

Technical University of Denmark



## Results from epidemiological research - prevalence, risk and characteristics of impaired drivers

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**DRUID**

Driving under the Influence of Drugs, Alcohol and Medicines

Integrated Project  
1.6. Sustainable Development, Global Change and Ecosystem  
1.6.2: Sustainable Surface Transport

**6th Framework Programme**

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# Results from epidemiological research - prevalence, risk and characteristics of impaired drivers

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# Results from epidemiological research - prevalence, risk and characteristics of impaired drivers

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# 1 Introduction

## 1.1 Introduction

The use of psychoactive substances can influence people's motor and cognitive performance, and, consequently, be a hazard to traffic safety. Alcohol is a well-known contributor to road accidents, but other substances, such as illicit drugs and psychoactive medicines, can also adversely affect the fitness to drive, and, therefore, endanger traffic safety.

## 1.2 General background

DRUID (Driving under the Influence of Drugs, Alcohol and Medicines) aimed to combat the problem of driving under the influence of psychoactive substances by providing a solid scientific base for European policy makers. It brought together experienced organisations in Europe to assemble a co-ordinated set of data resources and measures. DRUID is an integrated European research project which consisted of different sub-projects (Work Packages) that were aimed at different topics such as the prevalence and risk of psychoactive substances, enforcement, classification of medicines, rehabilitation of offenders and withdrawal of driving licenses.

The main objective of WP2 of DRUID is to assess the situation in Europe regarding the prevalence and risk of the use of illicit drugs, alcohol and psychoactive medicinal drugs by drivers.

## 1.3 Objectives

The objectives of this deliverable is to summarise the findings of the various epidemiological studies of the relation between psychoactive substance use and the risk of injury in a road accident while positive for alcohol or other psychoactive substances.

## 1.4 Participating countries

In total 25 partners from 15 countries took part in the epidemiological work package, see figure 1.

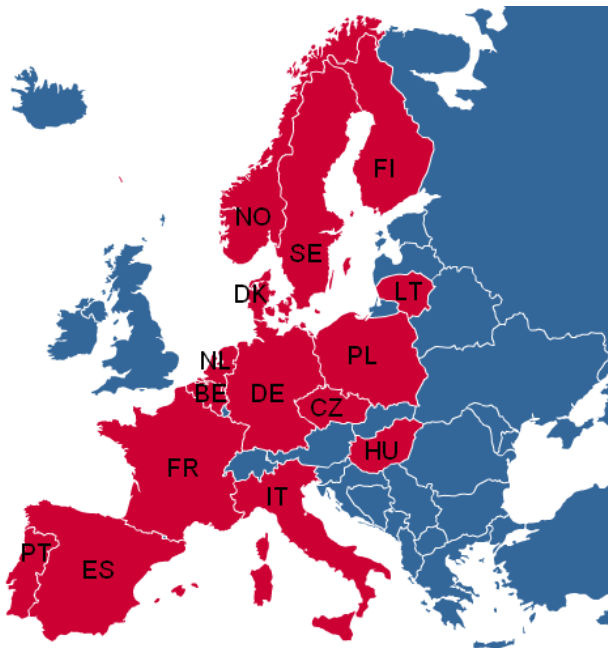


Figure 1 Participating countries in the epidemiological work package

## 2 Prevalence of alcohol and/or other psycho-active substances

Within DRUID, prevalence of alcohol and other drugs was surveyed in the following populations:

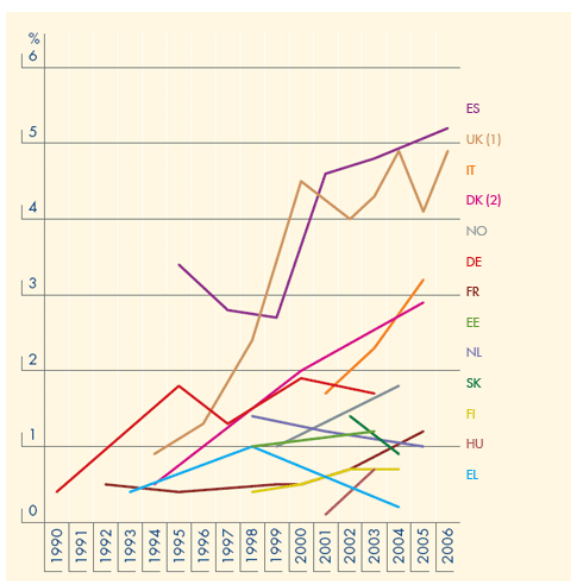
- The general population
- The general population of car drivers
- Seriously injured car drivers
- Killed car drivers
- All types of drivers involved in fatal accidents

### 2.1 Prevalence in the general population

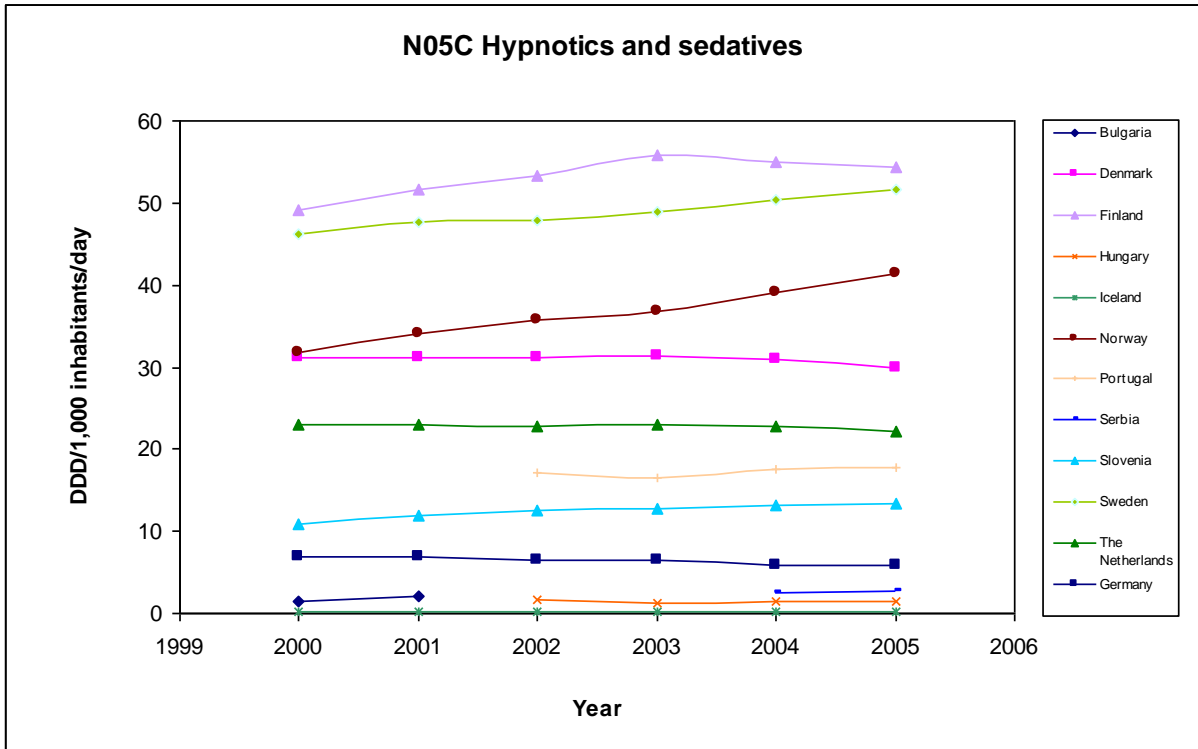
Information on the prevalence of consumption of some frequently used medicines with effects on the central nervous system (i.e. opioids, antipsychotics, anxiolytics, hypnotics and sedatives, antidepressants, drugs used in addictive disorders, and antihistamines for systemic use) in a non-hospitalised EU population was collected over the years 2000 to 2005. In the same way, information on the use of illicit drugs in Europe (i.e. cannabis, amphetamines, ecstasy, LSD, cocaine and crack cocaine, and opioids) was collected on retrospective data from the years 1994 until 2006 (Ravera et al., 2007).

An increase in the use of medicinal psychotropic drugs and drugs with central nervous system side-effects has been observed before and it could also be observed in the results of this study. The major increase was seen in the consumption of antidepressants and drugs used in addictive disorders. For the other classes of interest either a slight increase or no increase was noted.

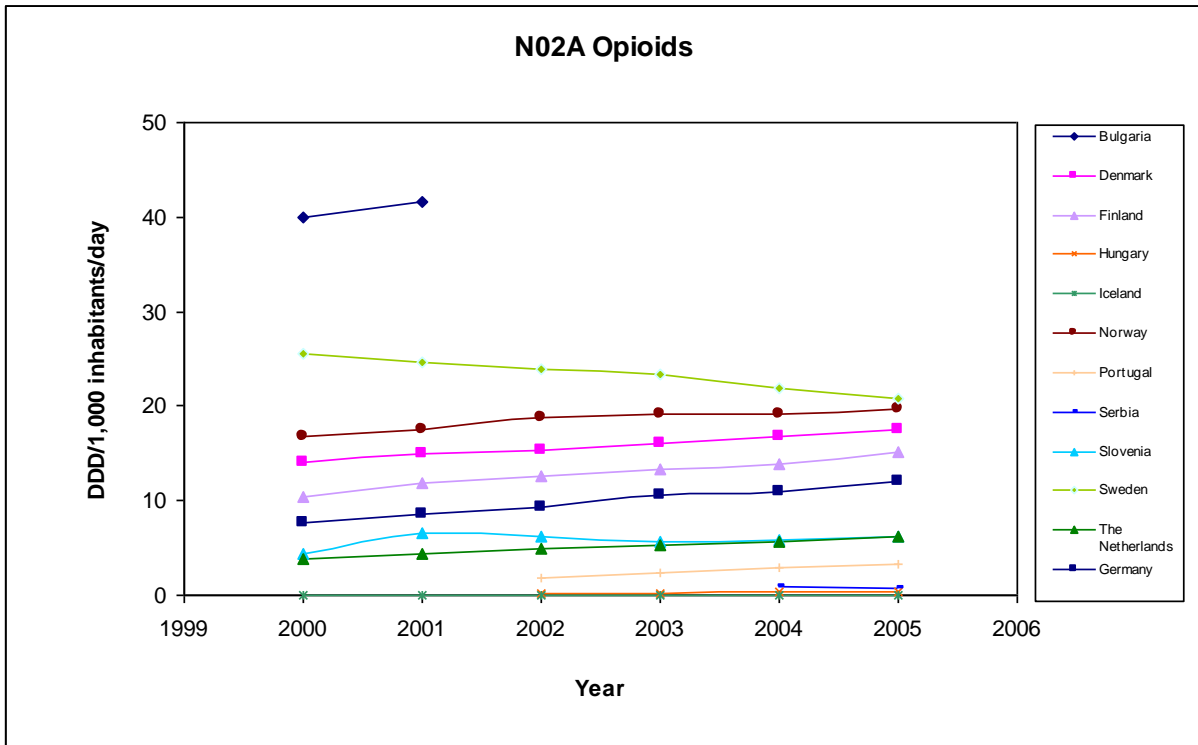
As illustrated by the examples in the following figures on cocaine, hypnotics and sedatives as well as opioids, illicit drugs are most prevalent among the population in the Southern European countries whereas medicines are most prevalent in the Nordic countries. These data serve as background information for a better understanding of the European illicit drug use problem and, subsequently, for comparison with the prevalence of illicit and medicinal drug use in the driving population.



**Figure 2** Cocaine use in the general population in various European countries, 1990-2006 (Source: D 2.1.1, see Annex 1)



**Figure 3** Use of hypnotics and sedatives in the general population in various European countries, 2000-2005  
(Source: D 2.1.1, see Annex 1)



**Figure 4** Use of opioids in the general population in various European countries, 2000-2005  
(Source: D 2.1.1, see Annex 1)



## 2.2 Prevalence in the general population of car drivers

The prevalence of alcohol and other drugs in the driving population was calculated in thirteen European countries based on road side surveys (Houwing et al., 2011). For this purpose, in total more than 50,000 drivers of passenger cars and vans from the driving population in the participating countries gave a saliva sample, a blood sample or both samples.

