NATIONAL INSTITUTE OF TOXICOLOGY
AND FORENSIC SCIENCES

GOBIERNO DE ESPAÑA
MINISTERIO DE JUSTICIA

INT CIENCIAS FORENSES

TOXICOLOGICAL FINDINGS IN ROAD TRAFFIC FATALITIES

2019 Annual Report

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National Institute of Toxicology and Forensic Sciences

Toxicological findings in road traffic fatalities

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The Director of the National Institute of Toxicology and Forensic Sciences

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Introduction and acknowledgements

The National Institute of Toxicology and Forensic Sciences, hereinafter INTCF by its initials in Spanish presents, as it has since 1996 [1], the annual report on deaths occurring in road accidents that have been investigated from a toxicological-forensic point of view. The data presented in relation to the toxicological findings of 766 fatalities were gathered through requests made by the different Judicial courts of law regarding the samples sent from the corresponding Institutes of Legal Medicine and Forensic Sciences, hereinafter IMLCF by its initials in Spanish. However, it should be noted that not all traffic accidents with fatalities in Spain are reported and analysed by the INTCF. In this regard, see, for example, the overall data published by the National Road Safety Observatory of the Directorate General for Traffic, which includes a total of 1,007 fatal accidents in 2019, in which 1,098 people died [2].

The information presented in this report refers to toxicological analyses carried out by the INTCF on post-mortem samples from 558 drivers and 130 pedestrians fatally injured in road traffic accidents during 2019. Its purpose is to show the results of the toxicological tests for the presence of alcohol, drugs of abuse and psychoactive drugs. Therefore, it shows the incidence of consumption of each of these three types of toxic substances, either alone or in combination. The study also links these toxicological findings to several epidemiological variables, such as: gender, age, type of vehicle, or the day of the week on which the fatal accident occurred. These data, as well as those presented in previous reports, provide information that is highly relevant for those working on traffic-accident prevention. Finally, the report presents a comparative study with the data obtained by the Institute in previous years, in order to show the evolution of some of the evaluated parameters.

The INTCF wishes to express its acknowledgement to the following IMLCFs, without whose contribution this report would not have been possible:

- Institutes of Legal Medicine and Forensic Sciences of Andalucía
- Institutes of Legal Medicine and Forensic Sciences of Castilla y León
- Institutes of Legal Medicine and Forensic Sciences of Castilla-La Mancha
- Institute of Legal Medicine of Galicia (IMELGA)
- Institutes of Legal Medicine and Forensic Sciences of the Valencian Community
- Forensic Anatomical Institute of the Community of Madrid
- Institute of Legal Medicine and Forensic Sciences of the Canary Islands
- Institutes of Legal Medicine of Extremadura
- Institute of Legal Medecine and Forensic Sciences of Navarra Institute of Legal Medicine and Forensic Sciences

- Institute of Legal Medicine and Forensic Sciences of Asturias
- Institute of Legal Medicine and Forensic Sciences of Cantabria
- Institute of Legal Medicine of the Balearic Islands
- Institute of Legal Medicine of La Rioja
- Institutes of Legal Medicine and Forensic Sciences of Ceuta and Melilla
- Institute of Legal Medicine and Forensic Sciences of Aragon

We would also like to express our gratitude to the National Road Safety Observatory of the Directorate General of Traffic, and especially to its director, Álvaro Gómez Méndez, and to Pilar Zori Bertolín, Head of the Statistics Service, for the work done on the detailed review of each of the cases presented in accordance with the criteria established by the Directorate General of Traffic.

In addition, as Director, I would like to express my special thanks to all the staff of the National Institute of Toxicology and Forensic Sciences (physicians, technical specialists and laboratory assistants) who were involved in the investigation related to these cases, and especially to the heads of the Chemical and Drug Services of the INTCF departments (María Antonia Martínez González, Begoña Bravo Serrano, María del Carmen Jurado Montoro, Nuria Sanvicens Diez and Luis Manuel Menéndez Quintanal)and, to Elena Almarza Lorente, for their efforts in coordinating and reviewing the analytical data presented. Finally, our thanks to the staff of the IT staff of the Seville and Barcelona Departments (Ángel Corral Amorós and Enrique Arguijo Vila) for performing statistical searches in the INTCF's LIMS system, and to David Barroso Domínguez for data compilation and final processing.

The Director of the National Institute of
Toxicology and Forensic Sciences
Dr Antonio Alonso Alonso

General information

FIGURE 1: ACTIVITY SCOPE OF THE INTCF

FIGURE 2: NUMBER OF FATALITIES (n=766) ANALYSED BY THE INTCF DEPARTMENTS

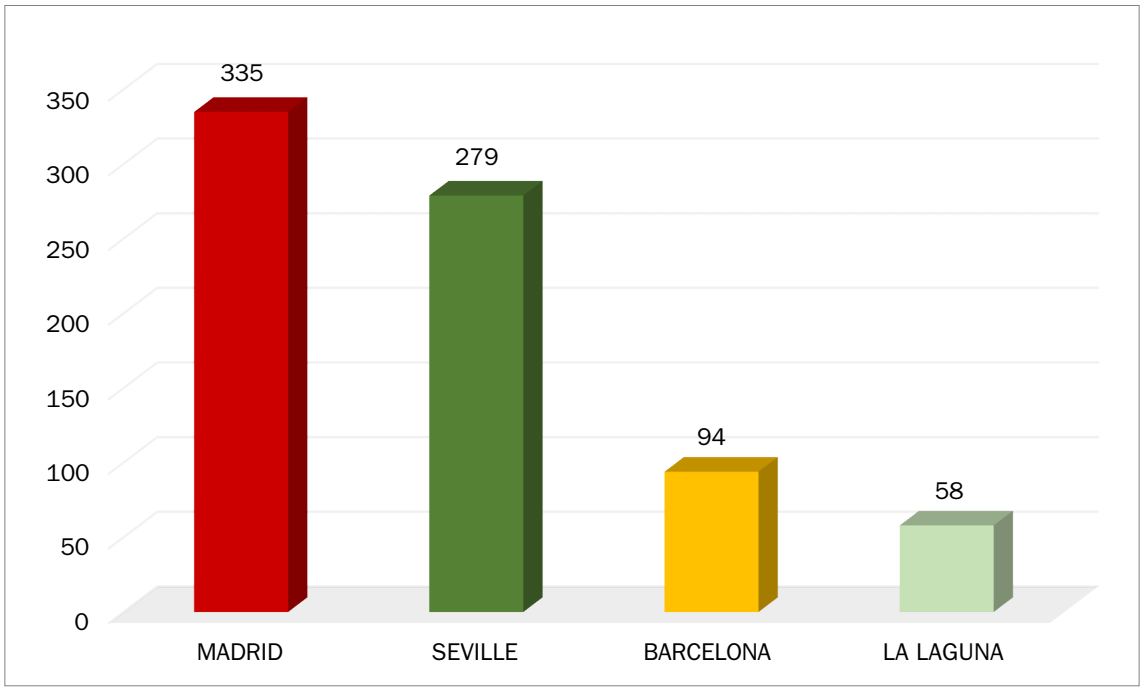


FIGURE 3: DISTRIBUTION BY AUTONOMOUS COMMUNITY

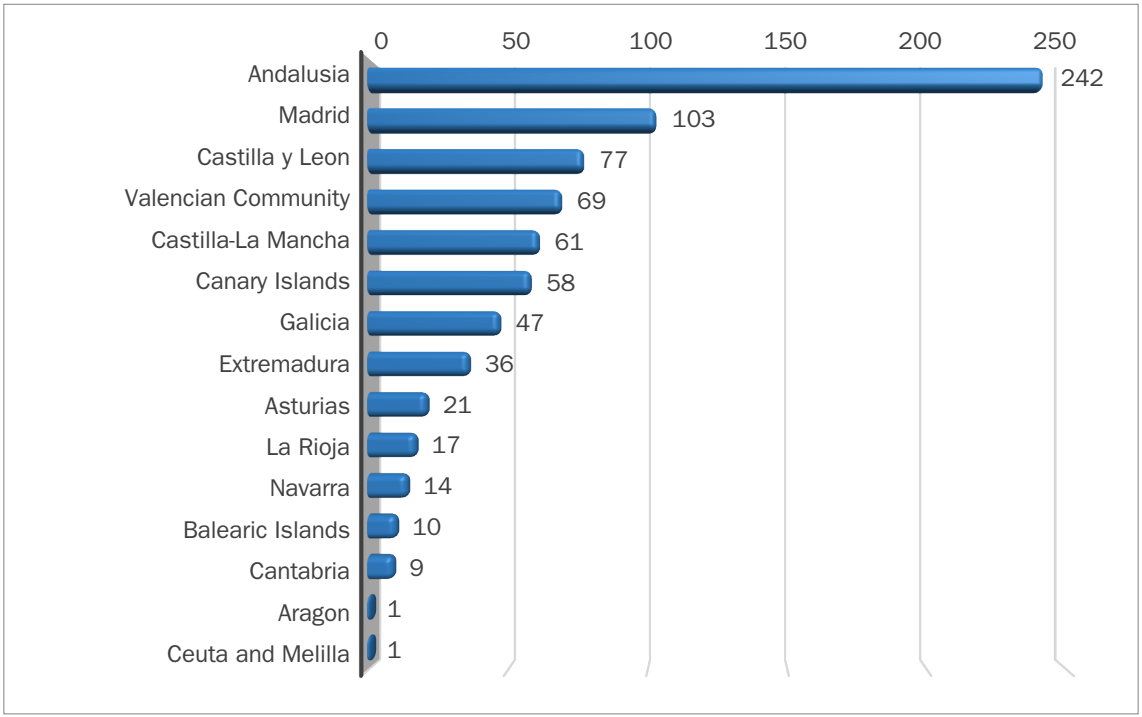
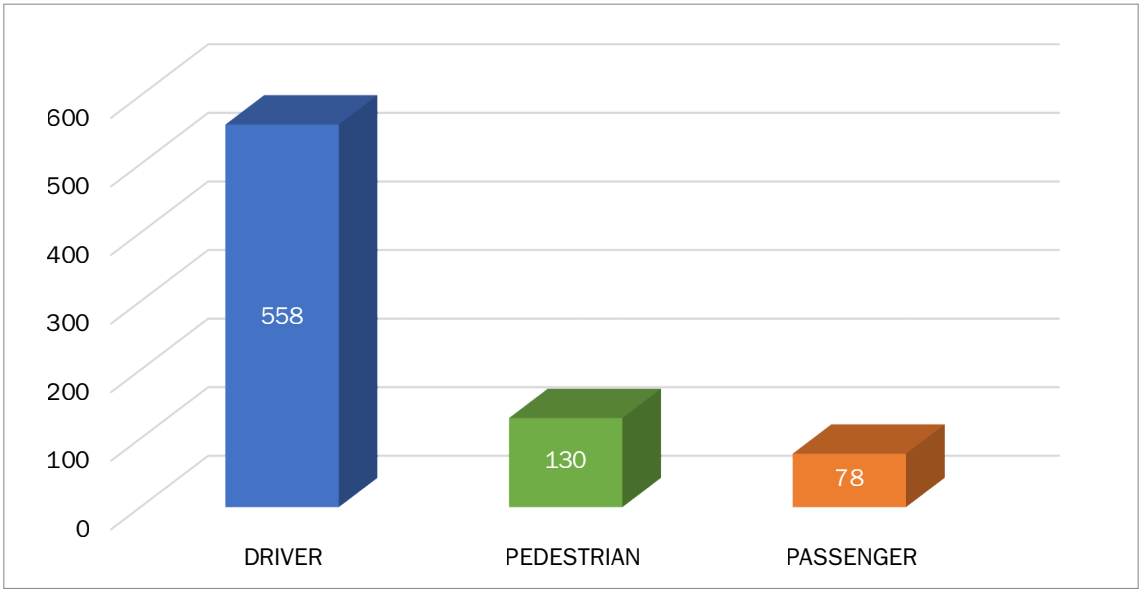


FIGURE 4: FATALITY NUMBER PER ROAD USER TYPE (n=766)



Drivers (n = 558)

