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Title: Substance Use Disorders Among Diverse Driver Populations in Iran: A Systematic Review and Meta-Analysis

Running Title: Substance Use in Iranian Drivers

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Abstract

Introduction: Substance Use Disorders (SUDs) represent a significant public health issue, particularly among high-risk populations such as drivers. This review aimed to quantify the prevalence of SUDs among diverse driver populations in Iran.

Methods: We followed PRISMA guidelines and conducted a comprehensive literature search using PubMed, Scopus, and Web of Science from 2013 through August 2024. Meta-regression analyses were conducted to explore heterogeneity sources, while subgroup analyses were performed based on data collection methods and demographic factors.

Results: A total thirteen studies were included, revealing an overall pooled prevalence of SUDs among specific groups of Iranian drivers (accident involved, commercial and motorcycles drivers) who were investigated previously at 29% (95% CI: 21% to 37%). Prevalence rates by substance type included opium-based drugs (20%), alcohol (9%), cannabis (8%), sedative-hypnotic drugs (1%), and stimulants (2%). Notably, drivers involved in accidents exhibited a higher prevalence of 36%, compared to 23% for commercial drivers and 13% for motorcyclists. Significant heterogeneity was observed ($I^2 = 98.5\%$, $p < 0.001$), indicating variability across studies.

Conclusion: The high prevalence of SUDs among drivers in Iran highlights the urgent need for targeted interventions to enhance driver safety and well-being. Further research is essential to address the factors contributing to these elevated rates among specific driver demographics.

Keywords: Substance Use Disorders; Drivers; Addiction; Iran; Systematic review; meta-analysis

Introduction

Substance Use Disorders (SUDs) represent a significant public health issue, characterized by various manifestations and outcomes, and they often co-occur with other psychiatric and physical problems (Schulte & Hser, 2013; Volkow & Blanco, 2023). According to the latest United Nations report, the number of people who use drugs is increased by 23% over the past decade and now exceeding 296 million worldwide. Among them, 39.5 million individuals definitively suffer from SUDs, which reflects a 45% raise during the same period (United Nations Office on Drugs and Crime, 2023). The country under study, Iran, is known as one of the major routes for drug trafficking between Asia and Europe and has experienced a similar pattern of increasing prevalence of SUDs in its population (Amirabadizadeh et al., 2018).

Although prevalence is a key epidemiological metric, it is conventionally assessed using cross-sectional study designs, limited to a single point in time; When such data is synthesized through a well-conducted systematic review, it can meaningfully inform healthcare professionals in planning and managing a given condition (Borges Migliavaca et al., 2020). This approach has also been applied in Iran to several at-risk populations for substance use, including university students (Soleimanvandiazar et al., 2023), high-school male adolescents (Hosseini et al., 2022), and imprisoned individuals (Mehrabi et al., 2024).

To effectively address SUDs and their associated challenges, it is essential to identify at-risk populations along with their specific risk and protective factors, because these groups may be more significantly influenced by these factors due to their unique circumstances (Thatcher & Clark, 2008). In recent years, drivers have been recognized as one of the most at-risk groups around the world. This recognition is primarily attributed to the significantly higher prevalence of SUDs, particularly among commercial drivers. Furthermore, factors such as extended working hours, occupational stress, and prevailing cultural attitudes towards substance use contribute to this substantial challenge (Akande et al., 2023). Also, a study performed in Spain that collected mandatory saliva samples from randomly selected drivers from diverse groups showed a 16.4% prevalence of drug use, which is much higher than the predictions we mentioned for the general population (Alcañiz et al., 2018). However, no systematic review to date has examined the prevalence of SUDs among drivers in Iran.

An assessment of mortality trends due to traffic accidents in Iran found 325,851 deaths over less than two decades, with a decline during the first decade followed by a marked rise between 2017 and 2022 (Taherian et al., 2025). This trend could be a motivation for better understanding of traffic accident risk factors and the individuals involved, particularly within our own country.

Alcohol consumption, even in small amounts, significantly impairs driving performance. This risky behavior plays a key role in leading to traffic accidents, injuries, and related deaths (Li et al., 2013). In addition to alcohol, other substances contribute to impaired driving in their own way. For example, opioids can cause drowsiness and cognitive problems, and cannabis can alter perception, impair coordination, and reduce reaction times. Also, chronic abuse of stimulant drugs like Methamphetamine causes negative effects on cognitive and psychomotor skills certainly (Verstraete et al., 2014; Taslimi et al., 2018). Besides them, a case-control study performed in Canada showed a relation between positive tests for sedative-hypnotic drugs like Benzodiazepine and being in traffic accidents, with an odds ratio of 4.1 (Dussault et al., 2002).