The study was carried out in the following countries and during the years mentioned below

- Northern Europe
  - Denmark (2008-2009)
  - Finland (2007-2009)
  - Norway (2008-2009)
  - Sweden (2008-2009)
- Eastern Europe
  - Czech Republic (2008-2009)
  - Hungary (2008-2009)
  - Lithuania (2008-2009)
  - Poland (2007-2009)
- Southern Europe
  - Spain (2008-2009)
  - Italy (2008-2009)
  - Portugal (2008-2009)
- Western Europe
  - Belgium (2008-2009)
  - The Netherlands (2007-2009)

A set of guidelines for these surveys were developed within the DRUID project and were followed in the national setups of the studies, implying that a blood and/or saliva sample was collected from each driver in the study and confirmation analysed for the same number of substances in all countries. The guidelines also gave advice on how to collect information on a random sample of drivers at all times of the day and week in various locations spread out over the regions included in the study.

New less time consuming toxicological methods for analysing whole blood and saliva were developed by the laboratories who confirmation analysed the samples from the road side surveys as part of the DRUID project. Proficiency test analyses of saliva and whole blood were carried out by all laboratories, resulting in a high quality of toxicological analyses in all countries.

Because blood was collected in some of the countries (Italy and Lithuania), both blood and/or saliva in two countries (Belgium and The Netherlands), and saliva in the remaining nine countries, equivalent concentrations for blood and saliva were developed within the DRUID project to be used for the decision on whether a sample was positive for a substance or considered negative (Verstraete et al, 2011). This means that concentrations of both blood and saliva could be included in the calculations. These equivalent concentrations have not been known before they were developed in DRUID WP2. This is a most important finding, that solves the problem of two different specimen being collected in the road side surveys. The equivalent cut offs are shown in **Table 1**.

**Table 1** Recommended equivalent cut-offs for DRUID core substances

Substance	Equivalent cut-offs	
	Whole blood (ng/mL)	Oral fluid/saliva (ng/mL)
Ethanol	0.1 (g/L)	0.082 (g/L)
6-AM	10	16
Alprazolam	10	3.5
Amphetamine	20	360
Benzoyllecgonine	50	95
Clonazepam	10	1.7
Cocaine	10	170
Codeine	10	94
Diazepam	140	5.0
Flunitrazepam	5.3	1.0
Lorazepam	10	1.1
MDA	20	220
MDEA	20	270
MDMA	20	270
Methadone	10	22
Methamphetamine	20	410
Morphine	10	95
Nordiazepam	20	1.1
Oxazepam	50	13
THC	1.0	27
Zolpidem	37	10
Zopiclone	10	25
Tramadol	50	480
7-amino-clonazepam	10	3.1
7-amino-flunitrazepam	8.5	1.0

Based on the above substances that were included in the toxicological analyses, the following substance groups were formed:

- Alcohol
- Amphetamines, including methamphetamines and MDA, MDEA and MDMA
- Cocaine, including benzoylecgonine
- Cannabis
- Illicit opiates
- Benzodiazepines
- Z-drugs
- Medicinal opioids
- Alcohol and drug(s)
- Multiple drugs

As THCCOOH cannot be detected in saliva with commonly available methods, THCCOOH concentrations were not considered in the results from the road side surveys (Houwing et al., 2011).

The following figures show the prevalence for each of the involved countries, grouped according to the regions of Europe (Northern, Eastern, Southern and Western Europe).

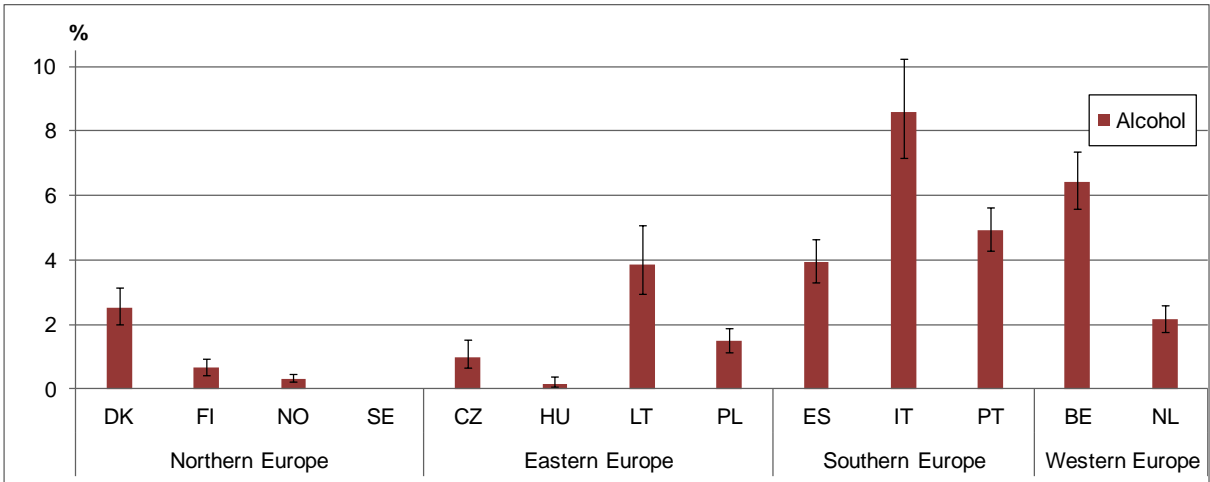
The prevalence concerns concentrations of the substances in question that are equal or exceeds the above mentioned concentrations in blood (for blood samples) and the above mentioned concentrations in saliva, equivalent to blood (for saliva samples). If both a saliva sample and a blood sample was analysed, the concentration in blood was used for this sample.

Because the results are based on random sampling and not on the whole driving population, the results are shown together with their confidence intervals, that is there is 95% possibility that the prevalence in the whole driving population lies between the upper and lower confidence interval.

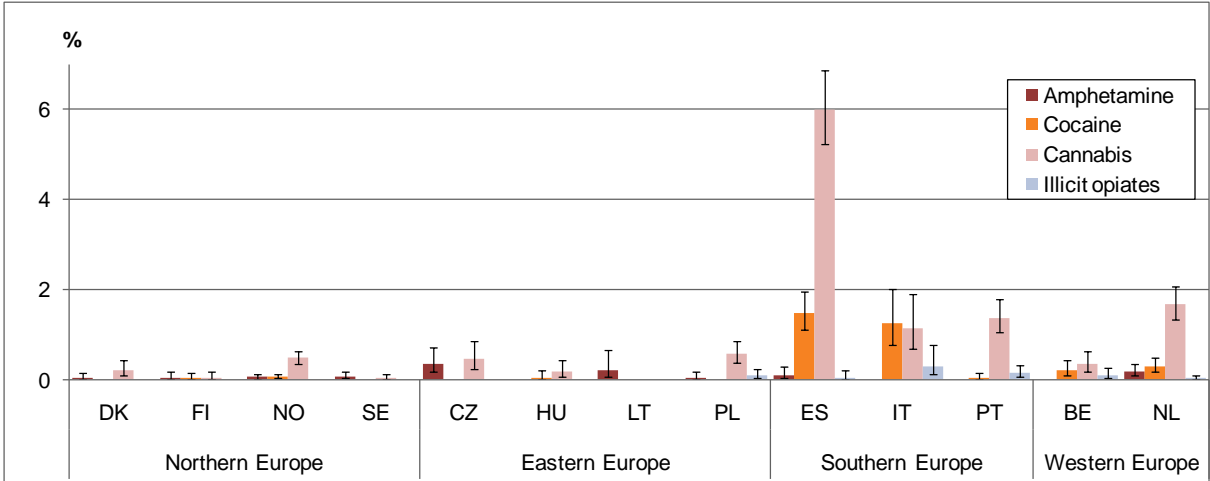
When considering whether there are differences between the prevalence of e.g. alcohol in two countries, this difference is only significant if the upper confidence interval of one country is smaller than the lower confidence interval of the other country.

The following tables show the prevalence for alcohol in the driving population in the countries involved, and for the most prevalent illicit and medicinal drug groups in the surveys, including confidence intervals. The countries are divided into European regions.

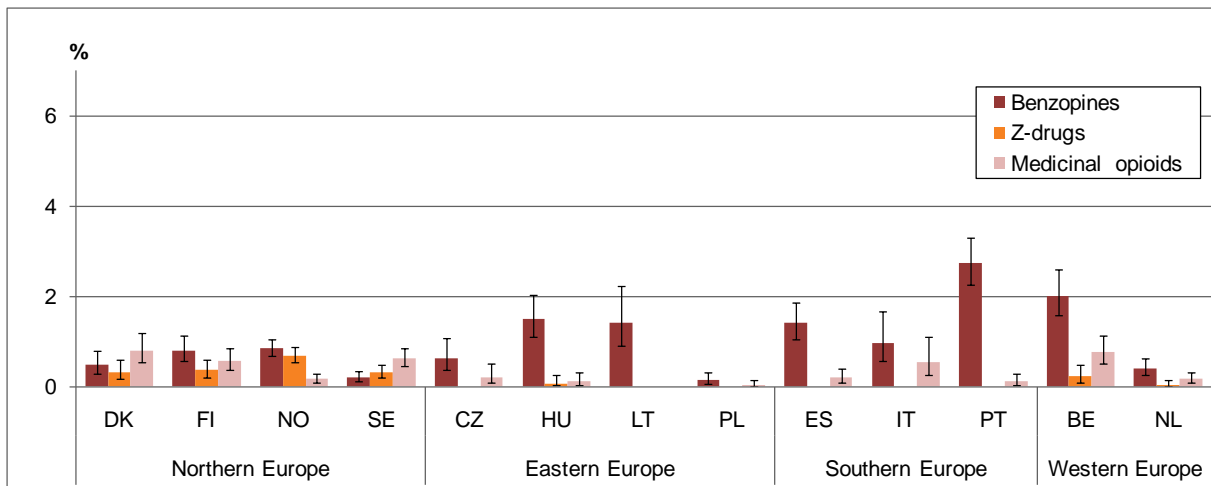
For some of the substance groups, the prevalence was too low to be calculated. For Sweden, information on alcohol is missing due to restrictions from the police.



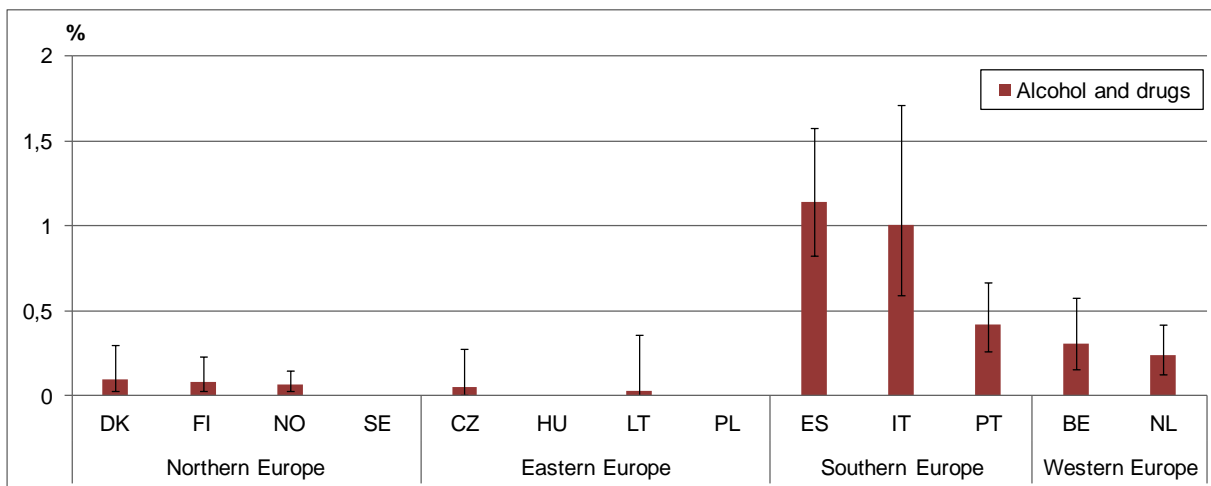
**Figure 5** Overall prevalence of alcohol in the general driving population in thirteen European countries