FIGURE 5 and 6: FATALITY PERCENTAGE BY GENDER AND AGE RANGE (558 DRIVERS)

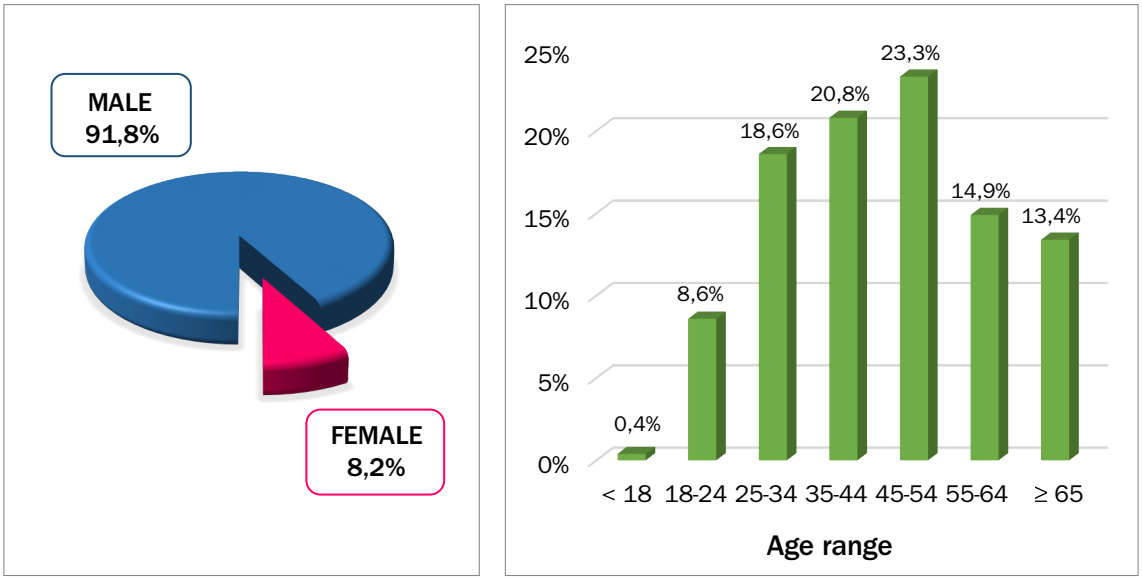
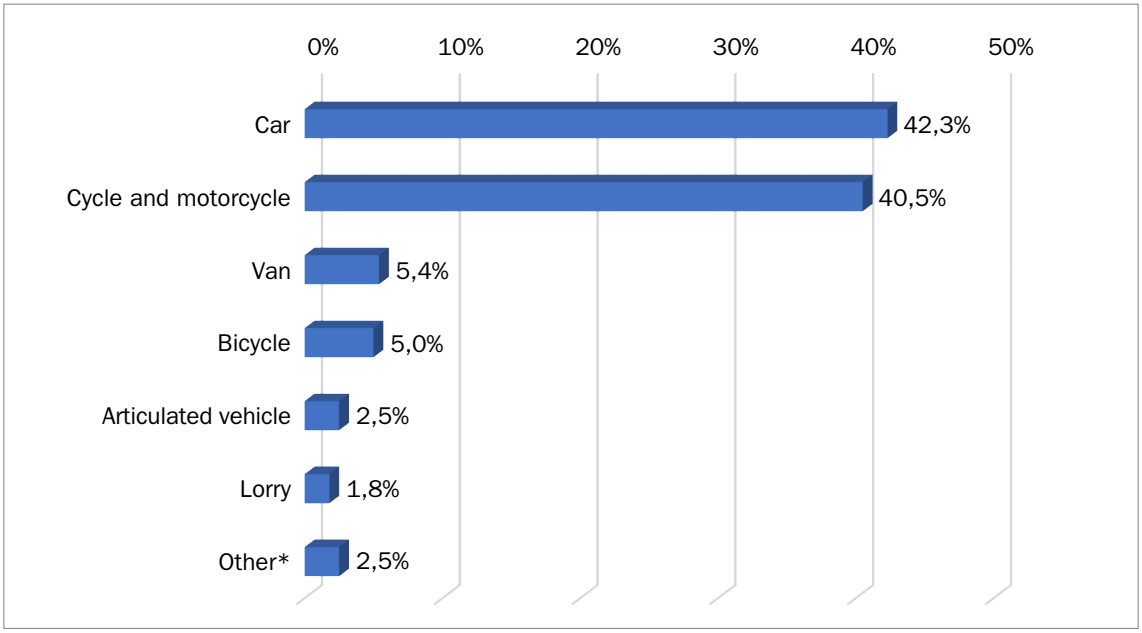
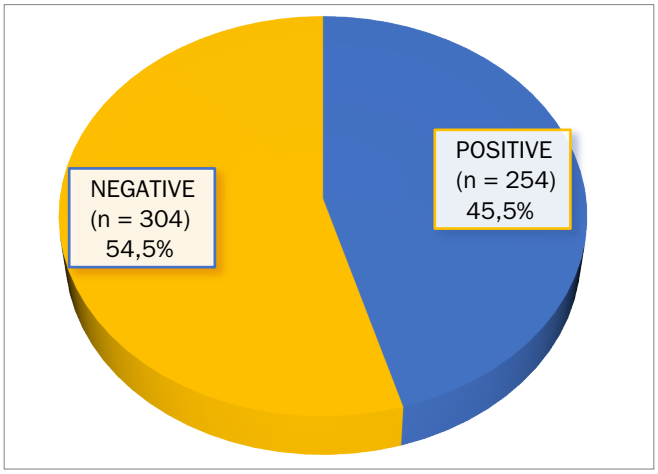


FIGURE 7: PERCENTAGE DISTRIBUTION BY VEHICLE TYPE (558 DRIVERS)



*Other: construction/service vehicle, quad, tractor unit

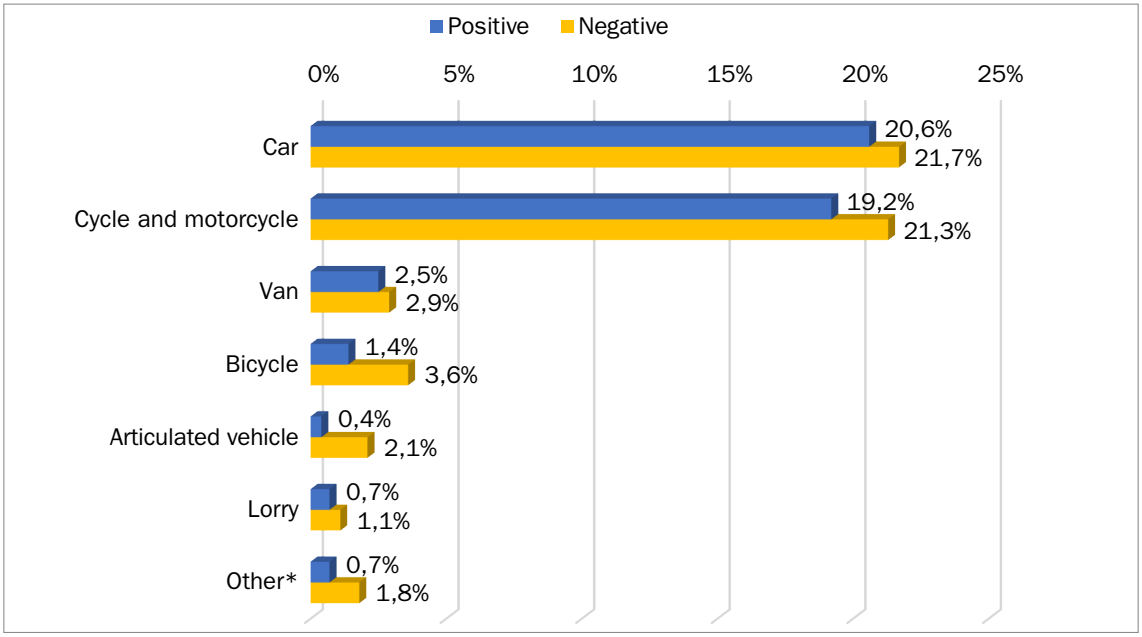
FIGURE 8: PERCENTAGE ACCORDING TO TOXICOLOGICAL RESULTS (558 DRIVERS)



In this report, a "positive" result is considered as the result of a confirmatory test reporting the presence of any drug of abuse or psychoactive drug regardless of quantity, or blood alcohol concentration greater than 0.3 g/L (novice/professional drivers) or 0.5 g/L (other drivers) [3-6].

In this figure, noteworthy that out of 558 drivers who died in traffic accidents and underwent an autopsy, 254 (45.5%) showed positive toxicological results for alcohol, drugs of abuse and psychoactive drugs, alone or in combination.

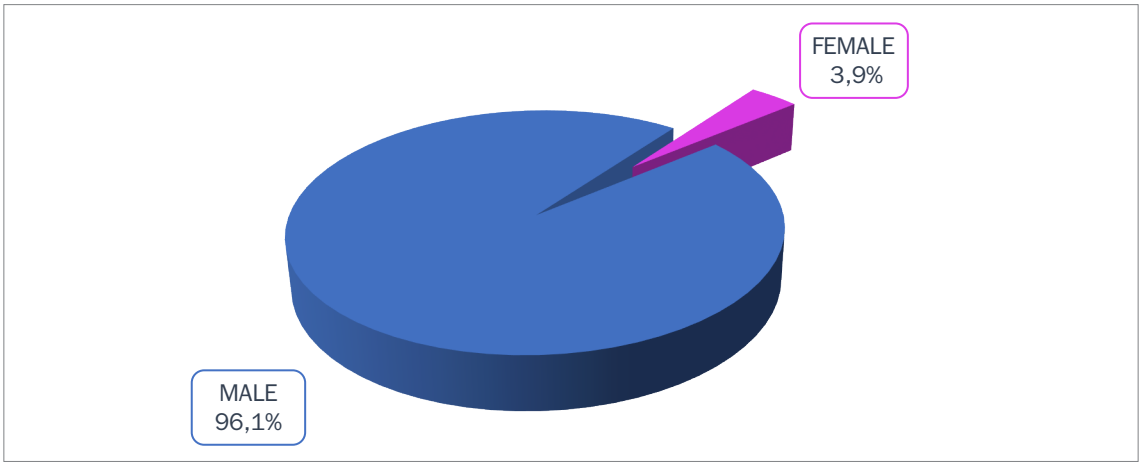
FIGURE 9: PERCENTAGE ACCORDING TO TOXICOLOGICAL RESULTS AND VEHICLE TYPE (558 DRIVERS)



*Other: construction/service vehicle, quad, tractor unit

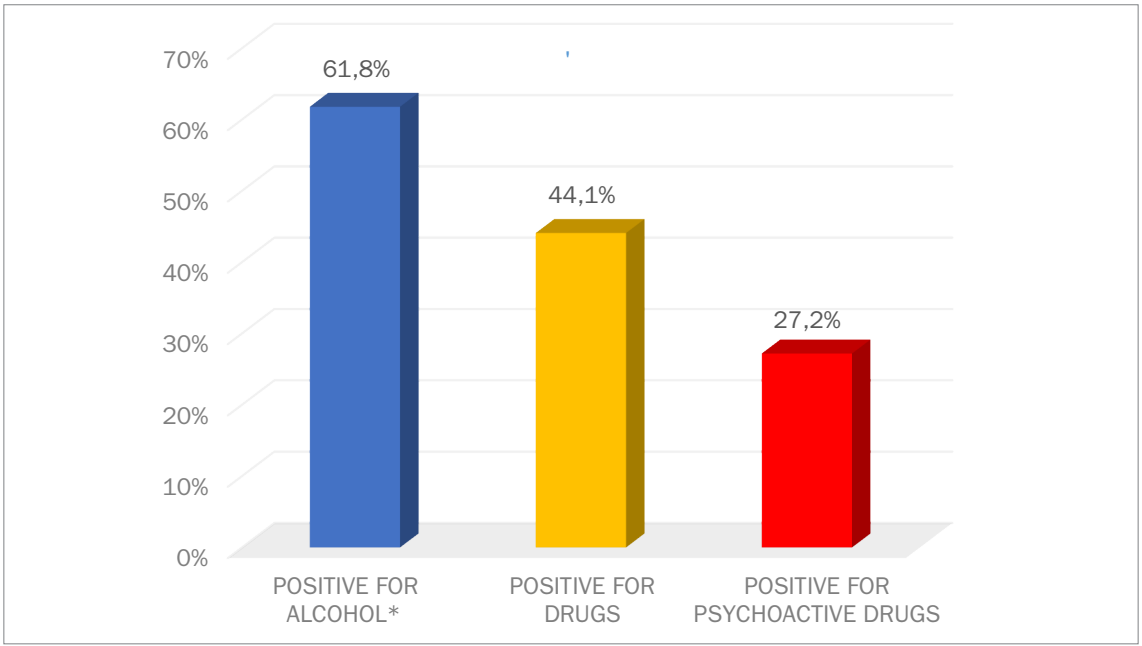
DRIVERS: CASES WITH POSITIVE TOXICOLOGICAL RESULTS (n=254)

