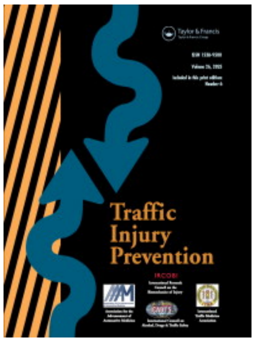

Traffic Injury Prevention

Taylor & Francis
Taylor & Francis Group

ISSN: 1538-9588 (Print) 1538-957X (Online) Journal homepage: www.tandfonline.com/journals/gcpi20

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To cite this article: Fatemeh Bakhtari Aghdam, David C. Schwebel, Ali Jafari-Khounigh, Behjat Shokrvash, Sepideh Harzand-Jadidi, Homayoun Sadeghi-bazargani, Leila Jahangiry, Shahab Papi & Kavous Shahsavari Nia (22 Sep 2025): Unsafe driving behaviours in northwest Iran: A cross-sectional study using observational methods, Traffic Injury Prevention, DOI: 10.1080/15389588.2025.2551154

To link to this article: https://doi.org/10.1080/15389588.2025.2551154

TRAFFIC INJURY PREVENTION
https://doi.org/10.1080/15389588.2025.2551154

Unsafe driving behaviours in northwest Iran: A cross-sectional study using observational methods

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ABSTRACT

Objective: This cross-sectional study using observational methods study was conducted in 2022 to investigate risky driving behaviors among 3005 drivers in various areas of Tabriz, the largest city in northwest Iran. Observations were made when drivers stopped at intersections or before entering their government workplace.

Methods: Observational sites represented low, middle, and high income areas, and locations serving local areas, commuting areas, and workplaces. Observations occurred at various times of day and were conducted by recording drivers' behavior using a checklist based on the Martinez-Sanchez method. Chi-square and binary logistic regression analyses examined relations between demographic variables and drivers' behavior.

Results: Among the observed drivers, 67.39% failed to use seat belts, 29.72% used mobile phones while driving, and 74.24% stopped beyond the stop line. Women used seat belts 1.64 times more often than men [OR = 1.64; 95% CI: 1.36–1.97]. Drivers estimated to be under 25 years and aged 25–40 years used mobile phones significantly more often than drivers estimated to be over age 50 [OR = 2.65; 95% CI: 1.96–3.60], [OR = 1.75; 95% CI: 1.34–2.30]. Drivers were significantly more likely to use mobile phones on weekends than during the week [OR =1.49; 95% CI: 1.15–1.93] and at noon compared to the morning [OR = 1.25; 95% CI: 1.03–1.53]. Drivers observed in middle socioeconomic status (SES) locations failed to fasten seat belts 1.23 times more frequently than drivers in high SES areas [OR = 1.23; 95% CI: 1.01–1.51]. Drivers at workplaces and in local areas failed to fasten their seat belts 2.07 and 1.78 times more than drivers in commuting areas, respectively [OR = 2.07; 95% CI: 1.71–2.49; OR = 1.78; 95% CI: 1.45–2.17].

Conclusion: In summary, we observed considerable risk-taking behavior among drivers in Tabriz, Iran, with the highest risk occurring among male and younger drivers. Multifaceted intervention programs and policymaking, building off successful programs in other countries, should be implemented to increase safe driving behaviors.

ARTICLE HISTORY
Received 7 May 2025
Accepted 19 August 2025

KEYWORDS
Traffic crash; motor vehicle crashes; driving behavior; seat belt; driving distractions

Introduction

Motor vehicle crashes (MVCs) represent one of the most urgent public health issues. According to a World Health Organization (WHO) report, MVCs kill almost 1.19 million people globally each year (15 deaths per 100,000 population in 2021) and leave between 20 and 50 million people non-fatally injured (World Health Organization 2023b). Nine in Ten roadway fatalities occur in low and middle-income countries (LMICs), although these countries have only about 60% of the world's vehicles (World Health Organization 2022). Based on the WHO report, Iran stands out as one of the countries with the highest incidence of MVC fatalities and injuries in the world (World Health Organization 2022). Global Burden of Disease (GBD) 2017 data indicate the incidence of MVCs in Iran was almost 34.1 per 100,000 people, resulting in the loss of about 21,123 lives (World Health Organization 2023a). Further, the total disability adjusted life years (DALYs) from these incidents amounted to around 1,137,930 years (Seif et al. 2024).

Many factors affect the occurrence and severity of road traffic crashes. One theoretical model used to understand factors related to crashes is the "Haddon's Matrix" (Haddon 1968). This approach, which is cited widely to understand the incidence of traffic crashes and increase road safety, suggests that the intersection of three factors – infrastructure, vehicle, and human factors – contributes to risk at the

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Associate editor Anthanasios Theofilatos oversaw the review of this article
Supplemental data for this article can be accessed online at https://doi.org/10.1080/15389588.2025.2551154.

pre-crash, crash, and post-crash stages (Haddon 1968, 1980). Prevention of crashes can occur through changes to any of the three factors, but infrastructure and vehicle modifications are largely implemented by traffic and vehicle engineers.

