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Alcohol and psychoactive substances in fatal road traffic crash victims: an integrative review

Álcool e substâncias psicoativas em vítimas fatais de sinistros de trânsito: uma revisão integrativa

Alcohol y sustancias psicoactivas en víctimas de accidentes de tráfico mortales: una revisión integradora

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Abstract: Road traffic crashes are a persistent public health and medico-legal problem, especially when associated with alcohol and other psychoactive substances. This study aimed to analyze recent literature on the presence of alcohol, drugs, and psychoactive medications in fatal road traffic crash victims, emphasizing toxicological findings and their forensic implications. An integrative review was conducted in PubMed/MEDLINE, including studies published between 2016 and 2026. After screening, full-text retrieval, and eligibility assessment, 26 studies were included in the final synthesis. The findings indicated relevant presence of alcohol, cannabis/THC, opioids, benzodiazepines, stimulants, psychotropic medications, and polysubstance use patterns among different categories of fatal victims, including drivers, motorcyclists, pedestrians, and multiple road users. Limitations related to selective testing, heterogeneous toxicological panels, and incomplete official records were also identified. It is concluded that postmortem toxicological investigation in traffic-related deaths should not be limited to blood alcohol testing, requiring expanded and standardized toxicological panels and integration between medico-legal, police, and epidemiological data.

Keywords: Road traffic crashes. Forensic toxicology. Alcohol. Psychoactive substances. Fatal victims.

Resumo: Os sinistros de trânsito constituem problema persistente de saúde pública e de interesse médico-legal, especialmente quando associados ao consumo de álcool e outras substâncias psicoativas. Este estudo teve como objetivo analisar a literatura recente sobre a presença de álcool, drogas e medicamentos psicoativos em vítimas fatais de sinistros de trânsito, com ênfase nos achados toxicológicos e em suas implicações periciais. Foi realizada revisão integrativa na PubMed/MEDLINE, com estudos publicados entre 2016 e 2026. Após triagem, recuperação de textos completos e avaliação de elegibilidade, 26 estudos compuseram a síntese final. Os achados indicaram presença relevante de álcool, cannabis/THC, opioides, benzodiazepínicos, estimulantes, medicamentos psicotrópicos e padrões de poliuso em diferentes categorias de vítimas fatais, incluindo condutores, motociclistas, pedestres e múltiplos usuários da via. Também foram identificadas limitações associadas à testagem seletiva, heterogeneidade dos painéis toxicológicos e incompletude de registros oficiais. Conclui-se que a investigação toxicológica post mortem em mortes no

trânsito não deve se restringir à alcoolemia, sendo necessária a ampliação e padronização dos painéis toxicológicos e a integração entre dados médico-legais, policiais e epidemiológicos.

Palavras-chave: Sinistros de trânsito. Toxicologia forense. Álcool. Substâncias psicoativas. Vítimas fatais.

Resumen: Los siniestros de tránsito constituyen un problema persistente de salud pública y de interés médico-legal, especialmente cuando se asocian con el consumo de alcohol y otras sustancias psicoactivas. Este estudio tuvo como objetivo analizar la literatura reciente sobre la presencia de alcohol, drogas y medicamentos psicoactivos en víctimas fatales de siniestros de tránsito, con énfasis en los hallazgos toxicológicos y sus implicaciones periciales. Se realizó una revisión integradora de la literatura en PubMed/MEDLINE. Tras la remoción de duplicados y la evaluación de elegibilidad, se incluyeron 26 estudios en la síntesis final. Los estudios evidenciaron la presencia relevante de alcohol, cannabis/THC, opioides, benzodiazepinas, estimulantes, medicamentos psicotrópicos y patrones de policonsumo en diferentes categorías de víctimas fatales. Se concluye que la investigación toxicológica post mortem en muertes relacionadas con el tránsito no debe restringirse a la alcoholemia, siendo necesaria la ampliación y estandarización de los paneles toxicológicos y la integración entre datos médico-legales, policiales y epidemiológicos.

Palabras clave: Accidentes de tránsito. Toxicología forense. Alcohol. Sustancias psicoactivas. Víctimas fatales.

List of Acronyms and Abreviations

acronym/abreviation	Meaning
ABNT	Brazilian Association of Technical Standards
ARIMA	AutoRegressive Integrated Moving Average
BAC	Blood Alcohol Concentration / blood alcohol concentration
DBS	Dried Blood Spots / Dry Blood Staints
DeCS	Descriptors in Health Sciences
DETRAN-DF	Federal District Traffic Department
DOI	Digital Object Identifier
ELISA	Enzyme-Linked Immunosorbent Assay
ESR	Institute of Environmental Science and Research, New Zealand
EtG	Ethylglucuronide
EtS	Ethysulfate
FARS	Fatality Analysis Reporting System
FMS	Forensic Medicine and Science, Glasgow
GC-FID	Gas chromatography with flame ionization detector
GC-MS	Gas chromatography coupled with mass spectrometry
HPLC/DAD	High efficiency liquid chromatography with diode arrangement detector
HS-GC	Gas chromatography in headspace
IML	Legal Medical Institute
KSP	Kentucky State Police Laboratory
LABTOX	Laboratory of Forensic Toxicology
LC-MS	Liquid chromatography coupled to mass spectrometry
LC-MS/MS	Liquid chromatography coupled to tandem mass spectrometry
MDMA	3,4-methylenedioxymethamphetamine

acronym/abreviation	Meaning
MeSH	Medical Subject Headings
NBR	Brazilian Standard
NHTSA	National Highway Traffic Safety Administration
NRS	National Roadside Survey
NRPaTV	National Register of Autopsies and Toxicological Examinations
WHO/WHO	World Health Organization / World Health Organization
PCIES	Scientific Police of Espírito Santo
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PubMed/MEDLINE	National Library of Medicine's bibliographic base
THC	Tetrahydrocannabinol
UHPLC-MS/MS	Ultra-high efficiency liquid chromatography coupled to tandem mass spectrometry

1. Introduction

Road traffic crashes are a persistent public health, road safety and medico-legal investigation problem. According to the World Health Organization, traffic deaths remain at a high level in the global scenario, with a recent estimate of approximately 1.19 million deaths per year, despite advances observed in road safety policies in different countries (WORLD HEALTH ORGANIZATION, 2023). In addition to mortality, these events produce social, economic, social security and judicial repercussions, requiring an integrated approach between health, public safety, medico-legal investigation and epidemiological surveillance.