FIGURE 10:DRIVERS (POSITIVE TOXICOLOGICAL RESULT) (n=254)
PERCENTAGE BY GENDER



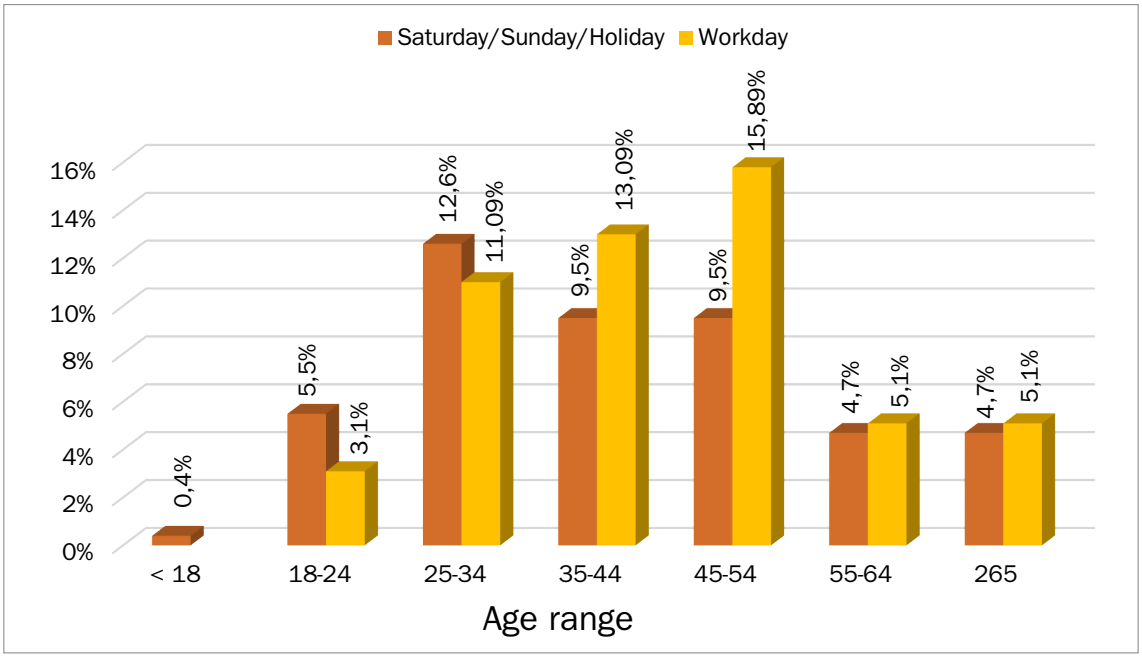
96.1% of the drivers with positive toxicological results were male.

FIGURE 11: DRIVERS (POSITIVE TOXICOLOGICAL RESULT) (n=254)
PERCENTAGE ACCORDING TO SUBSTANCE TYPE
(substance associations not considered)



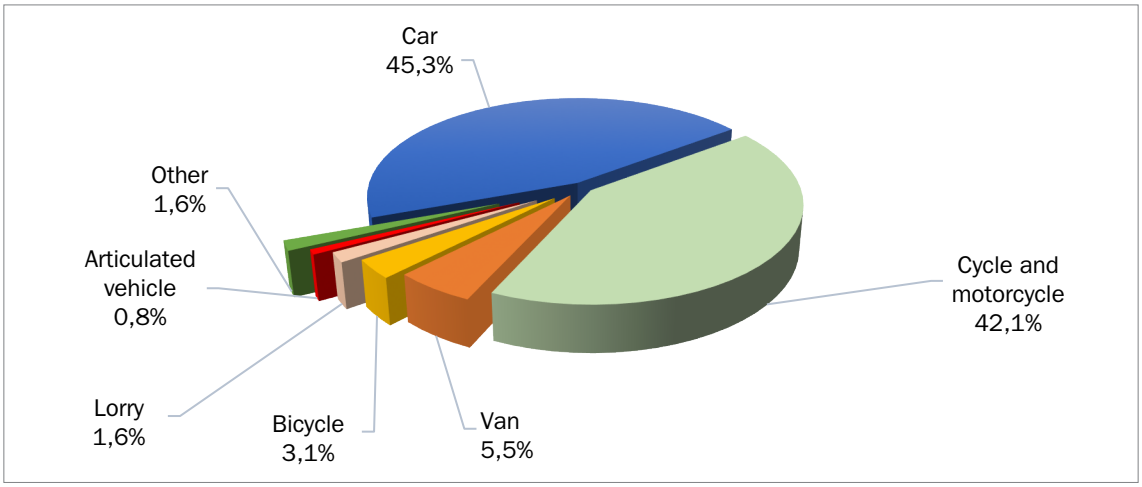
*Positive for alcohol: blood alcohol concentration greater than or equal to 0.30 g/L, for novice/professional drivers, or 0.5 g/L for other drivers

FIGURE 12: DRIVERS (POSITIVE TOXICOLOGICAL RESULT) (n=254)
PERCENTAGE BY AGE RANGE AND DAY OF THE WEEK



71.4% of the drivers with positive toxicological results were in the age range of 25-54. Another interesting fact in this Figure is that in the age ranges up to 34 years, most of the positives occur on weekends or holidays, while in the age ranges over 35 years, most of the positives occur on working days.

FIGURE 13: DRIVERS (POSITIVE TOXICOLOGICAL RESULT) (n=254)
PERCENTAGE DISTRIBUTION BY VEHICLE TYPE



45.3% of the drivers with positive toxicological results were driving a car and 42.1% a motorcycle or scooter.

FIGURE 14: DRIVERS (POSITIVE TOXICOLOGICAL RESULTS) (n=254)
RESULTS BY TYPE AND/OR COMBINATION OF SUBSTANCES DETECTED

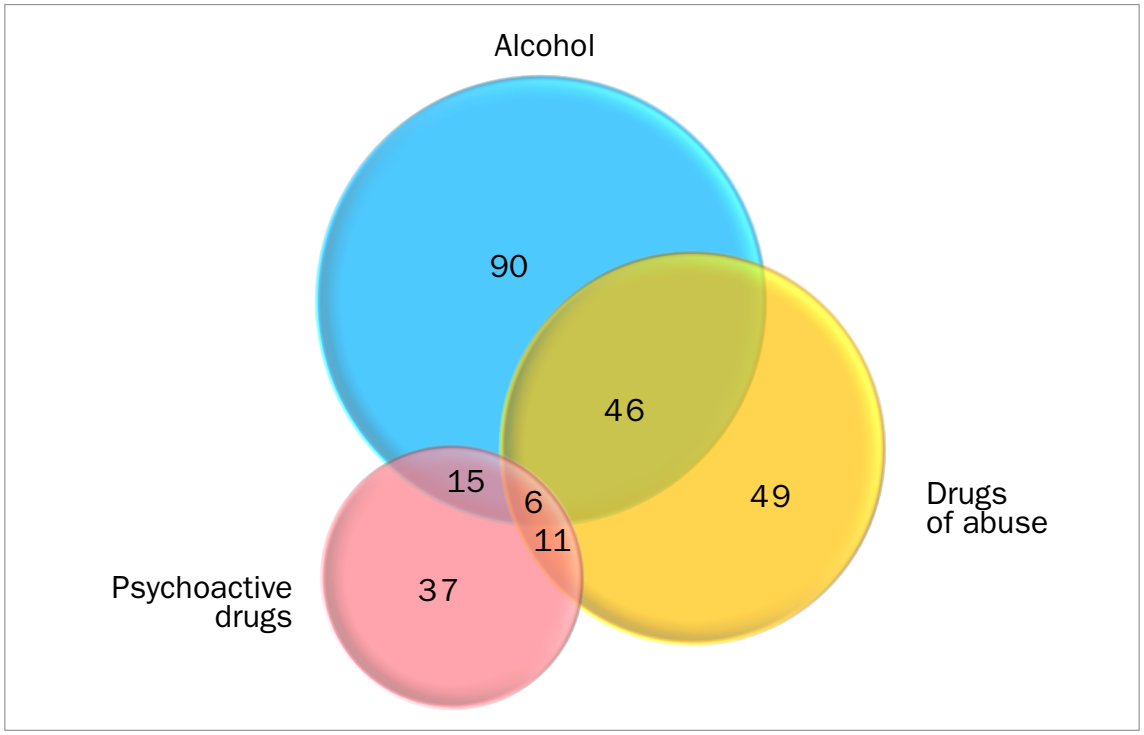
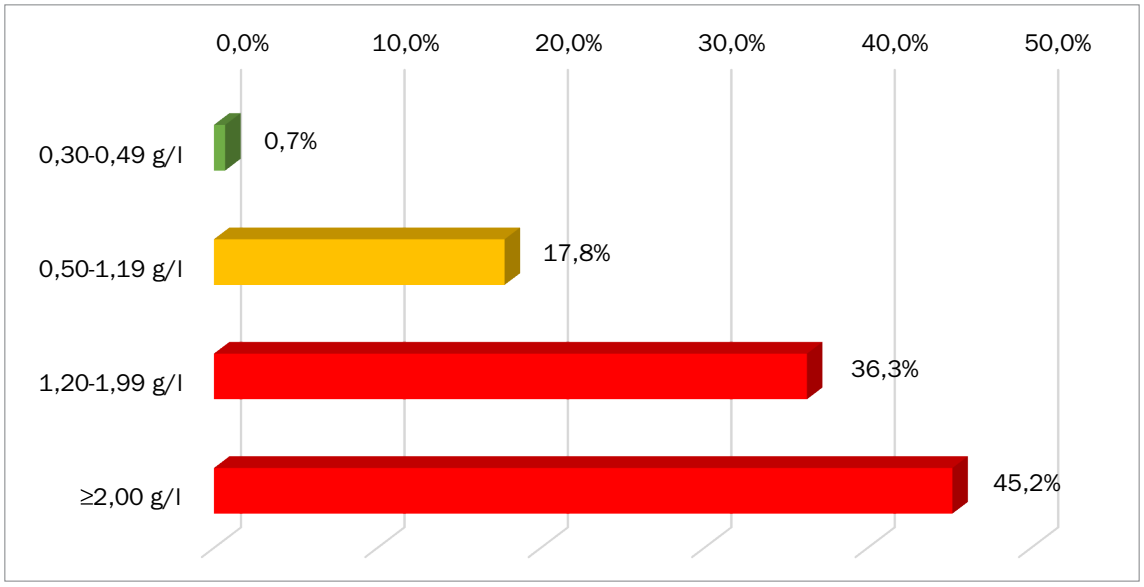
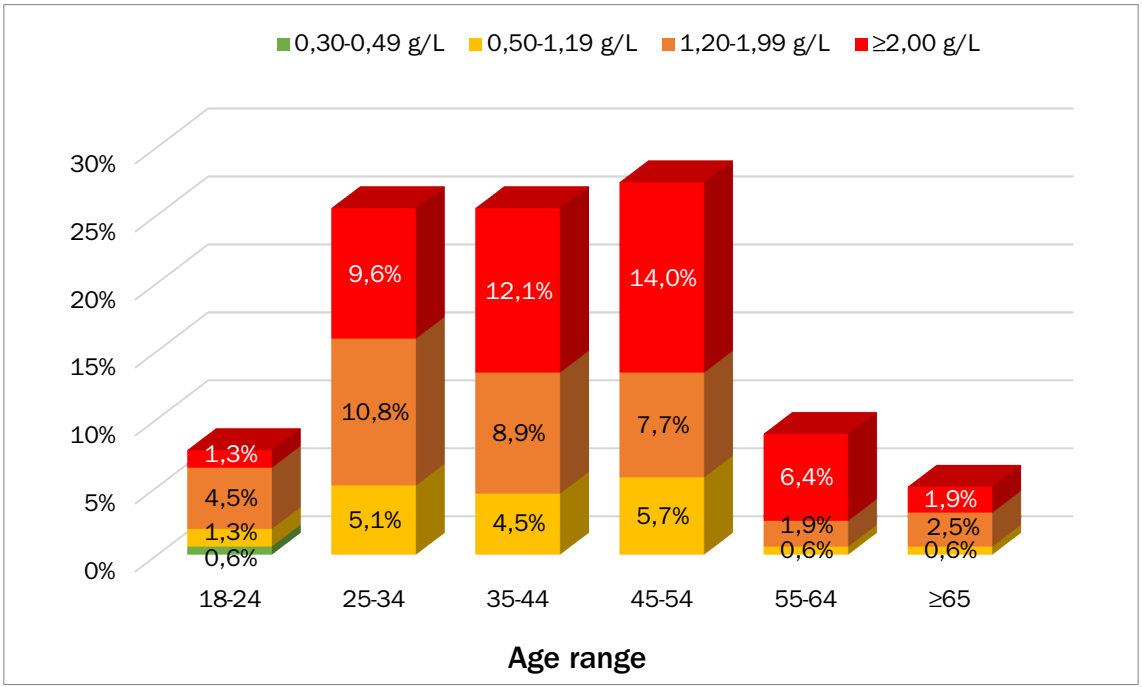