Human factors are addressed most often by social scientists and public health professionals, who seek to understand and change the way humans engage in road environments. According to the Haddon model, the behavior and decisions of humans on roadways – including drivers, passengers, pedestrians, motorcyclists, and bicyclists – can be modified to reduce crash risk (Sehat et al. 2022; Golfiroozi et al. 2024).

The Haddon Matrix refers to phases of the injury process also. Interventions to reduce the occurrence and severity of crashes can occur prior to the crash, during the crash, and after the crash (Haddon 1968). Stated in public health terms, we can implement both primary and secondary prevention to reduce the burden of MVCs. From a primary, or pre-crash prevention perspective (Degutis 2024), several factors play a role in the occurrence of MVCs. Among the most prominent – and a risk that has become more common over the past decade – is distracted road user behavior (Bakhtari Aghdam et al. 2020). Distracted driving slows reaction times (notably braking reaction time, but also reaction to traffic signals) and causes errors in staying within the correct lane and maintaining an appropriate following distance (Razzaghi et al. 2019). Recent studies confirm the rise of distracted driving worldwide, especially due to increasing smartphone usage, and its critical role in causing crashes (Johnson and Lee 2022; Smith et al. 2023). Estimates of mobile phone use while driving range widely across regions and types of drivers, and include 13.8% in Saudi Arabia (Alghnam et al. 2018), 7.5–10.7% in Qatar (Mahfoud et al. 2015), 13.6% among all drivers in Iran (Bakhtari Aghdam et al. 2021), and 36.7% among young Iranian drivers (Mazloomi et al. 2016). Although distraction from mobile phone use is most documented, distraction from other activities, including hands-free phone conversations, texting, smoking, eating/drinking, and conversing with passengers can also affect driver performance and behavior (Esmaeilnejad-Ganji and Karimi Nasab 2019). Moreover, new research highlights the emerging problem of smartphone applications designed to disable safety features while driving, which paradoxically can increase distraction (Wang et al. 2024).

When crashes do occur, secondary prevention strategies to reduce injury severity include use of protective equipment like seat belts (Degutis 2024), which are widely documented to reduce injury severity in case of a MVC (Beutel 2017; Razzaghi et al. 2019). In one study in Tehran, the largest city in Iran, about 68% of MVC deaths occurred to passengers who were not wearing a seat belt (Sadeghnejad et al. 2014). The prevalence of seat belt use varies greatly across cities and countries. Within Iran, recent reports indicate driver seat belt use of 30% in Shahin Dej (Bakhtari Aghdam et al. 2021) and 51% in Kashmar (Torkamannejad Sabzevari et al. 2016), both small cities, and 71% in the larger capital city of Tehran (Nabipour et al. 2014). Research in other large Middle Eastern cities reports rates of 34% in Riyadh, Saudi Arabia (Alghnam et al. 2018), and above 70% in Doha and Al Rayyan, Qatar (Mahfoud et al. 2015; Shaaban and Abdelwarith 2020). Seat belt use in European countries ranges from 45% in Greece and Portugal (Sethi and Mitis 2012) to over 90% in England and Germany (Liu et al. 2016). Recent meta-analyses support the effectiveness of combined legal enforcement and education programs in increasing seat belt usage and reducing injuries (Kim et al. 2022).

With this theoretical background, we designed a cross-sectional study using observational methods to examine distracted driver behavior and seat belt use, as well as several other less common driver risk behaviors, in Tabriz, the largest city in northwest Iran and the capital of East Azerbaijan province. Observations were made in two locations, when drivers stopped at intersections and when drivers were entering their government workplaces.

We extended previous research from smaller cities in Iran (Bakhtari Aghdam et al. 2021) and survey-based studies (Shams and Rahimi-Movaghar 2009; Tavafian et al. 2011; Mazloomi et al. 2016) in several ways. First, this is the first systematic observational study conducted in a major urban center in northwest Iran, where traffic patterns are more complex and driving behaviors more variable than in smaller cities. Second, we used two distinct observational settings—intersections monitored by traffic cameras and government workplace entry gates—which allowed us to examine driver behavior across different contextual environments. Third, we purposely included sites across low, middle, and high socioeconomic zones of the city to explore potential disparities in unsafe driving. Fourth, beyond mobile phone use and seat belt noncompliance, we also included several under-studied behaviors such as eating, smoking, or passenger interaction while driving. Together, these design features provide new and contextually rich insights into unsafe driving behaviors in Iran.