The high prevalence of SUDs and their serious consequences in driver populations, along with the lack of review about these problems and related risk factors in the aimed country, despite of many published original papers, prompt us to investigate the prevalence of SUDs among diverse driver populations in Iran. Ultimately, the review aims to inform policymakers and stakeholders about the urgent need for tailored strategies that promote safer driving environments and support the well-being of drivers and their communities.

Materials and Methods

Defining aim and review methodology

This review was conducted as the first phase of a greater study progressing at Hamadan University of Medical Sciences, titled “Situation Analysis and Establishing a Roadmap for Monitoring and Controlling Addiction in Iran.” In this phase we aimed to identifying risky populations for SUDs in Iran based on scientific published papers, then investigating the prevalence of SUDs among them. Current study serves as systematic review and meta-analysis and specifically focuses on the prevalence of SUDs among diverse driver populations in Iran. We adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive, transparent, and methodologically rigorous approach throughout the research process (Page et al., 2021).

Search strategy

A comprehensive literature search was conducted using multiple electronic databases including PubMed, Scopus, and Web of Science from their inception through August 2024. Additionally, the reference lists of relevant articles were manually searched. The search strategy employed combinations of keywords related to addiction (e.g., "addiction", "addictive behavior", "substance use", "drug use", "drug abuse", "drug addiction", "substance abuse", "substance addiction", "substance dependence", "drug dependence", "substance use disorder", "substance dependence disorder") and drivers in Iran, utilizing Boolean operators AND and OR to optimize results.

Definition of Substance Use Disorders

In psychiatric contexts, SUDs are typically diagnosed according to DSM-5 criteria (American Psychological Association, 2022), however, due to varying methodologies in past studies and limited access to patients or researchers, we cannot strictly apply these criteria in this phase. Therefore, we will consider any reliable reported data as indicative of SUDs, including terms such as addiction, substance abuse, or misuse within specific time frames, positive urinalysis or blood tests, and autopsy reports. Additionally, caffeine and tobacco will be excluded from this review, because they're not illegal for adults in our focus country.

Inclusion and exclusion criteria

In the first step, studies were included if they provided information on various aspects of SUDs in Iran, published in peer-reviewed journals, and contained sufficient data for meta-analysis. These studies could also inform future research on related topics, even if not directly relevant to the current study. In the second step, we focused on the epidemiological aspects of SUDs over the past decade, retaining only studies with reliable prevalence data for Iranian populations. In the third step, we aimed to identify at-risk groups discussed in previous studies, articles were categorized by their main target populations. After all, in the present study we focused on articles that represent diverse populations of drivers as their primary target group.

Exclusion criteria were established based on the steps outlined in the review process. In the first step, studies that were not original, lacked information on SUDs, focused solely on tobacco or caffeine use, or were unrelated to Iran in terms of target population or researchers were excluded. In the second step, studies published before 2013 or lacking epidemiological data, such as prevalence rates, were also excluded. Finally, in the third step, articles that did not target drivers as their primary group were removed from consideration.

Data extraction and analyses

Data extraction was performed independently by two reviewers (S. BC, F. E) capturing essential information such as author names, location, publication year, sample size, driver type (motorcycle drivers, commercial drivers, accident-involved drivers), data collection methods (direct, indirect, self-report) and demographic details. Also, substance type defined and divided in 5 types based on DSM-5 categories (Opium based drugs, Alcohol, Sedative-Hypnotic drugs, Cannabis, Stimulant drugs) (American Psychological Association, 2022).

The statistical analysis employed a random-effects model then, overall prevalence rates and substance-specific prevalence were calculated with 95% confidence intervals. Meta-regression analyses were conducted to identify potential sources of heterogeneity based on sample size and publication year. For subgroup analyses based on demographic factors, particularly age, we utilized the categorized data as reported in the primary studies. Given that the majority of included studies reported age as a dichotomous variable (under 30 vs. 30 years and older)—and considering the established clinical consensus that the age of 30 serves as a critical epidemiological cut-off distinguishing early-onset/experimental substance use from chronic, established SUDs—we adopted this threshold for our pooled analyses. Attempting to divide age into multiple separate

cohorts (e.g., 10-year intervals) was not feasible due to the aggregate nature of the published data and would have resulted in insufficient statistical power (fewer than 3 studies per subgroup) to yield stable prevalence estimates. All statistical analyses were performed using Stata version 17 (Stata Corp LLC, College Station, TX, USA).