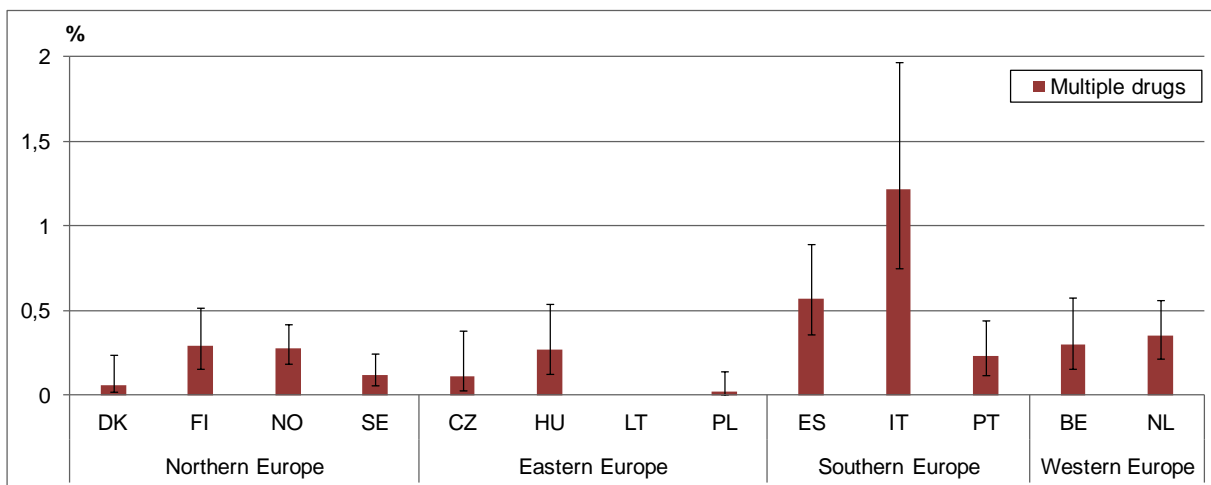
**Figure 6** Overall prevalence of illicit drugs (amphetamines, cocaine, cannabis, illicit opiates) in the general driving population in thirteen European countries



**Figure 7** Overall prevalence of medicinal drugs (benzodiazepines, Z-drugs, medicinal opioids) in the general driving population in thirteen European countries



**Figure 8** Overall prevalence of combined use of alcohol and drug(s) in the general driving population in thirteen European countries



**Figure 9** Overall prevalence of multiple drug use in the general driving population in thirteen European countries

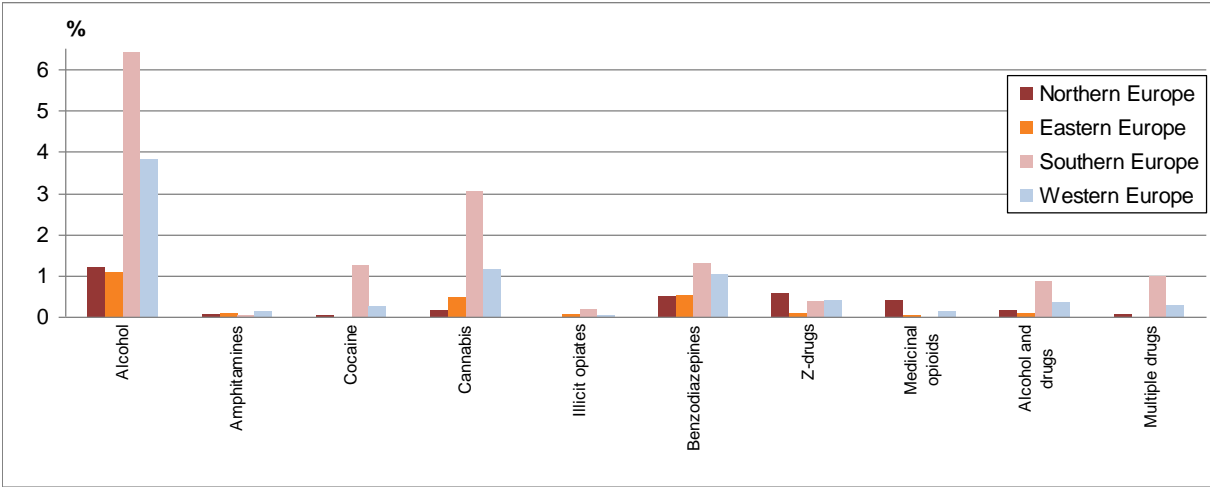
Highest prevalence in general was found for alcohol, with highest prevalence in the Southern countries of Europe. As shown in the figures there were big differences between the prevalence in the various countries.

The same tendency for the prevalence in the driving population as for the prevalence in the whole population was observed, see section 2.1: Higher prevalence of medicinal drugs in the Nordic countries and higher prevalence of illicit drugs in the Southern countries of Europe. However, regarding the prevalence of medicine in the Northern Europe, there were differences in the prevalence between the four countries for the various types of medicines analysed for.

In Eastern Europe the prevalence of both alcohol, illicit as well as medicinal drugs was relatively low compared to the other European regions whereas drug use in Western Europe was more or less on the European average. Combined use of alcohol and drugs and multiple drug use was more common in the southern countries of Europe.

For illicit drugs THC was the most frequently detected drug in traffic, followed by cocaine. Amphetamines and illicit opiates were less frequently detected. Illicit drugs were in general mainly detected among young male drivers, during all times of the day but mainly in the weekend

Medicinal drugs were in general mainly detected among older female drivers during daytime hours. Benzodiazepines were the most prevalent medicinal drug in traffic, z-drugs were less prevalent. However, considerable differences between countries were observed.



**Figure 10** European mean of the prevalence of alcohol, various illicit drugs and medicinal drugs, alcohol in combination with drugs and multiple drugs by European region

On a European level alcohol was estimated to be used by 3.48% of the drivers, illicit drugs by 1.90% of the drivers, medicinal drugs by 1.36% of the drivers, drug-drug combinations by 0.39% of the drivers and alcohol-drug combinations by 0.37% of the drivers. However, as shown in figure 10, there was big differences between the means in the four European regions. Figure 10 confirms the high prevalence of alcohol, cocaine, cannabis as well and combined use in Southern Europe, partly also in Western Europe, whereas z-drugs and medicinal opioids were more common, although still low prevalent in the Nordic countries.

### 2.3 Prevalence in seriously injured and killed car drivers

The prevalence of alcohol and other drugs in seriously injured and killed car drivers was calculated in nine countries based on studies in hospitals in six countries of seriously injured car drivers and studies in four countries of killed car drivers (Isalberti et al., 2011).

For this purpose, seriously injured drivers gave a blood sample in connection to the treatment in the hospital. A set of guidelines were developed within the DRUID project and followed in the national setups of the studies.

The study of seriously injured drivers was carried out in the following countries and during the years mentioned below:

- Northern Europe
  - Denmark (2007-2010)
  - Finland (2008-2010)
- Eastern Europe
  - Lithuania (2008-2010)
- Southern Europe
  - Italy (2008-2009)
- Western Europe
  - Belgium (2008-2010)
  - The Netherlands (2008-2010)

App. 2600 seriously injured drivers from six countries gave a blood samples, but the number of drivers varied very much among the involved countries. Most countries collected data from 4-5 hospitals.

Information on drugs in killed drivers were obtained from blood samples that had been collected in connection to national accident investigations.

The study of killed drivers was carried out in the following countries and during the years mentioned below:

- Northern Europe
  - Finland (2006-2008)
  - Norway (2006-2008)
  - Sweden (2008)
- Southern Europe
  - Portugal (2009)

Blood samples from app. 1000 killed drivers were included in the study obtained from traffic accidents in the study periods mentioned above.

Samples were considered positive if the concentration was at or above a cut-off as decided among the toxicological partners in DRUID. The cut-offs for blood are shown in **Table 2**.

**Table 2** Whole blood cut-offs for DRUID core substances

Substance	Whole blood (ng/mL)
Ethanol	0.1 (g/L)
6-AM	10
Alprazolam	10
Amphetamine	20
Benzoyllecgonine	50
Clonazepam	10
Cocaine	10
Codeine	10
Diazepam	20
Flunitrazepam	2
Lorazepam	10
MDA	20
MDEA	20
MDMA	20
Methadone	10
Methamphetamine	20
Morphine	10
Nordiazepam	20
Oxazepam	50
THC	1
THCCOOH	5
Zolpidem	20
Zopiclone	10
Tramadol	50
7-amino-clonazepam	10
7-amino-flunitrazepam	2

Based on the substances included in the toxicological analyses of the blood samples (see table XX), the following substance groups were formed:

- Alcohol
- Amphetamines, including methamphetamines and MDA, MDEA and MDMA
- Benzoyllecgonine
- Cocaine
- THCCOOH
- Cannabis (THC)
- Illicit opiates
- Benzodiazepines
- Z-drugs
- Medicinal opioids
- Alcohol and drug(s)
- Multiple drugs

The list of substance groups differs slightly from that of the road side surveys. As all samples were taken from blood, cannabis was split into THCCOOH and THC. Furthermore the metabolite of cocaine, benzoyllecgonine formed its own group. However, in this illustration of the results, the same grouping as for the road side surveys of alcohol and drugs in the driving population is used (Houwing et al., 2011), that is cocaine includes drivers positive for benzoyllecgonine and cannabis includes drivers positive for THCCOOH.

Based on the DRUID cut-offs for blood that were agreed upon, see **Table 2**, the following tables show percentages of the most prevalent drugs in seriously injured drivers of passenger cars and vans for six

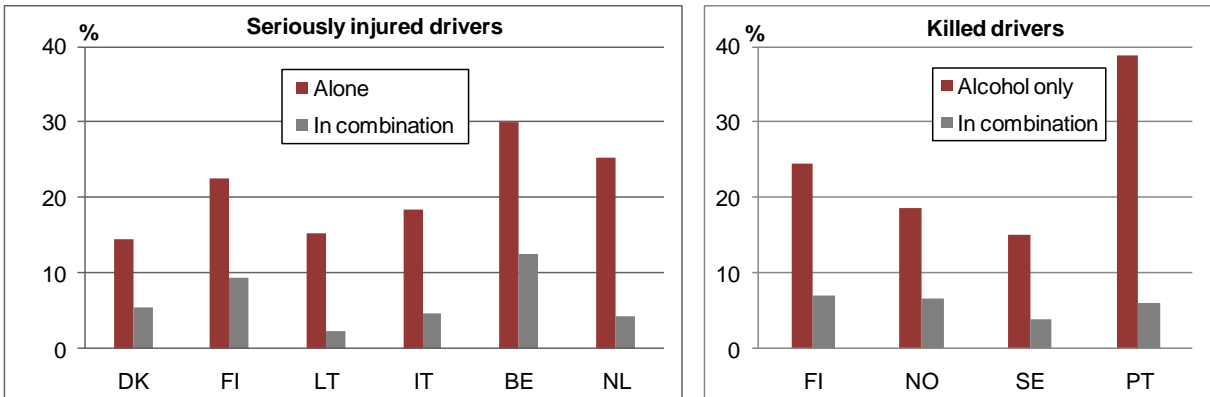
European countries: Denmark, Finland, Lithuania, Italy Belgium and the Netherlands and killed drivers of passenger cars and vans for Finland, Norway, Sweden Portugal.

In these studies, the seriously injured drivers included in the studies were supposed to represent all patients who were admitted to a hospital as drivers of passenger cars and vans in a road accident and thus fulfilled the inclusion criteria. Of course, some patients were lost in the study population due to various reasons, so as lack of personnel in the hospitals. Because the drivers in the study were not randomly collected, but consisted of the whole population of seriously injured drivers, the results of percentages of drivers positive for a substance group are definite without confidence intervals.

In the same way, the study populations of killed drivers included all drivers who were killed in traffic accidents in the period in question.

In the following three sections (2.3.1 Alcohol, 2.3.2 Illicit drugs and 2.3.3 Medicines), there are two tables for each substance group, that is one for seriously injured drivers and one for killed drivers. For each country, there are two columns, one for the percentage of drivers who were positive for the substance alone (red) and the percentage who were positive for the substance in combination with other substances (grey). This means that the percentages for combined use cannot be added because the percentages of any combined use are shown for each substance.

**2.3.1 Alcohol**



**Figure 11** Alcohol alone and in combination with drugs

The prevalence of alcohol alone lied between app 15 and 30% except for Portugal (40%). Alcohol in combination with other drugs was found in 12% of the samples in Belgium down to about 2% in Lithuania. Furthermore, the following remarks characterize alcohol use:

- For seriously injured drivers, the highest percentage of positive drivers was found in Belgium (alcohol alone in app. 30% and alcohol combined with other drugs in app. 12,5% of the drivers).
- For killed drivers, the highest percentage of positive drivers was found in Portugal (alcohol alone in app. 40% and alcohol combined with other drugs in app. 6% of the drivers).
- Among the positive drivers – both seriously injured and killed, the majority had a blood alcohol concentration equal to or above 0,5 g/L.