Among the factors associated with road traffic crashes, alcohol consumption occupies a historically relevant position. Driving under the influence of alcohol increases the risk of involvement in collisions, and this risk grows progressively with increased alcohol concentration in the blood. Driving under the influence of alcohol is recognized as a risk factor for injuries and deaths in traffic, which justifies enforcement policies, legal limits of alcohol and prevention strategies directed to road users (WORLD HEALTH ORGANIZATION, 2023).

However, the contemporary understanding of fatal road traffic crashes cannot be limited to alcohol. The use of non-alcoholic psychoactive substances, including cannabis, stimulants, opioids, benzodiazepines and other centrally acting medicines, has received increasing attention in the international literature. The relationship between drugs and road safety is complex, as different substances can interfere with attention, judgment, motor coordination, reaction time, and risk behavior (WORLD HEALTH ORGANIZATION, 2016; NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, 2024).

Post mortem forensic toxicology plays a central role in investigating these deaths. The analysis of blood, urine, vitreous mood, oral fluid and other matrices can contribute to

identify recent or previous exposure to alcohol and drugs, as well as support the interpretation of the circumstances of the event. However, the interpretation of the toxicological findings post mortem requires caution, since it can be influenced by factors such as interval between the claim and the collection, post mortem redistribution, sample degradation, endogenous ethanol production, therapeutic use of medications and limitations of the analytical panel used (BASELT, 2020).

In the Brazilian context, the expert investigation of traffic deaths still faces challenges related to the availability of examinations, standardization of protocols, breadth of toxicological panels and integration between police, medical and epidemiological data. The realization of alcohol is fundamental, but may be insufficient when not accompanied by expanded research for other psychoactive substances. This limitation may produce underestimated the participation of illicit drugs, psychotropic drugs and polysubstance use patterns in official statistics and in the forensic interpretation of cases.

Given this scenario, it is relevant to synthesize the recent literature on alcohol and other psychoactive substances in fatal victims of road traffic crashes. The meeting of these findings can contribute to qualify the expert discussion, guide laboratory priorities, identify research gaps and subsidize public policies aimed at reducing traffic mortality. Thus, the objective of this study was to analyze the recent literature on the presence of alcohol and other psychoactive substances in fatal victims of road traffic crashes, with emphasis on toxicological findings, the populations evaluated, the biological matrices used and the implications for medico-legal practice.

2. Material and Methods

An integrative review of the literature was carried out, a method that allows to gather, analyze and synthesize studies with different designs, enabling a broad understanding of a particular health phenomenon (WHITTEMORE; KNAFL, 2005). The conduct and presentation of the selection process of the studies observed, in an adapted way, principles of methodological transparency used in literature reviews, including description of the search strategy, eligibility criteria, screening, full text recovery and data synthesis (PAGE et al., 2021).

The guiding question of the review was: what are the main findings of the recent literature on the presence of alcohol and other psychoactive substances in fatal victims of road traffic crashes and what are their implications for medico-legal practice?

The bibliographic search was carried out at PubMed/MEDLINE in July 2026. Two strategies structured with MeSH descriptors and free terms related to accidents or road traffic crashes, fatality, mortality, alcohol, ethanol, blood alcohol concentration, psychoactive substances, illicit drugs, forensic toxicology and toxicological analysis post mortem were used. The searches were delimited to the period from 2016 to 2026, involving studies in humans and publications in the English, Portuguese or Spanish languages. The structure of the Boolean operators used is shown in Table 1.

Table 1 - Search strategies used in PubMed/MEDLINE

Database	Descriptors / DeCS/MeSH	Used Boolean Operators (AND, OR)	Applied Filters
PubMed/MEDLINE (Search 1)	Traffic/fatality block: "Accidents, Traffic"[Mesh], "Automobile Driving"[Mesh], road traffic crash*, road traffic fatalit*, traffic death*, vehicle crash engine*, fatally injured driver*/road user*, fatal victim*. Death block: "Death"[Mesh], "Mortality"[Mesh], death*, mortality, fatalit*, fatal injury/outcome. Block substances: "Alcohol Drinking"[Mesh], "Ethanol"[Mesh], alcohol, ethanol, BAC, blood, alcohol concentration/content, alcohol-positive, intoxication, drunk; driving "Street Drugs"[Mesh], "Substance-Related Disorders"[Mesh], drug*, illicit drug*, psychoactive/psychotropic/ substance*, cannabis/marine/methamphetamine*/MDMA/ecstasy, benzodiazepine*, opioid*/opiate*, sedative*/hypnotic*, multiple substances, polydrug/poly-drug.	OR between synonyms within each block; AND between the blocks traffic/fatality, death/mortality and alcohol/drugs.	2016:2026[dp]; humans[MeSH Terms]; languages: English, Portuguese or Spanish. Gross result: n = 889. Note: Executed and included in the protocol.
PubMed/MEDLINE (Search 2)	Traffic/fatality block: "Accidents, Traffic"[Mesh], road traffic fatalit*, traffic fatalit*, traffic death*, fatal crash*, fatal collision*, vehicle crash engine*, fatally injured driver*/road user*. Block forensic toxicology: "Forensic Toxicology"[Mesh], forensic toxicology, postmortem/postmortem toxicology, toxicological analysis/analyses, toxicology screening, toxicological findings. Block substances: alcohol, ethanol, blood alcohol concentration, BAC, drug*, psychoactive substance*, illicit drug*, cannabis/marijuana, cocaine/benzoylegonine, amphetamine*/methamphetamine*, benzodiazepine*, opioid*, polydrug.	AND between traffic/fatality, forensic toxicology/post mortem and alcohol/drugs; OR between synonyms within each block.	2016:2026[dp]; humans[MeSH Terms]; languages: English, Portuguese or Spanish. Gross result: n = 48. Note: Executed and included in the protocol.

Source: Prepared by the author from the search strategy in Pubmed/MEDLINE, 2026.