Importantly, while several European initiatives such as SafetyNet, DaCoTA, Baseline, and Trendline have institutionalized the systematic monitoring of key safety performance indicators (KPIs) to inform evidence-based policymaking, such structured and comprehensive data collection systems are currently lacking in Iran. Our study addresses this critical gap by generating local, high-resolution observational data on unsafe driving behaviors, thereby providing an essential evidence base for developing targeted interventions and policies in the Iranian context.

Our study responds to a gap in the literature regarding high-resolution, real-world behavioral observations in large urban centers, particularly within diverse socioeconomic settings. We included these observations with the hypothesis that government workers may be more educated, and therefore may engage in safer driving behaviors than the general population. Overall, we hypothesized higher rates of driving risk among men and among younger drivers. We also hypothesized substantial risk-taking and higher rates of unsafe driving behaviors during night time, on weekends, and in low socioeconomic areas. It should be noted that the socioeconomic status mentioned here refers to the classification of the observation area and does not reflect individual drivers' characteristics.

Materials and methods

Study design and setting

This cross-sectional study observed 3005 drivers in Tabriz city, the capital and largest city in East Azerbaijan province, northwest Iran. Data were collected from April 10 to 27, 2022.

Observational sites were systematically selected in several steps. First, the city was divided into three socioeconomic classes: high, middle and low, based on a composite index incorporating variables such as average household income, education level, employment rates, and housing quality. These data were obtained from the latest national census and municipal records (Harzand-Jadidi et al. 2023). Geographic Information System (GIS) techniques were applied to map and classify neighborhoods accordingly. Second, within each socioeconomic area, two intersections with traffic lights and cameras and one government office were selected, totaling nine observational sites across the city. At each area, one of the intersections was a connecting intersection where drivers from other parts of the city often passed as commuting drivers, and the other was a local intersection where most drivers were from the neighborhood. It should be emphasized that the socioeconomic classification refers solely to the area or neighborhood where the intersection is situated, and does not imply that all drivers observed at these sites share the socioeconomic characteristics of the area. Individual socioeconomic data of drivers were not collected or analyzed. We included government offices as observation sites for several reasons. First, government employees often represent a more stable and relatively homogeneous group in terms of socioeconomic status and education level, which allows us to explore how these factors might influence driving behaviors compared to the general population. Second, observations at the entry gates of government workplaces provide a controlled setting where driver behavior can be systematically recorded as vehicles enter the premises, minimizing variability caused by external traffic conditions. Finally, including these sites extends previous research that focused mainly on public intersections, thereby providing a more comprehensive understanding of unsafe driving behaviors across different social and environmental contexts within Tabriz.

We purposely selected intersections equipped by the municipality with traffic lights and cameras to detect violations because we felt the presence of cameras, which are readily recognized visually, would impact driver behaviors. Using the Martinez Sanchez random sampling method (Martínez-Sánchez et al. 2012) which involves observing the first five vehicles stopping at the red light during each cycle, all drivers of vehicles who stopped at the intersection traffic lights were eligible for inclusion in the study. This method was selected for its practicality, ability to reduce observer bias by applying a clear, replicable selection criterion, and its prior successful use in similar traffic behavior studies. The third step in our research was to select a government office in each of the socioeconomic class areas where we observed the behavior of drivers employed there. Risk-taking behavior of drivers entering the facility was observed as they passed by a security gate to enter. At all observation sites, driver behavior was observed on two Iranian workdays (Saturday and Tuesday) and one weekend day (Friday) during three time intervals: morning (7:00–9:00), midday (12:00–14:00), and evening (17:00–19:00). These specific time slots were chosen based on prior municipal traffic reports and expert consultation, in order to reflect typical traffic patterns in Tabriz. The morning and evening intervals correspond to recognized peak commuting hours associated with work and school travel, while the midday period reflects moderate to high traffic volumes due to school dismissals, lunch breaks, and other public activities. This scheduling aimed to capture a broad spectrum of driving behaviors under varying traffic conditions. All observations at all sites occurred during daylight hours. Supplemental Figure 1 shows a map of Tabriz, with the observational sites marked. Figure 2 presents a view of selected intersections observed in the study.

