Interior, General Directorate of Security, there has been a decrease in the number of licensed weapons in Turkey over the past ten years. However, the precise use of unlicensed weapons cannot be determined due to unregistered procurement. According to the ten-year crime statistics, 25 547 crimes were committed using licensed firearms and 159 123 crimes were committed using unlicensed firearms (Orhan & Yeter, 2019). Hence, it is important to control the availability of weapons around the world. Who is allowed to own a gun is one of the most important issues. Individuals must undergo a thorough psychological assessment (such as personality traits, impulsivity, anger) before the authorities issued a gun license.

As in our study, other factors such as having a weapon (sticks, knives, batons, guns, pepper sprays, etc.) in the vehicle come to the forefront in some studies. The weapons effect is thought to be a significant factor that influences road rage behaviors. Some studies (Bushman et al., 2017; Dukes, 2001; Miller et al., 2002), particularly those conducted in the United States, address this issue. Having a weapon in the car was linked to driver aggression, such as following other drivers aggressively. In addition, it has been reported that drivers who have guns in their vehicles are more likely to commit acts of road rage (Miller et al., 2002; Hemenway et al., 2006). According to the findings of a study that was carried out on drivers in Turkey, drivers who had a weapon in their vehicle were more likely to be both the perpetrators and the victims of road rage (Aktaş, 2021).

4.4 Road rage among vulnerable road users

Vulnerable road users are road users other than drivers. In the traffic environment, it is assumed that they are more vulnerable than others (Cavacuiti et al., 2013). As discussed above, many previous studies focus on driver behaviors. It is believed that drivers' actions have received more attention than pedestrians' (Rosenbloom et al., 2004). The World Health Organization (WHO, 2018b), says that pedestrians, cyclists, and motorcyclists account for more than half of road traffic deaths. 36.2% of our study sample are passengers, cyclists, and pedestrians. Our findings indicate that drivers are more likely than other road users to encounter road rage.

It has been suggested that the pedestrian behaviors such as violations are also an effective factor in the realization of traffic accidents and male pedestrians displayed higher frequency of aggressive behaviors than females (Qu et al., 2016). Demographic factors like gender and age are linked to risky traffic behavior in some studies with pedestrians (Rosenbloom et al., 2004; Granié et al., 2013; Papadimitriou et al., 2013; Deb et al., 2017). According to the findings of a study conducted in Turkey, both the actions of drivers and pedestrians are crucial to road safety (Öztürk & Öz, 2021). Turkish and Russian pedestrians are more likely than other pedestrians to engage in aggressive behavior, according to a cross-cultural study (Solmazer et al., 2020). Additionally, it is essential to investigate the actions of cyclists, pedestrians, and passengers. According to a different cross-cultural study, approximately 80% of cyclists, 75% of pedestrians, and 40% of passengers in Turkey reported that car drivers did not treat them with respect (Azık et al., 2021). In short, all road users must interact with the traffic system, which is a dynamic and complicated system (Özkan & Lajunen, 2011).

4.5 Applications related to road rage

The issue of road rage and whether it should be included in the laws is a widely debated topic. It is emphasized the importance of research conducted to establish special laws that facilitate law enforcement officers and other justice officials in dealing with road rage (Asbridge et al., 2006). In the majority of legal jurisdictions, acts that involve the threat or actual physical harm are deemed unlawful. However, certain road rage behaviors such as yelling, cursing, or making negative comments about others' driving

are likely not illegal in most places. For example, in Canada, most road rage cases brought to court involve assault, vehicular manslaughter, or dangerous driving behaviors. However, in the state of Illinois in the United States, road rage is specifically addressed in a statute (Asbridge et al., 2006). In Turkey, some opinions also suggest that traffic offenses should be perceived as ordinary crimes, considering the possibility that every vehicle driven by anyone behind the wheel could be a potential killing machine (Yüksel et al., 2013). Nevertheless, it can be argued that the existing legal regulations in this matter are inadequate. For instance, in the Turkish Penal Code numbered 5237, Article 179, which was created with reference to the German Penal Code, addresses the offense of endangering traffic safety. It states that a prison sentence ranging from 1 year to 6 years can be imposed for this offense. In practice, particular attention is given to the third paragraph of the same article, which states that individuals who operate a vehicle while being unable to do so safely due to the influence of alcohol, drugs, or any other reason, shall be punished according to the provisions of the aforementioned paragraph (Temel, 2019). Therefore, in Turkey, behaviors that are of a minor nature but occasionally pose a risk to traffic safety are not considered within the scope of criminal law.

