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Subsequent Risky Driving Behaviors, Recidivism and Crashes among Drivers with A Traffic Violation: A Scoping Review

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Abstract

Purpose: Drivers who have committed a traffic violation are a particularly high-risk group, yet studies conducted among this group are scarce. We analyzed and synthesized the current literature concerning subsequent risky driving behaviors, recidivism, and crashes among drivers with a traffic violation.

Methods: We searched PubMed, Education Resources Information Center (ERIC), Academic Search Complete, Web of Science, and Scopus for articles published in English between January 1, 1999, and May 31, 2023. A total of 25 articles met the selection criteria and were included in the final analysis. Two coders independently extracted and analyzed the selected articles to identify common categories across the articles, including study design, study population, type of traffic violation, and study outcomes including subsequent driving behaviors, recidivism, and crash risks.

Results: Of the 25 selected articles, 19 (76%) involved both male and female participants. Fourteen (56%) studies were interventions/evaluation studies, with the other 11 (44%) being observational. Nineteen (76%) studies included alcohol-impaired driving violations, and 23 (92%) studies examined recidivism as an outcome measure. Over half of the observational studies demonstrated that traffic offenders were more likely to commit a subsequent traffic violation or had elevated risk of crashes. Most of the intervention/evaluation studies demonstrated a significant

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reduction in driving under the influence (DUI) of alcohol among the study participants. However, such positive effects observed during the active intervention period were not always sustained.

Conclusions: Traffic offenders are a high-risk group for subsequent violations and crashes. Evidence from this review calls for more effective interventions implemented following a traffic violation to prevent recidivism, crashes, and crash-related injuries and deaths.

Keywords

traffic violation; recidivism; epidemiology; road safety; prevention

1. Introduction

Globally, road traffic injuries are a major public health concern and the leading cause of death among children and young adults aged 5–29 years.[1] Each year, approximately 1.3 million people worldwide are killed by road traffic crashes and an additional 20 to 50 million are injured.[1] Road traffic injuries and deaths can result in an enormous economic, social, and human toll, both through treatment costs for the injured and loss of productivity of those killed or disabled.[2]

Drivers with traffic violations are a high-risk, yet understudied group. Existing evidence shows that traffic offenders of all ages are at an increased risk for crashes,[3] crash-related injuries requiring hospitalization,[4,5] and crash-related deaths.[4–6] A 24-year follow-up study based on an on-road sample of traffic offenders and control drivers revealed that offenders have more traffic violations than non-offenders, even after adjusting for age and mileage driven.[3] In another cohort study, Elliott et al[7] found that a serious previous-year offense doubled the odds of an offense in the next year, and at-fault crashes increased odds of subsequent-year at-fault crashes by nearly 50%.[7] Driving under the influence (DUI) of alcohol is one of the leading causes of crash-related deaths, accounting for 373,000 deaths worldwide each year,[8] with recidivism rates ranging from 21%–47%. However, this estimate is largely conservative, due to exclusion of individuals who drink and drive but were not re-arrested. Finally, studies suggest that certain subgroups are at increased risk for recidivism compared to others. For example, up to 73% of young adults commit at least one traffic offense within 7 years of receiving their driver's license,[7] with a 6-month re-offense rate as high as 56%.[9,10] Male, teen drivers have the highest rates of recidivism with 8–21 times greater recidivism rates than females or drivers in other age subgroups.[11]

To prevent recidivism among traffic offenders and increase road safety for all drivers, most countries, states, and local governments pass laws and regulations that govern how drivers should behave, in addition to providing road safety education to drivers.[12,13] Legal actions, such as corrective or sanctioning measures (e.g., penalties, jail, alcohol treatment, alcohol ignition interlock) and license suspension or revocation, are enforced against drivers who have committed a traffic violation. Furthermore, many countries including the United States, impose more severe sanctions on young, novice drivers when they incur convictions in an effort to decrease the probability of subsequent offenses.[7,14]

Despite being a high-risk group, research on driving behaviors, recidivism and crash risks among drivers who have committed a traffic violation is scarce. Understanding driving behaviors, and risk of recidivism and crashes following a traffic violation, as well as the effectiveness of court-ordered educational and sanction programs, is an important first step in the prevention of traffic violations and recidivism. This scoping review aimed to examine the subsequent risky driving behaviors, recidivism and/or crashes among drivers who have committed a traffic violation.

2. Methods

2.1 Identify Relevant Studies (search terms, databases)

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[15,16] to identify studies relevant to our research question. We searched 5 electronic databases: PubMed, Education Resources Information Center (ERIC), Academic Search Complete, Web of Science, and Scopus using the following search terms: (automobile driv* OR accident* OR crash OR traffic OR driving behavior) AND (recidivism OR violation OR citation) AND (licens*). We also searched the references of all included studies for additional relevant articles.

To be included in this scoping review, articles were required to be peer reviewed and published in English after 1998. The start date of January 1, 1999 was selected because of the road traffic safety project Vision Zero, which aimed to have zero fatalities or serious injuries from road traffic crashes, which was created and first adopted in Sweden in 1997.[17,18] Additional inclusion criteria included: a) the study population must have consisted of drivers with a traffic violation or have included a comparison group of drivers with and without a traffic violation; b) the study aim must have addressed the influence of a history of or current traffic violation on driving-related outcomes; and c) the study outcome must have included driving behaviors, re-offense/recidivism, or crashes (occurrence or severity).