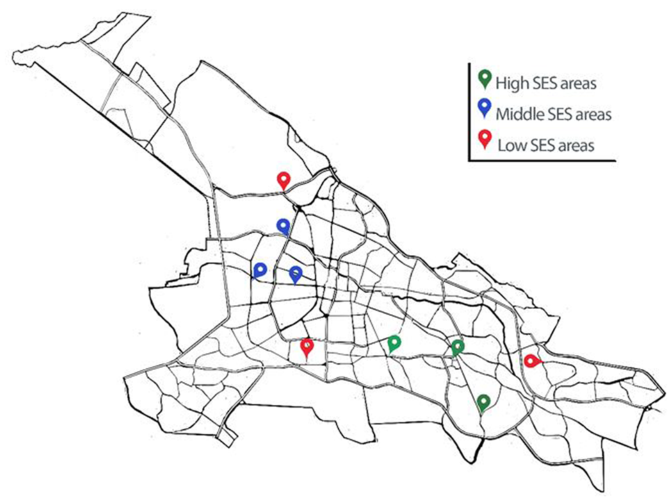

Figure 1. Map of Tabriz showing the nine observation sites categorized by socioeconomic level (three from each of low, medium, and high SES).

Figure 2. Sample intersections observed in Tabriz, Iran. These examples are selected from the nine observation areas shown in figure 1, representing different socioeconomic levels (low, medium, and high).

Study protocol and measures

Inclusion at intersections was based on the Martínez-Sánchez method (Martínez-Sánchez et al. 2012) and incorporated the first 5 drivers of vehicles to stop at the red light. If fewer than five vehicles were present during a red-light cycle, only the available ones were observed. In rare cases when no vehicles were present, no observation was recorded for that cycle. Drivers of two-wheelers, three-wheelers and heavy vehicles/trucks were excluded. At government offices, behavior of all drivers of vehicles who entered was observed.

Ten trained observers recorded risky traffic behaviors using a 13-item checklist previously validated by Bakhtari Aghdam et al. (2021) and shown to have both a strong content validity index (0.74) and content validity ratio (0.81). All observers were trained traffic safety master's students (5 observers) or graduates of that field (5 observers). They each received three 60-minute training sessions on how to conduct observations and complete the study checklist. Following training, on the first day of data collection, a senior researcher (FBA) observed and monitored observers to ensure the quality of the observations. These evaluations continued until observers independently achieved reliable observations of driver behavior.

To code behavior, teams of two observers stood in carefully-selected discrete locations. One observer completed items 1–6 on the checklist as well as estimating the age and gender of the driver. The other observer completed items 7–13. On average, completion of the checklist took each observer 10–13 s, which was ample time to gather information within the light cycles at intersections and the lifting of the security guard gate at government offices (note that Iranian red light cycles, unlike other global locations, generally have red lights for at least 60 s and often longer). Checklist items, all coded in a binary (yes vs no) fashion, included: (1) driver seat belt fastened, (2) driver talking on mobile phone, (3) driver texting on mobile phone, (4) driver reading/checking mobile phone, (5) driver talking using hands-free, (6) driver eating or drinking, (7) driver smoking, (8) driver stopped behind the stop line (or for observation at government offices, driver stopped behind the security barricade rather than quickly following the vehicle ahead when the security barricade opened), (9) driver in conversation with passenger, (10) driver picking up or dropping off a passenger at a red light, (11) driver distracted by a child passenger, (12) the driver's getting out of the vehicle at a red light to complete a quick task such as washing the windshield or retrieving an item from the trunk, and (13) driver arguing with a passenger. Observers also recorded the estimated age (under 25, 25–40, 41–50, over 50) and gender (male, female) of the driver, while the socioeconomic status variable refers to the classification of the intersection's location, not to individual drivers. The type of intersection (commuting, local, government office), the time of observation (morning, midday, evening), and the observation day (workday, weekend).

Sample size

Sample size was determined using the formula, $n = (Z_{\alpha/2}+Z_{\beta})^2 * p_0(1-p_0)/(p-p_0)^2$ and based on Bakhtari et al. (Bakhtari Aghdam et al. 2021), who reported the frequency of not wearing a seat belt at 71%. Assuming p_0 = 71%, $p = 64\%$, and $\alpha = 0.05$, the sample size required to achieve 80% power was estimated to be 330. Since a stratified sampling method was used to observe three socio-economic classes (high, middle and low), and 3 observational sub-classes (commuting intersection, local intersection, government office) were included at each socio-economic level, we multiplied the desired sample size of 330 by 9 and sought a total sample size greater than 2970.

Statistical analysis

First, descriptive data were examined for all variables. As part of the descriptive analysis, we created a variable of "using mobile phone in any way" which represented a binary score of any type of distraction with a mobile phone present versus no mobile phone distraction present. Second, chi-square was used to evaluate associations between drivers' behavior and the following categorical variables: age group, gender, socioeconomic status, and day and time of observation. Third, we used binary logistic regression to predict the two most common risk-taking behaviors, failure to wear a seat belt and any use of a distracting mobile phone. Age, gender, day of observation, time of observation, and socioeconomic status were included in the model as predictors, and odds ratios and 95% confidence intervals reported. P values less than 0.05 were considered statistically significant. All data analyses were conducted using Stata software version 17.