It is possible to say that transportation regulations are directly dependent on government practices when it comes to traffic safety (Gaygısız, 2010). To increase traffic safety, traffic authorities must especially take a comprehensive approach that takes into account all road users (Öztürk & Öz, 2021). The World Health Organization says that effective road safety programs, including changes to laws, have been implemented in some countries, resulting in significant decreases in traffic deaths and injuries. In addition, it is reported that the public's awareness of these issues and the continual and robust implementation of the legislation lead to the most beneficial behavioral changes in road users (WHO, 2015). A study conducted in Hungary revealed that road safety measures have a beneficial effect, particularly on traffic accidents involving pedestrians (Mako & Szakonyi, 2016).

It is critical to develop programs for prevention and intervention that effectively reduce road rage incidents. In the context of traffic safety, it is essential to know which personal variables and psychopathologies are problematic in order to develop effective and remedial studies (Berdoulat et al., 2021). It is thought that it would be beneficial to include individuals in driver education programs about anger management and non-aggressive driving practices who are likely to exhibit aggressive behavior (Asbridge et al., 2006). According to the findings of a psychological intervention study that was carried out by (Galovski & Blanchard, 2002), cognitive behavioral therapy techniques have the potential to have an impact on those who commit acts of violence on the road. Recent research on emotion and emotion regulation has shed new light on the causes of road rage and the treatment and prevention options for it (Bjureberg & Gross, 2021).

Besides all these, autonomous vehicles offer hope for a safer traffic environment in the future. According to some companies, these vehicles may affect road rage behaviors. But this issue is not clear. For instance, it is difficult to predict how human drivers will react when a driver-less car is involved in an accident or cuts off the road (Giarratana, 2019).

5 Conclusion

Overall, these data suggest that a significant set of factors may be associated with road rage victimization and perpetration reported by Turkish road users (i.e., drivers, cyclists, pedestrians, and passengers). The frequency of experiencing different forms of road rage is influenced by factors such as age, gender, marital status, driving a vehicle, carrying a weapon. Consequently, road rage is a complex phenomenon (Fong et al., 2001). The emergence of road rage is facilitated by the interaction of these and other contextual factors. In some cultures, for instance, unnecessarily honking may mean something different from causing the other person to be disturbed. Some drivers in Turkey may honk to greet one another. Or, on November 10, the anniversary of Atatürk's death, vehicles stop on the road and honk in remembrance. The intention is the determining factor here, as demonstrated by these examples. Therefore, it is critical to look at this problem from multiple angles.

Based on our findings, it becomes evident that there is a need to review the existing legal regulations in Turkey and implement preventive measures. Particularly in the traffic environment, behaviors such as abruptly changing lanes (weaving in and out of traffic), verbally abusing or yelling at other drivers can be deterred by imposing heavier penalties. However, the problem of road rage cannot be solely solved through penalties. At this point, we believe that it would be beneficial, in the

long run, to make it mandatory for drivers to undergo psychotechnical and psychological evaluations during the driver's license application process. Providing training specifically focused on anger management could prove beneficial in practice. Additionally, mass media plays a crucial role in informing road users about the risks associated with road rage and how to avoid them. In addition to all of these, sharing road safety messages through electronic traffic signs and utilizing advertising billboards in crowded areas for this purpose can be beneficial.

6 Limitations

Our findings have various limitations. First of all, the social desirability principle should be taken into account when interpreting these data collected by the self-report. Another limitation is that the majority of the sample consisted of females. It is common knowledge that men and women have distinct traffic behavior patterns. Once more, a limitation is likewise that most of the example comprised of drivers. Additionally, it may be a limitation to conduct a survey using both online and in-person methods. It is worth mentioning that a limitation of this study is the possibility for individuals to occupy both victim and perpetrator roles simultaneously. Finally, the current study is a cross-sectional study. Furthermore, a significant issue is the causality's direction. Thus, the findings require careful interpretation.

CRediT contribution statement

Alev Aktaş: Conceptualization, Methodology, Writing—original draft, Writing—review, Writing—editing. **Serap Annette Akgür:** Conceptualization, Supervision, Writing—original draft.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

AAA_Foundation (2014), 'Prevalence of Self-Reported Aggressive Driving Behavior: United States', AAA Foundation for Traffic Safety, https://aaafoundation.org/prevalence-self-reported-aggressive-driving-behavior-united-states-2014/.