2.2 Study Selection

A total of 973 articles were returned in the initial search for records published between January 1, 1999 and May 31, 2023. Following the removal of duplicates between the 5 databases, we screened 466 studies by title and abstract. From these, 39 articles underwent a full-text review. A total of 17 articles met our inclusion criteria while the remaining 22 articles were excluded for the following reasons: the study did not include drivers with a traffic violation (n = 5), study design did not fit our criteria (n = 8), and study outcomes were not related to driving behaviors, re-offense/recidivism, and/or crashes (n = 9). An additional 10 studies were identified via the reference sections and were assessed via full-text review. Eight of the 10 articles met inclusion criteria, while the 2 others were excluded due to study outcomes being unrelated to driving behaviors, re-offense/recidivism, or crashes (n = 1), and study exposure being unrelated (n=1). In total, 25 articles met all inclusion criteria, focused on assessing the associations of a traffic violation with subsequent driving outcomes (Figure 1). At least 2 authors independently reviewed and assessed each article at every stage of the review process, with discrepancies being resolved via discussions among all authors.

2.3 Charting the Data

The following data were extracted from the selected articles: authors, year of publication, study population (e.g., drivers with a traffic violation, comparison/control group), type of traffic violation (e.g., alcohol-related, speeding), study design (e.g., randomized controlled trial), cohort), data source (e.g., survey, police report data), participant information (e.g., sex, age), outcome measures (e.g., recidivism, risky driving behaviors, crashes), overall results of the study, and country where the study was conducted. The extracted data were recorded in Microsoft Excel. We provided a general description of all included studies such as study population, study design and duration, country where the study was conducted, data source, type of citation, and study outcomes (Table 1). To better organize and present our results, we assembled all included observational studies in Tables 2a & 2b to facilitate comparison of the study design, main exposures, and outcomes of interest across articles; we also arranged all intervention or evaluation studies in Tables 3a & 3b to illustrate the differences in intervention approaches and strategies for targeted changes in the outcomes of interest.

3. Results

3.1 Study Characteristics

A total of 25 studies were included in this scoping review. All studies included adults over the age of 18. Nineteen studies (76%) included both males and females, with a greater percentage of male than female participants, while two studies included males only, and four had an unknown gender distribution. Fourteen articles (56%) reported the results from intervention or evaluation studies, while 11 (44%) were observational studies. Eleven studies were conducted in the United States, three in Canada, and two in each of Spain, Italy, Denmark, and Sweden, respectively. Twelve out of 14 (86%) intervention/evaluation studies and 7 of 11 (64%) observational studies examined alcohol-impaired violations or driving under the influence (DUI) of alcohol as outcome variables, while only eight out of 25 (32%) articles included moving related violations. Three observational studies collected primary data while all others utilized existing data, such as police reports or national transportation databases (Table 2a). The study outcomes analyzed in the articles were categorized into three groups, including risky driving behaviors (n= 2), recidivism/repeated offense (n=23), and crashes or crash-related injuries regardless of whether it was due to the driver's fault (n=7), with five studies examining more than one of these outcome groups. For example, Boulagouas et al[20] evaluated the impact of all three study outcome groups: risky driving behaviors, repeated offenses, and crashes or crash-related injuries.

3.2 Observational Studies

A total of 11 observational studies were examined, with 10 cohort studies and one case-control study. Specifically, five cohort studies were retrospective, one was prospective, one was both retrospective and prospective, and four did not provide sufficient information for further classification (Table 2a). The retrospective studies used existing data, while the prospective studies collected primary data. All studies included comparison group(s) to assess the study outcomes, including time to subsequent offense or crash or committing at least one subsequent offense or crash during the follow-up period (Table 2b).

Six studies addressed the relationship between alcohol-related violations and DUI recidivism, revealing that drivers with prior alcohol-related violations had an increased risk for DUI recidivism (Table 2b) and that drivers with higher BAC levels at the first violation had a higher risk of DUI recidivism.[27,28] Portman et al,[27] compared drivers that received random breath checks to those apprehended during police work using biomarkers of alcohol to predict DUI recidivism. Drivers in the random breath check group with one prior conviction were three times more likely to re-offend when compared to those with no prior offense. Similar findings were observed among the apprehended group. Another study followed drivers aged 18 or older in Denmark for five years and found that 34.3% of recidivists received another traffic violation during the study period, whereas only 28.1% of those with only one alcohol-related violation and 8.3% of those with no previous alcohol-related violations received a violation during the study period.[26]

Three of the six studies reported mixed results for DUI recidivism (Table 2b). For example, Fitts et al[22] found that among young drivers (ages 14–20) in Australia who committed an alcohol-related violation, 30% were considered recidivists, and males were more likely to offend at a younger age. In this study, blood alcohol concentration (BAC) was categorized into three different groups, and anything greater than or equal to 0.15 g/100 ml was considered above the high limit. However, no difference in BAC levels was observed at the time of the first offense when comparing the first-time offenders with recidivists. Another study followed 77 DUI offenders for 12 years and presented similar findings, showing no difference in BAC level at the time of the first offense between first-time offenders and recidivists.[21] However, when comparing first-time offenders to recidivists, this study reported that 45% of recidivists committed reckless driving violations, while only 17% of first-time offenders did. Additionally, 55% of recidivists were involved in at least one traffic crash during the study period.