Results

In September 2024, we identified 13,101 records related to our study. After removing duplicates, we reviewed 9,142 papers and excluded 5,125 articles for various reasons during the first screening. We then removed another 3,638 articles due to the absence of prevalence data or publication before 2013. Among the remaining articles, 362 did not focus on drivers, and from the last 17 articles, four were excluded after a detailed review. Ultimately, our quantitative meta-analysis included 13 studies, as shown in Figure 1. (Figure 1 near here)

A total of 13 studies reported the prevalence of SUDs among drivers. Table 1 provides a comprehensive overview of the key characteristics of all studies included in the meta-analysis. (Table 1 near here)

The results of the random-effects meta-analysis indicated that the overall prevalence (95% confidence interval) of SUDs among drivers in Iran is 29% (21% to 37%). The I^2 statistic was calculated to be 98.5% ($p < 0.001$), indicating significant heterogeneity among the studies (Figure 2). (Figure 2 near here)

Based on classification by type of substance used, the meta-analysis results showed that the overall prevalence rates for Sedative-hypnotic drugs, Cannabis, Opium based drugs, alcohol, and stimulant drugs were 1%, 8%, 20%, 9%, and 2%, respectively. The level of heterogeneity was estimated to be above 50% for all cases except for stimulant drugs ($I^2 = 15.8\%$) (Table 2). (Table 2 near here)

The results of the meta-regression analysis indicated that sample size and year of publication were not the main sources of heterogeneity. However, it was found that as the sample size and year of publication increased, the overall prevalence of SUDs decreased (Figure 3). (Figure 3 near here)

The results of subgroup analyses are presented in Table 3. The overall prevalence of SUDs in studies utilizing direct methods (42%) for data collection was more than double that of indirect methods (18%) and based on self-reports (19%). The prevalence among drivers involved in an accident (36%) was higher than that among commercial drivers (23%) and motorcyclists (13%). The overall prevalence among individuals over 30 years old was found to be 29%, whereas it was estimated at 13% for those under 30 years old. This more than two-fold difference robustly demonstrates that the selected age threshold effectively stratifies the risk of SUDs among Iranian drivers, despite the simplicity of the dichotomous grouping. Of note, in the subgroup of drivers aged over 30 years, the test for heterogeneity yielded a statistically significant p-value ($p < 0.05$), while the I^2 statistic was estimated at 0%. This seemingly discrepant finding is a recognized statistical phenomenon, particularly in meta-analyses with a limited number of studies. It occurs because the Q-test (p-value) evaluates the existence of heterogeneity, whereas I^2 quantifies its magnitude relative to random error; moreover, negative I^2 values are conventionally truncated to zero. In this subgroup, the small number of included studies reduced the degrees of freedom, resulting in a Q value only marginally exceeding the degrees of freedom, which translates to a negligible proportion of true variance ($I^2 \approx 0\%$) despite a statistically significant test. (Table 3 near here)

Discussion

This meta-analysis reveals a concerning pooled overall prevalence of SUDs among the groups of drivers assessed in previous studies in Iran, estimated at 29%. This figure is significantly higher than the 11.2% prevalence reported for Iranian adults in the latest national survey (Moradinazar et al., 2020), indicating that the studied driver groups, particularly accident-involved drivers, motorcycle drivers, and heavy vehicle drivers, may represent a distinct at-risk group for SUDs. In other study which also performed in Iran, the most prevalent illicit drugs identified were opium and alcohol, consistent with our findings. However, cannabis use among our targeted groups was notably higher than stimulant use, contrasting with the general adult population where these two substances have close prevalence rates (Rastegari et al., 2023).

Throughout this review we use "substance use disorders" rather than labeling terms such as "addict" or "abuser" for all individuals meeting SUD criteria, following evidence that person-

first language reduces stigma compared to labeling language, which remains uncommon in practice, with 61.04% of counseling journal articles failing to fully adhere to it (Ricciutti & Davis, 2025). Another analysis focused on drug seeking behavior identified this as a problem, finding that only 13.6% of articles used PFL consistently (Sharp et al., 2021). By adopting PFL in this review, we aim to reduce stigma and encourage the same practice in future Iranian research.