Studies addressing fatal victims of road traffic crashes, fatally injured drivers, motorcyclists, pedestrians, passengers or other road users were included, provided that they presented evaluation, description or discussion of findings related to alcohol use and/or other psychoactive substances. Observational, retrospective, cross-sectional, database analyses, toxicological studies, temporal trend studies and medico-legal or epidemiological investigations with extractable data on alcohol, drugs, psychoactive drugs or polysubstance use were considered eligible.

Studies without direct relation to traffic, studies without evaluation of alcohol or psychoactive substances, publications without relation to fatality, articles aimed exclusively at

non-fatal lesions without applicability to the objective of the review, animal studies, editorials, comments, letters without original data, duplicates and publications without sufficient information for extraction of relevant data were excluded. Studies whose full text was not obtained after recovery attempts were recorded as not recovered and excluded from the final synthesis.

The recovered records were exported from PubMed/MEDLINE to the Zotero bibliographic manager, where duplicate removal was performed. Then, the screening was proceeded by title and summary. Potentially eligible articles were selected for full-text recovery. The full reading was performed to confirm the eligibility criteria. At the end of this process, 26 studies were included in the final synthesis.

The data extraction was performed in a standardized spreadsheet, contemplating the following variables: author and year, country, type of study, objective, data source, studied period, population evaluated, sample size, type of victim, substances evaluated, biological matrix used, toxicological method or data source, main result on alcohol, main result on other drugs, data on polysubstance use, conclusion of the authors, main methodological limitation and relevance to the Brazilian expert discussion.

The data were analyzed by narrative synthesis, considering the heterogeneity of the designs, populations, data sources, biological matrices, toxicological methods and ways of presenting the results. Meta-analysis was not performed, due to the methodological diversity between the studies and the absence of homogeneous measures of effect. The findings were organized in descriptive tables and grouped into thematic axes related to alcohol, non-alcoholic drugs and psychotropic drugs, polysubstance use, selective underreporting/testing and implications for medico-legal practice.

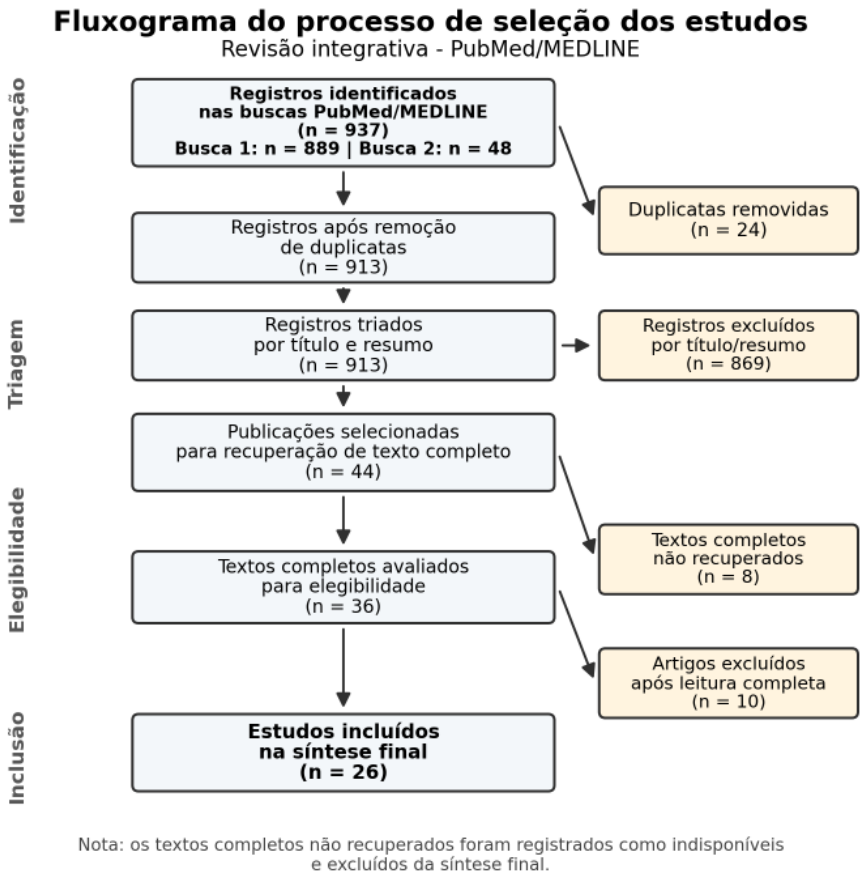
3. Results

3.1 Study Selection

The two search strategies in PubMed/MEDLINE identified 937 records. After the removal of 24 duplicates, 913 records were submitted to screening by title and summary. In this stage, 869 records were excluded because they did not meet the eligibility criteria. Forty-four publications were selected for full-text recovery. Eight complete texts were not obtained after attempts at recovery, with 36 articles fully evaluated. After complete reading, 10 studies were excluded because they did not meet the defined criteria, resulting in 26 studies included in the final synthesis.

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Figure 1 - Flowcharting of the selection process of the studies.



3.2 General Characteristics of the Included Studies

The 26 included studies presented predominantly observational, retrospective, epidemiological or record-based designs. Data sources included national systems of traffic fatalities, police records, forensic toxicology banks, necropsy reports, medico-legal records and administrative banks. The studies covered different countries, with a predominance of investigations carried out in the United States, European countries, Brazil, Australia, Canada, China and Taiwan. The populations evaluated included drivers, motorcyclists, pedestrians, passengers and multiple categories of road users (Table 2).