Four studies investigated speeding violations (Table 2b).[20,23–25] One study[23] followed two groups of drivers (those with a speeding violation and those without any violations) and showed that drivers with a speeding violation were twice as likely to receive a subsequent violation during the follow up period.[23] Li et al[24] followed drivers with a speeding violation for two years in Maryland. The findings suggested that offenders who chose to appear in court had a lower risk of receiving a subsequent speeding violation when compared to those paying fines by mail. However, offenders with court appearances showed a greater risk for subsequent crashes than those who paid fines by mail. Additionally, a study conducted in Spain used the Bayesian network method to explore unsafe driving behaviors among drivers with an invalid license.[20] Their findings indicated that compared to those with a valid license, those with an invalid license were more likely to engage in unsafe behaviors, such as speeding, and had a greater risk of serious injury or death following a crash. However, those with a valid license were more likely to receive right-of-way violations and more likely to have crashes. These findings were confirmed by Alrejjal et al[19] who reported driving too fast was one of main predictors of injury severity on Wyoming's interstates.

3.3. Evaluation/Intervention Studies

Of 14 evaluation/intervention studies included (Table 1), most evaluated prevention/ treatment program effects on the reduction in DUI (n=11) using secondary prevention strategies, such as alcohol interlock devices (Table 3b). Of the 11 studies, nine reported a positive intervention effect on DUI reduction. For example, Blom and Blokdijk[34] evaluated Netherland's Alcohol Ignition Interlock Program (AIIP) by assessing whether the AIIP was effective in reducing post-interlock recidivism. The study outcome was the prevalence of DUI convictions or offenses up to two years following completion of the program. They found that the AIIP decreased prevalence of DUI recidivism. Notably, individuals in the interlock group had a significantly lower risk (OR=.30; 95 % CI=.21, .43) of DUI recidivism within two years of the ignition interlock device being removed, compared to individuals in the control group who only received a penal sanction.[34] Similar findings were observed from Rauch et al study which found participation in the interlock license restriction program reduced drivers' risk of a subsequent alcohol impaired driving offense statistically by 36% during the 2-year intervention, and 26% during the 2-year postintervention period.[40] However, other studies reported mixed intervention effects, showing improved outcomes during the active intervention period that ceased after the intervention ended (e.g., after the alcohol interlock device was removed).[30,31,42,43] A randomized control trial by Beck et al[31] that determined whether an individual committed an alcohol-related traffic violation during the first year of the study, when the interlock device was installed, and during the year following the removal of the interlock device found reduced recidivism rates while the interlock device was installed that were not sustained in the year following the device removal. These findings were supported by the findings of Voas et al, suggesting once the interlock was removed, recidivism rate increased markedly.[43]

Although most studies utilized or evaluated a passive prevention strategy, others assessed the impact of remedial intervention programs on recidivism and subsequent violations or crashes (Table 3a). Three studies investigated effects of an alcohol-related remedial intervention program as part of a multifaceted approach targeting behavior change, with two reporting improved outcomes and one reporting mixed outcomes (Table 3a & 3b). Findings from Lapham[38] evaluating Oregon's DUI Intensive Supervision Program (DISP) measured driving with a revoked or suspended license, re-arrests, and DUI rates of recidivism for program participants and revealed that the program had a positive impact. Specifically, DISP participants had lower rates of recidivism and other driving offenses compared to DUI offenders who did not participate in DISP. Additionally, Robertson[41] assessed the effectiveness of two versions (1989/old version and 2000/current version) of the Mississippi Alcohol Safety Education Program (MASEP), a court-mandated intervention for first-time DUI offenders using a 3-group post-test only design. The findings showed reduced rates of recidivism among DUI offenders who completed either version of the program, with greater reductions among offenders who completed the most current version of the program compared to those who did not enroll. However, those who enrolled but did not complete the program had higher rates of recidivism than those who did not enroll.

Four studies examined the effect of various policies on crash rates, driving behaviors, and recidivism (Table 3b). These policy-based interventions targeting individual-level

behavior change (i.e., deterrence) reported both mixed and positive outcomes on the number/frequency of subsequent offenses/crashes. Abay and Kahsay[30] evaluated the demerit point system (DPS) in Denmark via measuring individuals' driving behavior using the annual frequency of traffic violations committed and frequency of speed-related offenses. The study reported mixed outcomes, finding that those who were assigned demerit points had reduced subsequent traffic offenses, but only for about two years, after which the points expire.[30] However, for offenders who were assigned demerit points resulting in license suspension, the reduction continued beyond two years. Another study by Deyoung[36] analyzed the impact of a vehicle impoundment policy on one-year subsequent driving behaviors among suspended/revoked and unlicensed drivers in the US. They found that both first-time and repeat offenders whose vehicles were impounded for 30 days exhibited reduced recidivism, including total traffic convictions and crashes in the year following the impoundment.