Akşar, C., T. Alavci (2018), 'Cinsiyetçiliğin Sürücü Öfkesi ve Sürücü Öfke İfadesi ile İlişkisi', *Trafik ve Ulaşım Araştırmaları Dergisi*, 1(1), 69–87, https://dergipark.org.tr/en/download/article-file/467703.

Aktaş, A. (2021), 'Sürücülerde alkol kullanımı ve yol şiddeti (road rage) arasındaki ilişkinin incelenmesi', PhD thesis, Ege Üniversitesi, https://www.researchgate.net/publication/354007214_Suruculerde_Alkol_Kullanimi_ile_Yol_Siddeti_Road_Rage_Arasindaki_Iliskinin_Incelenmesi.

Aktaş, A., S. A. Akgür (2022a), 'Drinking, drug use and road rage in Turkish drivers', *Transportation Research Part F: Traffic Psychology and Behaviour*, 89, 16–28, https://doi.org/10.1016/j.trf.2022.06.012.

Aktaş, A., S. A. Akgür (2022b), 'Yol Şiddeti Öyküleri: Bir Nitel Çalışma', *Trafik ve Ulaşım Araştırmaları Dergisi*, 5(1), 1–21, https://doi.org/10.38002/tuad.1054784.

Anderson, C. A., B. J. Bushman (2002), 'Human Aggression', *Annual Review of Psychology*, 53(1), 27–51, https://doi.org/10.1146/annurev.psych.53.100901.135231.

Asbridge, M., R. G. Smart, R. E. Mann (2003), 'The homogamy of road rage: understanding the relationship between victimization and offend- ing among aggressive and violent motorists', *Violence and Victims*, 18(5), 517–531, https://doi.org/10.1891/vivi.2003.18.5.517.

Asbridge, M., R. G. Smart, R. E. Mann (2006), 'Can We Prevent Road Rage?', *Trauma, Violence, & Abuse*, 7(2), 109–121, https://www.jstor.org/stable/26636138.

Azık, D., et al. (2021), 'Road users' evaluations and perceptions of road infrastructure, trip characteristics, and daily trip experiences across countries', *Transportation Research Interdisciplinary Perspectives*, 11, https://doi.org/10.1016/j.trip.2021.100412.

Benavidez, D. C. (2013), 'Road rage among drug dependent patients', *Accident Analysis & Prevention*, 50, 848–853, https://doi.org/10.1016/j.aap.2012.07.010.

Benjamin, A. J., B. J. Bushman (2016), 'The weapons priming effect', *Current Opinion in Psychology*, 12, 45–48, https://doi.org/10.1016/j.copsyc.2016.05.003.

Berdoulat, E., J. Deninotti, D. Vavassori (2021), 'Typology of aggressive and transgressive drivers', *Accident Analysis & Prevention*, 162, 106404, https://doi.org/10.1016/j.aap.2021.106404.

Berkowitz, L. (1974), 'Some determinants of impulsive aggression: Role of mediated associations with reinforcements for aggression', *Psychological Review*, 81(2), 165–176, https://doi.org/10.1037/h0036094.

Berkowitz, L. (1993), *Aggression: Its causes, consequences, and control* (New York, NY: McGraw-Hill).

Bjureberg, J., J. J. Gross (2021), 'Regulating road rage', *Social and Personality Psychology Compass*, 15(3), 1–16, https://doi.org/10.1111/spc3.12586.

Blanchard, E. B., K. A. Barton, L. Malta (2000), 'Psychometric Properties of a Measure of Aggressive Driving: The Larson Driver's Stress Profile', *Psychological Reports*, 87(3), 881–892, https://doi.org/10.2466/pr0.2000.87.3.881.

Brewer, A. M. (2000), 'Road rage: What, who, when, where and how?', *Transport Reviews*, 20(1), 49–64, https://doi.org/10.1080/014416400295338.

Britt, T. W., M. J. Garrity (2003), 'An integrative model of road rage', *Revue Internationale de Psychologie Sociale*, 16(3), 53–79.

Briz-Redón, A., F. Martínez-Ruiz, F. Montes (2019), 'Spatial analysis of traffic accidents near and between road intersections in a directed linear network', *Accident Analysis & Prevention*, 132, 105252–105252, https://doi.org/10.1016/j.aap.2019.07.028.