Validation and assumptions of logistic regression models

To ensure the reliability and validity of the binary logistic regression models used to predict seat belt use and mobile phone distraction (Table A4), several model diagnostics and assumption checks were performed.

Multicollinearity assessment. Multicollinearity among independent variables was assessed using the Variance Inflation Factor (VIF). All VIF values were below 2, indicating no significant multicollinearity issues that could distort model estimates.

Model fit and explained variance. The goodness-of-fit of the models was evaluated by the Hosmer-Lemeshow test, which showed acceptable fit for both models (seat belt use model: χ^2 = 7.23, df = 8, $p = 0.51$; mobile phone use model: χ^2 = 6.18, df = 8, $p = 0.63$). Additionally, Nagelkerke pseudo R^2 values were 0.18 for the seat belt use model and 0.16 for the mobile phone use model, indicating moderate explanatory power appropriate for behavioral data.

Cross-validation. To evaluate model stability and generalizability, 5-fold cross-validation was conducted, resulting in average classification accuracies of 78.4% (seat belt use) and 74.9% (mobile phone use), confirming robustness of the models.

Interaction effects. Potential interaction terms, such as age × gender, were tested but did not show statistically significant effects and therefore were excluded from the final models to maintain simplicity and interpretability.

Handling of missing data. No missing data were present for the variables included in the logistic regression analyses, as data collection was complete and thorough.

Together, these diagnostic procedures confirm that the logistic regression models are valid, stable, and suitable for interpretation in the context of this study.

Ethical approval

This study was conducted in accordance with the ethical standards of the 1964 Helsinki Declaration. Ethical approval was provided by the Ethical Committee of Tabriz University of Medical Sciences, reference number IR.TBZMED.REC.1401.040.

Results

As shown in Table 1, the largest portion of drivers (42.00%) were estimated to be ages 25–40 years. Drivers were mostly male (78.27%). As expected due to traffic volume in Tabriz, observations were more common during workdays (86.72%) and during midday hours (49.82%). As planned by our study design, observations were carried out with approximately equal frequency across areas categorized by different levels of socioeconomic status (SES), based on the characteristics of the recorded locations—not the individual drivers.

Table A1 lists risk-taking behavior both for the overall sample and divided by age and gender. Overall, 67.39% of the drivers did not fasten their seat belts. Use of seat belts was poor in all age groups but lowest among drivers aged 25–40 years, among whom 70.21% failed to use a seat belt. Men (69.60%) failed to use seat belts significantly more often than women (59.42%).

Almost 29.72% of drivers were distracted by a mobile phone in some way. Mobile phone use occurred among all age groups but was most common among young drivers under age 25 (40.97%). Among the mobile phone users, the majority of drivers (almost 17.74%) were checking/reading their mobile phones rather than writing messages or talking.

Several other risky behaviors also were frequently observed. About 74.24% of observed drivers passed the marked stop line, and women were more likely to disobey this regulation than men (84.69% vs. 71.34%). Almost 23% of drivers were observed conversing with passengers. Male drivers were more likely to do this than women (24.96% vs. 15.93%). The frequency of the other coded unsafe behaviors was generally low (under 7%), but several age and gender differences emerged, as shown in Table A1.

Table A2 presents patterns of risk-taking behavior by type and time of day. Drivers used their mobile phones significantly more often on weekends than workdays (37.84% vs. 28.47%), and they disobeyed the stop line more often on weekends compared to workdays (83.71% vs. 72.79%). There also were differences in risk-taking by time of day. Drivers used their mobile phones at midday (31.93%) significantly more than the morning (29.23%) or evening (26.05%). Drivers talked with passengers more often at midday (24.92%) than in the morning (21.78%) or evening (20.49%). Further, 70.61% of the drivers disobeyed the stop line at midday, significantly lower than the rate in the morning (73.78%) or evening (81.36%).

Table A3 displays risk-taking behavior by neighborhood socioeconomic status and observation site type. Drivers observed in high SES areas read/checked their mobile phones (13.48%) significantly less often than drivers in middle (19.09%) or low (20.79%) SES areas, and they also disobeyed the stop line (86.22% in high SES) more than drivers in middle (65.81%) or low (71.53%) SES areas. Drivers observed in low SES areas talked with passengers more often than the other drivers (26.33% vs. 21.05% and 22.23% in middle and high SES, respectively). Drivers at government offices (73.25%) and in local areas (70.17%) failed to fasten their seat belts significantly more often than drivers on commuting roads (56.78%), and drivers at government offices (82.33%) and on commuting roads (77.78%) disobeyed the stop line more often than those in local areas (60.00%). Drivers at government offices (14.75%) talked with their passengers less often than those on commuting (29.44%) or local roadways (27.51%).