4. Discussion

This review examined the subsequent risky driving behaviors, re-offense/recidivism, and/or crashes among drivers who have committed a traffic violation. Our results included studies from a wide range of countries, the majority of which focused on alcohol-related violations or driving under the influence of alcohol in the adult population. Overall, the observational studies revealed that drivers who received either alcohol or non-alcohol-related violations were at increased risk for recidivism and subsequent crashes. Further, the intervention and evaluation studies examined the implementation of policies, remedial intervention programs, and device installation-focused programs using both single and multi-faceted approaches. Generally, interventions demonstrated positive effects on improvement of driving outcomes and crash risks, though in some cases, this improvement was not maintained after the active intervention period had ended. Future studies using varied approaches are needed to promote safe driving practices, prevent recidivism and crashes.

Over two-thirds of peer reviewed articles included in this review focus on drivers who received alcohol-related violations rather than moving-related violations. This is likely due to the great prevalence and consequence of alcohol-impaired driving, as every day, 29 people in the United States die in motor vehicle crashes involving alcohol-impaired drivers.[44] The concentration on alcohol-related violations is potentially related to the large burden of alcohol-impaired crashes, which accumulate over $44 billion in costs, including loss of productivity, legal, and medical expenses as well as account for around one-third of deaths from all traffic crashes in the United States.[44,45] Existing studies have found that alcohol-impaired driving events are more likely to occur in drivers with previous alcohol-related convictions (4.5 times increased risk for drivers involved in fatal crashes or with BAC of at least 0.08%) or binge drinkers (86% of all alcohol-related events in 2018).[44,46] These findings are alarming given that alcohol addiction or alcoholism may be more prevalent in repeat offenders' alcohol-related traffic violations despite people underreporting their alcohol-impaired driving events. Further efforts, such as using community-based approaches to control alcohol consumption and creating policies to raise the unit price of alcohol by increasing taxes, may help prevent alcohol-impaired driving.[44,46–50]

Our findings showed that most intervention/evaluation studies targeting drivers with alcohol-related violations demonstrated positive outcomes (Table 3b), although the premise of each of these studies varies with different definitions and regulations that constitute a violation. Since this review encompasses articles from several countries, including Canada, Denmark, Australia, and the US, the legal BAC level and severity of consequences for violations differs between countries, as does the legal driving age. For example, the US has an illegal BAC of 0.08 or greater, while Australia and Denmark have an illegal BAC of 0.05 or greater.[26,51] Thus, regulations and penalties for drivers who commit alcohol-related violations differ across countries.

Although young drivers, particularly teen drivers, are at higher risk for traffic violations,[7,9–11] very few articles focused on this age group. This is likely due to the fact that teen drivers ages 15 to 17 are unique to specific countries, such as the US and Canada. The majority of countries, including most of Europe, do not permit drivers to obtain their license until they are 18 years of age. A study conducted in Australia found that lowering the licensing age from 18 to 16 increased fatal crashes by 80–100 and injury crashes by 1,275 – 1,325.[52] Thus, increasing licensing age or extending driver's training time may help improve driving safety among teen drivers, which may carry lifelong benefits throughout adulthood.

Drivers with a prior traffic violation are at increased risk for recidivism and subsequent risky driving behaviors and crashes, with the risk increasing as number of violations increase.[53–55] The World Health Organization considers speeding to be a critical risk factor for road traffic crashes and their severity.[1] A previous study supported this notion, finding that drivers who sped had a higher number of prior moving violations and 60% more crashes per year compared to drivers who did not speed.[54] Previous studies have shown some effective programs for repeat offenders and recidivism. Specifically, McKnight et al concluded that drivers who completed a recidivism prevention program had a lower risk of subsequent violations and crashes compared to those who completed an accident prevention program.[55] Additional interventions targeting this high-risk population of drivers are needed to prevent recidivism, crashes, and crash-related injuries.

Six of the 14 intervention and evaluation studies included in this review targeted those with alcohol-related violations and used a multi-faceted approach when assessing program efficacy and effectiveness. Of these six studies, three used an alcohol-interlock device along with specified educational or other sobriety-focused components,[32,34,38] all of which reported reduced recidivism and subsequent offenses, and/or greater time to re-offense. Though difficult to evaluate using traditional research methods,[56] multi-faceted approaches are considered to be more effective than single-level approaches for injury prevention as they are able to target various aspects and levels of the determinants simultaneously.[1,57,58] One study included in the review directly compared single- and multi-faceted approaches and found that those exposed to the multi-faceted, full "Back on Track" program showed lower subsequent offense rates compared to those who were only exposed to the single-level, education component of the "Back on Track" program.[39]