Due to the diverse population characteristics, variable study designs, and differing data collection methods, along with inconsistencies in the definition of SUDs, our analysis exhibited a heterogeneity of 98.5% ($p < 0.001$) as indicated by the I^2 statistic. This high level of heterogeneity highlights the need for further investigation and comparisons within distinct subgroups, similar to order analyses performed above (Imrey, 2020).

The articles included in our analysis examined three different populations. Drivers involved in accidents, studied in eight articles, showed a prevalence of 36%, which is higher compared to others. That percentage is lower than the roughly 54.4% reported for the exact same population in the United States (Thomas et al., 2022). Estimates of drug consumption among commercial drivers worldwide suggest a prevalence of approximately 27.6% (Dini et al., 2019), and our findings of 23% for this group align closely with earlier studies. Additionally, we were unable to find reliable studies specifically investigating SUDs among casual motorcycle drivers. This area warrants further research, especially considering that motorcyclists are 28 times more likely to die in accidents per mile traveled than car occupants (Chaudhuri et al., 2019).

The preceding two paragraphs, on the high heterogeneity ($I^2=98.5\%$) and the focused, high risk driver populations included in our analysis, suggest that our pooled prevalence estimate of 29% cannot be taken to represent the general "driver population" in Iran. This limitation could be reduced by future studies of regular, non-selected drivers. For example, through routine drug testing at license renewal dates. Reward based screening programs, or mandatory background check requirements specifically for drivers with known SUDs, could also serve as practical models for future research in this area, like what has recently been implemented in Italy (Tittarelli et al., 2024).

In our study, the prevalence of SUDs was significantly higher using direct methods. This finding aligns with other articles demonstrating indirect methods, such as the Network Scale-Up (NSU) and Capture-Recapture methods used in the studies by Ahmadi-Gohari (Ahmadi-Gohari et

al., 2019) and Ainy (Ainy & Soori, 2019), respectively, tend to underestimate prevalence compared to direct methods (Jones et al., 2016; Zahedi et al., 2018). The same issue is observed with self-report questionnaires, which were also utilized in five of our studies (Khalili et al., 2021).

As said before, in studies with large sample sizes, the prevalence of SUDs tends to decrease slightly. This finding may be attributed to most included studies with this property that did not utilize direct data collection methods. Although a study conducted in India indicated that larger sample sizes provide more insightful information, reduce margins of error, increase confidence levels, and enhance model accuracy (Gumpili & Das, 2022), It is essential to consider other factors that may influence these outcomes. Based on this consideration and to avoid bias in our study favoring the specific population from the Ahmadi-Gohari article, which involved 363 commercial drivers and wanted them to estimate SUDs among 36,300 colleagues using the NSU method (Ahmadi-Gohari et al., 2019), we focused on those same 363 participants.

This slight decrease is also reflected in the increasing years of publication, which is intriguing when contrasted with the rising number of individuals using drugs globally (United Nations Office on Drugs and Crime, 2023). This discrepancy suggests that the motivations and causes behind SUDs among drivers may differ from the general population, these issues require further investigation by researchers and relevant organizations.

We could not determine the mean age of participants in three articles; however, analysis of the other ten suggests that SUDs are more prevalent among drivers aged over 30. Notably, the pooled prevalence for drivers over 30 years old was 29%, which is more than double the 13% observed among those under 30. However, a methodological caveat must be acknowledged regarding this age-related analysis. In our meta-analysis, we were strictly limited to the categorized data as reported in the primary studies. Since the majority of included studies presented age as a dichotomous variable (under 30 vs. 30 years and older), we adopted this threshold for our subgroup comparisons. While the 30-year cut-off is supported by clinical and epidemiological consensus—differentiating early-onset/experimental use from chronic, established SUDs—we acknowledge that this dichotomization inevitably sacrifices granularity and may obscure potential non-linear age-related patterns. Ideally, analyzing age in multi-tiered cohorts (e.g., 10-year intervals) or as a continuous variable would provide richer insights; however, due to the aggregate nature of our source data and to maintain sufficient statistical power (as narrower age bands would have resulted