### 2.3.2 Illicit drugs

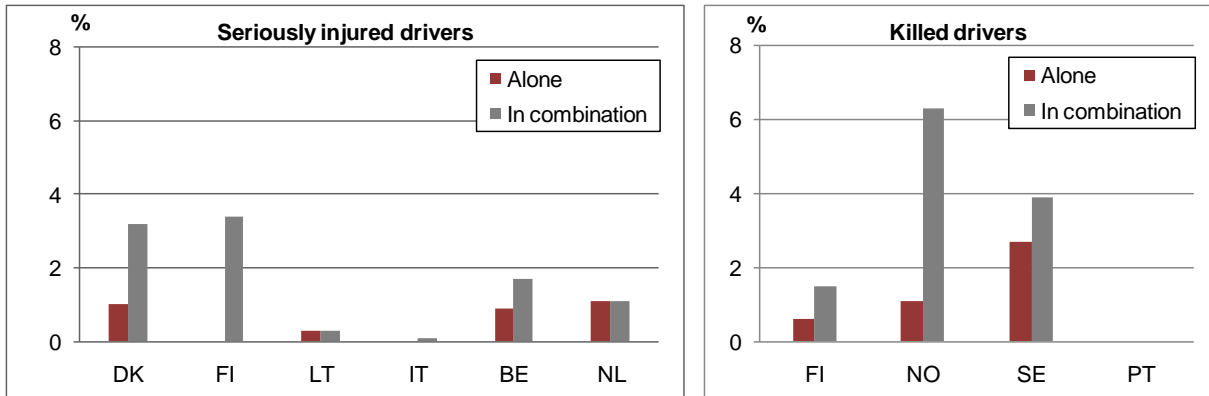


Figure 12 Amphetamines alone and in combination with other substances

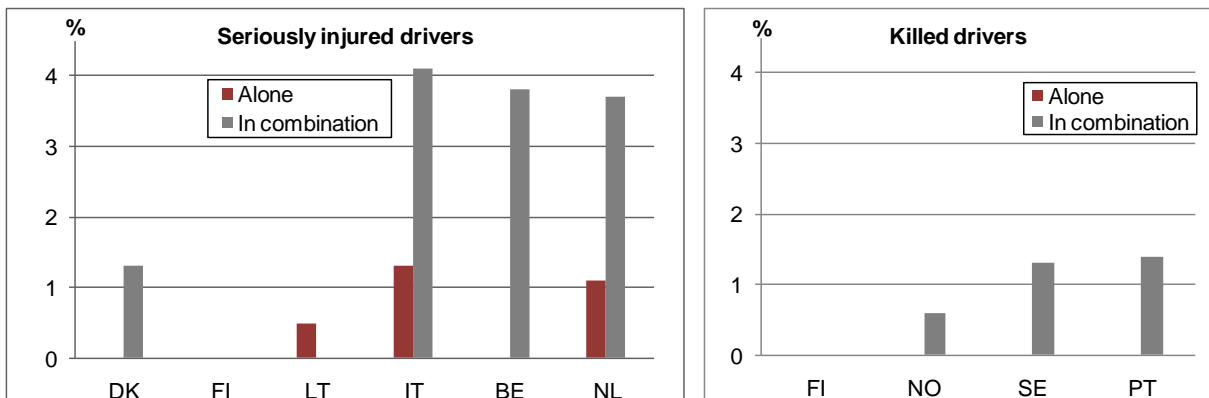


Figure 13 Cocaine, including benzoylecgonine, alone and in combination with other substances

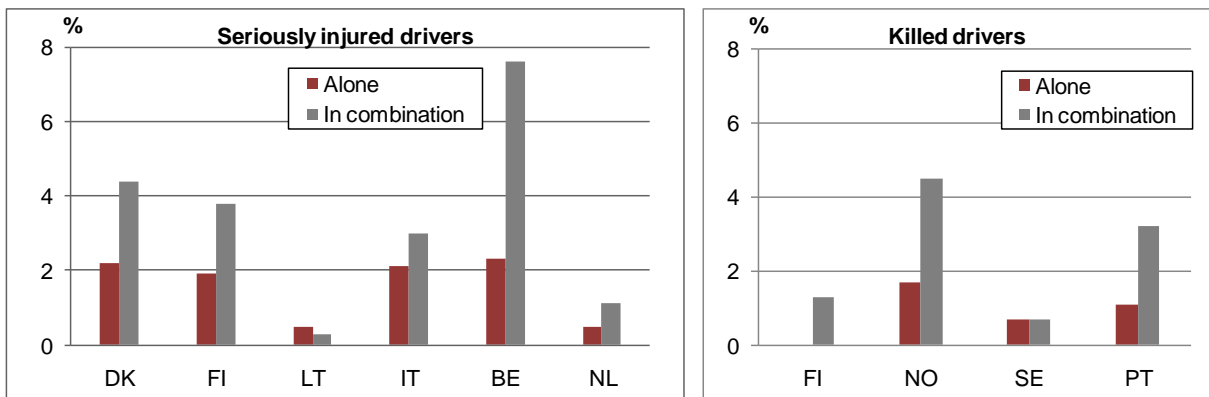
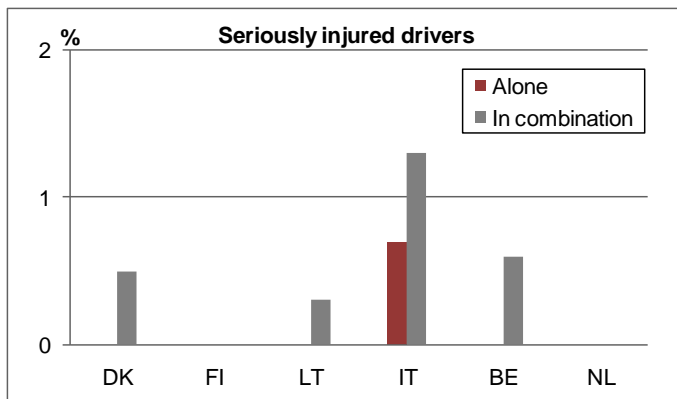


Figure 14 Cannabis (THCCOOH and THC) alone and in combination with other substances

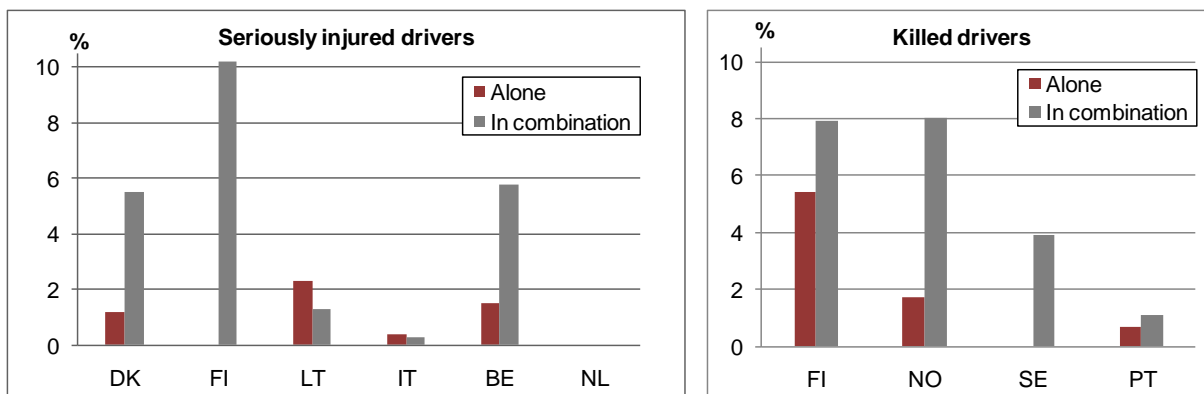


**Figure 15** Illicit opiates alone and in combination with other substances

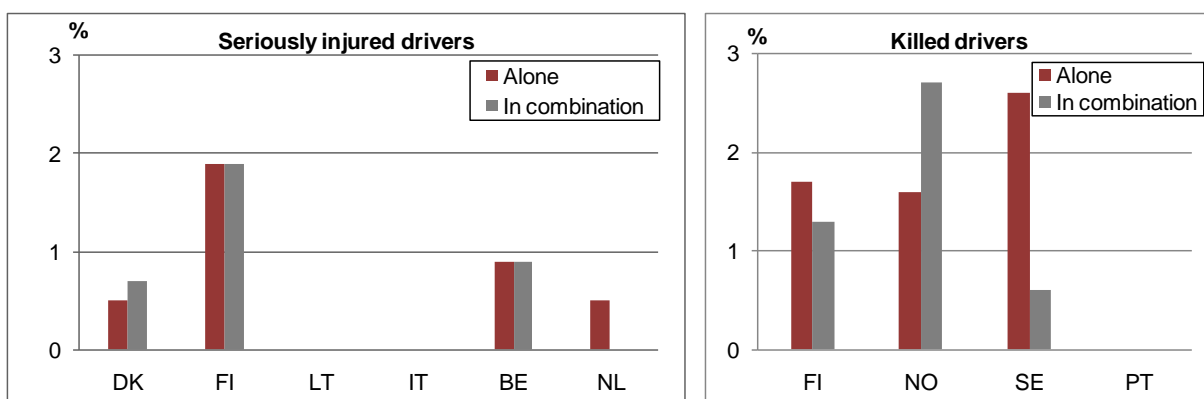
The prevalence of illicit drugs varied between the countries with considerable combined use of various substances. Furthermore, the following remarks characterize illicit drug use:

- Amphetamine use appeared to be more common in northern Europe, both for seriously injured and killed drivers. In Portugal, no killed drivers were positive for amphetamines
- Cocaine use seemed to be more prevalent in southern Europe, except for killed drivers in Sweden. In Finland neither any seriously nor killed drivers were positive for cocaine
- The percentages of cannabis positive drivers varied, with the highest percentage in seriously injured drivers in Belgium (app 10% alone and in combination with other drugs) and the lowest in Lithuania (below 1% alone and in combination with other drugs). For killed drivers the highest percentage was found in Norway (app 6% alone and in combination with other drugs) and the lowest in Finland (app 1,3% but only found combination with other drugs)
- No illicit opiates were found in the killed drivers.

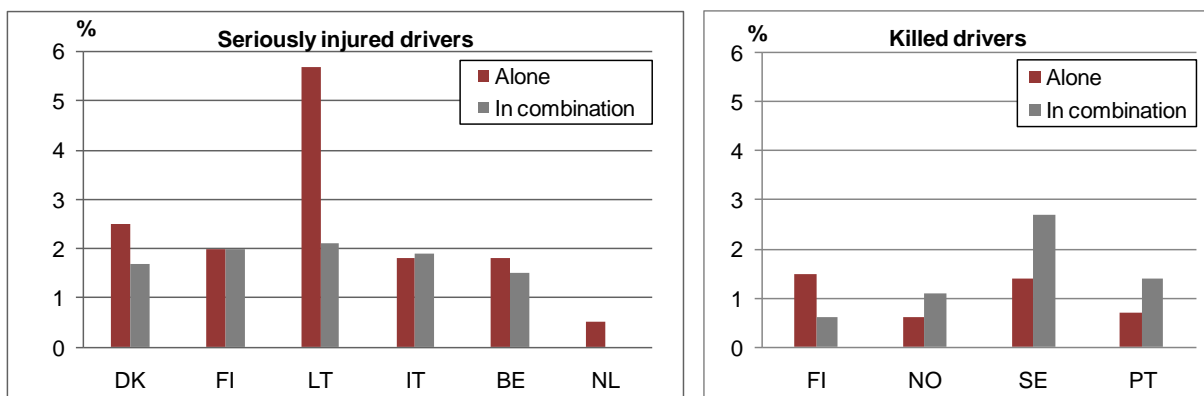
### 2.3.3 Medicines



**Figure 16** Benzodiazepines alone and in combination with other substances



**Figure 17** Z-drugs alone and in combination with other substances



**Figure 18** Medicinal opioids alone and in combination with other substances

A few countries had outstanding high prevalence, that is for benzodiazepines alone in seriously injured drivers in Finland (app. 10%) and for medicinal opioids alone in Lithuania in seriously injured drivers (close to 6%). Furthermore, the following remarks characterize medicinal drug use:

- Benzodiazepine use appeared to be more common in northern Europe, both for seriously injured and killed drivers, with a maximum for Finland both for seriously injured drivers (app. 10%) and for killed drivers (app. 5%). In the Netherlands no seriously drivers were positive for benzodiazepines
- Z-drug use was only found in northern Europe. No positive findings for Z-drugs were recorded in Italy, Lithuania and Portugal.