Passive prevention strategies, such as policies against speeding or device-installation-focused programs to reduce drunk driving, have been widely successful in encouraging

behavior change to prevent injuries.[59,60] These passive prevention strategies, such as requiring airbags in motor vehicles, are often preferred over active prevention strategies as they are automatic, protect everyone, and require no cooperation or action from those intended to be protected.[61,62] Oftentimes, they are more effective in situations where active prevention strategies cannot be consistently applied or are less reliable.[62] However, in line with the research supporting multi-faceted approaches, using multiple strategies, including both passive and active strategies, may have the largest impact on behavior change.[60,63] For example, to combat alcohol-related driving incidents, a combination of passive strategies, including economic actions (e.g., taxation), policy actions (e.g., drunk driving laws, warning labels on alcohol containers), organizational actions (e.g., law enforcement), and active strategies such as health education (e.g., school or community programs, media campaigns) have been implemented in many countries around the world. Using these varied approaches and targeting multi-level determinants, an intervention program could achieve better outcomes in reducing recidivism, risky driving behaviors, and crashes.[57,64]

4.1 Limitations

It is important to acknowledge the limitations of this scoping review. First, this review synthesizes publications across multiple countries. Definitions of traffic violation, regulations, policies, and penalties differ by country, which may result in differences in interventions or program effectiveness. Second, we only searched five common academic databases without using other academic search engines. It is unlikely that we have identified all relevant research related to the impact of a traffic violation on individuals' re-offense/recidivism, subsequent driving behaviors, and/or crash risks. Only peer reviewed publications, written in English, and published in 1999 and after were reviewed. Specifically, research or materials produced by organizations outside academic publishing (e.g., grey literature) were not assessed, though hand searching of the references was used to identify relevant articles that may not have been returned during the initial search. Third, the quality of the literature was not formally evaluated. We also did not limit our search to the crashes that were due to the driver's fault. Therefore, conclusions based on this review may be subject to bias. Finally, although multiple reviewers were included in the entire process of article identification and data extraction, the characterization and interpretation of the included manuscripts are susceptible to subjective bias. While other researchers may have a different interpretation, the researchers made considerable efforts to reduce bias in this study. Despite these limitations, this review contributes to existing literature addressing a traffic violation and re-offense/recidivism, subsequent driving behaviors, and/or crash risks.

5. Conclusion

This scoping review systematically examined 25 studies on traffic violations and subsequent driving behaviors, recidivism, and/or crashes. The findings showed that drivers with a traffic violation are at elevated risk for recidivism, subsequent violations, and crashes. Given the negative impacts these increased risks may have not only on the high-risk drivers themselves but also passengers and other road users, reducing these risks is imperative. Based on the results obtained from this study, the authors have reached the following recommendations for policies and future studies among drivers with traffic violations:

1. Conduct more observational studies that use a prospective study design, include a comparison group, and involve young drivers to understand the subsequent risky driving behaviors, recidivism, and crashes;
2. Develop and enforce the policies, regulations, and penalties for drivers who have committed a traffic violation, especially those with alcohol-related violations, to ensure traffic safety of all road users;
3. Design and implement effective interventions that employ rigorous study design, target multi-level influences, and take behavioral and/or policy approaches to improve safe driving practices and reduce risk of subsequent recidivism and crashes; and
4. Promote a safety culture that encourages all drivers to use safety gear voluntarily, obey traffic laws, and refrain from operating a vehicle when impaired.

As research addressing this topic is still somewhat sparse, additional studies are warranted to further our understanding of the specific risks to drivers with traffic violation. More research is also needed to develop and implement multi-faceted interventions that include both passive and active prevention strategies to effectively prevent recidivism and protect these drivers, as well as other road users, from crashes, crash-related injuries, and deaths.

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Highlights:

- Drivers with alcohol or non-alcohol-related traffic violations were at increased risk for recidivism and subsequent crashes
- A larger portion of articles included in this review focused on alcohol-related rather than moving-related violations
- Positive outcomes of interventions targeting drivers with traffic violations were not always sustained
- Although teen drivers are at higher risk for traffic violations, few studies focused on recidivism in this population