Bushman, B. J., C. A. Anderson (2001), 'Is it time to pull the plug on hostile versus instrumental aggression dichotomy?', *Psychological Review*, 108(1), 273–279, https://doi.org/10.1037/0033-295x.108.1.273.

Bushman, B. J., T. Kerwin, T. Kerwin, J. M. Weisenberger (2017), 'The weapons effect on wheels: Motorists drive more aggressively when there is a gun in the vehicle', *Journal of Experimental Social Psychology*, 73, 82–85, https://doi.org/10.1016/j.jesp.2017.06.007.

Carpenter, J. (2020), 'Kill switch: The evolution of road rage in an increasingly AI car culture', in and others (ed.), *Living with Robots*, Elsevier, , pp. 75–90, https://doi.org/10.1016/b978-0-12-815367-3.00004-9.

Cavacuiti, C., et al. (2013), 'Victims of Road Rage: A Qualitative Study of the Experiences of Motorists and Vulnerable Road Users', *Violence and Victims*, 28(6), 1068–1084, https://doi.org/10.1891/0886-6708.vv-d-12-00068.

Deb, S., L. Strawderman, J. DuBien, B. Smith, D. W. Carruth, T. M. Garrison (2017), 'Evaluating pedestrian behavior at crosswalks: Validation of a pedestrian behavior questionnaire for the U.S. population', *Accident Analysis & Prevention*, 106, 191–201, https://doi.org/10.1016/j.aap.2017.05.020.

Deffenbacher, J. L., D. M. Deffenbacher, R. S. Lynch, T. L. Richards (2003), 'Anger, aggression, and risky behavior: a comparison of high and low anger drivers', *Behaviour Research and Therapy*, 41(6), 701–718, https://doi.org/10.1016/s0005-7967(02)00046-3.

Deffenbacher, J. L., R. S. Lynch, E. R. Oetting, R. C. Swaim (2002), 'The Driving Anger Expression Inventory: a measure of how people express their anger on the road', *Behaviour Research and Therapy*, 40(6), 717–737, https://doi.org/10.1016/s0005-7967(01)00063-8.

Deffenbacher, J. L., E. R. Oetting, R. S. Lynch (1994), 'Development of a Driving Anger Scale', *Psychological Reports*, 74(1), 83–91, https://doi.org/10.2466/pr0.1994.74.1.83.

Deffenbacher, J. L., A. N. Stephens, M. J. M. Sullman (2016), 'Driving anger as a psychological construct: Twenty years of research using the Driving Anger Scale', *Transportation Research Part F: Traffic Psychology and Behaviour*, 42, 236–247, https://doi.org/10.1016/j.trf.2015.10.021.

Dukes, R. L. (2001), 'Effects of aggressive driving and driver characteristics on road rage', *The Social Science Journal*, 38(2), 323–331, https://doi.org/10.1016/S0362-3319(01)00117-3.

Dula, C. S., M. E. Ballard (2003), 'Development and Evaluation of a Measure of Dangerous, Aggressive, Negative Emotional, and Risky Driving1', *Journal of Applied Social Psychology*, 33(2), 263–282, https://doi.org/10.1111/j.1559-1816.2003.tb01896.x.

Dula, C. S., E. S. Geller (2003), 'Risky, aggressive, or emotional driving: Addressing the need for consistent communication in research', *Journal of Safety Research*, 34(5), 559–566, https://doi.org/10.1016/j.jsr.2003.03.004.

Ellison, P. A., J. M. Govern, H. L. Petri, M. H. Figler (1995), 'Anonymity and Aggressive Driving Behavior:A Field Study', *Journal of Social Behavior & Personality*, 10(1), 265–272.

Ellison-Potter, P., P. Bell, J. Deffenbacher (2001), 'The Effects of Trait Driving Anger, Anonymity, and Aggressive Stimuli on Aggressive Driving Behavior', *Journal of Applied Social Psychology*, 31(2), 431–443, https://doi.org/10.1111/j.1559-1816.2001.tb00204.x.

Eşiyok, B., Y. Yasak, İ. Korkusuz (2007), 'Trafikte öfke ifadesi: sürücü öfke ifadesi envanteri'nin geçerlik ve güvenilirliği', *Türk Psikiyatri Dergisi*, 18(3), 231–243.

Evans, L. (2004), *Traffic Safety* Science Serving Society.