FIGURE 15: ALCOHOL-POSITIVE DRIVERS (n=157)
DISTRIBUTION ACCORDING TO BLOOD ALCOHOL CONCENTRATION (BAC)



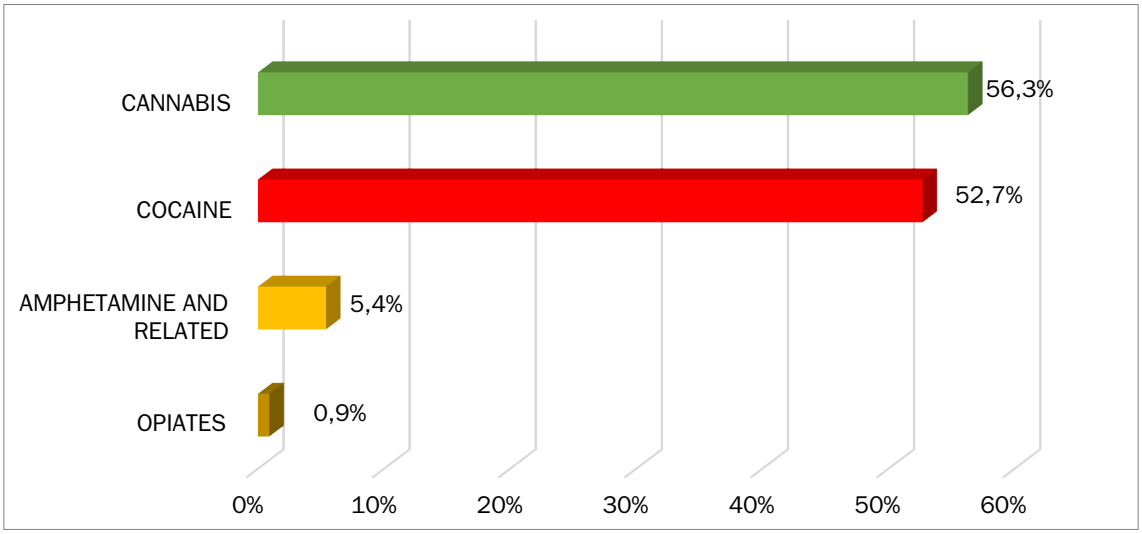
81.5 % of the drivers who tested positive for alcohol had a BAC of 1.20 g/L or higher.

FIGURE 16: ALCOHOL-POSITIVE DRIVERS (n=157)
DISTRIBUTION BY BLOOD ALCOHOL CONCENTRATION AND AGE RANGE



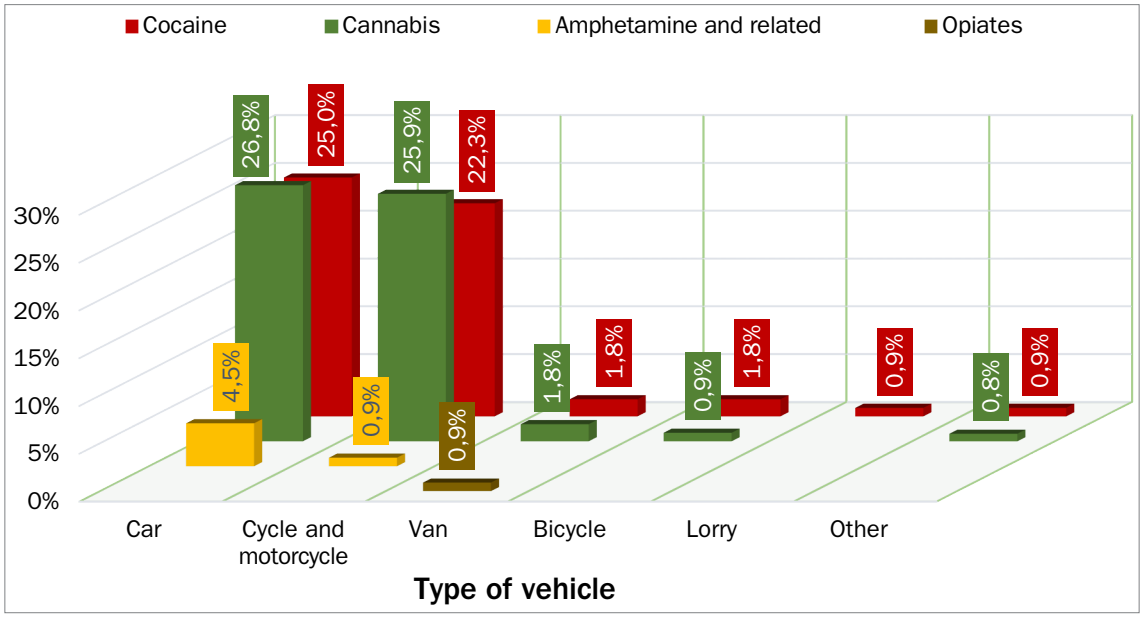
63.1% of alcohol-positive drivers with a BAC of 1.20 g/L or more were in the 25-54 age group.

FIGURE 17: DRUG-POSITIVE DRIVERS (n=112) - PERCENTAGE BY DRUG TYPE



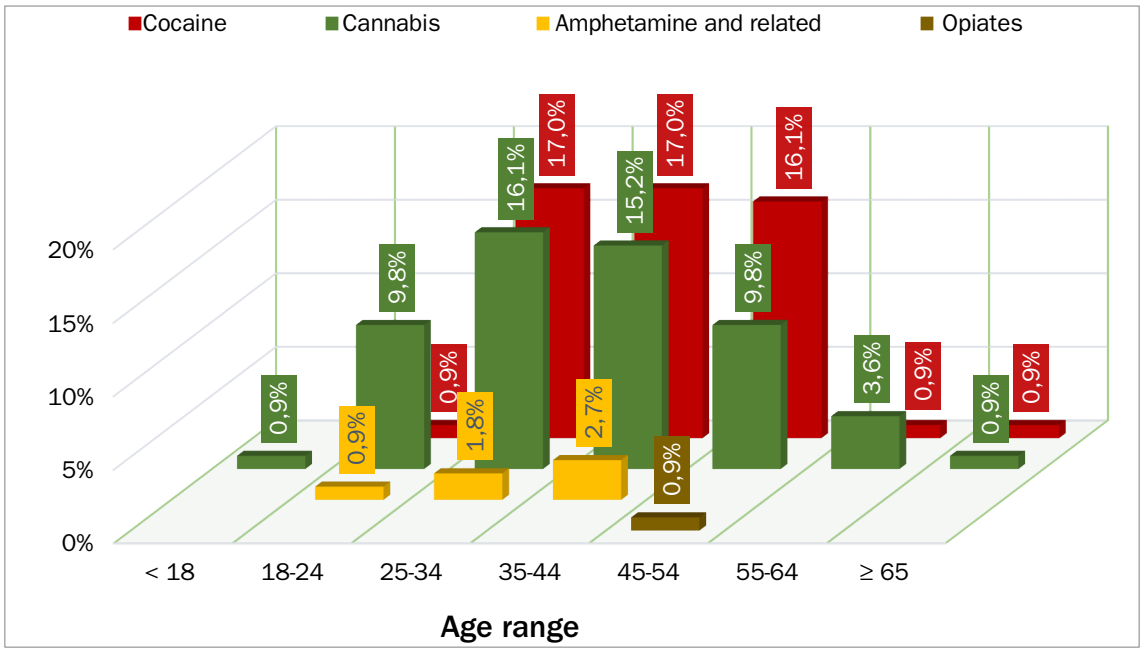
Regardless of whether there was associated use of drugs of abuse, alcohol and/or psychoactive drugs, the most widely used single drug was cannabis (56.3%), followed by cocaine (52.7%).

FIGURE 18: DRUG-POSITIVE DRIVERS (n=112)
PERCENTAGE ACCORDING TO DRUG DETECTED AND TYPE OF VEHICLE



The highest percentages correspond to the abuse of cannabis (52.7%) and/or cocaine (47.3%), in car and scooter/motorcycle drivers.

FIGURE 19: DRUG-POSITIVE DRIVERS (n=112)
PERCENTAGE BY DRUG DETECTED AND AGE RANGE



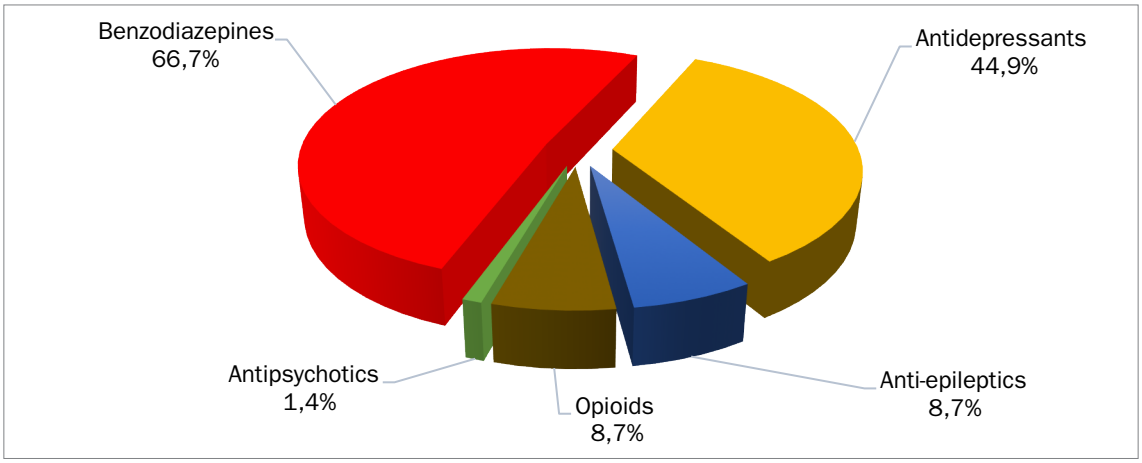
The highest percentages correspond to cocaine (50.1%) and/or cannabis (41.1%) abuse in drivers aged 25-54.