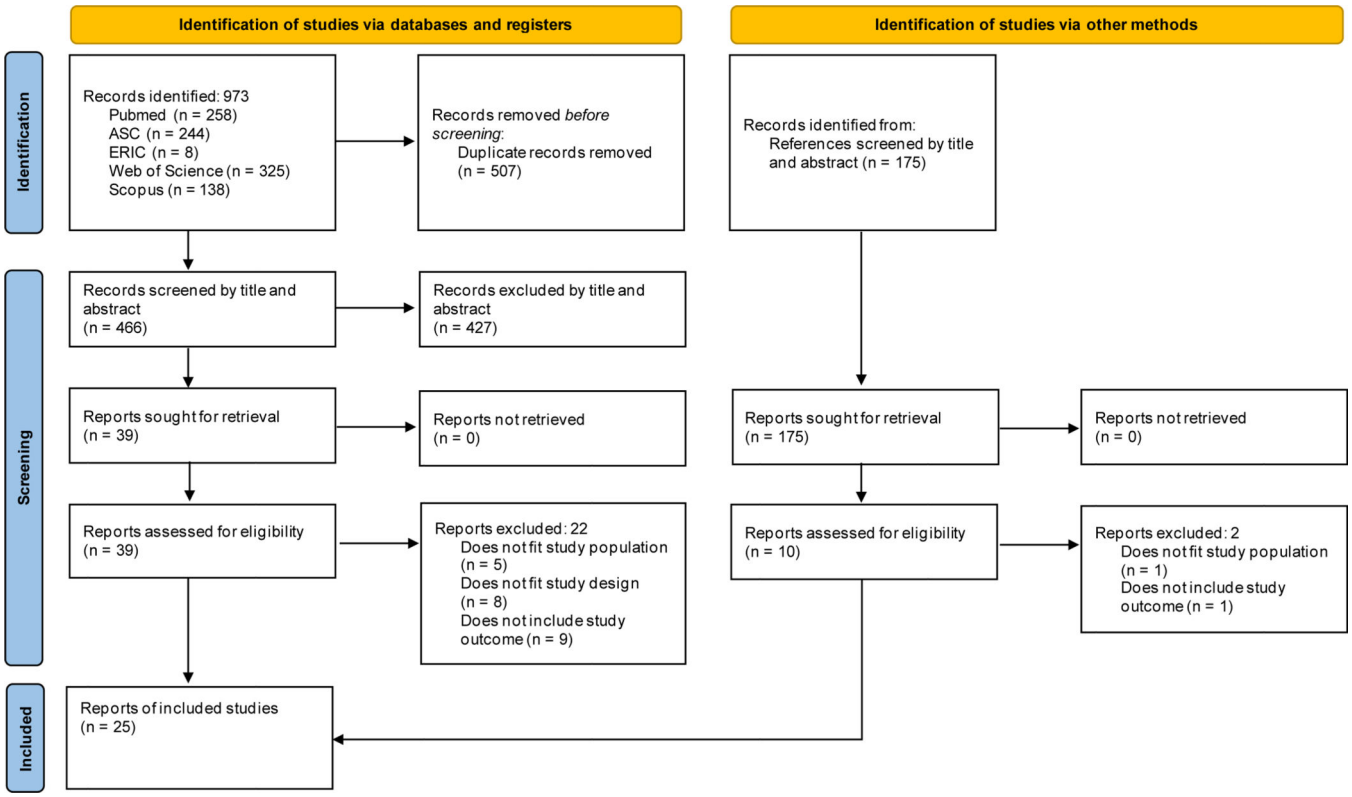

Figure 1.
PRISMA Diagram

Table 1.

Summary of Included Studies, n=25

Study#. Author, Year	Study Population Participants, % Males, Age range/mean age	Study Design and Duration	Type of Violation Moving	 Alcohol	Outcome	Country
Observational Study						
1. Alrejjal A, 2022[19]	**N**=5, 290 drivers with traffic violations leading to crashes **% M**: 74.8; **Age range**: < 26 −>55	Retrospective cohort, 2013–2015	X	X	C/I	USA
2. Boulagouas W, 2020[20]	**N**=467,431 drivers involved in crashes, Valid (n=253,306), Invalid (n=7,057), and Other license (n=207,068) **% M**: 71.2; **Age range**: <25–60+	Retrospective cohort, 2016–2018	X		DB, R, C/I	Spain
3. Cavaiola A, 2007[21]	**N**=77 drivers with DUI offense (s), Repeated (n=29), One-time (n=48) **% M**: 83.1; **Mean Age**: 29.6	Cohort with 12-year follow-up, 1990–2004		X	R	USA
4. Fitts M, 2017[22]	**N**=1,538 adolescent drivers with DUI offense(s), Recidivists (n=481) and Non-recidivists (n=1,102) **% M**: 74.1; **Age range**: 14–24	Retrospective cohort, 2006–2013		X	R	Australia
5. Lawpoolsri S, 2007[23]	**N**=3,739,951 drivers with or without a speeding violation, Study group (n=15,814), and Control (n=3,724,137) **% M**: Study group: 60.0, Control group: 48.0 **Age range**: 17–60+	Cohort with 1-year follow-up, 2002–2003	X		R	USA
6. Li J, 2011[24]	**N**=29,754 drivers with a speeding violation, Mail (n=13,109), and Court (n=16,645) **% M**: Mail: 62.7, Court: 61.8; **Age range**: <20–50	Cohort with 3-year follow-up, 2003–2006	X	X	R C/I	USA
7. Martin-delosReyes L, 2022[25]	**N**= 130,376 drivers involved in crashes, Multi-vehicle case (n=50,100), Single-vehicle case (n=28, 620), and Control (n=51,656) **% M**: Multi-vehicle case: 68.8, Single-vehicle case: 66.3, Control: 63.0 **Age range**: 18–74+:	Retrospective case-control, 2014–2017	X	X	C/I	Spain
8. Moller M, 2015[26]	**N**=4,231,810 adult drivers, 1 incident (n=7,693), and ≥ 2 incidents (n=1,584) **% M**: 48.8; **Age range**: 18+	Retrospective cohort, 2008–2012		X	R	Denmark
9. Portman M, 20 1 0[27]	**N**=422 male drivers with DUI offense(s), Random breath testing (n=229), and Apprehended (n=193) **% M**: 100; **Age range**: 16–77	Cohort, 1990–1996 (Retrospective) and 1996–2006 (Prospective)		X	R	Finland