Table 2 - Characterization of studies included

No	Author/year	Country	Type of study	Data source	Period	Population/samset
1	Tegner et al., 2022	Brazil	Cross-sectional prospective/retrospective study and method development	General Institute of Expertise of Rio Grande do Sul	2021	Fatal victims of road traffic crashes; 99 fatalities
2	Guimarães e Silva, 2019	Brazil	Ecological study, time series ARIMA	DETRAN-DF	2000–2017	Victims of fatal accidents in the Federal District; 6,949 fatal

No	Author/year	Country	Type of study	Data source	Period	Population/samset
						accidents
3	Ponce et al., 2019	Brazil and Norway	Cross-sectional retrospective study	Expert reports from São Paulo and University Hospital of Oslo	2005–2015	2- and 4-wheel vehicle drivers; 1,356 victims
4	Gjerde and Frost, 2023	Norway	Retrospective epidemiological study	Accident records and forensic toxicology banks	2011–2020	Motor vehicle drivers; 863 drivers, 645 tested
5	Beirness et al., 2021	Canada	Retrospective toxicological study	Center for Forensic Sciences and Ministry of Transport	2016–2018	Road vehicle drivers; 921 drivers
6	Davey et al., 2020	Australia	Case study with records of coroners	Lector reports and laboratory toxicological certificates	2011–2015	Drivers and motorcyclists; 701 cases
7	Ehsani et al., 2021	United States	Comparative study of databases	FARS and Maryland Medical Examiner	2006–2018	Fatal traffic victims; 4,803 matched cases
8	Jan Mario Breen et al., 2021	Norway	Retrospective study of necropsy	Necropsy records and police reports	2000–2014	Fatal victims occupying vehicles; 401 victims
9	Sarmiento et al., 2020	United States	Retrospective study	Medical Miami-Dade Examiner and Signal Four Analytics	2009–2014	Fatal motorcycle victims; 227 fatalities
10	Massilkovah and Vorel, 2023	Czech Republic	Comparative retrospective study	NRPaTV and Czech Republic Police	2016–2021	Fatal victims within 24h; 2,715 fatalities
11	Chihuri and Li, 2017	United States	Time trend study	Fatality Analysis Reporting System	1995–2015	Drivers fatally injured; 36,729 drivers
12	Koskinen et al., 2026	Finland	Case-control study with linkage	Institutes of Health and Finnish Death Record	1990–2011	Deceased drivers with psychotic disorder versus controls; 282 conductors
13	T. Bunn et al., 2019	United States	Retrospective study with data connection	FARS, CRASH and death certificates	2010–2014	Fatal conductors in Kentucky; 2,235 drivers
14	Wang, 2022	Taiwan	Retrospective epidemiological study	Taiwan National Police Administration	2016–2020	Motorcyclists involved in claims; 1,628,909 motorcyclists
15	Wiratama et al., 2020	Taiwan	National cross-sectional study	National Taiwan Traffic Crash Dataset	2011–2015	Motorcyclists in collisions with automobiles; 669,292 victims
16	Hamnett and Poulsen, 2018	Scotland and New Zealand	Comparative retrospective study	FMS Glasgow and ESR Wellington	2013–2015	Drivers and fatal motorcyclists; 364 cases
17	Romano et al., 2017	United States	Case-control reanalysis	FARS and NRS	2006–2008	Fatal conductors and traffic controls; approximately 5,200 cases/controls
18	Romano et al., 2018	United States	Case-population control study	FARS and NRS	2007; 2013–2014	Drivers of passenger vehicles; approximately 18,400 drivers
19	Hamnett et al., 2017	Scotland	Retrospective analysis	Laboratory of Toxicology at the University of Glasgow	2012–2015	Drivers and motorcyclists killed; 118 cases
20	Anja Valen et al., 2019	Norway	Cross-sectional descriptive study	National records and forensic toxicology bank	2005–2015	Drivers and motorcyclists killed; 1,220 drivers, 772 tested
21	Thomas et al., 2020	United States, Georgia	Descriptive epidemiological study	Fatality Analysis Reporting System	2007–2016	Pedestrians fatally injured; 1,781 pedestrians
22	Thomas, Riemann and Jones, 2019	United States	Descriptive epidemiological study	Fatality Analysis Reporting System	2014–2016	Pedestrians killed in claims; 13,228 fatalities
23	Azagba et al., 2020	United States	Cross-sectional multivariate study	Fatality Analysis Reporting System	2015–2017	Drivers who died within 1am; 43,723 drivers
24	Rohit Chakraborty et	United States	Retrospective study with class analysis	Fatality Analysis Reporting System	2018–2022	Cannabis-positive conductors; 31,830 claims

No	Author/year	Country	Type of study	Data source	Period	Population/samset
	al., 2026					
25	Xu et al., 2021	China	Interruptor time series	Registry of Deaths and Bureau of Public Safety	2008–2018	Guangzhou residents; 6,536 deaths
26	Wundersitz & Raftery, 2017	Australia	Descriptive case analysis	Coroner's reports and infringement records	2008–2010	Drivers and motorcyclists killed; 284 fatal crashes

Source: Prepared by the author from the data extracted from the included studies,2026.

3.3 Assessed Substances and Toxicological Methods

The substances evaluated included mainly alcohol/ethanol, cannabis/THC, opioids, benzodiazepines, stimulants, methamphetamine, cocaine, psychotropic drugs and polysubstance use patterns. Table 3 summarizes the main neurocognitive, psychomotor and behavioral effects of classes of substances identified in the included studies, with emphasis on aspects relevant to conduction and forensic interpretation.

Table 3 - Repercussions of alcohol and psychoactive substances on functions relevant to driving

Substance/class	Main effects on body, cognition and attention relevant to driving	Implication for road safety/speritice	Source
Alcohol/ethanol	Progressive prejudice of judgment, coordination, surveillance, reaction time and psychomotor control as alcohol concentration increases.	Increases the risk of collisions, injuries and deaths; remains a central marker in the toxicological investigation of fatal road traffic crashes.	WHO, 2023; NHTSA, 2024
Cannabis/THC	It can compromise motor coordination, divided attention, psychomotor performance and track maintenance; the relationship between concentration and commitment requires caution.	Positivity should be interpreted with matrix, concentration, time of collection and circumstances of the event.	WHO, 2016; NHTSA, 2024
Opioids	They can produce drowsiness, sedation, relaxation, reduction of alertness and impairment of reaction, especially in association with other substances.	They should integrate toxicological panels when therapeutic, recreational or polysubstance use use is suspected.	NHTSA, 2024
Benzodiazepines and sedatives	Sedation, psychomotor slowing, attention impairment, memory, coordination and surveillance are associated.	They have high expert relevance when combined with alcohol, opioids or other central nervous system depressants.	NHTSA, 2024
Stimulants, cocaine and methamphetamine	They can induce excitement, impulsivity, risk behavior, aggression, altered judgment and erratic direction.	The presence in fatalities should be correlated with sinister dynamics and other circumstantial findings.	NHTSA, 2024
Centrally acting psychotropic drugs	Some antidepressants, antipsychotics, hypnotics, and relaxants can impair judgment, coordination, attention, and reaction time.	Interpretation should distinguish therapeutic use, dose, drug association and possible contribution to functional impairment.	NHTSA, 2024

Source: Prepared by the author based on World Health Organization (2016, 2023) and National Highway Traffic Safety Administration (2024).