in extremely sparse data with fewer than 3 studies per subgroup), this approach was not feasible. We recommend that future primary studies adopt standardized reporting of age in continuous or multi-tiered formats to facilitate more precise individual participant data (IPD) meta-analyses in the future. In contrast, studies conducted in the United States indicate that younger drivers have higher rates of alcohol and illicit drug use (Lipari et al., 2016). This cross-cultural discrepancy highlights an important area for further research into the correlation between age and the causes or effects of drug use on driving in Iran. Furthermore, when interpreting the heterogeneity indices for individual subgroups, readers should exercise caution. For instance, in the over-30 age subgroup, a statistically significant Q-test p-value alongside an I^2 of 0% was observed. This reflects the inherent limitations of these metrics in small-sample meta-analyses, where the Q-test retains relatively higher sensitivity to detect any deviation from homogeneity, while I^2 —due to its dependency on the $(Q-df)/Q$ ratio and truncation at zero—may estimate the proportion of true variance as negligible. Therefore, decisions regarding the choice between fixed- and random-effects models in subgroup analyses should not rely solely on I^2 point estimates, especially when the number of constituent studies is small. After all, we should discuss about papers of Assari (Assari et al., 2014), Divsalar (Divsalar et al., 2021), and Manouchehri (Manouchehri et al., 2018) which reported a significantly higher prevalence of SUDs compared to the other ten studies. These three studies share two key characteristics (data collection using direct methods and a focus on accident-involved drivers) that contribute to the elevated prevalence estimates observed in our investigation. Regarding Manouchehri Article (Manouchehri et al., 2018), the reported drug type prevalences likely reflect a limitation in the article's data presentation, since the total exceeded 100% because many participants used more than one drug. Therefore, we relied only on the overall prevalence and calculated the proportion of multiple drug users as 54/220 (24.6%).

Finally, the lack of studies focusing on the population of regular drivers may have posed a limitation in our article. Therefore, we recommend that future research prioritize this demographic.

Conclusion

In Iran, a considerable proportion of the driver groups studied in previous research appear to have used drugs, with notably higher estimates among studies employing direct methods and focusing

on accident-involved drivers. Evidence also indicates that SUDs are more prevalent among drivers over 30. This review highlights the urgent need for policymakers to focus on enhancing the safety and well-being of drivers and their communities. It underscores the necessity for targeted interventions and further research too.

Ethical Considerations

Compliance with ethical guidelines

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability

Data supporting this study's findings are available upon a reasonable request from the corresponding author.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tool influenced the scientific content, data analysis, or conclusions of this work.

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Authors' contribution

All authors contributed equally to the conception and design of the study, data collection, interpretation of the results, and drafting of the manuscript. Data analysis was performed by Erfan Ayubi and Salman Khazaei. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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Table 1. Key characteristics of all studies included in meta-analyses

Author	Year	Province	Data collection	Sample size	Total Prevalence	Q	SE	Driver populations	Mean Age	Sedative-Hypnotic drugs	Cannabis	Opioid based drugs	Alcohol	Stimulant drugs	Multiple drugs
Afzali (Afzali, Saleh et al. 2013)	2013	Hamadan	Direct	106	0.17	0.83	0.0365	Accident-involved	> 30	1.9		11.3	1.9		1.8
Ahmadi-Gohari (Ahmadi-Gohari, Zolala et al. 2019)	2019	Kerman	Indirect	363	0.22	0.78	0.0217	Commercial			3.27	12.8	3.91	1.97	
Ahmadzadeh (Ahmadzadeh, Mousavi et al. 2017)	2017	Isfahan	Self-report	450	0.16	0.84	0.0173	Accident-involved	> 30			11.5		3.4	
Ainy (Ainy and Soori 2019)	2019	National	Indirect	1176	0.14	0.86	0.0101	Commercial	> 30	0.06	0.27	11.04		1.34	
Akbari (Akabari, Sarikhani et al. 2021)	2021	Shiraz-Yazd	Self-report	1747	0.132	0.87	0.0078	motorcycle	< 30						
Assari (Assari, Lankarani et al. 2014)	2014	National	Direct	51	0.6	0.4	0.0686	Accident-involved	> 30		16	51			
Divsalar (Divsalar, Mohammadi et al. 2021)	2021	Kerman	Direct	222	0.77	0.23	0.0282	Accident-involved			1.8	64.8		2.3	7.7
Ghadirzadeh (Ghadirzadeh, Forouzesh et al. 2018)	2018	Tehran	Direct	618	0.12	0.88	0.0131	Accident-involved	> 30			6.47	4	1.46	0.5
Heydari (Heydari, Vossoughi et al. 2016)	2016	Shiraz	Self-report	414	0.15	0.85	0.0175	motorcycle	< 30	2.4	3.6	9.9	36.2	1	
Khanjani (Khanjani, Mousavi et al. 2017)	2017	Shiraz	Direct	441	0.267	0.73	0.0183	Accident-involved	> 30		5.21	9.97	8.84	2.72	