Study#. Author, Year	Study Population Participants, % Males, Age range/mean age	Study Design and Duration	Type of Violation Moving	 Alcohol	Outcome	Country
10. Roma P, 2019[28]	**N**=357 drivers with DUI offense(s), Repeated (n=97) and One-time (n=260) **% M**: 100; **Age range**: 20–75	Prospective cohort with 5-year follow-up, 2010–2017		X	R	Italy
11. Terranova C, 2021[29]	**N**=1,678 drivers with DUI offenses, Recidivist (n=196), and First-time (n=1,482) **% M**: Recidivist: 94.9, First-time: 87.7 **Mean age**: Recidivist: 30.6, First-time: 32.9	Cohort, 2012–2019		X	R	Italy
Intervention/Evaluation Study						
12. Abay, K., 2018[30]	**N**=47,608 drivers with a speeding offense, Treatment 1 (n=32,375), Treatments 2 & 3 (n=4,246), and Control (n=10,987) **% M**: Treatment 1: 79.8, Treatments 2 & 3: Unknown, Control: 78.5 **Age range**: 25–65	Longitudinal, 4-group, pre-and post-deterrence policy implementation, 2000–2012	X		DB R	Denmark
13. Beck K, 1999[31]	**N**=1,387 drivers with ≥2 DUI offenses, Interlock (n=698), and Control (n=689) **% M**: Interlock: 88.7, Control: 91.0 **Age Range**: 19–75	Parallel randomized trial, 2-group 2-year follow-up		X	R	USA
14. Bjerre B, 2005[32]	**N**=1,374 drivers with DUI offense(s), Primary prevention (n=538), and Secondary prevention: (1) n= 470, (2) n= 865, (3) n= 3,065 **% M**: Unknown; **Age range**: Unknown	3-group, multiple post-tests, 2000–2002 (primary prevention) and 2003–2006 (secondary prevention)		X	R	Sweden
15. Bjerre B, 2008[33]	**N**=10,225 drivers with DUI offense(s), Interlock (n=1,266), Control groups 1 (n= 865) & 2 (n=8,094) **% M**: Interlock: 90.3, Control 1: 85.9, Control 2: 85.1 **Age range**: 24 to 65; **Mean age**: Interlock: 48.4, Control 1: 45.6, Control 2: 43.4	3-group, pre- and post-test with 1 intervention and 3 control groups; 5-year pre-test period, 2-year intervention, 1999 to 2005		X	R C/I	Sweden
16. Blom M, 2021[34]	**N**=2,583 drivers with DUI offense(s), Interlock (n=1,676) and Control (n=907) **% M**: Interlock: 83.4, Control: 88.0 **Mean Age**: Interlock: 38.6, Control: 34.4	2-group, post-test only, 4.5-year follow-up, 2011–2018		X	R	Netherlands
17. Byrne P, 20 1 6[35]	**N**=310,833 drivers with DUI offense(s), Long term impound (n=207,067) and 7-day impound (n=103,766). **% M**: Unknown; **Age range**: Unknown	Interrupted time series, pre-and post-test, 1995–2009 (Long term impound) and 2005–2013 (7-day impound)		X	R	Canada
18. Deyoung D, 1999[36]	**N**=12,724 suspended/unlicensed drivers with DUI offense(s), Impound (n=6,327) Control (n=6,397) **% M**: Unknown; **Age range**: Unknown	2-group, post-test only, 1 year follow-up, 1994–1996	X	X	R C/I	USA

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Study#. Author, Year	Study Population Participants, % Males, Age range/mean age	Study Design and Duration	Type of Violation Moving	 Alcohol	Outcome	Country
19. Gebers A, 20 1 0[37]	**N**=378,578 drivers with a moving violation, Traffic violator school (n=210,015) and Conviction (n=168,563) **% M**: Traffic violator school: 58.9, Conviction: 63.9 **Mean age**: Traffic violator school: 37.5, Conviction: 36.8	2-group, pre-and post-test, 1 year follow-up, 2000–2003	X		C/I	USA
20. Lapham S, 2006[38]	**N**=957 drivers with ≥ 2 DUI offenses, Intensive Supervision Program (n=460), Comparison (n=497) **% M**: Intensive Supervision Program: 89.1, Comparison: 88.3 **Age range**: 18–30+	2-group, post-test only, frequency-matched controls, 5-year follow-up, 1998–2004		X	R	USA
21. Ma T, 2015[39]	**N**=50,294 drivers with DUI offense(s), Unexposed (n=19,163), Education only (n=15,362), All components (n =15,769). **% M**: Unexposed: Unknown, Education only: On-time= 87.6, Late= 88.2, All components: On-time= 87.1, Late= 88.1 **Age range**: <31–45+, **Mean age**: Unexposed: Unknown, Education only: On-time= 39.6, Late= 35.8, All components: On-time= 40.8, Late= 36.6	3-group, staggered, pre- and post-test, and interrupted time series, 1996–2001 (“Back On Track”) and 1991–2001 (90-day administrative driver’s license suspension)		X	R	Canada
22. Rauch W, 2011[40]	**N**=1,927 drivers with ≥ 2 DUI offenses, Interlock (n=944) and Control (n=983) **% M**: Interlock: 89.0, Control: 87.0 **Age Range**: 19–75, **Mean age**: Interlock: 40, Control: 40	Parallel randomized trial, 2-group 2-year intervention, 2-year follow-up		X	R	USA
23. Robertson A, 2009[41]	**N**=32,945 drivers with first DUI offense, Completers (n=24,102), Non-completers (n=8,843), Non-enrollees (n=17,937) **% M**: 84.9, **Age range**: 13–90; **Mean age**: 35.3	3-group, post-test (completers vs. non-completers vs. non-enrollers) and 2-group, post-test (1989 vs. 2000 version program), 1996–2004		X	R	USA
24. Roth R, 2007[42]	**N**=19,023 drivers with first DUI offense, Interlock (n=1,461) and Comparison (n=17,562) **% M**: Interlock: 75.4, Comparison: 74.2 **Mean age**: Interlock: 35.7, Comparison: 31.7	2-group, post-test only, 3-year follow-up, 2003–2005		X	R	USA
25. Voas R, 199 9[43]	**N**=32,892 drivers with DUI offense(s), Interlock: First DUI (n= 1,982), Second DUI (n= 781), Comparison: First DUI (n= 17,587), Second DUI (n= 10,840), Ineligible: First DUI (n= 247), Second DUI (n= 1,455) **% M**: Unknown; **Age range**: Unknown	3-group, at 3, 6, 9, 12 months during and after the interlock period, 1988–1996		X	R	Canada