The most frequently informed biological matrix was blood, including post mortem blood and femoral blood. Some studies have also used urine, vitreous mood, oral fluid, tissues

or secondary information from databases. Toxicological methods, when described, included HS-GC, GC-FID, GC-MS, LC-MS/MS, UHPLC-MS/MS, ELISA, and laboratory or medico-legal records (Table 4). .

Table 4 - Substances evaluated, biological matrix and toxicological method/source

No	Author/year	Type of victim	Substances assessed	Matrix/toxicological source	Toxicological method/source of data
1	Tegner et al., 2022	Multiples	Alcohol, ethanol, EtG and EtS	Blood in DBS and femoral blood	UHPLC-MS/MS and Headspace GC-FID
2	Guimarães e Silva, 2019	Multiples	Alcohol in legal context	Not informed	Not informed
3	Ponce et al., 2019	Drivers and motorcyclists	Alcohol/ethanol	Blood post mortem	Not informed in detail
4	Gjerde and Frost, 2023	Multiples	Alcohol and 17 drugs, including THC, amphetamines and benzodiazepines	Blood	HS-GC for alcohol; LC-MS/MS or GC-MS for drugs
5	Beirness et al., 2021	Drivers and motorcyclists	Alcohol, THC, stimulants, depressants and opioids	Blood post mortem	Immunessay, GC-FID, GC-MS and LC-MS/MS
6	Davey et al., 2020	Drivers and motorcyclists	Alcohol, THC, meth, cocaine and MDMA	Blood, glassy humor and tissues	GC-MS and LC-MS; HPLC/DAD
7	Ehsani et al., 2021	Multiples	Alcohol, depressants, narcotics and stimulants, except cannabis	Blood, urine and glassy mood	ELISA and GC-MS
8	Jan Mario Breen et al., 2021	Drivers and passengers	Alcohol, psychoactive drugs and illicit drugs	Blood post mortem	Not detailed; mentions threshold of 0.5 g/kg
9	Sarmiento et al., 2020	Motorcyclists	Alcohol, cocaine, ambethamines and synthetic catinones	Blood, urine and glassy mood	Not informed in detail
10	Massilkovah and Vorel, 2023	Multiples	Ethanol, meth, THC, benzodiazepines and opioids	Blood and urine	HS-GC for alcohol; method for non-detailed drugs
11	Chihuri and Li, 2017	Drivers	Alcohol, prescription opioids and other drugs	Blood or urine	LC, GC-MS and radioimmunoassay
12	Koskinen et al., 2026	Drivers	Alcohol, psychopharmaceuticals and illicit drugs	Blood and urine	Forensic toxicological analyses, Finland standard
13	T. Bunn et al., 2019	Drivers	Alcohol, depressants, THC, narcotics and stimulants	Blood, breath or urine	KSP Laboratory
14	Wang, 2022	Motorcyclists	Alcohol/BAC	Implicit blood	Not informed
15	Wiratama et al., 2020	Motorcyclists	Alcohol/BAC	Not informed	Not informed
16	Hamnett and Poulsen, 2018	Drivers and motorcyclists	Alcohol, cannabinoids, opioids, benzodiazepines and stimulants	Blood	GC-FID, ELISA, GC-MS and LC-MS
17	Romano et al., 2017	Drivers	Alcohol, marijuana and other drugs	Blood, urine and oral fluid	Not detailed
18	Romano et al., 2018	Drivers	Alcohol/BAC	Alveolar air and blood	Not informed
19	Hamnett et al., 2017	Multiples	Alcohol, drugs of abuse and medicines	Blood, urine and glassy mood	GC-FID, ELISA, GC-MS and LC-MS/MS
20	Anja Valen et al., 2019	Drivers and motorcyclists	Alcohol, benzodiazepines, opioids, stimulants and THC	Blood	Quantitative Forensic Toxicological Analysis
21	Thomas et al., 2020	Pedestrians	Narcotics, stimulants, cannabinoids and other drugs	Not informed	Not informed
22	Thomas,	Pedestrians	Alcohol and nine classes of	Blood, urine or serum	Not informed

No	Author/year	Type of victim	Substances assessed	Matrix/toxicological source	Toxicological method/source of data
	Riemann and Jones, 2019		drugs		
23	Azagba et al., 2020	Drivers	Cannabinoids and other drugs	Blood or urine	Not informed
24	Rohit Chakraborty et al., 2026	Multiples	Cannabis/THC and alcohol	Blood	Toxicological confirmation
25	Xu et al., 2021	Multiples	Alcohol	Not informed	Not informed
26	Wundersitz & Raftery, 2017	Drivers and motorcyclists	Alcohol and illicit drugs	Blood	Legal forensic processes

Source: Prepared by the author from the data extracted from the included studies,2026.

3.4 Main Findings

Alcohol was the most frequently investigated substance in the included studies, with relevant prevalences in drivers, motorcyclists, pedestrians and multiple categories of fatal victims. In addition to alcohol, the studies identified the presence of cannabis/THC, opioids, benzodiazepines, stimulants, cocaine, methamphetamine, psychotropic drugs and other psychoactive substances. Polysubstance use has been reported in several studies, especially in combinations between alcohol and THC, alcohol and illicit drugs, opioids and other drugs, or multiple classes of substances (Table 5).