- Medicinal opioids were found in all countries, with a maximum for seriously injured drivers in Lithuania (app 6% alone and 2% in combination with other drugs) and a minimum in the Netherlands (app 0,5%, only found alone). Lithuania had almost a double percentage of seriously injured drivers who were positive for medicinal opioids, compared to the other five countries. Similar, Sweden had a double percentage of killed drivers who were positive for medicinal opioids compared with the other three countries.

The main result of the studies is that psychoactive substances in accident involved drivers were very often found:

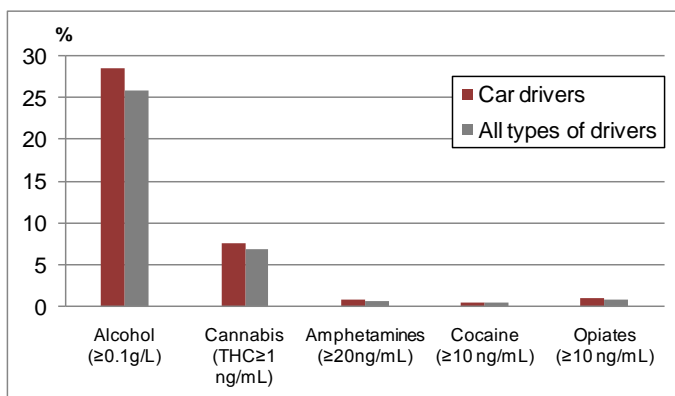
- Alcohol was the most common finding
- For seriously injured drivers, the percentages of drivers positive for any substance group ranged from nearly 30% (Lithuania) to above 50% (Belgium)
- For killed drivers, the percentages of drivers positive for any substance group ranged from nearly 15% (Sweden) to nearly 50% (Portugal)
- For most illicit drugs and medicines, the percentage of combined use exceeded that of single use of the substance.

Finally, it can also be concluded that in addition to single use of various drug groups, combined use of drugs was much more common than was the case for driver in the general driving population (Houwing et al.). Thus, the majority of illicit and medicinal drugs appeared to be used in combinations, mostly with alcohol.

## 2.4 Prevalence of drivers (all types) involved in fatal accidents

Prevalence of alcohol, drugs and medicines in drivers involved in fatal accidents was calculated, based on a database including 10,519 drivers aged 18 and above involved in fatal accidents in France (Gadegbeku and Amoros, 2010). All types of drivers, among others car drivers, motorcyclists, cyclists who were involved in fatal accidents in the period October 2001 – September 2003 were included in this study.

Blood samples from all drivers, whether killed, injured or non-injured were confirmation analysed for alcohol and illicit drugs. The cut-offs, as agreed upon within the DRUID project and illustrated in section 2.3, Table 2, were used as indication for a sample being positive for a drug.



**Figure 19** Prevalence of alcohol and various illicit drugs in drivers involved in fatal accidents

Alcohol was the most prevalent drug with a prevalence above 25%, followed by cannabis (6.9%), amphetamines (0.6%), cocaine (0.5%) and opiates (0.9%). The prevalence of alcohol and cannabis was highest in moped users.

For all age groups, the prevalence was higher for men than for women. The prevalence of cannabis was highest for men in the younger age groups, whereas the prevalence of alcohol was highest for women in the 35-49 year old group. Among drivers who were positive for cannabis, 47% were also positive for alcohol.

All drivers in the accidents were split into drivers responsible for the accidents and drivers not responsible for the accident, using a method adapted from the method of Robertson and Drummer (Robertson, 1992). The prevalence of alcohol was 35.6% for drivers responsible for the accident and 9.4% for non-responsible drivers. The prevalence of cannabis was 8.7% for drivers responsible for the accident and 3.8% for non-responsible drivers.

### 3 Accident risk for driving with alcohol and/or psychoactive substances

Within DRUID, the risk while driving with alcohol and other drugs was surveyed in the following populations:

- The relative risk for a car driver of getting seriously injured in a road accident while positive for alcohol and other psychoactive substances
- The relative risk for a car driver of getting killed in a road accident while positive for alcohol and other psychoactive substances
- The relative risk for a responsible car driver of getting killed in a road accident while positive for alcohol and other psychoactive substances
- The relative risk for a responsible car driver of getting involved in a fatal car accident while positive for alcohol and other psychoactive substances
- The relative risk for patients using psychotropic medicines of getting involved in an accident

Relative risk is defined as the ratio of two risks, the risk of an event occurring in the group of exposed subjects and the risk of the event occurring in the group of non-exposed subjects. The relative risk estimates were approximated to odds ratios, and calculated by means of logistic regression.

The odds ratio is a measure which is often used in epidemiological studies. The odds ratio is as the name says a ratio between two odds, that is - in this study - between the odds of having the event (here drivers who were injured/killed in an accident or drivers who were responsible for an accident) among drivers (subjects) who were positive for a given substance group (exposed ) and the odds of having the event among negative drivers (non-exposed subjects).

Two study populations are needed in order to calculate the odds ratios:

- A case population, consisting of subjects, who had the event
- A control population, consisting of subjects who did not have the event

In both study populations, the subjects can be separated in exposed subjects (positive for a substance) and non-exposed subjects (negative for any substances).

The relative risk, as approximated to the odds ratio, is significantly different from 1 if its confidence interval does not include the value 1. The confidence intervals in this report were all computed with 95% confidence intervals, that is with 95% chance of containing the true value of the odds ratio.

Negative samples, that is samples for whom no substances had been found in concentrations above or equal to the cut off that was agreed upon, see section 2.2, **Table 1**, formed the reference group irrespective of the substance group in question.

#### 3.1 The relative risk for a car driver of being seriously injured or killed in a road accident while positive for alcohol and other drugs

The relative risk for a driver of getting seriously injured in an accident while positive for a given substance was approximated to the odds ratio between the odds for a driver of getting seriously injured in an accident while positive for a given substance and the odds of getting seriously injured while negative (Hels et al., 2011).

The approximation to the relative risk was calculated for the following substance groups:

- Alcohol
- Amphetamines
- Cocaine
- Cannabis
- Illicit opiates
- Benzodiazepines and z-drugs
- Medicinal opioids
- Alcohol in combination with drugs
- Multiple drugs

As the case study population, the data from the hospital studies of seriously injured drivers (see section 2.3) were used and as the control study population, the data from the road side surveys (see section 2.2) were used (Hels et al., 2011). As the information about whether a subject was exposed to a substance or not, came from toxicological analyses of samples from both blood and saliva, it was crucial for this study that equivalent cut-offs for blood and saliva were developed in order to be able to compare the saliva-exposed subjects with the blood-exposed subjects. As a consequence, the risk estimates have been based on blood samples collected in the case study population and both blood samples and saliva samples collected in the control study population. Samples were considered positive if the concentration was at or above the equivalent cut-off either in blood or saliva, as shown in section 2.2, **Table 1**.

Six countries contributed to the study on the relative risk for getting seriously injured: Denmark, Finland, Lithuania, Italy, Belgium and the Netherlands.

The relative risk as approximated to the odds ratio between the odds for a driver of getting killed in an accident while positive for a given substance and the odds for a driver of getting killed in an accident while negative was calculated by means of logistic regression for the same substance groups as were used in the study of relative risk for seriously injured drivers, see above.

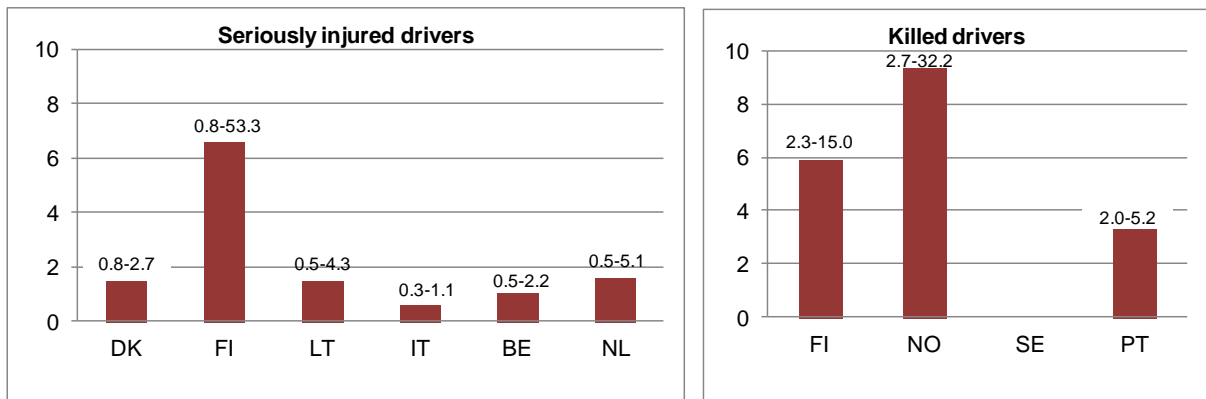
As the case study population, the data from the killed drivers (see section 2.3) were used and as the control study population, the data from the road side surveys (see section 2.2) were used. Like for the study on the relative risk for drivers of getting seriously injured, the relative risk estimates for killed drivers were based on blood samples collected in the case population and saliva samples collected in the control study population. Samples were considered positive if the concentration was at or above the equivalent cut-off either in blood or saliva, as shown in section 2.2, **Table 1**.

Four countries contributed to the study on the relative risk for getting killed: Finland, Norway, Portugal and Sweden.

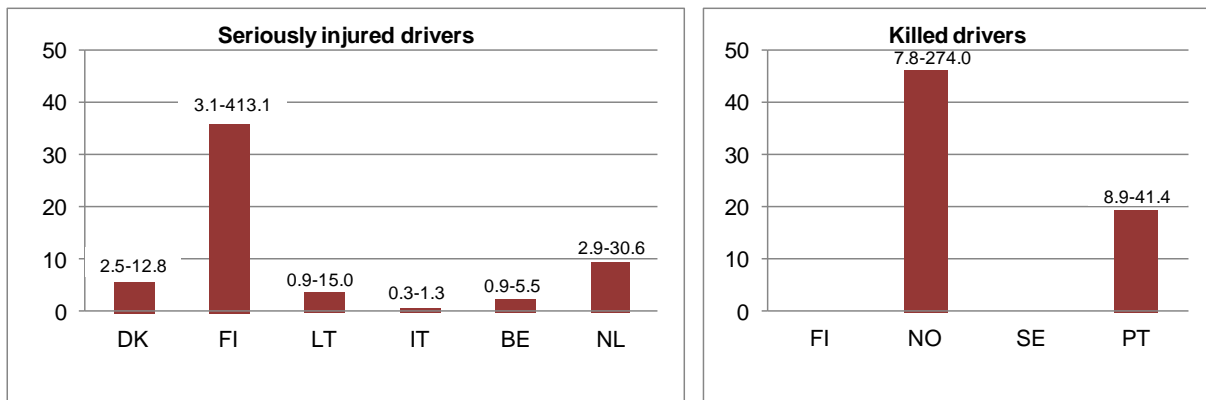
The results of the relative risk estimates are shown in the figures in the following sections (3.1.1 Alcohol, 3.1.2 Illicit drugs, 3.1.3 Medicines and 3.1.4 Combined use). Most of the estimates were adjusted by age and gender. If there were not data enough for calculating the adjusted odds ratio, then the crude odds ratio is shown (country marked with \*). Risk estimates for seriously injured drivers and killed drivers are shown side by side. The numbers above the columns present the confidence intervals, see page 17.