TABLE 1: DRIVERS POSITIVE FOR ALCOHOL AND DRUGS (n=52)
DISTRIBUTION OF CASES ACCORDING TO DRUG COMBINATIONS

The most frequently detected combinations were:	
Alcohol and cocaine	40.4%
Alcohol and cannabis	32.7%
Alcohol, cocaine and cannabis	21.1%

The most prevalent associated uses of alcohol and drugs of abuse were, first, the associated use of alcohol and cocaine (40.4%), followed by the associated use of alcohol and cannabis (32.7%) and the associated use of alcohol, cocaine and cannabis (21.1%).

FIGURE 20: DRIVERS POSITIVE FOR PSYCHOACTIVE DRUGS (n=69)
PERCENTAGE BY PSYCHOACTIVE DRUGS



Pedestrians (n = 130)

FIGURE 21: PEDESTRIANS (n=130)
PERCENTAGE DISTRIBUTION BY GENDER

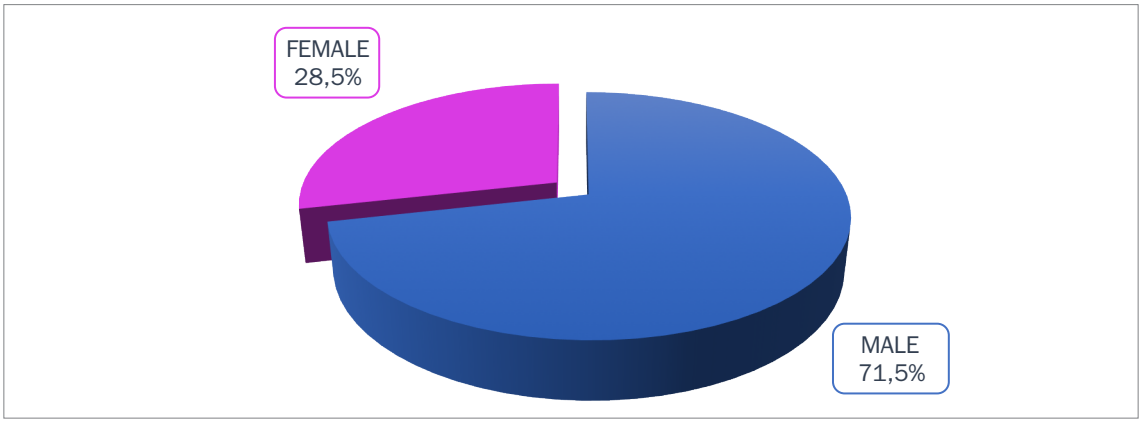


FIGURE 22: PEDESTRIANS (n=130)
PERCENTAGE DISTRIBUTION BY AGE RANGE

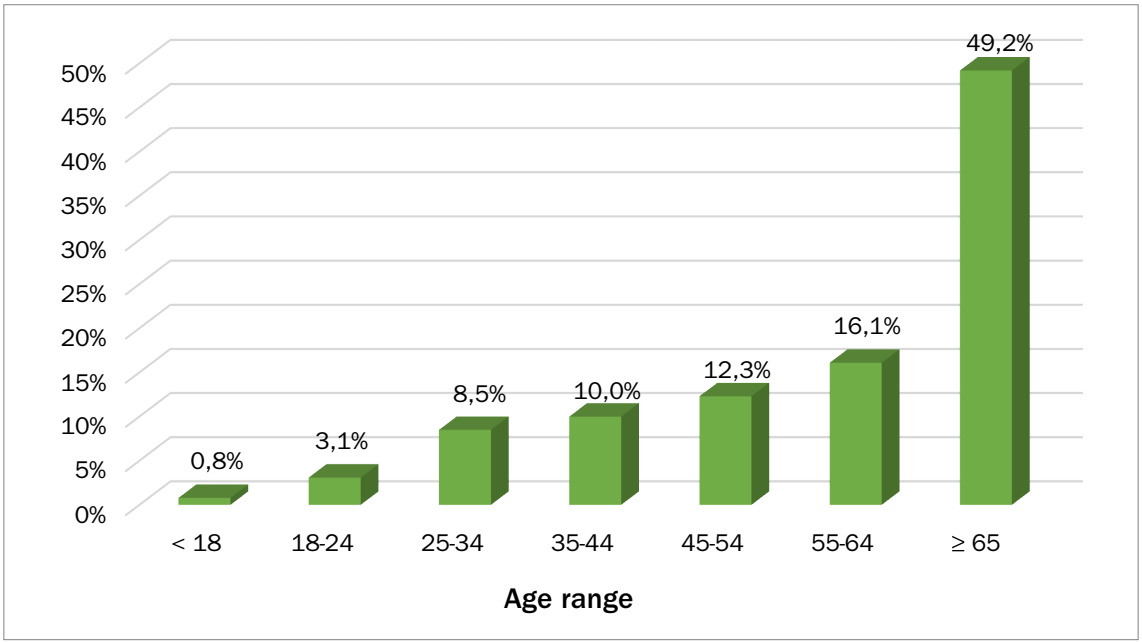
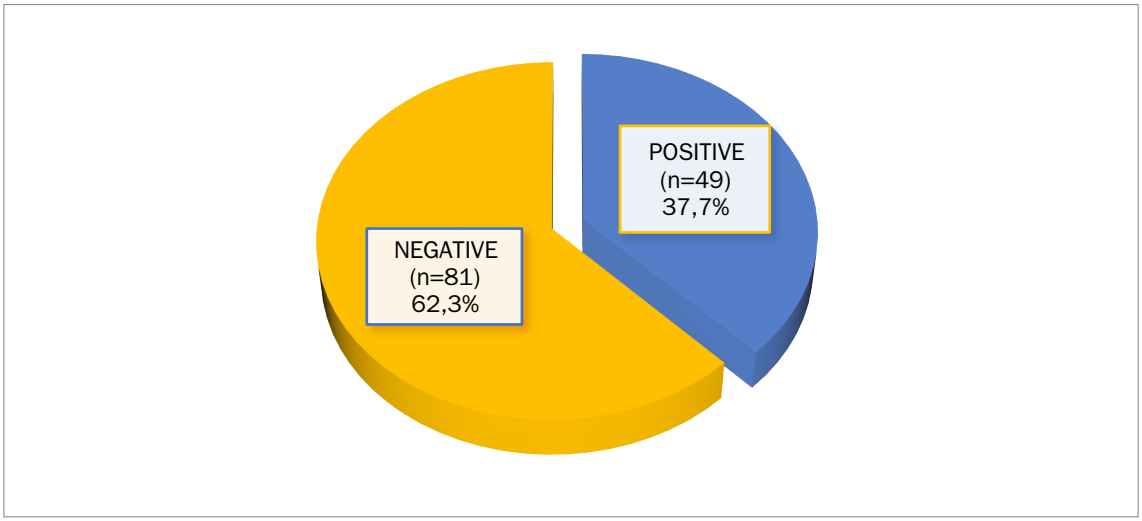


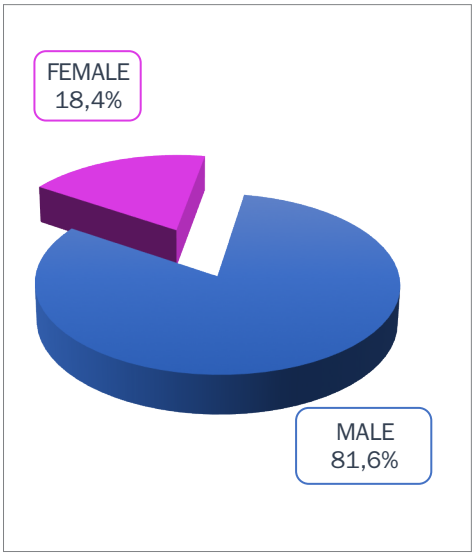
FIGURE 23: PERCENTAGE ACCORDING TO TOXICOLOGICAL RESULTS (130 PEDESTRIANS)

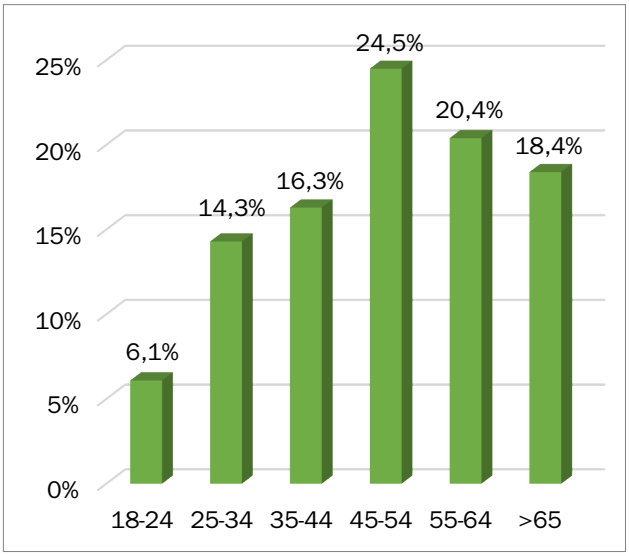


Out of 130 pedestrians killed in traffic accidents and subjected to autopsy, 49 (37.7%) tested positive for alcohol, drugs of abuse and psychoactive drugs, alone or in combination.

PEDESTRIANS: CASES WITH POSITIVE TOXICOLOGICAL RESULTS (n = 49)

FIGURES 24 AND 25: PEDESTRIANS (POSITIVE TOXICOLOGICAL RESULTS) (n=49) PERCENTAGE BY GENDER AND AGE RANGES

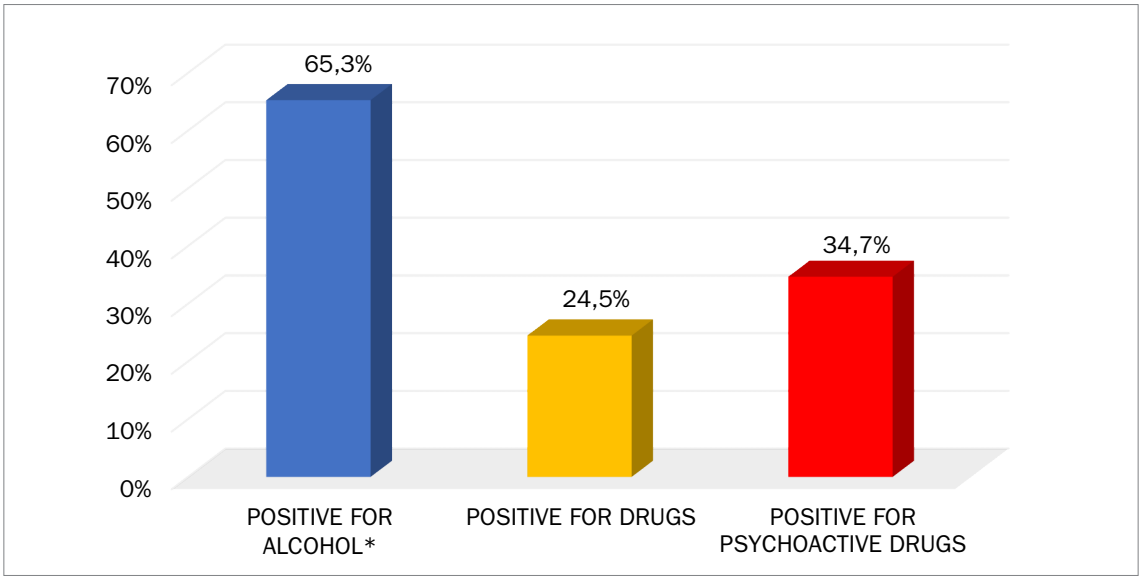




81.6% of the pedestrians killed in traffic accidents, with positive toxicological results, were men. First figure right shows the distribution by age range, with the highest prevalence among pedestrians between 45 and 54 years of age (24.5%).

FIGURE 26: PEDESTRIANS (POSITIVE TOXICOLOGICAL RESULTS) (n=49) PERCENTAGE ACCORDING TO SUBSTANCE TYPE

Substance associations not considered



*Positive for alcohol: blood alcohol concentration greater than or equal to 0.30 g/L

The highest prevalence of pedestrians with positive results corresponded to alcohol (65.3%), followed by psychoactive drugs (34.7%) and drugs of abuse (24.5%).