Table 5 - Main findings on alcohol, drugs, polysubstance use and expert relevance

No	Author/year	Main finding on alcohol	Main finding on other drugs	Polysubstance use	Conclusion/peritial relevance
1	Tegner et al., 2022	69.6% positive for ethanol; 72.7% positive for EtG and EtS	Not informed	Not informed	EtG/EtS in DBS allows to identify alcohol consumption even after elimination of ethanol, useful to differentiate alcohol intake from post mortem production
2	Guimarães e Silva, 2019	Focus on the impact of zero tolerance legislation; no individual alcohol data	Not informed	Not informed	Law 12,760/2012 and CONTRAN Resolution 432 were associated with the significant and continuous reduction of fatal accidents
3	Ponce et al., 2019	São Paulo had a higher prevalence of alcohol than Norway; a similar mean BAC, about 1.7 g/L	Not informed	Not informed	Despite Prohibition, São Paulo maintained a high prevalence of alcohol in dead drivers
4	Gjerde and Frost, 2023	Positive alcohol by 14.4%; reduction from previous decade	Drugs in 15.8%; THC 7.9%; amphetamines 4.7%	33.3% of the positives presented polysubstance use	Integration of police and expert data allows you to monitor alcohol and drugs in fatalities
5	Beirness et al., 2021	Alcohol in 26.2%; 78.9% above 80 mg/dL	THC was the most frequent drug, 27.2%	38% of positive cases; alcohol + THC was the most common combination	Need for large panels including cannabis and combinations of substances
6	Davey et al., 2020	Alcohol in 31.8%; 51.1% with BAC ≥0.15 g/100 mL	Illicit drugs in 21%; THC 15.5%; meth 9%	11.8%; alcohol + THC as the main combination	Growth of illicit drugs in fatalities, contrasting with fall in alcohol deaths

No	Author/year	Main finding on alcohol	Main finding on other drugs	Polysubstance use	Conclusion/peritial relevance
7	Ehsani et al., 2021	Alcohol prevalence about 36% on both bases	Medical Examiner detected more narcotics and stimulatis than FARS	56% of cases with three drugs in FARS had more substances in the ME	Coroners' data are more complete than police bases; there is risk of underreporting
8	Jan Mario Breen et al., 2021	Alcohol in 19%; more common in front passengers than drivers	Psychoactive drugs in 9.8%; illicit drugs in 11.4%	9.3% of the total	Necropsy and toxicology can help determine the position in the vehicle and risk behavior
9	Sarmiento et al., 2020	Alcohol in 35.2%; alcohol/drugs in 44.5%	Cocaine and synthetic catinones were frequent	20.7% of the positives had alcohol + illicit drugs	Substances associated with lower helmet use and greater guilt in single vehicle claims
10	Massilkovah and Vorel, 2023	24% of positive tested; pedestrians with higher index, 39.2%	9% positive for illicit; 24% for medicines	Combinations between alcohol, illicit and medicines have been identified	Selective testing generates underreporting; reinforces need for systematic examinations on fatalities
11	Chihuri and Li, 2017	39.3% alcohol positive; 30% of opioid users had alcohol ≥0.01 g/dL	Opioids increased from 1.0% to 7.2%; hydrocodone was the most common	66.9% of opioid positives also used other drugs	Prescription opioids should be considered in forensic toxicological panels
12	Koskinen et al., 2026	Severe drunkenness in 31.4% of controls versus 19.7% of psychotics without medication	Psychopharmaceuticals in 53.2% of cases with psychotic disorder	Concomitant use of psychotropic classes was detailed	Relevant for forensics with suspected traffic suicide or psychiatric history
13	T. Bunn et al., 2019	Alcohol in 28%, most frequent substance	Depressors 15%, THC 11% and narcotics 11%	Polyusus with three or more drugs cited as growing	Cross-checking of police, expert and death data reduces underreporting
14	Wang, 2022	Positive BAC, even <0.03 g/dL, raised the risk of fatality	Not informed	Not informed	Reinforces discussion on zero tolerance for alcohol in motorcyclists
15	Wiratama et al., 2020	Positive alcohol raised the risk of fatal injury by 9.47 times	Not informed	Not informed	Alcohol and absence of helmet had synergistic effect, increasing the risk of death by 18 times
16	Hamnett and Poulsen, 2018	No statistical difference in BAC averages after legal change; in New Zealand, high BAC increased	Scotland had increase in drugs except THC; New Zealand had increased combined use	Increased alcohol + drugs in New Zealand and Scotland	Reducing the legal limit did not reduce fatalities immediately; drug detection increased
17	Romano et al., 2017	Alcohol increased risk of collision more consistently than marijuana	Cannabis association reduced after adjustment for alcohol and demographics	Adjustment for alcohol reduced marijuana-accident association	Risk estimates for cannabis depend on methodological adjustments and matrix/cut-off
18	Romano et al., 2018	Risk increases exponentially with BAC, especially in young people	Not analyzed	Not informed	It upholds low legal limits and zero tolerance policies
19	Hamnett et al., 2017	Alcohol in 20%; BAC mean 125 mg/100 mL	THC 20%; opioids 14%	13% alcohol + drugs; 36% only drugs	Alcohol and cannabis were prevalent; it reinforces screening for drugs other than illicit drugs
20	Anja Valen et al., 2019	BAC >0.2 g/kg in 21.9% of car drivers and 14.7% of motorcyclists	Drugs above the legal limit on 21.6% of drivers and 15.2% of motorcyclists; main THC	13.0% of drivers and 7.9% of motorcyclists	Integrated expert bases enable trend monitoring and policy impact
21	Thomas et al., 2020	Not informed; exclusive focus on drugs	27.8% drug positive; stimulants 45.4% and cannabinoids 14.7%	57.4% of the positives had a second substance; 51.4% of these had a third	Fatal pedestrians had a high prevalence of drugs and polysubstance use
22	Thomas, Riemann and Jones, 2019	74.7% of fatal pedestrians were tested for alcohol	67.1% were tested for drugs	52% of drug positives had second substance	Lack of standardization between states hinders prevention and surveillance

No	Author/year	Main finding on alcohol	Main finding on other drugs	Polysubstance use	Conclusion/peritial relevance
23	Azagba et al., 2020	Not informed	Cannabis: 14.5% in urban area versus 11% in rural areas; higher in young people and men	Not detailed quantitatively	Demographic and geographic profile can direct oversight and preventive policies
24	Rohit Chakraborty et al., 2026	Alcohol remains leading substance; co-use with cannabis increases risk of guilt	THC doubled between 2000 and 2018; present in 21.5% of deaths in 2018	Cannabis often combined with alcohol	Discusses limits of legislation per se versus evidence of real commitment
25	Xu et al., 2021	Average reduction of 9.01% per year in deaths after regulations; 73.98% drop in relative risk	Not informed	Not informed	Strict laws and active supervision with random breathalyzers were associated with reduced mortality
26	Wundersitz & Raftery, 2017	34% had illegal BAC; 28% with BAC >0.20 g/100 mL	27% of drivers with illegal BAC also had illicit drugs, mainly cannabis	27% among alcohol-positive drivers	Risk profile: young man, repeat offender, prior consumption in homes; relevant for prevention and expertise

Source: Prepared by the author from the data extracted from the included studies,2026.