Table A4 presents logistic regression models predicting seat belt use and distraction using mobile phones based on driver gender and age, observation day, time of observation, socioeconomic status, and type of observation site. In the model predicting seat belt use, men failed to fasten their seat belt 1.64 times more often than women [OR = 1.64; 95% CI: 1.36–1.97]. Drivers failed to fasten their seat belt on weekends significantly more often than on workdays [OR = 1.34; 95% CI: 1.02–1.75]; drivers observed in middle

Table 1. Demographic characters of drivers in Tabriz, Iran ($N = 3005$).

Characteristics	N (%)
Age group (years)	
Under 25	476 (15.84)
25–40	1262 (42.00)
41–50	866 (28.82)
Over 50	401 (13.34)
Gender	
Male	2352 (78.27)
Female	653 (21.73)
Observation day	
Workday	2606 (86.72)
Weekend	399 (13.28)
Time of observation	
Morning	698 (23.23)
Midday	1497 (49.82)
Evening	810 (26.96)
Socioeconomic status of recorded area	
Low	885 (29.45)
Middle	1126 (37.47)
High	994 (33.08)
Type of drivers	
Drivers entering government offices	1200 (39.93)
Commuting drivers	900 (29.95)
Local drivers	905 (30.12)

SES areas failed to fasten their seatbelts 1.23 times more than those in high SES areas [OR = 1.23; 95% CI: 1.01–1.51]; and drivers at government offices and in local areas failed to fasten their seat belts 2.07 and 1.78 time more often than drivers on commuting roads, respectively [OR = 2.07; 95% CI: 1.71–2.49], [OR = 1.78; 95% CI: 1.45–2.17].

In the model predicting mobile phone use, drivers under 25 years used distracting mobile phones significantly more often than drivers over age 50 [OR = 2.65; 95% CI: 1.96–3.60] and drivers aged 25–40 years were significantly more likely to use mobile phone than drivers over age 50 [OR = 1.75; 95% CI: 1.34–2.30]. Also, drivers were significantly more likely to use mobile phones on weekends compared to workdays [OR = 1.49; 95% CI: 1.15–1.93] and drivers used mobile phones at midday significantly more than in the evening [OR = 1.25; 95% CI: 1.03–1.53].

Discussion

The present study investigated unsafe driving behavior in Tabriz, Iran. Our findings revealed that approximately 70% of drivers did not fasten their seat belts, a behavior that was more common among men than women. Nearly 30% of drivers used mobile phones while driving, and mobile phone use among drivers estimated to be under 25 years old was significantly more common than among other age groups. Finally, 74% of observed drivers failed to stop behind the stop line, a behavior that was more common among women than men. We discuss each of these primary results below, followed by consideration of other study results and research strengths and weaknesses.

Our results concerning seat belt use support previous self-report studies in Iran (Adl et al. 2014; Beutel 2017) and observational research in Iran and Saudi Arabia (Alghnam et al. 2018; Bakhtari Aghdam et al. 2021). Importantly, unlike previous Iranian observational studies (Bakhtari Aghdam et al. 2021), our research included observations at intersections with violation cameras to detect traffic violations. Violation cameras typically emphasize speeding and red-light-running violations, a fact that most Iranian drivers know, and therefore may not be effective to prevent seat belt violations. If seat belt laws were enforced, either through violation cameras or directly by police officers, seat belt use may increase dramatically in Iran and reach levels of over 90% seen in Europe and North America (Beutel 2017).

In Europe, systematic monitoring and analysis of safety performance indicators (KPIs) has become a cornerstone of traffic safety policy. Large-scale collaborative initiatives—such as the SafetyNet and DaCoTA projects—have provided standardized methodologies and data to assess critical behaviors like seat belt use, speeding, and distracted driving across member states. More recent efforts such as the Baseline and Trendline projects continue this tradition, aiming to harmonize and improve the collection of KPIs to support evidence-based policymaking. Incorporating similar KPI-based frameworks in countries like Iran may facilitate benchmarking, enhance enforcement strategies, and support the development of targeted, data-driven road safety interventions.

Given the high rate of seat belt use noncompliance, however, comprehensive and multi-level programs might be most effective to increase the use of seat belts in Iran. Consistent with theoretical grounding in the Haddon Matrix (Haddon 1968), these programs would implement and enforce existing policies but also enact change at the environmental, social, and individual levels to create synergistic effects and improve behavior (Baghianimoghaddam et al. 2016). One goal might be to change social norms in society about safe driving behavior. Research consistently suggests that seeing safe behavior of others affects one's own performance of the behavior. Therefore, to promote safe traffic behaviors, programs might be designed and implemented to increase the frequency of safe behaviors in society (Jafari-Khounigh et al. 2024). As the frequency of the behavior increases through enforcement of policies, educational programs to enact behavior change, and other strategies, a wave of people may follow. Over time the changes create a cultural shift and unsafe behavior is seen as unusual rather than typical.