Khatir (Khatir, Azar et al. 2022)	2022	Mazandaran	Self-report	77	0.18	0.82	0.0438	Accident- involved				6.5	10.3	1.42
Maarefvand (Maarefvand, Kassaie et al. 2016)	2016	National	Self-report	349	0.34	0.66	0.0254	Commercial	> 30	0.3	0.9	33	1.4	1.5
Manouchehri (Manouchehri, Razaee et al. 2018)	2018	Babol	Direct	220	0.636	0.36	0.0324	Accident- involved	> 30					24.6

Table 2. The prevalence of SUDs in drivers by type of substance

Substance type	No of studies	Pooled Prevalence (95% CI)	I²	P for heterogeneity
Sedative- hypnotic drugs	4	0.01 (0.00, 0.01)	74.95%	0.01
Cannabis	7	0.08 (0.02, 0.13)	98.4%	<0.001
Opium based drugs	11	0.20 (0.13, 0.26)	97.6%	<0.001
Alcohol	7	0.09 (0.04, 0.14)	97.3%	<0.001
Stimulant drugs	9	0.02 (0.01, 0.02)	15.8%	0.30

Table 3. Subgroup analysis of the studies included in meta-analysis

Variable	No of studies	Pooled Prevalence (95% CI)	Weight (%)	I²	P for heterogeneity
Data collection method					
Direct	6	0.42 (0.20, 0.65)	45.24	99.2%	<0.001
Indirect	2	0.18 (0.10, 0.25)	15.83	91%	0.001
Self-report	5	0.19 (0.13, 0.25)	38.93	93.5%	<0.001
Driver populations					
Accident-involved drivers	8	0.36 (0.20, 0.52)	60.49	98.9%	0.05
Commercial drivers	3	0.23 (0.12, 0.34)	23.61	96.6%	0.001
Motorcycle drivers	2	0.13 (0.12, 0.15)	15.90	0%	<0.001
Age					
< 30 yrs	2	0.13 (0.12, 0.15)	15.90	97.9%	0.02
> 30 yrs	8	0.29 (0.20, 0.39)	61.19	0%	<0.001

Fig. 1.