4. Discussion

4.1 Alcohol as a Persistent Factor in Road Traffic Fatalities

The included studies demonstrate that alcohol remains one of the most frequently investigated and identified substances in transit fatalities. Its presence was observed in different categories of victims, including drivers, motorcyclists, pedestrians and multiple road users. Although the percentages varied according to the country, the population studied and the data source used, the findings indicate that alcohol is still a central element in the epidemiological and expert analysis of fatal road traffic crashes (TEGNER et al., 2022; PONCE et al., 2019; GJERDE; FROST, 2023; BEIRNESS et al., 2021; DAVEY et al., 2020;

In Brazilian studies, alcohol appeared both in post mortem toxicological analyses and in studies aimed at the impact of legal measures. The positivity for ethanol and for metabolites such as EtG and EtS reinforces the importance of complementary markers in the expert evaluation, especially when there is doubt about the origin of ethanol or about the interval between consumption, accident, death and collection (TEGNER et al., 2022; GUIMARÃES; SILVA, 2019; PONCE et al., 2019).

The international literature also points out a persistent association between alcohol, greater severity of claims and risk of fatality. In motorcyclists, the presence of alcohol was particularly relevant, even when associated with the absence of helmet. In pedestrians, studies have shown that alcohol research is also important, as alcohol-related risk is not restricted to drivers (GJERDE; FROST, 2023; BEIRNESS et al., 2021; DAVEY et al., 2020; WANG, 2022; WIRATAMA et al., 2020; XU et al., 2021).

From a medico-legal point of view, these findings support the need to maintain alcohol as a basic examination in traffic-related deaths. However, the interpretation of post mortem alcohol should consider the type of sample, the interval between the event and the collection, the possibility of postmortem production of ethanol and the presence of other laboratory markers (TEGNER et al., 2022; HAMNETT et al., 2017; MÁSILKOVÁ; VOREL, 2023).

4.2 Non-Alcoholic Drugs and Psychotropic Medications

In addition to alcohol, the included studies showed the presence of non-alcoholic drugs and psychotropic drugs in fatal traffic victims. Among the substances described were cannabis/THC, opioids, benzodiazepines, stimulants, methamphetamine, cocaine, synthetic cathinones and drugs with potential for psychomotor impairment (BEIRNESS et al., 2021; DAVEY et al., 2020; HAMNETT et al., 2017; VALEN et al., 2019; KOSKINEN et al., 2026).

Cannabis/THC has appeared recurrently in studies conducted in different countries, especially between drivers and motorcyclists. In some studies, its frequency was similar to or higher than that of alcohol in certain subgroups. This finding is relevant because the presence of THC in the blood may indicate recent exposure, but its forensic interpretation requires caution, since toxicological positivity does not always equate to functional impairment at the time of the claim (BEIRNESS et al., 2021; ROMANO et al., 2017; AZAGBA; SHAN; LATHAM, 2020; CHAKRABORTY et al., 2026).

Opioids and psychotropic drugs were also important in the studies included. The increasing detection of prescription opioids in fatally injured drivers demonstrates that the problem of psychoactive substances in traffic is not restricted to illicit drugs. Prescription medications, benzodiazepines, antidepressants, antipsychotics, and other central-acting substances can interfere with attention, reaction time, judgment, and psychomotor performance (CHIHURI; LI, 2017; BUNN; SINGLETON; CHEN, 2019; KOSKINEN et al., 2026).

These findings reinforce that postmortem toxicological investigation in fatal traffic victims should not be limited to alcohol. Restricted panels may fail to identify substances relevant to understanding the circumstances of the claim, especially in scenarios of polypharmacy, recreational use of drugs, cannabis use, opioid use or psychiatric treatment (DAVEY et al., 2020; HAMNETT; POULSEN, 2018; MÁSILKOVÁ; VOREL, 2023).

4.3 Polysubstance Use and Forensic Interpretive Complexity

The polysubstance use was a relevant finding in several studies included and represents one of the main challenges for the forensic interpretation of traffic fatalities. The association between alcohol and other drugs, or between multiple classes of psychoactive substances, has been described in fatally injured drivers, motorcyclists and pedestrians (BEIRNESS et al., 2021; DAVEY et al., 2020; CHIHURI; LI, 2017; THOMAS et al., 2020; WUNDERSITZ; RAFTERY, 2017).

The most frequently highlighted combinations involved alcohol and THC, alcohol and illicit drugs, opioids associated with other drugs, and the concomitant use of different classes of psychotropic drugs. The simultaneous presence of substances can enhance effects on attention, motor coordination, judgment, reaction time and risk behavior (BEIRNESS et al., 2021; DAVEY et al., 2020; CHIHURI; LI, 2017; HAMNETT; POULSEN, 2018).

The forensic interpretation of polysubstance use is more complex than the interpretation of an isolated substance. It is not always possible to attribute the claim or functional impairment to only one drug. The analysis should consider concentration, biological matrix, collection time, association between substances, accident circumstances, necroscopic findings and police information (ROMANO et al., 2017; CHAKRABORTY et al., 2026).

In addition, the simple detection of a substance does not necessarily prove functional impairment at the time of the event. This limitation is especially important for substances such as cannabis/THC, whose detection window may be longer than the period of psychomotor impairment. Therefore, the polysubstance use should be registered and discussed in a specific way, avoiding simplified conclusions based only on toxicological positivity (ROMANO et al., 2017; AZAGBA; SHAN; LATHAM, 2020; CHAKRABORTY et al., 2026).