FIGURE 27: PEDESTRIANS (POSITIVE TOXICOLOGICAL RESULTS) (n=49)
RESULTS BY TYPE AND/OR COMBINATION OF SUBSTANCES DETECTED

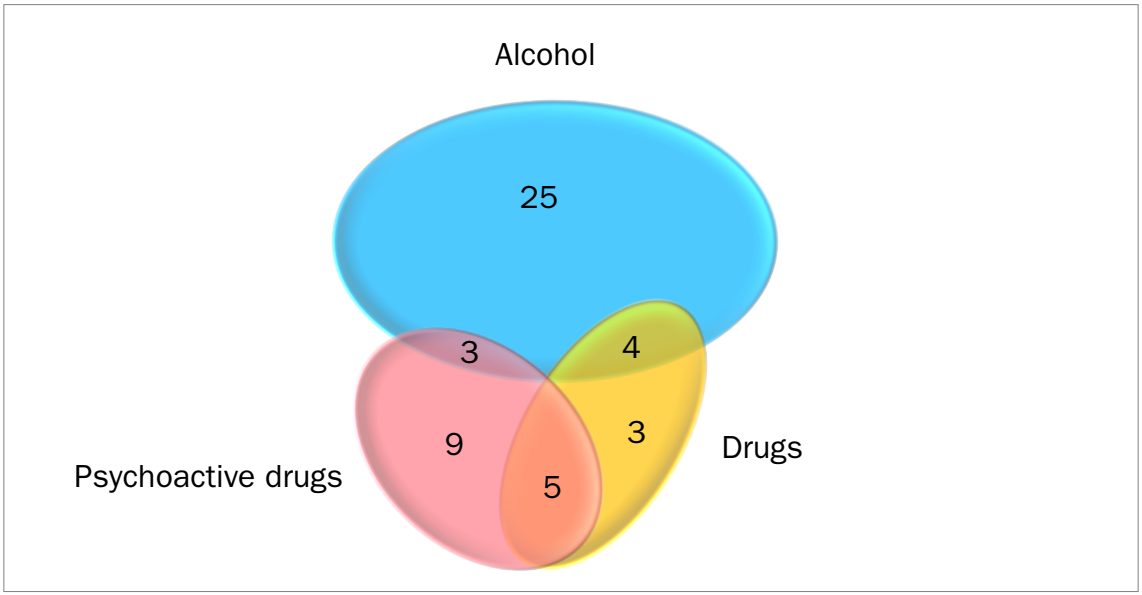
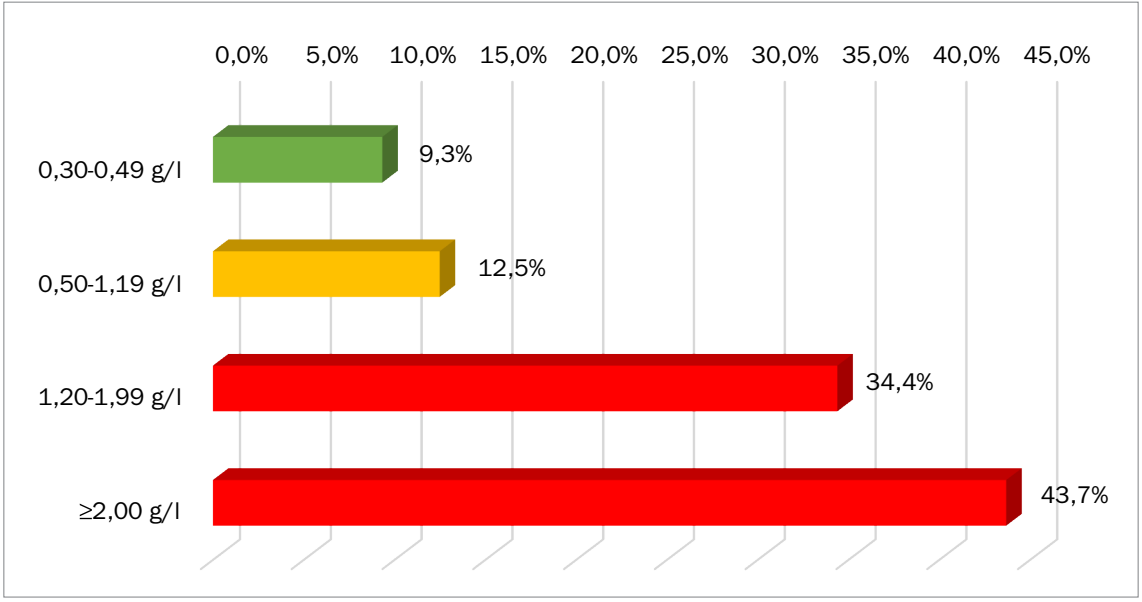


FIGURE 28: ALCOHOL-POSITIVE PEDESTRIANS (n=32)
DISTRIBUTION BY BAC



78.1% of the pedestrians who died and tested positive for alcohol had a BAC of 1.20 g/L or higher.

FIGURE 29: ALCOHOL-POSITIVE PEDESTRIANS (n=32)
DISTRIBUTION BY BAC AND AGE RANGE

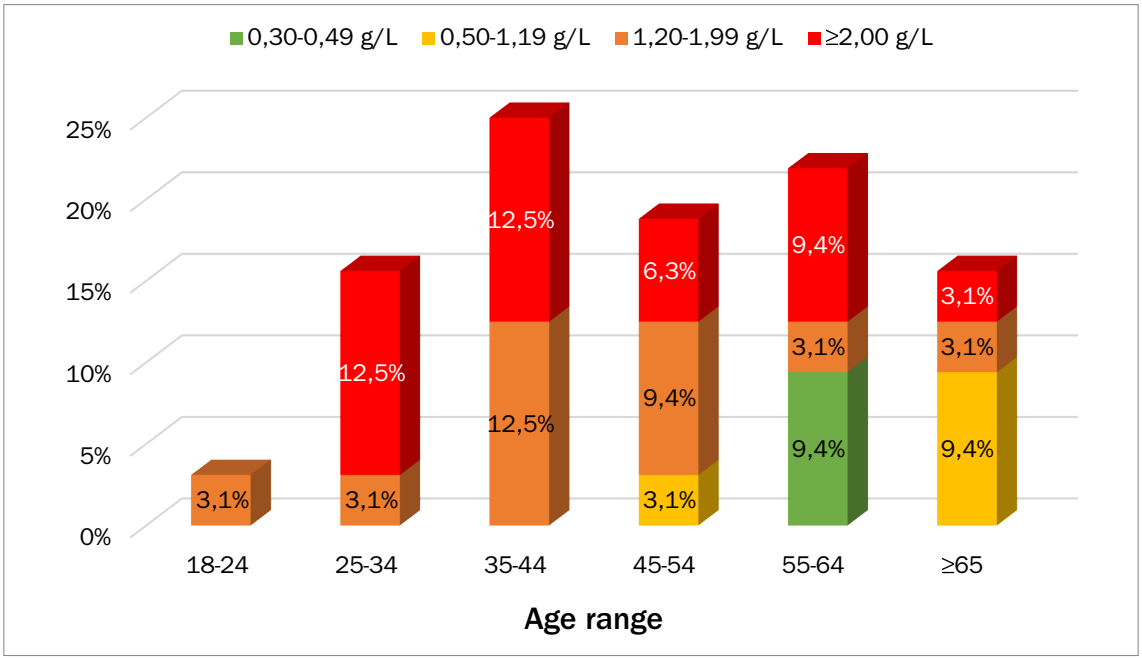
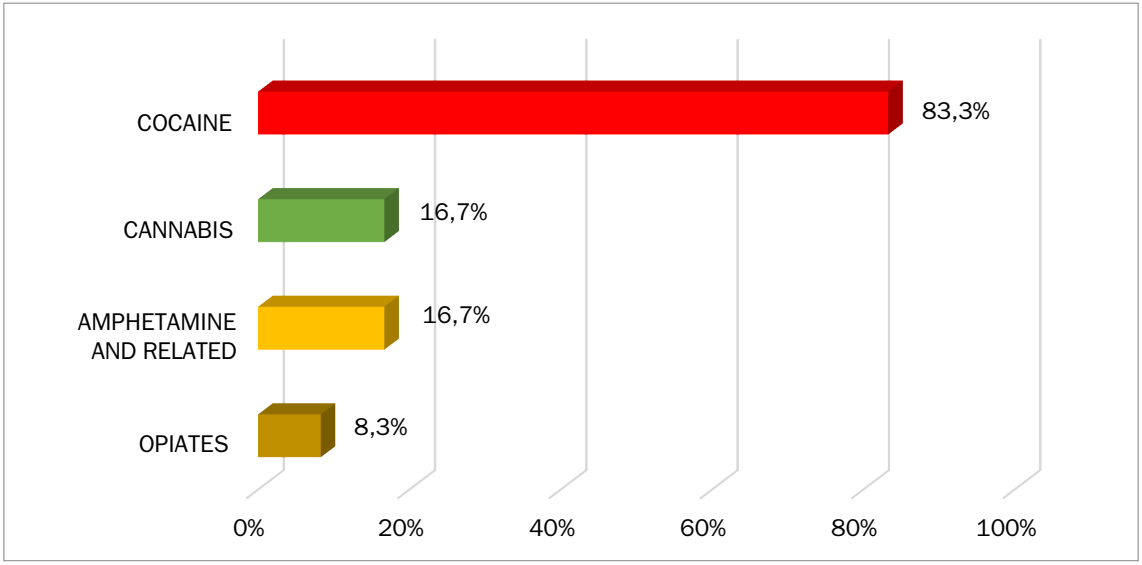


FIGURE 30: DRUG-POSITIVE PEDESTRIANS (n=12)
PERCENTAGE BY DRUG TYPE



Regardless of associated use of drugs of abuse, alcohol and/or psychoactive drugs, cocaine was the most widely used single drug (83.3%).