### 3.1.1 Alcohol

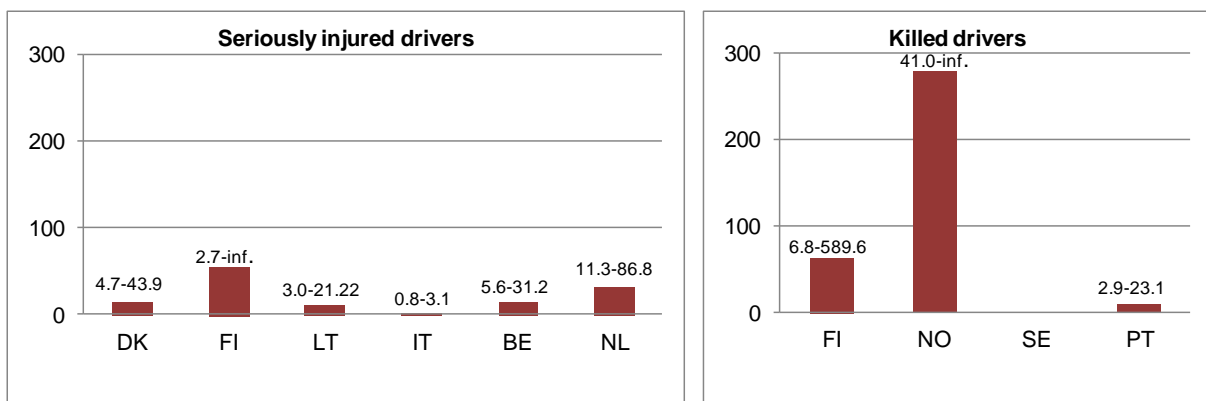
The first four figures show the relative risk for a driver of getting seriously injured and getting killed while positive for different alcohol concentrations.



**Figure 20** Relative risk of getting seriously injured / killed in an accident while positive for alcohol in the interval 0.1-0.49 g/L

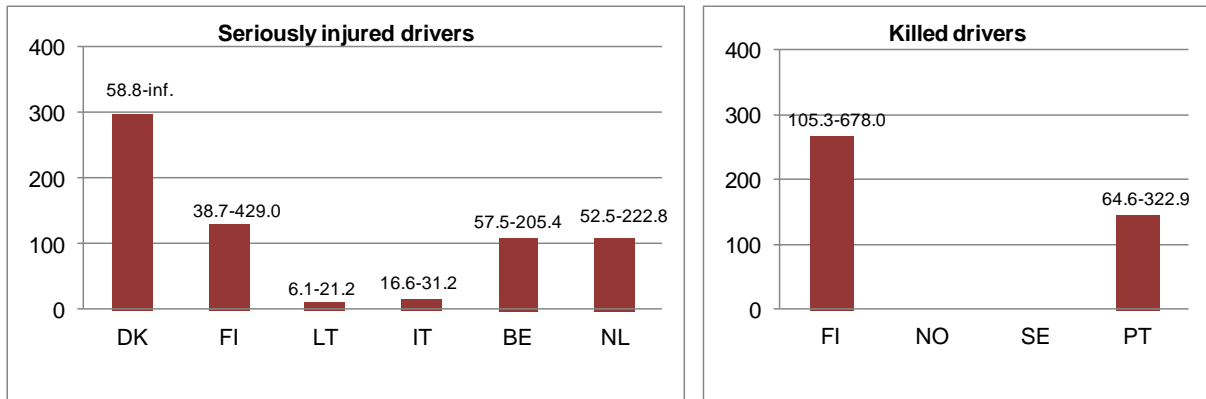


**Figure 21** Relative risk of getting seriously injured / killed in an accident while positive for alcohol in the interval 0.5-0.79 g/L



**Figure 22** Relative risk of getting seriously injured / killed in an accident while positive for alcohol in the interval 0.8-0.1.19 g/L





**Figure 23** Relative risk of getting seriously injured / killed in an accident while positive for alcohol at and above 1.2 g/L

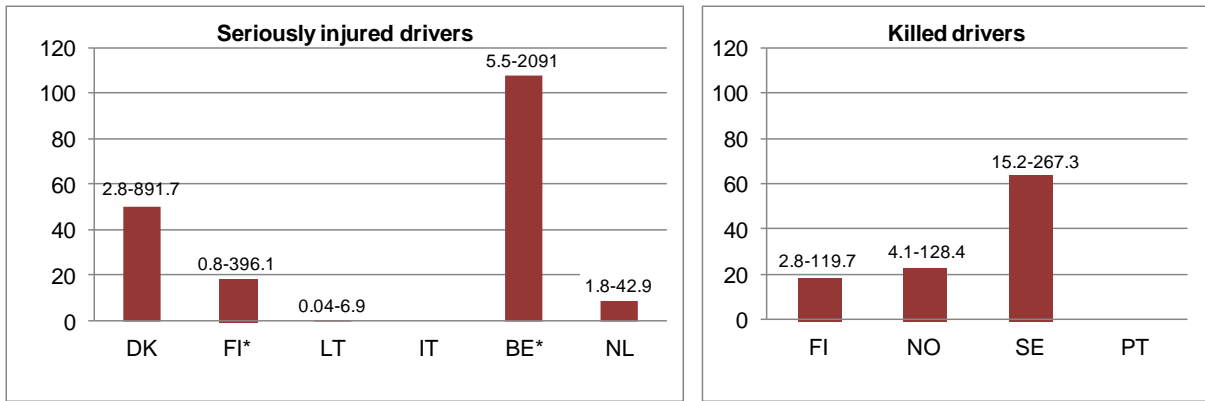
As seen from the figures, the relative risk varied considerably between countries. The relative risk of getting seriously injured was not significantly different from 1 for alcohol concentrations in the interval 0.1-0.49 (**Figure 19**). For killed drivers, the relative risk was already from 0.1 g/L significantly above 1. The estimate based on data from all countries indicated a risk of getting seriously injured of 1.18 (CI: 0.81-1.73) and the risk of getting killed of 8.01 (CI: 5.22-12.29).

For alcohol concentrations in the interval 0.5-0.79, the relative risk of getting seriously injured was significantly increased for some of the countries (Denmark, Finland and the Netherlands) and for killed drivers in Norway and Portugal (**Figure 20**). The estimate based on data from all countries indicated a risk of getting seriously injured of 3.64 (CI: 2.31-5.72) and a risk of getting killed of 45.93 (CI: 23.02-91.66).

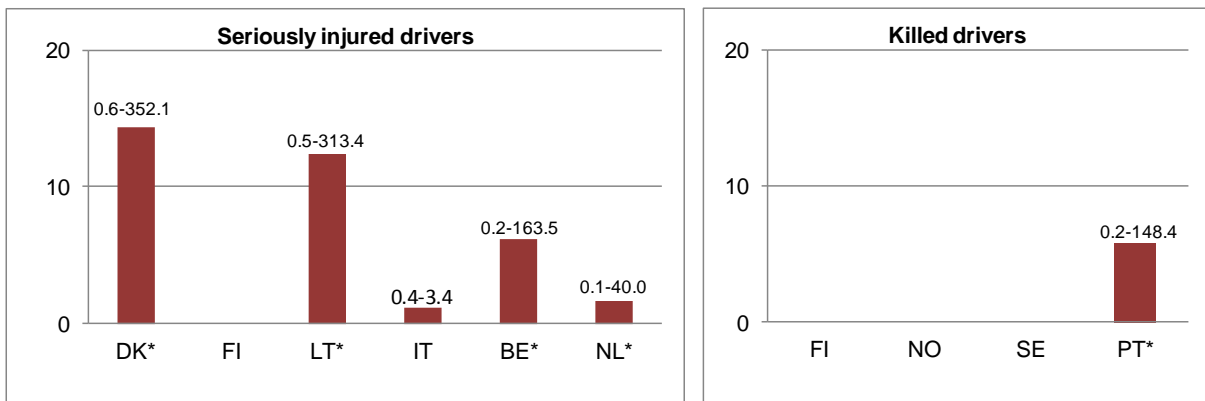
For alcohol concentrations at 0.8 and above all risk estimates except for Italy were significantly above 1. For alcohol concentrations in the interval 0.8-1.19, the estimate based on data from all countries indicated a risk of getting seriously injured of 13.35 (CI: 8.15-21.88) and a risk of getting killed of 35.69 (CI: 15.68-81.22) (**Figure 21**). For alcohol concentrations in the interval at 1.2 and above (**Figure 22**), the estimate based on data from all countries indicated a risk of getting seriously injured of 62.79 (CI:44.51-88.58) and a risk of getting killed of 500.04 (CI: 238.07-inf).

### 3.1.2 Illicit drugs

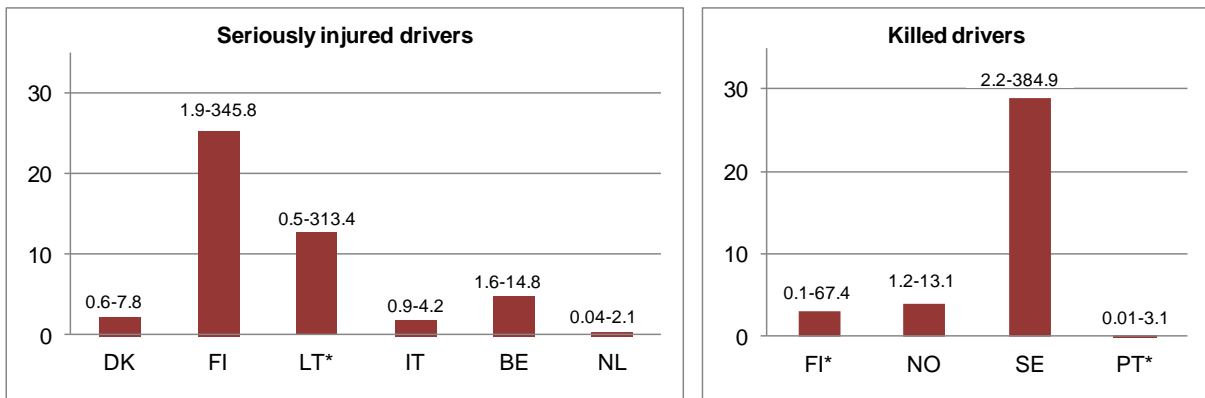
The next four figures show the relative risk for a driver of getting seriously injured and getting killed while positive for amphetamines, cocaine, cannabis and illicit opiates. It was not possible to calculate the relative risk for all countries due to too few positive cases.



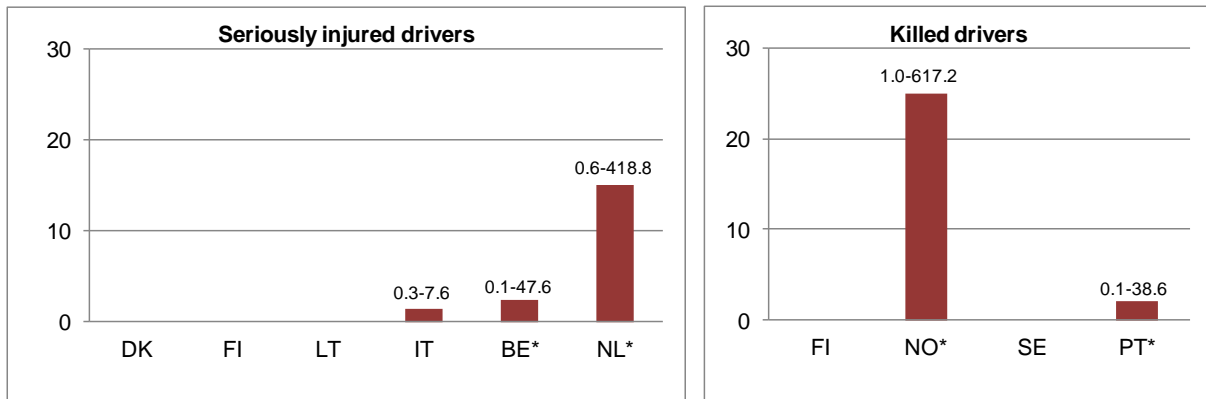
**Figure 24** Relative risk of getting seriously injured / killed in an accident while positive for amphetamines



**Figure 25** Relative risk of getting seriously injured / killed in an accident while positive for cocaine



**Figure 26** Relative risk of getting seriously injured / killed in an accident while positive for cannabis



**Figure 27** Relative risk of getting seriously injured / killed in an accident while positive for illicit opiates

Amphetamines alone were too rare in some of the countries to enable the calculation of the relative risk of getting seriously injured or killed. However the relative risk of getting killed was considerably increased for Finland, Norway and Sweden (**Figure 24**). The estimates based on data from all countries indicated a risk of getting seriously injured of 8.35 (CI: 3.91-17.83) and a risk of getting killed of 24.09 (CI: 9.72-59.71). The variations in the risk estimates reflect sparse data with positive concentrations. The results should therefore be handled with care.