Fierro, I., C. Morales, F. J. Álvarez (2011), 'Alcohol use, illicit drug use, and road rage', *Journal of Studies on Alcohol and Drugs*, 72(2), 185–193, https://doi.org/10.15288/jsad.2011.72.185.

Fong, G., D. Frost, S. Stansfeld (2001), 'Road rage: A psychiatric phenomenon?', *Social Psychiatry and Psychiatric Epidemiology*, 36, 277–286, https://doi.org/10.1007/s001270170045.

Galovski, T. E., E. B. Blanchard (2002), 'The effectiveness of a brief psychological intervention on court-referred and self-referred aggressive drivers', *Behaviour Research and Therapy*, 40(12), 1385–1402, https://doi.org/10.1016/s0005-7967(01)00100-0.

Gaygısız, E. (2010), 'Cultural values and governance quality as correlates of road traffic fatalities: A nation level analysis', *Accident Analysis & Prevention*, 42(6), 1894–1901, https://doi.org/10.1016/j.aap.2010.05.010.

Giarratana, C. (2019), Will Autonomous Cars Spark A New Form Of Road Rage?, https://www.trafficsafetystore.com/blog/will-autonomous-cars-spark-a-new-form-of-road-rage/, accessed 2023-06-22.

Granié, M.-A., M. Pannetier, L. Guého (2013), 'Developing a self-reporting method to measure pedestrian behaviors at all ages', *Accident Analysis & Prevention*, 50, 830–839, https://doi.org/10.1016/j.aap.2012.07.009.

Güngör, A., M. Tütenkan, G. Solmazer, B. Tekeş (2020), 'Emotion Regulation Strategies and Driving Anger Expression: The Moderating Role of Gender', *Nesne Psikoloji Dergisi*, https://doi.org/10.7816/nesne-08-16-09.

Guo, F., Y. Fang (2013), 'Individual driver risk assessment using naturalistic driving data', *Accident Analysis & Prevention*, 61, 3–9, https://doi.org/10.1016/j.aap.2012.06.014.

Hemenway, D., M. Vriniotis, M. Miller (2006), 'Is an armed society a polite society? Guns and road rage', *Accident Analysis & Prevention*, 38(4), 687–695, https://doi.org/10.1016/j.aap.2005.12.014.

Herrero-Fernández, D., S. Fonseca-Baeza (2017), 'Angry thoughts in Spanish drivers and their relationship with crash-related events. The mediation effect of aggressive and risky driving', *Accident Analysis & Prevention*, 106, 99–108, https://doi.org/10.1016/j.aap.2017.05.015.

Hussain, B., H. Sato, T. Miwa, T. Morikawa (2020), 'Influence of personality traits on aberrant driving behaviors: A comparison of Japanese, Chinese, and Vietnamese drivers', *Journal of Safety Research*, 75, 178–188, https://doi.org/10.1016/j.jsr.2020.09.011.

Indermaur, D. (1998), 'Preventing driving related violence', *7th international seminar on environmental criminology and crime analysis*, Barcelona, Spain, 21–24 June 1998, https://www.celt.uwa.edu.au/__data/assets/pdf_file/0009/118539/Preventing_Driving_Related_Violence.pdf.

Joint, M. (1995), 'Road rage', Automobile Association.

Joo, Y. J. (2022), 'A data-driven Bayesian network for probabilistic crash risk assessment of individual driver with traffic violation and crash records', *Accident Analysis & Prevention*, 176, https://doi.org/10.1016/j.aap.2022.106790.

Jovanović, D., K. Lipovac, P. Stanojević, D. Stanojević (2011), 'The effects of personality traits on driving-related anger and aggressive behaviour in traffic among Serbian drivers', *Transportation Research Part F: Traffic Psychology and Behaviour*, 14(1), 43–53, https://doi.org/10.1016/j.trf.2010.09.005.

Kenrick, D. T., S. W. MacFarlane (1986), 'Ambient Temperature and Horn Honking', *Environment and Behavior*, 18(2), 179–191, https://doi.org/10.1177/0013916586182002.

Kölbel, R. (2003), 'Violence on the Roads', *International Handbook of Violence Research* (Dordrecht, Germany: Springer), https://doi.org/10.1007/978-0-306-48039-3_46.

Krahé, B., I. Fenske (2002), 'Predicting aggressive driving behavior: The role of macho personality, age, and power of car', *Aggressive Behavior*, 28(1), 21–29, https://doi.org/10.1002/ab.90003.