The fact that our regression analysis results showed that women used seat belts 1.5 times more than men was expected, as other studies on healthy lifestyle (Aghdam et al. 2021; Harzand-Jadidi et al. 2023) suggest women have safer and healthier behaviors compared to men. Interventions might target men in particular, or identify ways to leverage women's decisions for safety to impact important men in their lives and increase safety.

Along with low rates of seat belt use, we observed that nearly 30% of Iranian drivers used mobile phones while driving, exceeding rates of 17% reported in previous research in a smaller city in northwestern Iran (Bakhtari Aghdam et al. 2021), and 14% in Saudi Arabia (Alghnam et al. 2018). Use of mobile phones are reported to increase the probability of MVCs 3 to 6.5 times (Arvin et al. 2017), so prevention efforts are needed. Paralleling seat belt law violations, enforcement and heavy fines should be considered for drivers who use mobile phones while driving, as drivers naturally respond to threat of punishment by changing behavior (Calabrese et al. 2023). Consistent with the Haddon Matrix (Haddon 1968), however, comprehensive multi-faceted interventions are likely to be most effective. They could incorporate policy change and enforcement as well as education campaigns to change social norms and use of existing cameras installed to detect speeding and red-light running to also detect and enforce mobile phone use policies (Bakhtari Aghdam et al. 2020).

In addition to highlighting the prevalence of mobile phone use among drivers, it is important to consider the practical impacts of such distracted driving behaviors. Mobile phone use while driving can lead to a range of adverse outcomes beyond just crashes, including harsh braking events, delayed reaction times, increased risk of near-misses, and contribution to traffic congestion and flow disruptions (Kontaxi et al. 2023). These factors collectively increase the risk of collisions and reduce overall road safety. Therefore, the findings emphasize the need for targeted interventions aimed at reducing mobile phone use while driving. For policymakers, this includes the implementation of stricter enforcement of existing laws banning mobile phone use, such as through enhanced camera surveillance and higher fines, particularly during high-risk times like weekends and for younger drivers who exhibit higher rates of usage. Moreover, educational campaigns to shift social norms around distracted driving, incorporating behavioral change theories, can enhance long-term effectiveness. Integration of smartphone technologies that limit mobile functionalities while driving could also be explored as a preventive measure. By addressing both the behavioral and technological aspects, policymakers can develop comprehensive strategies to mitigate the safety risks associated with mobile phone use on the road.

Our results revealed that drivers appearing to be under 25 years old used mobile phones significantly more often than drivers over 25 years old. This result replicates previous research (Asgarabad et al. 2012; Wells et al. 2018) and highlights the importance of targeting younger drivers in prevention programs focused on use of mobile phones while driving. We also found that drivers used mobile phones 1.5 times more on weekends than on working days, replicating previous findings (Bakhtari Aghdam et al. 2021) and reflecting cultural patterns in Iran to talk more with family to plan gatherings and activities on weekends. Increasing police monitoring on weekends/holidays and considering heavy fines for drivers who use mobile phone may be effective strategies to reduce distracted driving.

Finally, our findings revealed that 74% of drivers passed the stop line. According to the previous research, various factors may affect this risky behavior. Faster approach speeds reduce the probability of stopping properly (Pathivada and Perumal 2019); in one previous study, over 50% of drivers approaching the stop line exceeded the speed limit, creating failure to brake before the stop line (Papaioannou 2007). There is some evidence that drivers feel the law is unlikely to be enforced and unlikely to cause crashes, so violations are unimportant (Papaioannou 2007). As in other driver risk-taking, gender is related to this risky behavior; we found that men were more likely to disobey the rule, perhaps because they are more aggressive drivers (Pathivada and Perumal 2019). Prevention strategies grounded in theoretical models such as the Haddon Matrix and parallel to those for other driver risk behaviors should help.

Finally, our research uncovered several other driver distractions. First, we found that 23% of drivers were in conversation with passengers, including about 1% who appeared to be arguing with a passenger. Passenger presence in vehicle may influence driver behavior by increasing reaction time, impairing situational awareness through distraction and increasing crash risk (Maasalo et al. 2019). Arguments are particularly concerning given the impact on the driver's emotional state (Reader 2019). Second, we found almost 2% of drivers were distracted by child passengers. Child passengers may not recognize when drivers need to focus (and when they can more easily be distracted), so children represent a particularly risky distractor. Third, we found that almost 4% of drivers were eating or drinking and almost 7% were smoking. Although most drivers consider eating while driving to be a harmless activity (Saihood et al. 2021), eating, drinking and smoking may impair driver's visual attention and manual dexterity, increasing crash risk in a manner similar to texting (Choudhary and Velaga 2019).