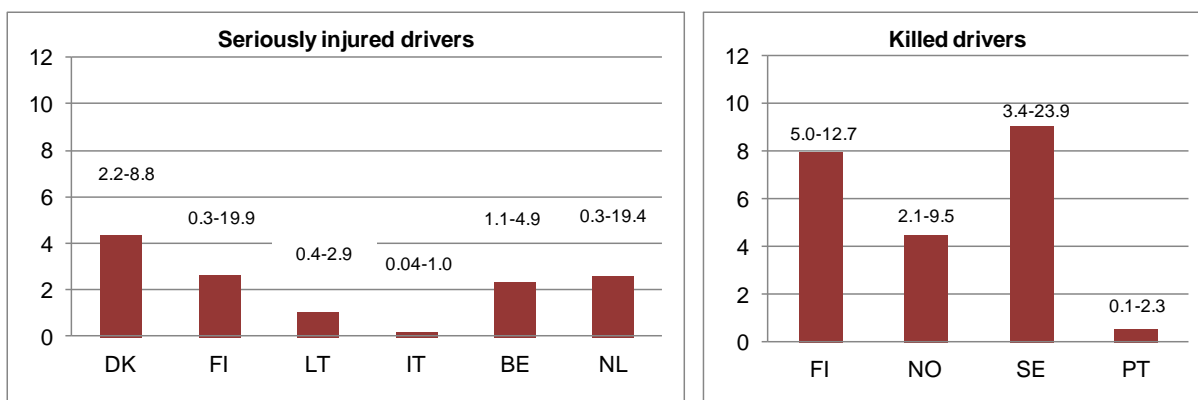
For cocaine alone there were only few positive samples, and the risk estimates for the single countries varied to a high degree without being significantly above 1 (**Figure 25**). On the contrary, this was the case when calculating the risk based on all countries with the estimate indicating a risk of getting seriously injured of 3.30 (CI: 1.40-7.79) and a risk (crude odds ratio) of getting killed of 22.34 (CI: 3.66-136.53).

The relative risk estimates for cannabis, based on single countries were only significantly increased for some of the countries but varied between countries to a high degree (**Figure 26**). However, based on data from all countries the relative risk for getting seriously injured and of getting killed while positive for cannabis were not significantly above 1 with a risk of getting seriously injured of 1.38 (CI: 0.88-2.17) and the risk of getting killed of 1.33 (CI: 0.48-3.67). But this result should be handled with care because of the very different single country estimates.

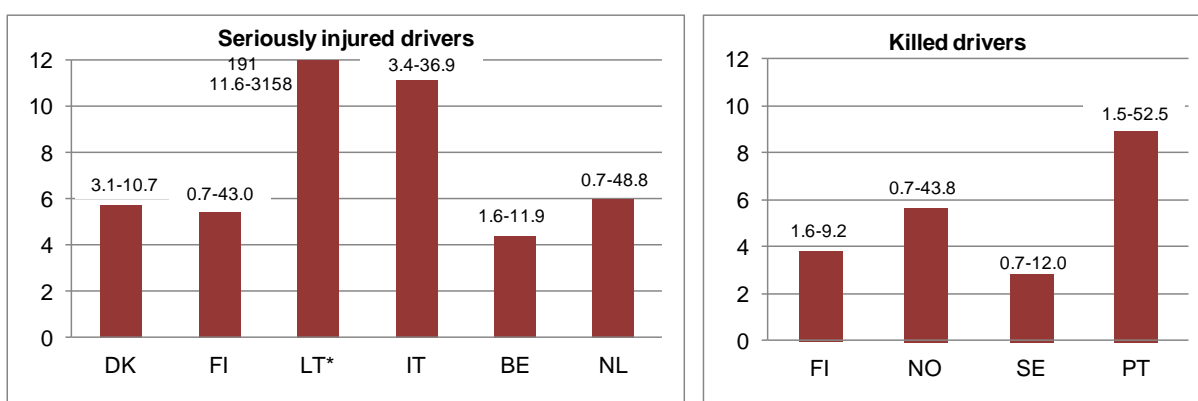
Positive samples were few for illicit opiates, and therefore the risk estimates should be handled with care. Risk estimates significantly above 1 for the single countries were only found for getting killed (**Figure 27**). The estimate based on data from all countries indicated a significantly increased risk of getting killed (crude odds ratio) of 10.04 (CI: 2.04-49.32). The estimate based on data from all countries of getting seriously injured of 2.47 (CI: 0.50-12.10) was not significantly increased. The variations in the risk estimates reflect sparse data with positive concentrations.

### 3.1.3 Medicines

The next two figures show the relative risk for a driver of getting seriously injured and getting killed while positive for benzodiazepines and / or Z-drugs and for medicinal opioids.



**Figure 28** Relative risk of getting seriously injured / killed in an accident while positive for benzodiazepines and / or Z-drugs



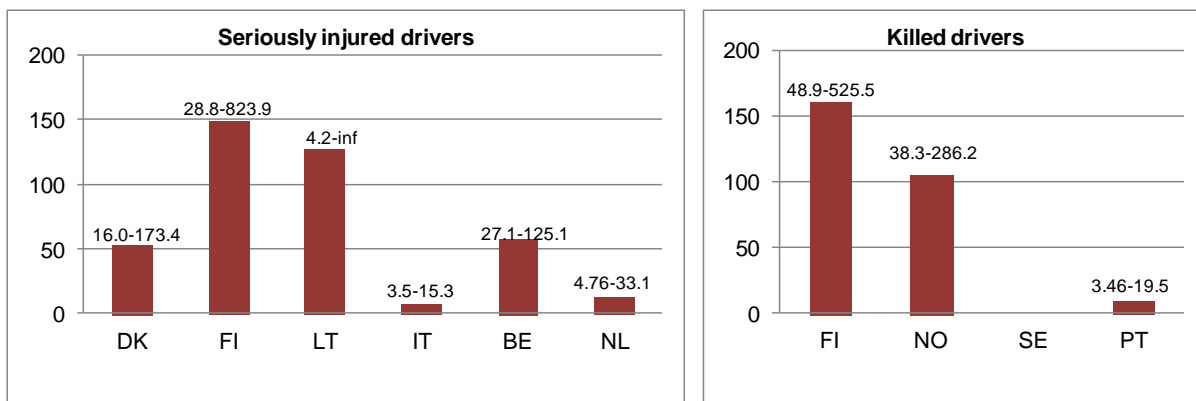
**Figure 29** Relative risk of getting seriously injured / killed in an accident while positive for medicinal opioids

The estimates of the relative risk of getting seriously injured and killed while positive for medicines did not vary much between most of the participating countries (**Figure 28** and **29**). However, the confidence intervals were very large for some of the estimates.

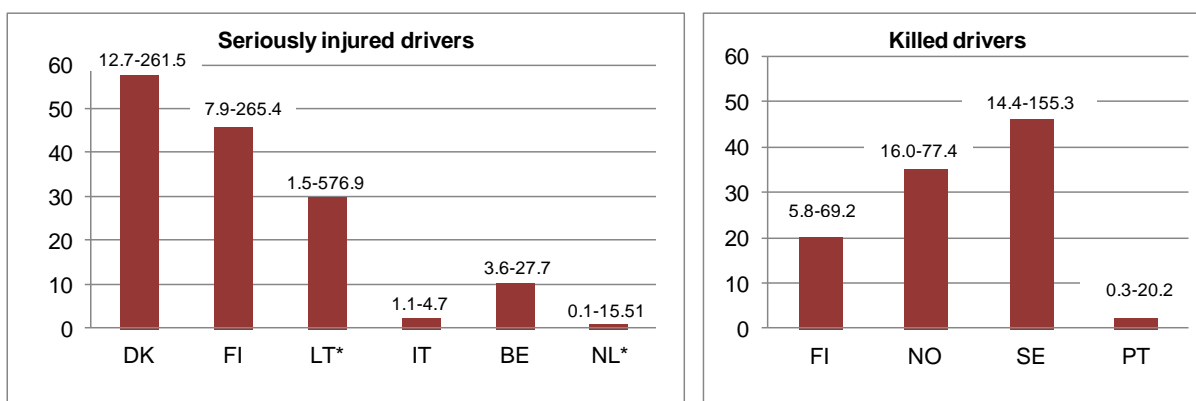
Some of the risk estimates based on calculations of data from single countries were significantly above 1. However, based on aggregated data from all countries, both the relative risk of getting seriously injured and the relative risk of getting killed were significantly above 1 both for benzodiazepines/ Z-drugs and for medicinal opioids. The estimate for benzodiazepines and Z-drugs of getting seriously injured was 1.99 (CI: 1.36-2.91) and of getting killed 5.40 (CI: 3.90-7.46) based on data from all countries. The estimate for medicinal opioids of getting seriously injured was 9.06 (CI: 6.40-12.83) and of getting killed 4.82 (CI: 2.60-8.93) based on data from all countries.

### 3.1.4 Combined use

The last two figures show the relative risk for a driver of getting seriously injured and getting killed while positive for combined use of alcohol and drugs and for multiple drug use.



**Figure 30** Relative risk of getting seriously injured / killed in an accident while positive for alcohol and drugs



**Figure 31** Relative risk of getting seriously injured / killed in an accident while positive for multiple drugs

The estimates of the relative risk of getting seriously injured and getting killed while positive for combinations of alcohol and/or drugs were considerably increased for nearly all countries (**Figure 30** and **31**). Based on aggregated data from all countries, the relative risk of getting seriously injured and getting killed while positive for alcohol and drugs was substantially increased. The same was the case for multiple drugs. The estimate for alcohol and drugs of getting seriously injured was 28.82 (CI: 18.41-45.11) and of getting killed 31.52 (CI: 16.83-59.05) based on data from all countries. The aggregated estimate for multiple drugs of getting seriously injured was 8.01 (CI: 5.34-12.01) and of getting killed 18.51 (CI: 10.84-31.63) based on data from all countries.

### 3.1.5 Overview of risk estimates

Based on the assessments of risk estimates based on aggregated data from all countries, together with the risk estimates for the single countries separately, an overall and general assessment of the magnitude of the relative risk by substance group is shown in **Table 3**. The confidence intervals of the risk estimates have been taken into account in the overall assessment of the relative risk.

**Table 3** Relative risk level of getting seriously injured or killed for various substance groups

Risk level	Risk	Substance group
Slightly increased risk	1-3	0.1 g/L ≤ alcohol in blood < 0.5 g/L Cannabis
Medium increased risk	2-10	0.5 g/L ≤ alcohol in blood < 0.8 g/L Cocaine Illicit opiates Benzodiazepines and Z-drugs Medicinal opioids
Highly increased risk	5-30	0.8 g/L ≤ alcohol in blood < 1.2 g/L Amphetamines Multiple drugs
Extremely increased risk	20-200	Alcohol in blood ≥ 1.2 g/L Alcohol in combination with drugs

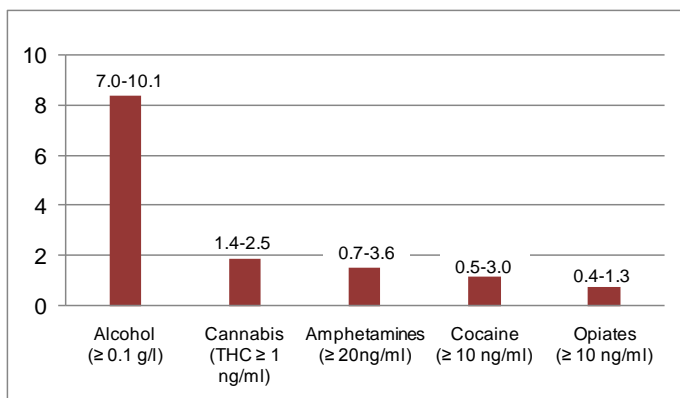
As indicated in **Table 3**, the highest risk was associated with driving with high blood alcohol concentration and alcohol combined with other psychoactive substances. Other problem groups were medium alcohol concentrations, multiple drug use and driving with amphetamines. Medium increased risk was assessed for alcohol concentrations between 0.5 and 0.8 g/L, for cocaine and for the medicines included in the study. The risk associated with cannabis was assessed to be similar to the risk of driving with a low alcohol concentration. However, it should be noted that the risk estimates for illicit drugs were based on small numbers of positive samples and should therefore be handled with care.