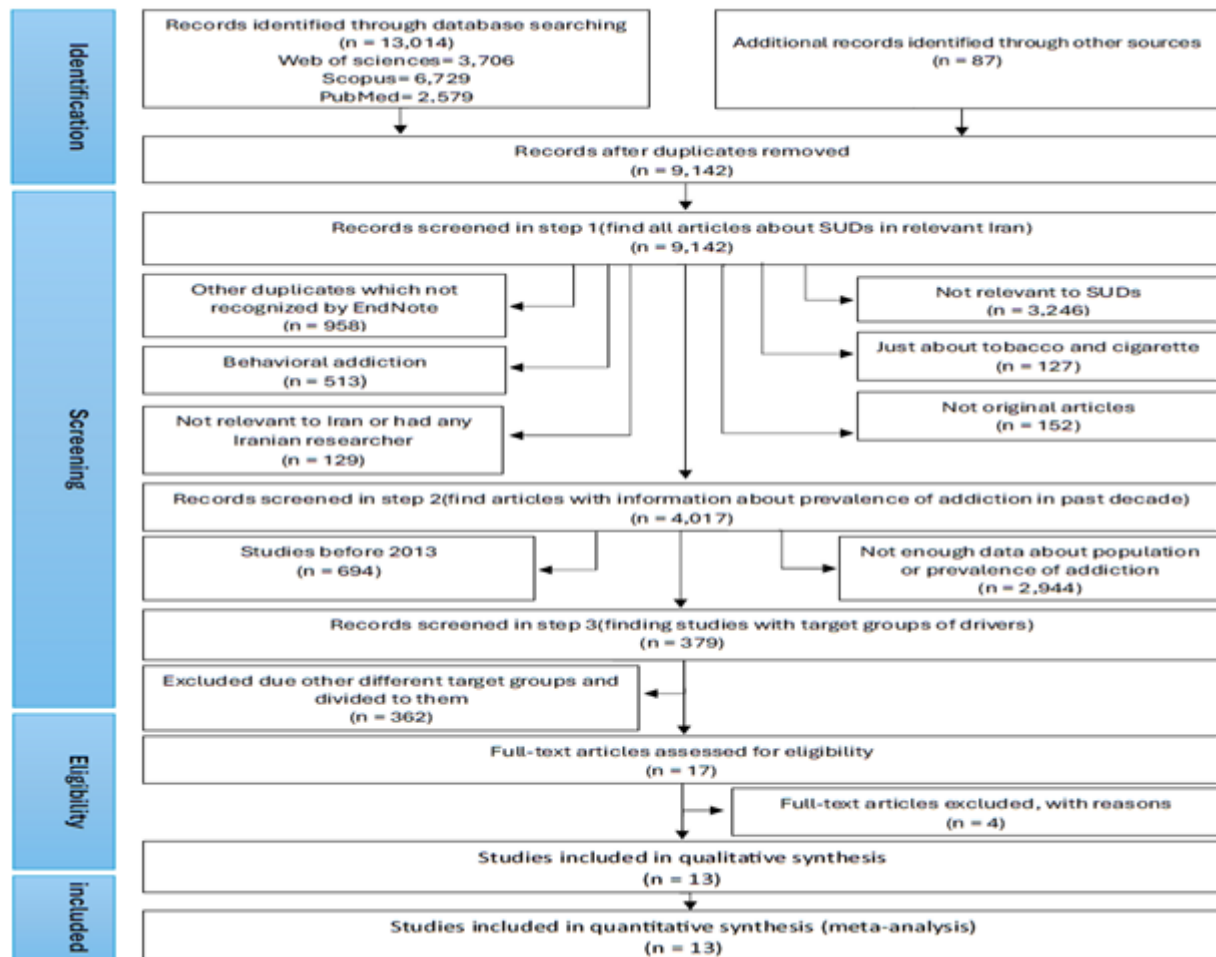


Fig. 2.