One secondary hypothesis we posed was that drivers entering government offices may be safer than the general population of drivers, partly because they tend to be more educated individuals. This hypothesis was not supported; in general, we found lower seat belt use and higher rates of violating stop line boundaries at government workplaces than we did among other drivers. Our findings should be interpreted with the context that we observed behavior when vehicles were stopped. Behaviors observed at red lights may or may not impact driving safety once the car starts to move, and may or may not continue once the car starts to move. Importantly, even some behaviors that stop will continue to distract drivers upon acceleration. There is evidence that mobile phone use when stopped, for example, may continue to create cognitive distraction even if the actual activity stops. Visual and manual distraction may be discontinued, but cognitive distracted from the phone content could continue to impair driving safety (Yan et al. 2018; Pouyakian et al. 2023).

The intervention programs should involve different agents of the matrix Haddon to could be used to develop preventive strategies. For example, implementing traffic training for drivers concerns the pre-crash phase and human factors in the Haddon Matrix could reduce the risk of a crash or the consequences of a crash by focusing on improving safe behaviors (Öztürk et al. 2021).

Although our study was not specifically designed to assess the effects of the COVID-19 pandemic, it is important to acknowledge potential behavioral changes among drivers in the post-pandemic context. Previous research has suggested that the pandemic may have influenced traffic behavior through several mechanisms, including reduced traffic volumes leading to increased speeding and risky driving, heightened psychological stress contributing to aggressive behaviors, and changes in travel patterns due to remote work or avoidance of public transportation. Additionally, limited driving during lockdowns might have affected driving skills or confidence, especially among older adults or low-frequency drivers. These factors, although not directly measured in our study, may have had a lingering influence on driver behavior in 2022.

Our study had several strengths. It was conducted with rigorous observational strategies in multiple real-world traffic environments across the largest city in northwest Iran. We purposively sampled behavior in low-, middle-, and high-SES locations as well as in locations where drivers were more likely to be driving locally, commuting, and entering government workplace offices.

However, the study also had several limitations. First, as a cross-sectional observational study, some demographic characteristics such as age and gender had to be estimated, and others like marital status could not be determined. Second, observations were limited to daytime hours due to challenges in data collection during darkness, which may limit generalizability, especially for behaviors like texting that could be more prevalent at night. Third, data collection was restricted to unsafe behaviors observed while drivers were stopped at intersections during red lights or entering government workplaces. Some behaviors, such as failure to use a seat belt, likely continued after vehicles started moving; others, like eating or smoking, might have ceased once the vehicle was in motion, while distractions like texting may have stopped physically but continued to affect cognitive focus even after the activity ended (Pouyakian et al. 2023) Another limitation relates to the geographic scope: data were collected from only six selected intersections in a single city, which limits generalizability to other Iranian cities or countries with different traffic cultures, road infrastructures, enforcement policies, and driver demographics.

Additionally, although data were collected in 2022, a post-pandemic year, the study did not assess potential behavioral changes due to the COVID-19 pandemic, since the design lacked pre-pandemic observations and was not comparative.

Two further methodological limitations deserve mention. First, observer bias may have affected the estimation of driver age and gender due to the observational nature of the study. Second, the inclusion criterion of observing only the first five vehicles stopped at red lights, based on the Martínez-Sánchez method, may have introduced selection bias. Drivers at the front of the queue may differ from those further back in risk tolerance, route familiarity, or urgency, potentially limiting the capture of the full range of risky behaviors and affecting generalizability. Future research could consider sampling drivers throughout the entire queue to better reflect variability.

Finally, the relatively small number of observation sites limits the findings' generalizability. Future studies with broader sampling across multiple urban and rural areas are needed to validate and extend our results.

Conclusion

Our study identified critical unsafe driving behaviors in Tabriz, including nearly 70% of drivers not fastening their seat belts—more prevalent among men—and about 30% using mobile phones while driving, especially drivers under 25 years old. These findings highlight the urgent need for comprehensive prevention strategies that integrate both enforcement and education. Applying theoretical frameworks such as the Haddon Matrix can guide the development of multi-level interventions targeting behavior change, including stricter law enforcement, public awareness campaigns, and efforts to shift social norms. Special attention should be given to high-risk groups like young drivers and males to effectively reduce unsafe practices. Policymakers and traffic safety authorities are encouraged to adopt tailored programs focusing on these vulnerable populations to improve road safety and decrease traffic-related injuries.

Acknowledgements

The authors give special thanks to staff of the Road Traffic Injury Research Center for their cooperation in data collection.

Disclosure statement

There are no conflicts of interest or personal relationships among the authors that could have affected their opinions or work reported in this paper.

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Data availability statement

Data will be made available to qualified users on reasonable request.

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