Lajunen, T., D. Parker, S. G. Stradling (1998), 'Dimensions of driver anger, aggressive and highway code violations and their mediation by safety orientation in UK drivers', *Transportation Research Part F: Traffic Psychology and Behaviour*, 1(2), 107–121, https://doi.org/10.1016/S1369-8478(98)00009-6.

Lajunen, T., D. Parker, H. Summala (1999), 'Does traffic congestion increase driver aggression?', *Transportation Research Part F: Traffic Psychology and Behaviour*, 2(4), 225–236, https://doi.org/10.1016/s1369-8478(00)00003-6.

Lawton, R., A. Nutter (2002), 'A comparison of reported levels and expression of anger in everyday and driving situations', *British Journal of Psychology*, 93(3), 407–423, https://doi.org/10.1348/000712602760146521.

Lee, Y.-C., D. J. Bonfiglio (2013), 'What is stressful on the road? Analysis on aggression-inducing traffic situations through self-report', *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 57, 1500–1503, https://doi.org/10.1177/1541931213571334.

Lupton, D. (2002), 'Road rage: drivers' understandings and experiences', *Journal of Sociology*, 38(3), 275–290, https://doi.org/10.1177/144078302128756660.

Mako, E., P. Szakonyi (2016), 'Evaluation of Human Behaviour at Pedestrian Crossings', *Transportation Research Procedia*, 14, 2121–2128, https://doi.org/10.1016/j.trpro.2016.05.227.

Mann, R. E., J. Zhao, G. Stoduto, E. M. Adlaf, R. G. Smart, J. E. Donovan, et al. (2007), 'Road rage and collision involvement', *American Journal of Health Behavior*, 31(4), 384–391, https://doi.org/10.5993/ajhb.31.4.5.

Mann, R. E., et al. (2004), 'Alcohol consumption and problems among road rage victims and perpetrators', *Journal of Studies on Alcohol*, 65(2), 161–168, https://doi.org/10.15288/jsa.2004.65.161.

Miller, M., D. Azrael, D. Hemenway, F. I. Solop (2002), '"Road rage" in Arizona: armed and dangerous', *Accident Analysis & Prevention*, 34(6), 807–814, https://doi.org/10.1016/s0001-4575(01)00080-x.

Møller, M., S. Haustein (2018), 'Road anger expression-Changes over time and attributed reasons', *Accident Analysis & Prevention*, 119, 29–36, https://doi.org/10.1016/j.aap.2018.06.013.

NHTSA (2022), 'Early Estimate of Motor Vehicle Traffic Fatalities for the First Half (January – June) of 2022', National Center for Statistics and Analysis. National Highway Traffic Safety Administration, DOT HS 813 376, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813376.

Orhan, G., Ö. B. Yeter (2019), 'Bir İç Güvenlik Sorunu Olarak Bireysel Silahlanma: Türkiye İçin Durum Değerlendirmesi Ve Politika Alternatifleri', *ASSAM Uluslararası Hakemli Dergi 13. Uluslararası Kamu Yönetimi Sempozyumu Bildirileri Özel Sayısı*, 130–143.

Özkan, T., T. Lajunen (2011), 'Person and environment: Traffic culture', in Porter, B. E. (ed.), *Handbook of Traffic Psychology* (San Diego, CA, USA: Elsevier),

https://doi.org/10.1016/b978-0-12-381984-0.10014-1.

Özkan, T., T. Lajunen, D. Parker, N. Sümer, H. Summala (2011), 'Aggressive driving among British, Dutch, Finnish and Turkish drivers', *International Journal of Crashworthiness*, 16(3), 233–238, https://doi.org/10.1080/13588265.2010.536687.

Öztürk, İ., B. Öz (2021), 'Investigating Young Male and Female Road Users' Behaviour as Pedestrians and Drivers', *Psikoloji Çalışmaları / Studies in Psychology*, 41(2), 581–614, https://doi.org/10.26650/sp2020-0045.

Öztürk, İ., Ö. Özkan, B. Öz (2021), 'Investigating sex, masculinity and femininity in relation to impulsive driving and driving anger expression', *Transportation Research Part F: Traffic Psychology and Behaviour*, 81, 14–26, https://doi.org/10.1016/j.trf.2021.05.009.

Papadimitriou, E. (2019), 'Review and ranking of crash risk factors related to the road infrastructure', *Accident Analysis & Prevention*, 125, 85–97, https://doi.org/10.1016/j.aap.2019.01.002.