4.4 Underreporting, Selective Testing, and Limitations of Official Records

One of the most important findings of the review was the recurrence of limitations related to underreporting, selective testing and incompleteness of official records. Several studies have shown that not all fatal traffic victims are subjected to complete toxicological examinations, and that the absence of systematic testing can distort the real magnitude of the participation of alcohol and other psychoactive substances in traffic deaths (MÁSILKOVÁ; VOREL, 2023; EHSANI et al., 2021; THOMAS; RIEMANN; JONES, 2019; VALEN et al., 2019).

Studies comparing police bases, fatality records and medico-legal data have shown that police or administrative systems can underestimate the presence of drugs when there is no

integration with toxicological and necroscopic reports. In some contexts, data from Medical Examiner or from national autopsy records detected more substances than secondary transit bases (EHSANI et al., 2021; BUNN; SINGLETON; CHEN, 2019; MÁSILKOVÁ; VOREL, 2023).

Selective testing also compromises comparability between studies. When only part of the victims is tested, the observed prevalence may not represent the reality of the total population of traffic dead. In addition, different toxicological panels, absence of standardization between laboratories, variation of biological matrices and lack of information on analytical method make it difficult to directly compare between countries and periods (GJERDE; FROST, 2023; VALEN et al., 2019; THOMAS; RIEMANN; JONES, 2019).

In the expert context, the absence of toxicological examination may affect the determination of the circumstances of death, the evaluation of psychomotor capacity, the attribution of responsibility, the formulation of public policies and the quality of official statistics. Thus, the review reinforces the need for integration between police records, medico-legal banks, health systems and forensic toxicology laboratories (EHSANI et al., 2021; MÁSILKOVÁ; VOREL, 2023).

4.5 Implications for Brazilian Medico-Legal Practice

The findings of this review have direct implications for Brazilian medico-legal practice. Although alcohol is historically recognized as a factor associated with road traffic crashes, the literature demonstrates that illicit drugs, psychotropic drugs, opioids, cannabis/THC, stimulants and polysubstance use patterns should also be considered in the investigation of fatal victims (TEGNER et al., 2022; PONCE et al., 2019; BEIRNESS et al., 2021; DAVEY et al., 2020; CHIHURI; LI, 2017).

In Brazil, the performance of alcohol in fatal victims of road traffic crash is fundamental, but may be insufficient when not accompanied by an enlarged toxicological panel. The review shows that different countries have identified substances other than alcohol in relevant proportions, including in drivers, motorcyclists and dead pedestrians. Thus, restricting research to ethanol may underestimate the participation of other psychoactive substances (TEGNER et al., 2022; PONCE et al., 2019; GUIMARÃES; SILVA, 2019).

From the expert point of view, the ideal investigation should include standardized collection of peripheral blood, urine and, when relevant, vitreous humor, in addition to the documentation of the interval between accident, death and collection. The proper choice of

biological matrix is essential to reduce misinterpretations, especially regarding the postmortem production of ethanol, postmortem redistribution of drugs and differentiation between previous use and possible functional impairment (TEGNER et al., 2022; HAMNETT et al., 2017; DAVEY et al., 2020).

The review also reinforces the importance of integrating medico-legal data into police and traffic records. The separation between systems can produce incomplete statistics and hinder the formulation of public policies. Integrated databases would enable better epidemiological surveillance, risk profile identification, assessment of oversight policies and definition of laboratory priorities (EHSANI et al., 2021; BUNN; SINGLETON; CHEN, 2019; MÁSILKOVÁ; VOREL, 2023).

For the Brazilian reality, especially in services with resource limitation, a viable strategy would be to establish mandatory minimum criteria for toxicological investigation in traffic deaths, including alcohol and basic panel for cannabis/THC, cocaine, amphetamines/methamphetamine, benzodiazepines, opioids and other psychotropic drugs. This measure would contribute to greater expert reliability, better epidemiological understanding and strengthening policies for the prevention of traffic deaths (GJERDE; FROST, 2023; VALEN et al., 2019; BEIRNESS et al., 2021; DAVEY et al., 2020).

As a national example of transparency and integration of expert information, the Expert Panel of Psychoactive Substances of the Scientific Police of Espírito Santo stands out. The tool makes available to the public structured data of toxicological examinations carried out by the Laboratory of Forensic Toxicology in victims of violent deaths examined by the Legal Medical Institute of Vitória, covering the period from 2013 to 2023. Although it does not replace a national protocol, this model demonstrates the feasibility of transforming medico-legal laboratory data into qualified public information, useful for epidemiological surveillance, expert planning and prevention policy formulation (SCIENTIFIC POLICE OF THE HOLY SPIRIT, [s.d.]).

5. Final Considerations

This integrative review identified that alcohol and other psychoactive substances are present in a relevant way in traffic fatalities, involving drivers, motorcyclists, pedestrians, passengers and multiple categories of road users. Alcohol remains the most frequently investigated substance, but the included studies also highlighted the importance of

cannabis/THC, opioids, benzodiazepines, stimulants, psychotropic medications, and polysubstance use patterns.

The findings demonstrate that the forensic interpretation of traffic deaths should go beyond isolated ethanol research. The presence of multiple substances, the diversity of biological matrices, the variation of toxicological methods and the incompleteness of official records make the analysis more complex and require a standardized approach. In this perspective, toxicological positivity should be interpreted together with concentration, biological matrix, interval between accident, death and collection, event circumstances, necroscopic findings and police information.

For the Brazilian reality, the main implication is the need to overcome a model centered almost exclusively on alcohol. The existence of services with limitation of resources does not eliminate the need for minimum criteria for toxicological investigation in traffic deaths, especially when the dynamics of the claim, the profile of the victim, the traces of the site or the necroscopic findings suggest possible influence of illicit drugs, central drugs or polysubstance use.

The experience of public provision of expert data, as occurs in state initiatives to organize toxicological panels, shows that medico-legal laboratories can contribute not only to the individual investigation of cases, but also to epidemiological surveillance. The transformation of reports and laboratory results into aggregated, auditable and accessible data favors institutional transparency, public policy planning, definition of laboratory priorities and identification of risk profiles.

6. Conclusion

The review maintains that the investigation of fatal victims of road traffic crashes should systematically incorporate alcohol and other psychoactive substances research. The expansion of toxicological panels, the standardization of post mortem collection and the integration between medico-legal, police and epidemiological records can qualify the forensic interpretation, reduce underreporting and guide public policies to prevent traffic deaths.

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