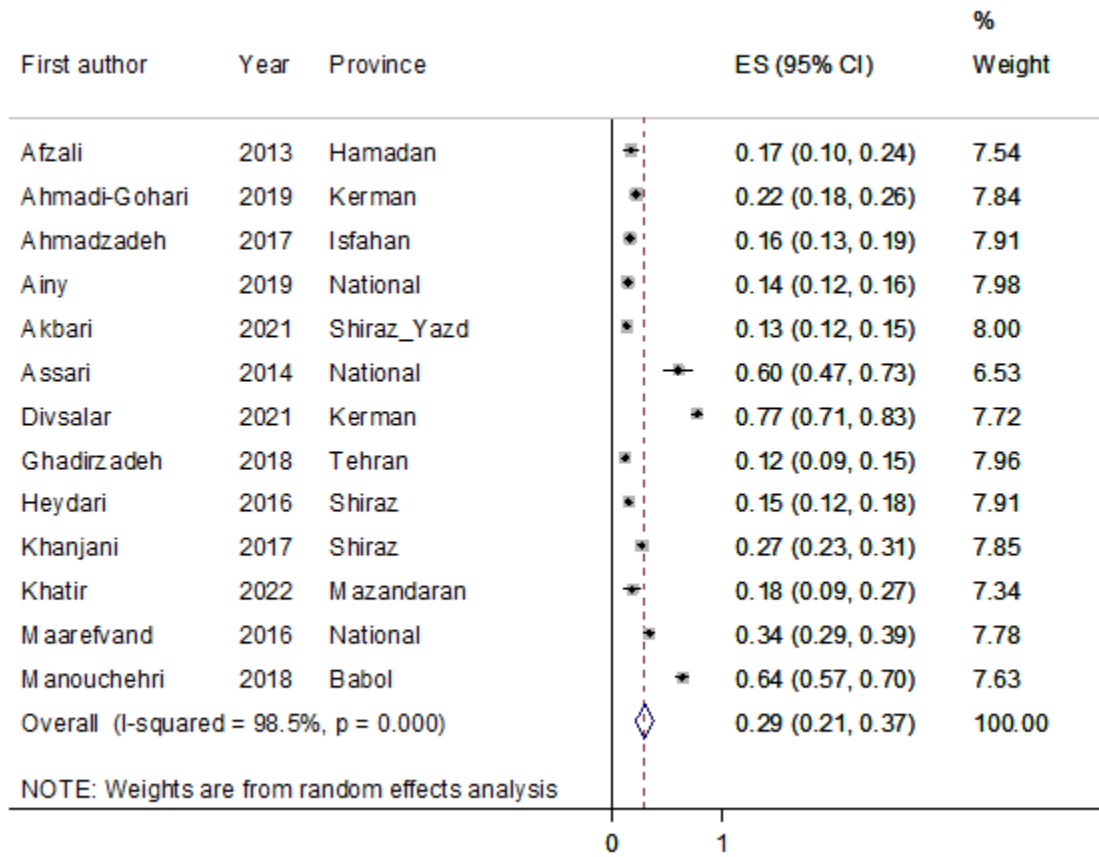


Fig. 3.

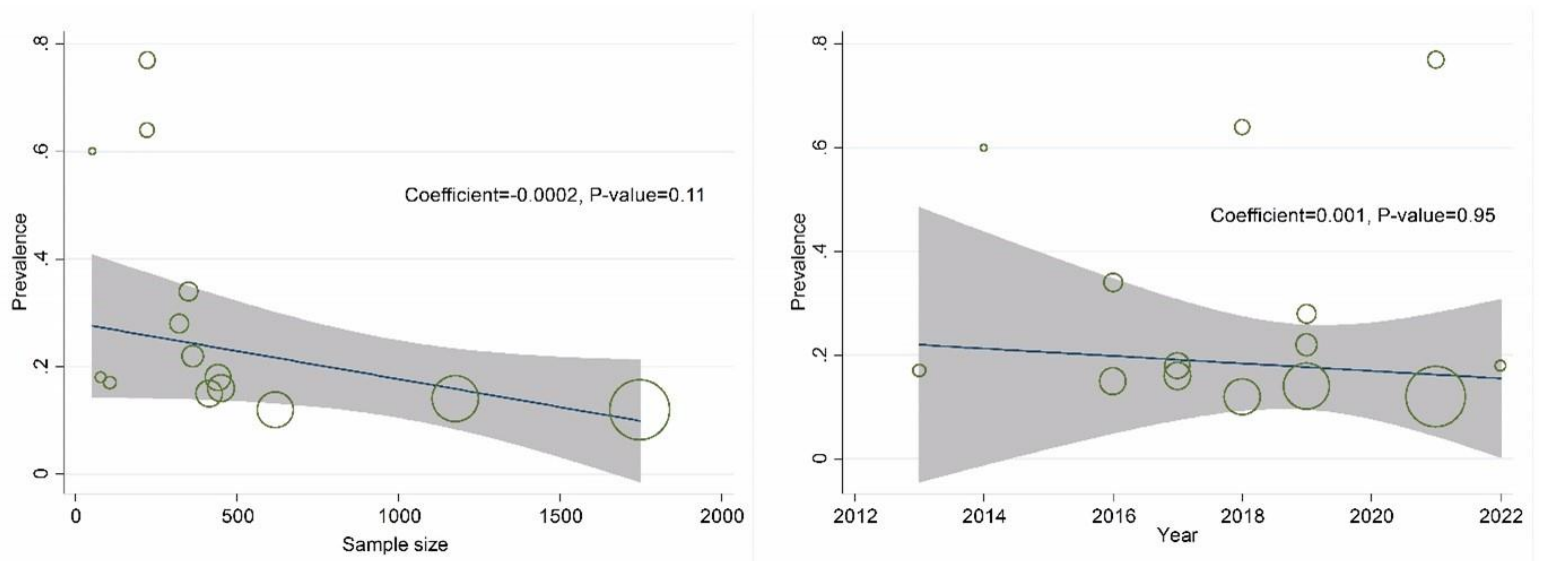


Figure legend

Figure 1. PRISMA flow diagram for systematic review and meta-analyses selection process (Specialized for our method)

Figure 2. Meta-analysis of prevalence of SUDs among drivers in Iran

Figure 3. Bubble plots of prevalence of SUDs by sample size and year of publication

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