FIGURE 31: DRUG-POSITIVE PEDESTRIANS (n=12)
PERCENTAGE BY DRUG DETECTED AND AGE RANGE

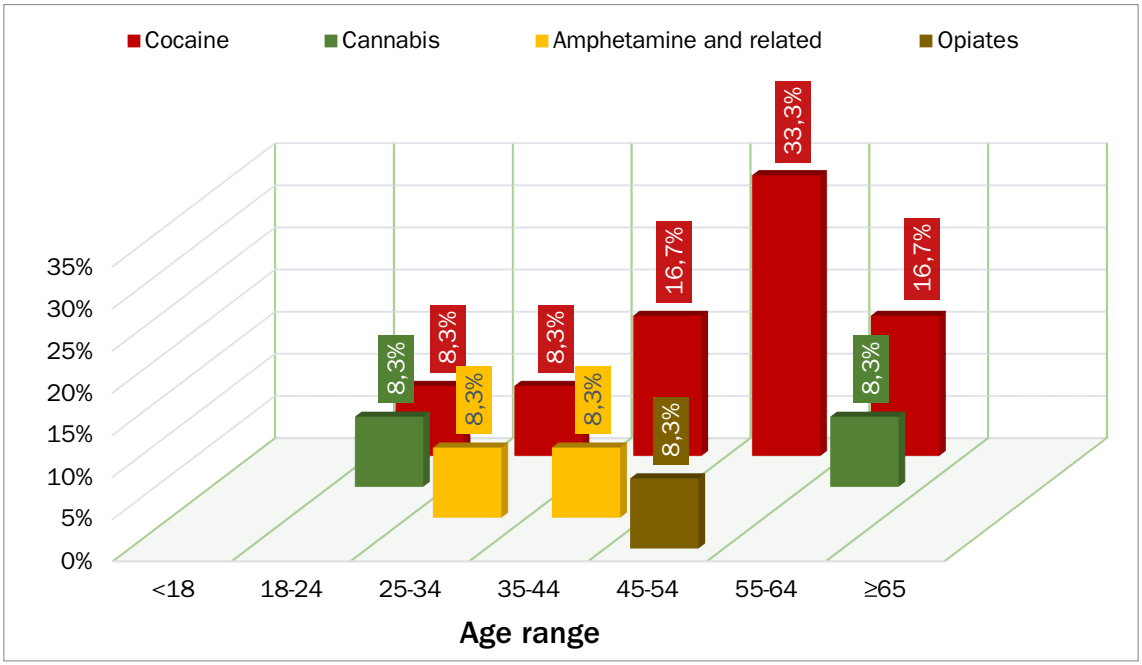
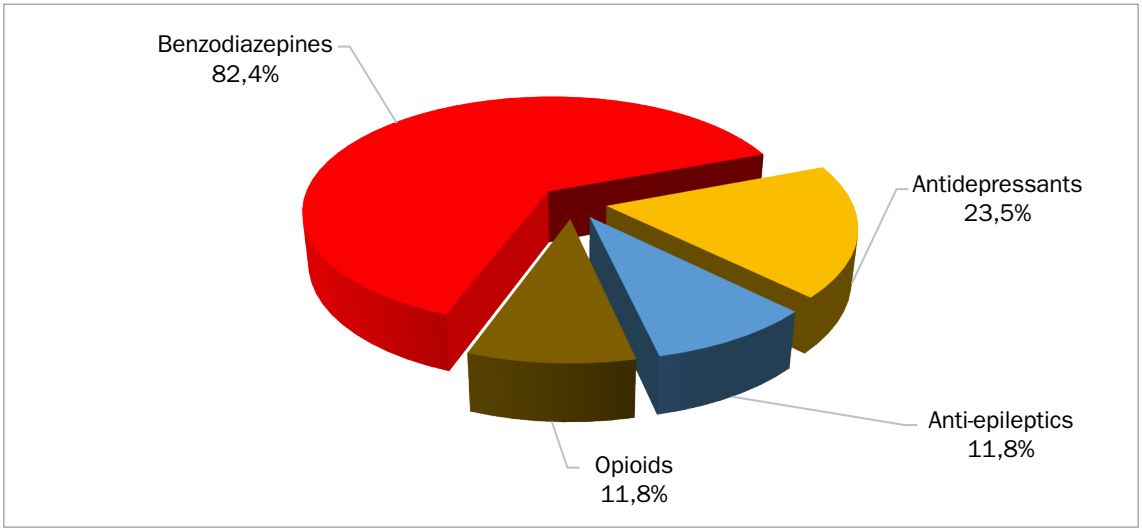


FIGURE 32: PEDESTRIANS POSITIVE FOR PSYCHOACTIVE DRUGS (n=17)
PERCENTAGE BY PSYCHOACTIVE DRUGS



The term “opioids” refers to drugs (tramadol, oxycodone, methadone, etc.), excluding heroin, that bind to the opioid receptors of the central nervous system.

Comparative study
(2009-2019)

FIGURE 33: NUMBER OF FATALITIES ANALYSED

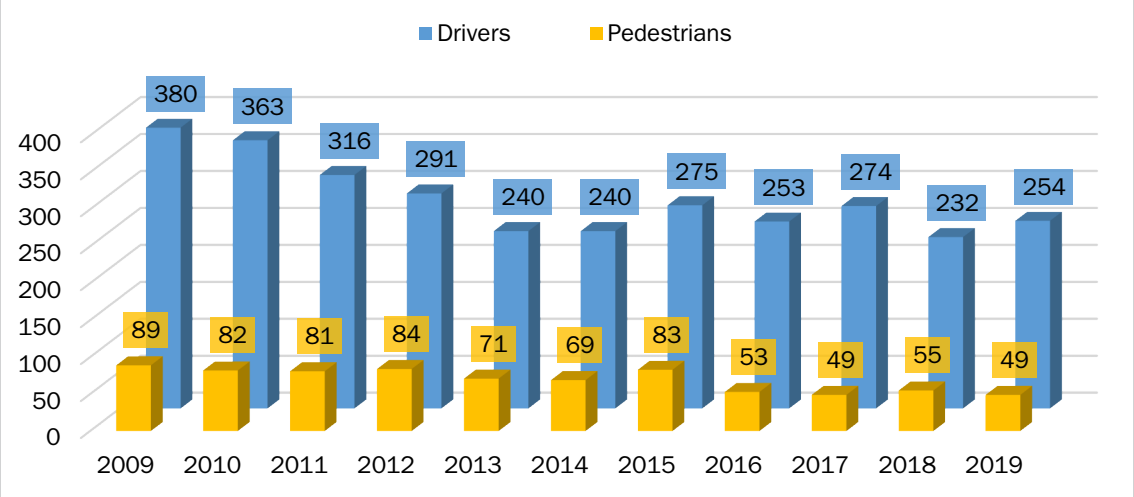


FIGURE 34: PERCENTAGE OF DRIVERS ACCORDING TO TOXICOLOGICAL RESULTS

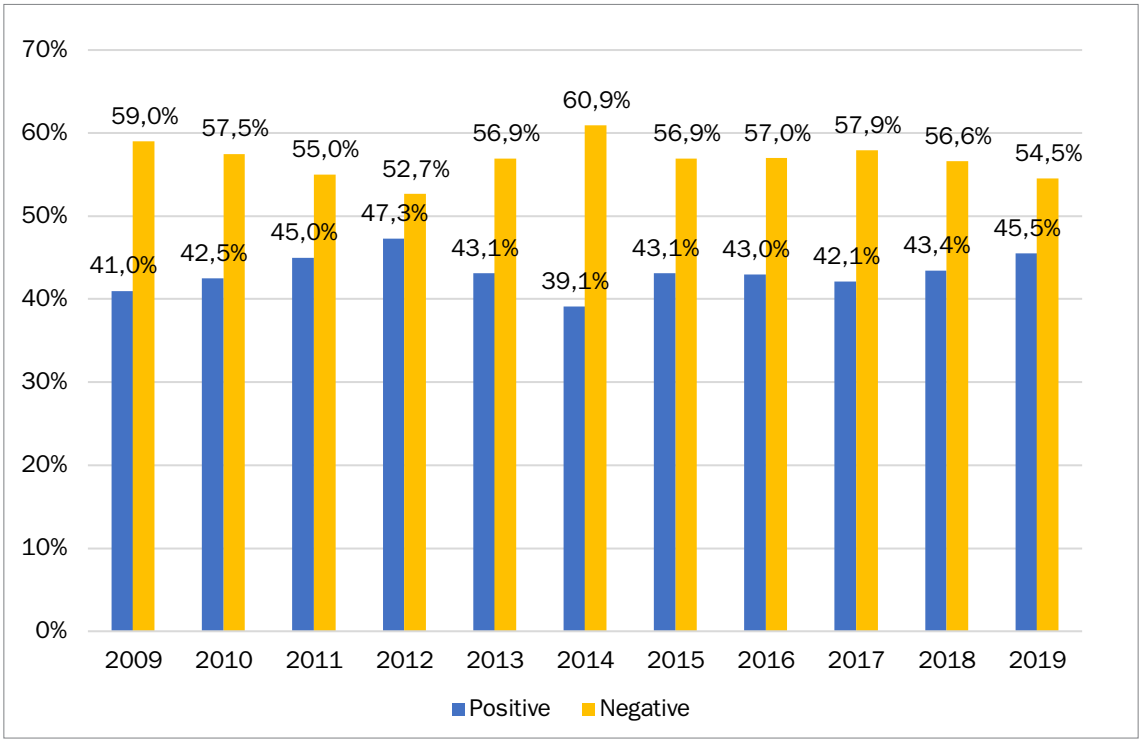


FIGURE 35: PERCENTAGE OF PEDESTRIANS ACCORDING TO TOXICOLOGICAL RESULTS

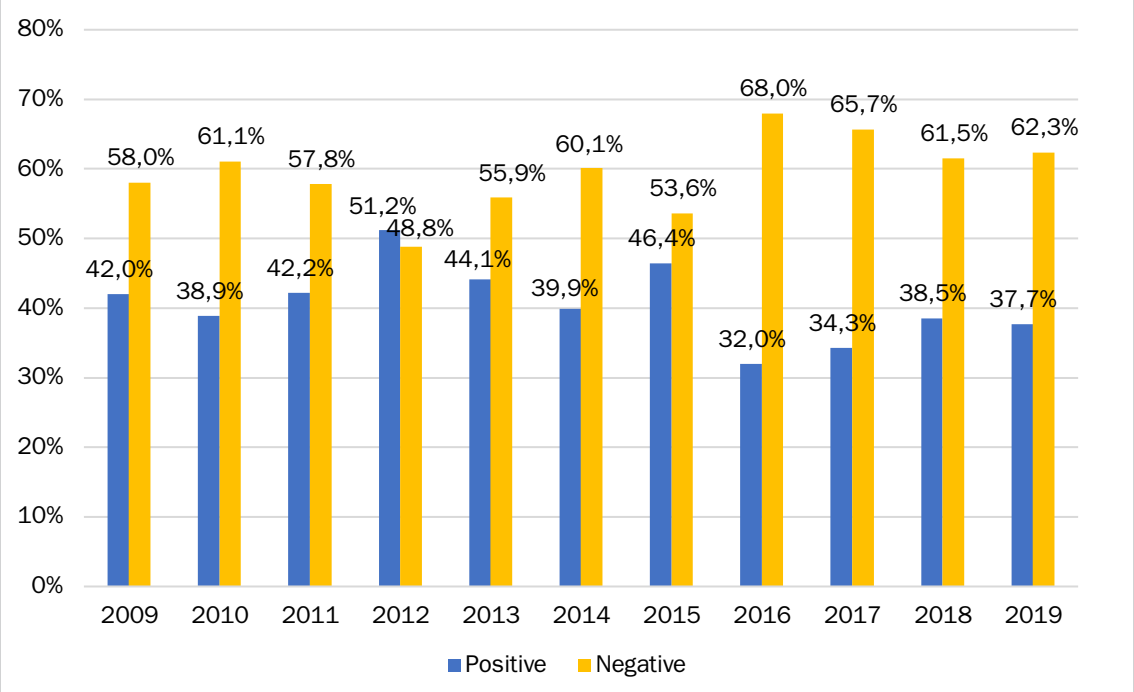
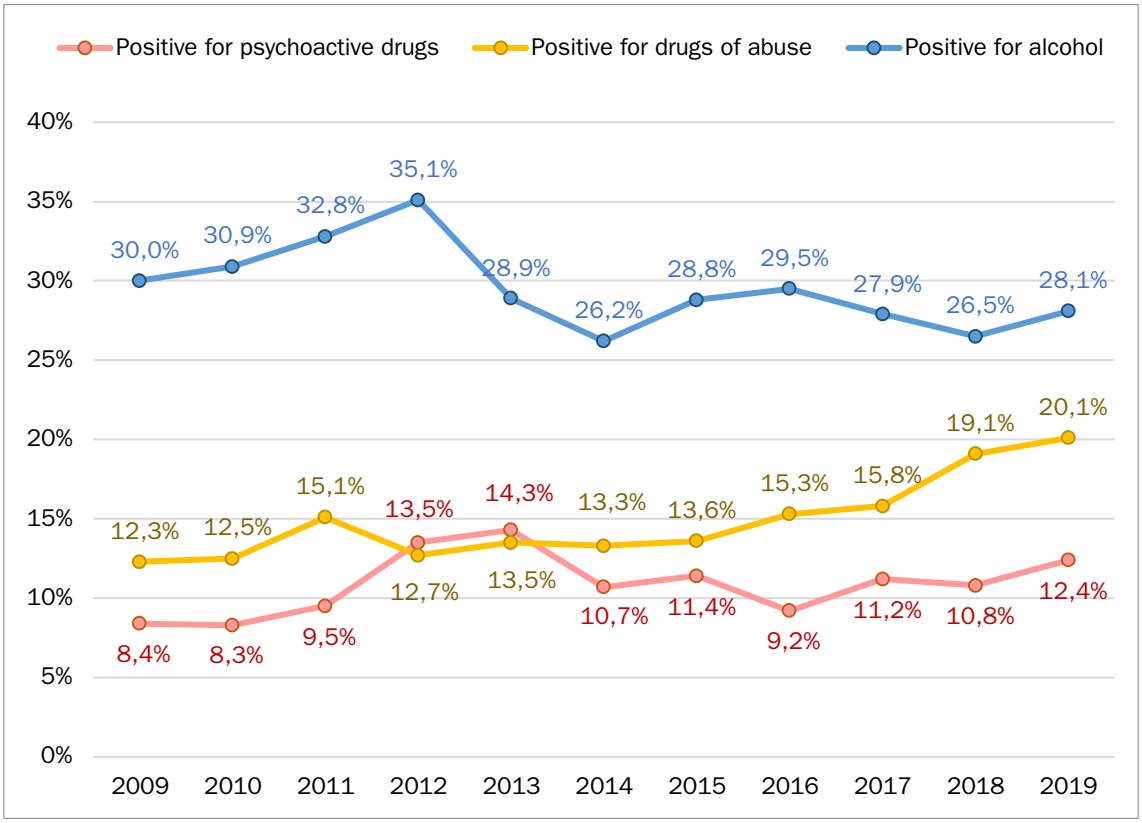
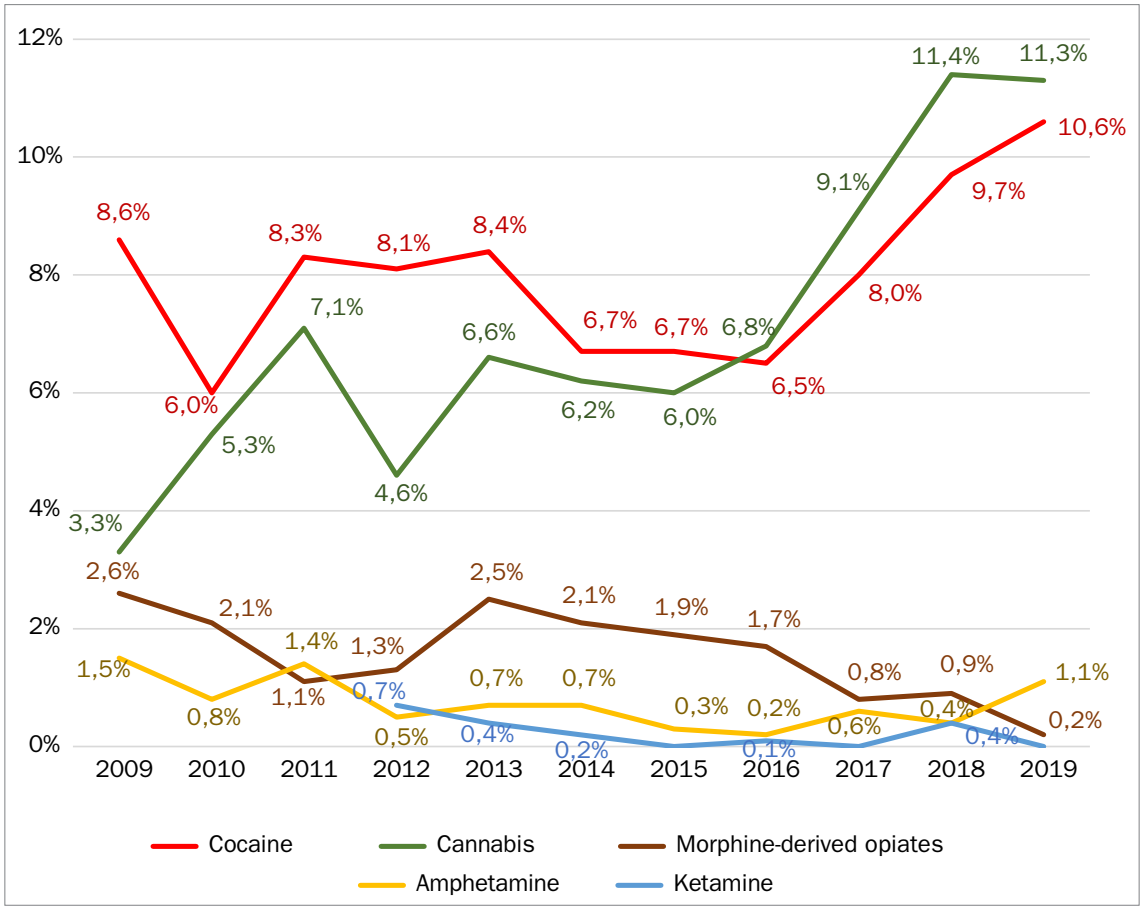