DUI= Driving under influence of alcohol; DB=Driving Behaviors, R=Recidivism, and C/I=Crash or Crash-Related Injury

Table 2a.

Study design and data source used in included observational studies

Study Design	Existing Data Only (n, %)	Involving Study Data Collection (n, %)	Total Studies (n, %)
Prospective Cohort		2, 18% (#9[a], 10)	2, 18%
Retrospective Cohort	4, 36% (#1,2,4,8)	1, 9% (#9[a])	5, 45%
Cohort[b]	3, 27% (#5,6,11)	1, 9% (#3)	4, 36%
Case-Control	1, 9% (#7)		1, 9%
Total	8, 73%	3, 27%	11, 100%[c]

Study# corresponds to the Study# listed in Table 1.

[a]Study #9 used both prospective and retrospective cohort design;

[b]Studies with insufficient information to classify as prospective or retrospective.

Table 2b.

Population type, outcome measures and level of risk reported in included observational studies

Population Type	Outcome Measures	*Level of Risk Reported in Included Studies (Study #)*			Total Studies (n, %)
		Increased Risk	Mixed	No Increased Risk	
Alcohol-Related Violation #3,4,8,9,10,11					6, 55%
	≥ 1 subsequent offenses (Yes vs. No)	#8,10	#3,4		
	Time to subsequent offense	#9	#11		
Non-Alcohol-Related Violation #2,5,6,7					4, 36%
	Driving behavior/Crash (Yes vs. No)	#7	#2		
	≥ 1 subsequent offenses (Yes vs. No)		#2		
	Time to subsequent offense/crash	#5	#6		
Both Alcohol and Non-Alcohol-Related Violation	Crash severity (Fatal/Incapacitating, Minor/Possible, vs. No injury)	#1			1, 9%
Total		6, 55%	5, 45%		11, 100%

Study# corresponds to the Study# listed in Table 1.

Table 3a.

Intervention type, evaluation design, and approach used in included intervention/evaluation studies

Intervention Type	As Single Intervention (n, %) #	As Part of a Multi-faceted Approach (n, %) #	Total Studies (n, %)
Implementation of Policy #12,17,18,19	4, 29% (#12,17,18,19)		4, 29%
Remedial Intervention Program #20,21,23		3, 21% (#20,21,23)	3, 21%
Interlock Installation #13,14,15,16,22,24,25	4, 29% (#15,22,24,25)	3, 21% (#13,14,16)	7, 50%
Total	8, 58%	6, 42%	14, 100%

Study# corresponds to the Study# listed in Table 1.

Table 3b.

Outcome measures and type of impact reported in included intervention/evaluation studies

Target Population	Outcome Measures	*Type of Impact Reported in Included Studies (Study #)*			Total Studies (n, %)
		Positive (all reported outcomes improved)	Mixed (some reported Outcomes improved)	Negative (outcomes worsened)	
Alcohol-Related Violation #13,14,15,16,17,20,21,22,23,24,25					11, 79%
	≥ 1 subsequent offenses (Yes vs. No)	#15,16	#25[a]		
	Time to subsequent offense	#20,22	#13[a],23,24[a]		
	Rate of subsequent offense/crash	#14,15,17,21			
Non-Alcohol-Related Violation #12, 19					2, 14%
	Rate of subsequent offense/crash			#19	
	Driving behavior/ Subsequent offense		#12[a]		
Both Alcohol and Non-Alcohol-Related Violation #18	Number/Frequency of subsequent offense/ crash	#18			1, 7%

Study# corresponds to the Study# listed in Table 1.

[a]Outcome improved during active intervention, but differences were not observed following end of intervention (e.g., after interlock device removal or program completion).