Papadimitriou, E., A. Theofilatos, G. Yannis (2013), 'Patterns of pedestrian attitudes, perceptions and behaviour in Europe', *Safety Science*, 53, 114–122, https://doi.org/10.1016/j.ssci.2012.09.008.

Pfeiffer, J. L., K. Pueschel, D. Seifert (2016), 'Interpersonal violence in road rage. Cases from the Medico-Legal Center for Victims of Violence in Hamburg', *Journal of Forensic and Legal Medicine*, 39, 42–45, https://doi.org/10.1016/j.jflm.2015.11.023.

Qu, W., H. Zhang, W. Zhao, K. Zhang, Y. Ge (2016), 'The effect of cognitive errors, mindfulness and personality traits on pedestrian behavior in a Chinese sample', *Transportation Research Part F: Traffic Psychology and Behaviour*, 41, 29–37, https://doi.org/10.1016/j.trf.2016.06.009.

Rathbone, D. B., J. C. Huckabee (1999), 'Controlling Road Rage: A Literature Review and Pilot Study', AAA Foundation for Traffic Safety, https://doi.org/10.1037/e363912004-001.

Rosenbloom, T., D. Nemrodov, H. Barkan (2004), 'For heaven's sake follow the rules: pedestrians' behavior in an ultra-orthodox and a non-orthodox city', *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(6), 395–404, https://doi.org/10.1016/j.trf.2004.10.004.

Sarkar, S. (2000), 'Spatial and Temporal Analyses of Observed and Reported Variations', *Transportation Research Record: Journal of the Transportation Research Board*, 1724(1), 7–13, https://doi.org/10.3141/1724-02.

Shinar, D. (1998), 'Aggressive driving: the contribution of the drivers and the situation', *Transportation Research Part F: Traffic Psychology and Behaviour*, 1(2), 137–160, https://doi.org/10.1016/S1369-8478(99)00002-9.

Smart, R. G., E. Cannon, A. Howard, P. Frise, R. E. Mann (2005a), 'Can we design cars to prevent road rage?', *International Journal of Vehicle Information and Communication Systems*, 1(1/2), https://doi.org/10.1504/ijvics.2005.007585.

Smart, R. G., R. E. Mann (2002), 'Deaths and injuries from road rage: Cases in Canadian newspapers', *Canadian Medical Association Journal*, 167(7), 761–762, https://www.cmaj.ca/content/167/7/761.short.

Smart, R. G., R. E. Mann, G. Stoduto (2003), 'The Prevalence of Road Rage: Estimates from Ontario', *Canadian Journal of Public Health*, 94(4), 247–250, https://doi.org/10.1007/BF03403543.

Smart, R. G., R. E. Mann, J. Zhao, G. Stoduto (2005b), 'Is road rage increasing? Results of a repeated survey', *Journal of Safety Research*, 36(2), 195–201, https://doi.org/10.1016/j.jsr.2005.03.005.

Smart, R. G., G. Stoduto, R. E. Mann, E. M.Adlaf (2004), 'Road Rage Experience and Behavior: Vehicle, Exposure, and Driver Factors', *Traffic Injury Prevention*, 5(4), 343–348, https://doi.org/10.1080/15389580490509482.

Smart, R. G., et al. (2007), 'Road Rage Victimization Among Adolescents', *Journal of Adolescent Health*, 41(3), 277–282, https://doi.org/10.1016/j.jadohealth.2007.04.013.

Solmazer, G., et al. (2020), 'Cross-cultural differences in pedestrian behaviors in relation to values: A comparison of five countries', *Accident Analysis & Prevention*, 138, https://doi.org/10.1016/j.aap.2020.105459.

Stephens, A., M. Fitzharris (2019), 'The frequency and nature of aggressive acts on Australian roads', *Journal of the Australasian College of Road Safety*, 30(3), 27–36, https://doi.org/10.33492/jacrs-d-18-00293.

Stephens, A. N., J. A. Groeger (2011), 'Anger-congruent behaviour transfers across driving situations', *Cognition & Emotion*, 25(8), 1423–1438, https://doi.org/10.1080/02699931.2010.551184.

Sullman, M. J., M. E. Gras, M. Cunill, M. Planes, S. Font-Mayolas (2007), 'Driving anger in Spain', *Personality and Individual Differences*, 42(4), 701–713, https://doi.org/10.1016/j.paid.2006.08.014.