FIGURE 36: PERCENTAGE OF DRIVERS
ACCORDING TO TOXICOLOGICAL RESULTS



Regarding alcohol consumption, we observe a slight decreasing trend over the last three years, with the exception of last year, when there was a slight increase of 1.6%. Regarding drug consumption, there is an increasing trend, of 7.8% *versus* 2009.

FIGURE 37: PERCENTAGE OF POSITIVE DRIVERS BY TYPE OF DRUG



Since 2016, there has been a strong increasing trend in cannabis and cocaine use.

Concluding remarks

CONCLUSIONS ON MEDICO-LEGAL & SOCIAL IMPACT

From the data obtained and presented in this report, we can draw the following conclusions that have the greatest impact, not only on the medico-legal aspects but also their relevant implications on road traffic safety.

DRIVERS

Out of 558 drivers who died in traffic accidents, and who underwent an autopsy and toxicological analysis, 254 drivers, i.e. 45.5%, (FIGURE 8) showed positive toxicological results for alcohol, drugs of abuse and/or psychoactive drugs, alone or in combination. If this figure is compared with the prevalence of alcohol and drug use in the general population of drug tested drivers (12%, according to DGT data in 2016 [4], or approximately 7% in European drivers [5]), we observe a significant impact of alcohol and drug abuse on traffic accidents; the prevalence of drug abuse in the group of drivers who died is more than 30% higher than the drug positive tested drivers in the general population.An overwhelming majority of cases (96.1%) with positive toxicological results were male drivers, whereas 3.9% were female drivers (FIGURE 10). This is, obviously, a very significant fact when performing traffic accident preventative campaigns.

The majority (87.4%) of drivers with positive toxicological results were driving a car (45.3%), or a motorcycle or scooter (42.1%) (FIGURE 13).

The distribution of drivers who died with positive toxicological results, according to the type of substance detected, was as follows: 61.8% (n:157) for alcohol (refers to BAC ≥0.30 g/L for novice/professional drivers, or ≥ 0.5 g/L for all other drivers), 44.1% (n:112) for drugs and 27.2% (n:69) for psychoactive drugs (FIGURE 11).

It is worth noting that 81.5% of the drivers who died with alcohol-positive results had a very high blood alcohol concentration (equal to or above 1.2g/L), which correlates with very severe intoxication degree (FIGURE 15). 63.1% of drivers with a BAC of 1.20 g/L or above were in the age groups of 25-34 (20.4%), 35-44 (21.0%) and 45-54 (21.7%) (FIGURE 16).

Regarding positive drug cases (n=112), and regardless of associated use of abuse drugs, alcohol and/or psychoactive drugs, the most widely used single drug was cannabis (56.3%), followed by cocaine (52.7%) (FIGURE 17).

The most prevalent associated uses of alcohol and drugs of abuse were, first, associated use of alcohol and cocaine (40.4%), followed alcohol and cannabis (32.7%) and alcohol, cocaine and cannabis (21.1%) (TABLE 1).

The comparative number of drivers with toxicological results positive for alcohol over the last ten years (from 2009 to 2019) shows a progressive downward trend, except for last year, when a slight 1.6% increase was observed. In addition, an upward trend was observed in drug abuse, which increased by almost 7.8% from 2019 (12.3%) to 2019 (20.1%)

(FIGURE 36). In particular, since 2016 there is an upward trend in cannabis and cocaine use (FIGURE 37).

PEDESTRIANS

Out of 130 pedestrians killed in traffic accidents and subjected to autopsy, 49 (37.7%) tested positive for alcohol, drugs of abuse and psychoactive drugs, alone or in combination (FIGURE 23).

The distribution by gender of pedestrians killed differs from the distribution of drivers killed, since 81.6% of the pedestrians killed by being run over with positive toxicological results were men and 18.4% were women (FIGURE 24).

The distribution by age range revealed a higher prevalence in pedestrians aged 45 years and older (63.3%) (FIGURE 25).

The highest prevalence of pedestrians rendered positive results for alcohol (65.3%), followed by psychoactive drugs (34.7%) and drugs of abuse (24.5%) (FIGURE 26).

It should be noted that 78.1% of the pedestrians who died and tested positive for alcohol had a BAC greater than or equal to 1.20 g/L (FIGURE 28).

Methodology

SAMPLES TESTED:

In order to carry out this study, post-mortem blood samples were analysed in 702 cases and vitreous humour in 438 cases. In 398 cases, both samples were analysed, evaluating the toxicological findings in the context of case circumstances and body condition. In 37 cases (25 drivers and 12 pedestrians), only one vitreous humour sample was available for analysis. In these cases the presence of cannabis could not be determined since tetrahydrocannabinol (THC) and its metabolites are restricted from passing through the blood-retinal barrier.

ANALYTICAL TECHNIQUES USED:

- Enzyme immunoassay.
- Gas chromatography with flame ionization detector and headspace autoanalyser (HS-GC-FID).
- High performance liquid chromatography with diode-array detector (HPLC-DAD)
- Gas chromatography coupled to mass spectrometry (GC-MS).
- Gas chromatography coupled to tandem mass spectrometry (GC-MSMS).
- High resolution liquid chromatography coupled to tandem mass spectrometry (UPLC-MSMS).
- Liquid chromatography coupled to high resolution mass spectrometry (LC-HRMS)

All reported results of drugs of abuse and psychoactive drugs [6] were confirmed by analytical techniques based on mass spectrometry [7-16].

All of the analytical results were obtained within the quality system implemented at the INTCF in accordance with ISO 17025. The INTCF is specifically accredited by the National Accreditation Body (ENAC) for the quantitative determination of alcohol in biological fluids, among others [17].

The following is a description of the national and international intercomparison exercises in which the Chemistry and Drug Services of the different Departments of the INTCF participate annually, and whose results are essential for the external evaluation of the competence of our laboratories in this type of tests for the determination of drugs of abuse.

TABLE 2: PARTICIPATION IN INTERCOMPARISON EXERCISES OF THE CHEMISTRY AND DRUG SERVICES OF THE DIFFERENT DEPARTMENTS OF THE INTCF

	Barcelona	Madrid	Seville	La Laguna
Program: Blood Ethyl Alcohol Intercomparison Exercise Organiser: INTCF Seville Frequency: Four-monthly Parameters/samples: Ethyl alcohol and other volatile compounds in blood and plasma	X	X	X	X
Program: Whole Blood Alcohol / Volatiles Survey (AL1) Organiser: College of American Pathologists Frequency: Four-monthly Parameters/samples: Ethyl alcohol, volatiles and ethylene glycol in the blood	X	X		
Program: Toxicology Program Organiser: LGC Standards Frequency: Yearly Parameters/samples: Identification and quantification of blood ethanol			X	
Program: Vitreous Fluid (VF) Organiser: College of American Pathologists Frequency: Half-yearly Parameters/samples: Ethyl alcohol, potassium and sodium in vitreous humour		X		
Program: Forensic Toxicology Criminalistics (FTC) Organiser: College of American Pathologists Frequency: Half-yearly Parameters/samples: Drugs in blood and urine	X	X		
Program: Forensic Blood Toxicology Proficiency Testing (Quartz) Organiser: LGC Frequency: Three-monthly Parameters/samples: Drugs of abuse and psychoactive drugs in the blood		X	X	
Program: Blood Drug Analysis (CTS-5661) Organiser: Collaborative Testing Services Frequency: Yearly Parameters/samples: Drugs of abuse and psychoactive drugs in the blood		X		

STATISTICAL DATA ANALYSIS

The data received in each application (date of the accident, date of death, role, age, gender, type of vehicle, Autonomous Community, province, requesting body, sending body), as well as the data from the toxicological studies obtained by the INTCF, were recorded in the LIMS Labware (Laboratory Information Management System) of the INTCF information management system.

The data were compared with the inrecorded data y by the Directorate General of Traffic, and cases selected.

The LIMS system queries were performed using different strategies/approached with the Data Explorer module and data was exported to Microsoft Excel 2016.

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