Sullman, M. J. M., A. N. Stephens, D. Kuzu (2013), 'The expression of anger amongst Turkish taxi drivers', *Accident Analysis & Prevention*, 56, 42–50, https://doi.org/10.1016/j.aap.2013.03.013.

Sümer, N., T. Lajunen, T. Özkan (2005), 'Big Five Personality Traits as the Distal Predictors of Road Accident Involvement', *Traffic and Transport Psychology*, Elsevier, https://doi.org/10.1016/b978-008044379-9/50173-4.

Temel, M. (2019), 'Trafik Güvenliğini Tehlikeye Sokma', Marmara Üniversitesi (Turkey), Postgraduate thesis (TCK 179/3).

TSI (2021), 'Road Traffic Accident Statistics, 2020', Turkish Statistical Institute, https://data.tuik.gov.tr/Bulten/Index?p=Road-Traffic-Accident-Statistics-2020-37436&dil=2.

Underwood, G., P. Chapman, S. Wright, D. Crundall (1999), 'Anger while driving', *Transportation Research Part F: Traffic Psychology and Behaviour*, 2(1), 55–68, https://doi.org/10.1016/s1369-8478(99)00006-6.

Vanlaar, W., H. Simpson, D. Mayhew, R. Robertson (2008), 'Aggressive driving: A survey of attitudes, opinions and behaviors', *Journal of Safety Research*, 39(4), 375–381, https://doi.org/10.1016/j.jsr.2008.05.005.

Wells-Parker, E., et al. (2002), 'An exploratory study of the relationship between road rage and crash experience in a representative sample of US drivers', *Accident Analysis & Prevention*, 34(3), 271–278, https://doi.org/10.1016/s0001-4575(01)00021-5.

WHO (2015), 'Global Status Report on Road Safety 2015', World Health Organization, https://www.afro.who.int/publications/global-status-report-road-safety-2015.

WHO (2018a), 'Global Status Report on Road Safety', World Health Organization, https://apps.who.int/iris/rest/bitstreams/1164010/retrieve.

WHO (2018b), 'Road traffic injuries', World Health Organization, https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries.

Wickens, C. M., R. E. Mann, G. Stoduto, J. E. Butters, A. Ialomiteanu, R. G. Smart (2012), 'Does gender moderate the relationship between driver aggression and its risk factors?', *Accident Analysis & Prevention*, 45, 10–18, https://doi.org/10.1016/j.aap.2011.11.013.

Wickens, C. M., R. E. Mann, G. Stoduto, A. Ialomiteanu, R. G. Smart (2011), 'Age group differences in self-reported aggressive driving perpetration and victimization', *Transportation Research Part F: Traffic Psychology and Behaviour*, 14(5), 400–412, https://doi.org/10.1016/j.trf.2011.04.007.

Wickens, C. M., D. L. Wiesenthal (2007), 'State Driver Stress as a Function of Occupational Stress, Traffic Congestion, and Trait Stress Susceptibility1', *Journal of Applied Biobehavioral Research*, 10(2), 83–97, https://doi.org/10.1111/j.1751-9861.2005.tb00005.x.

Wu, X., Y. Wang, Z. Peng, Q. Chen (2018), 'A questionnaire survey on road rage and anger-provoking situations in China', *Accident Analysis & Prevention*, 111, 210–221, https://doi.org/10.1016/j.aap.2017.12.003.

Yu, J., P. C. Evans, L. Perfetti (2004), 'Road aggression among drinking drivers: Alcohol and non-alcohol effects on aggressive driving and road rage', *Journal of Criminal Justice*, 32, 421–430, https://doi.org/10.1016/j.jcrimjus.2004.06.004.

Yüksel, Y., H. Tosun, Durna (2013), 'Köşe Yazarları Gözüyle Türkiye'de', *International Journal of Human Sciences*, 10(2), 718–750, https://www.j-humansciences.com/ojs/index.php/IJHS/article/view/2658/1216.

Zhang, T., A. H. Chan, W. Zhang (2015), 'Dimensions of driving anger and their relationships with aberrant driving', *Accident Analysis & Prevention*, 81, 124–133, https://doi.org/10.1016/j.aap.2015.05.005.

Zhang, T., A. H. S. Chan (2016), 'The association between driving anger and driving outcomes: A meta-analysis of evidence from the past twenty years', *Accident Analysis & Prevention*, 90, 50–62, https://doi.org/10.1016/j.aap.2016.02.009.

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