High blood alcohol concentrations and the combination of alcohol and other drugs indicated the highest risk of getting seriously injured and getting killed. This was in line with the fact that in contrast to the driving population, alcohol was found in high concentrations in accident involved drivers.

### 3.2 The relative risk of responsibility for a fatal accident while positive for alcohol and other drugs

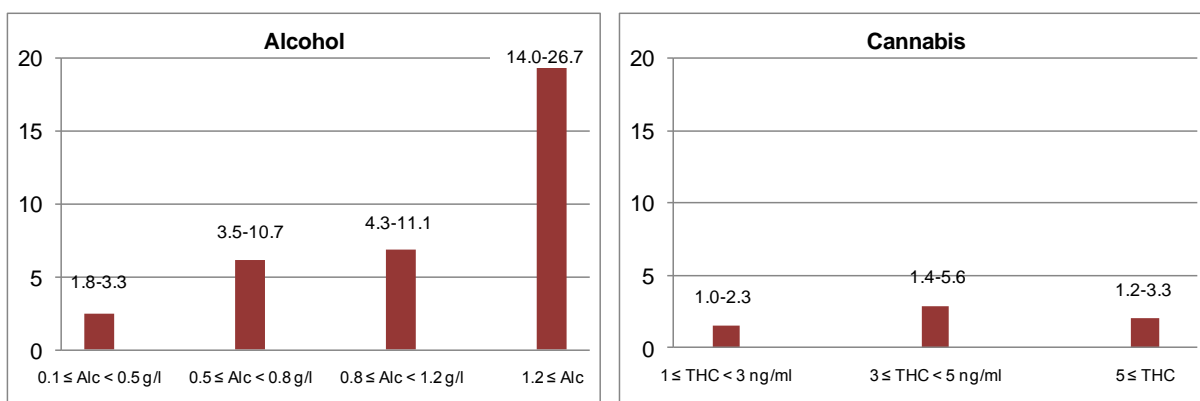
Relative risk estimates of impaired car drivers involved in fatal accidents were calculated based on a responsibility study in France (Gadegbeku and Amoros, 2010). Blood samples from the car drivers involved in fatal accidents in the period October 2001 – September 2003, whether killed, injured or non-injured were confirmation analysed for alcohol and illicit drugs. In total, 7455 car drivers were included in the study. The cut-offs, as illustrated in section 2.3, **Table 2**, were used as indication for a sample of being positive for a drug.

The reference group was car drivers with alcohol concentration below 0.1 or zero. The relative risk estimates were approximated to odds ratios. The relative risk explains the difference in risk of responsibility between sober car drivers (relative risk for the reference group=1) and responsible car drivers who were positive for a substance. The odds ratios were adjusted for age and gender.



**Figure 32** Relative risk of responsibility for a fatal accident while positive for various substances

For amphetamine, cocaine and opiates, adjusted odds ratios of responsibility were not significantly different from 1. This means that the risk of responsibility for positive drivers was not significantly different from that of sober drivers (**Figure 32**).



**Figure 33** Relative risk of accident responsibility for killed drivers while positive for alcohol and cannabis

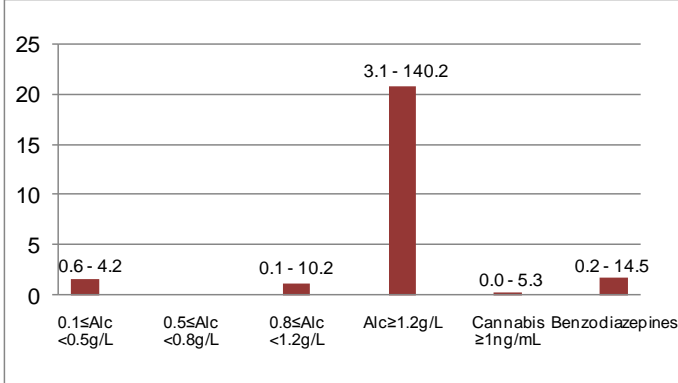
Among car drivers, positive cannabis detection was found to be associated with increased risk of responsibility. A significant dose effect was identified. The effect of cannabis remained significant after adjustment for age, sex and alcohol: adjusted odds ratio 1.89 (CI: 1.43-2.51). This means that the risk of responsibility for a driver positive for cannabis was between 1.43 and 2.51 times as high as for a sober driver. **Figure 33** shows the risk of responsibility for various concentrations of alcohol and cannabis.

For alcohol (≥0.1 g/l), adjusted odds ratios of responsibility were much higher than those associated to cannabis: adjusted odds ratio for alcohol 8.39 (CI: 6.95-10.11), that is the risk of responsibility for a driver positive for alcohol was between 6.95 and 10.11 times as high as for a sober driver.

No interaction was statistically significant between alcohol and cannabis. This means that the odds ratio of responsibility associated to being positive to both cannabis and alcohol is merely the product of the respective odds ratios of cannabis and alcohol alone.

### 3.3 The relative risk of responsibility for killed drivers while positive for alcohol and other drugs

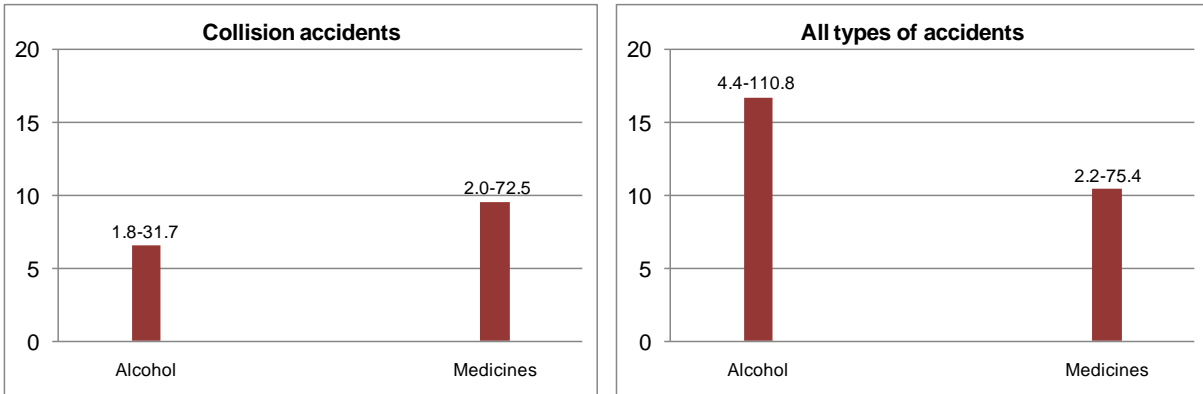
Relative risk estimates for the responsibility of killed drivers while positive for alcohol and other drugs were based on data from Germany, Lithuania, Hungary and Slovakia. In total, 483 drivers were included in the study (Thorsteinsdóttir, 2011).



**Figure 34** Relative risk of accident responsibility for killed drivers while positive for alcohol, cannabis and amphetamines

Relative risk of responsibility is shown in **Figure 34**. However, due to in particular a low number of controls the results were only for alcohol concentrations at and above 1.2 g/L significantly different from one and therefore the corresponding analysis did not show an effect of the respective substance on the risk of being responsible for a fatal accident.

A similar study was carried out in Finland, based on retrospective data from drivers who were killed in accidents from the database of the Traffic Accident Investigation Teams in Finland (Laapotti and Keskinen, 2010). Information on alcohol and other drugs were based on toxicological analysis of blood samples, as requested by the Traffic Accident Investigation Teams, and thus not identical with the substances included in the DRUID list and neither with the cut-off limits as set in DRUID, see section 2.3. In total 946 drivers were included in the study.



**Figure 35** Relative risk of accident responsibility for killed drivers while positive for alcohol and medicines. Collision accidents and all types of accidents.

93 percent of the killed drink-drivers were the most responsible party compared to 68 percent of sober drivers in collision accidents. As shown in **Figure 35**, the relative risk was significantly above 1, that is 6.66 (CI: 1.8 – 31.8). Considering all accidents, the figures were 97 percent compared to 72 percent



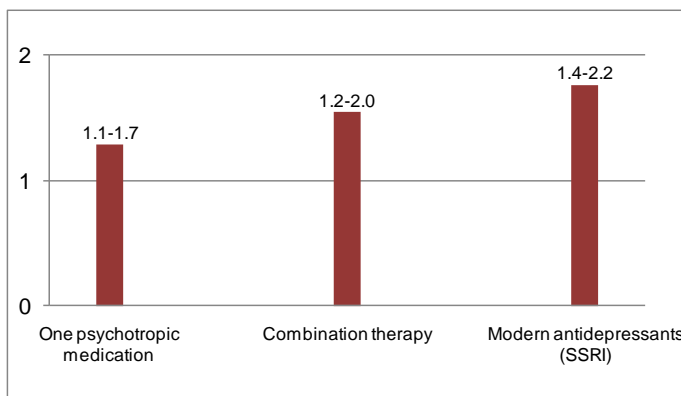
with a relative risk 16.72 (CI: 4.4 – 110.9), and drivers under 36 years were the most responsible party more often than drivers 36 years and older.

Compared to killed drivers with no medicine in their blood, those with medicine were typically middle-aged, were more often suffering from some chronic disease, and were more often tired at the time of the accident. 87 percent of drivers with medicine in their blood were recorded as the most responsible party in collision accidents compared to 52 percent of non-medicine drivers with a relative risk 9.54 (CI: 2.0 – 72.5). Considering all accidents, the figures were 89 percent compared to 50 percent with a relative risk 10.42 (CI: 2.2 – 75.4).

### 3.4 The relative risk for patients using psychotropic medicines of being involved in an accident

The aim of this study was to assess the association between the risk of a traffic accident and the exposure to psychotropic medication by means of a case-control study, a so called pharmaco-epidemiological study. The study was performed in the Netherlands and was based on the linkage of databases regarding pharmacy prescription, police registered traffic accidents, hospital records and driving licence data (Ravera and de Gier, 2010).

The case population was defined as adults, who had a traffic accident between 2000 and 2007 and were driving, and received medical assistance. The control population was defined as adults, who had a driving license and had no traffic accident during the study period. In total, 3963 cases and 18828 controls were selected for the case-control analysis.



**Figure 36** Relative accident risk for patients using medicines

Calculations showed an increased accident risk for drivers exposed to at least one psychotropic medication of 1.28 (CI: 1.1 - 1.5). The risk was found to be higher for drivers in combination therapy users, namely 1.55 (CI: 1.2 - 2.0) and users of modern antidepressants, namely 1.76 (CI: 1.4 - 2.2). The highest risk groups were new users, intermediate and long half-life benzodiazepine users, female users, and young/middle-aged users, although only some of the trends in elevated risk were statistically significant.

The increased relative risks found in this study indicate that psychoactive medications can constitute a problem in traffic safety. Therefore, both health care providers and patients should be properly informed and aware of the potential risks associated with the use of these medications.

# 4 Characteristics of drink and drug impaired drivers

## 4.1 Characteristics of drivers in the general driving population

Results from the road side surveys (Houwing et al., 2011) showed for which age groups and gender of drivers various substances were most prevalent. In addition to this, the study includes information on the prevalence by time of the day and week

### 4.1.1 Alcohol

As expected, the prevalence of alcohol was significantly higher for male drivers than for female drivers. In most countries the prevalence of alcohol-positive drivers was highest for the two oldest age groups (35-49 and 50+). This was both the case for male and for female drivers.

For alcohol concentrations equal to and above 0.1 g/L, the prevalence was significantly different in different time periods. As expected, the highest prevalence was on weekend nights whereas the lowest was on weekend days. But surprisingly, there was no difference in prevalence of concentrations at and above 0.5 g/L over the various time periods.

### 4.1.2 Illicit drugs

*Amphetamines* were mainly used by drivers younger than 35 years. In some countries this drug was more prevalent among male drivers and in other countries more prevalent among female drivers. The distribution of amphetamines by time period differed by country

*Cocaine* was nearly only found in male drivers and in general, the prevalence of cocaine was very low, but varied significantly by age and country. Cocaine was most prevalent among male drivers aged 25-34 years, and least prevalent in the age group 50 and above. Cocaine was detected during all time periods.

*Cannabis* seems to be a weekend drug mainly used by young male drivers. There was a significant difference in the prevalence of cannabis in different time periods, most prevalent in weekend days and least prevalent in weekend mornings. However, cannabis was found during all days and hours of the week in most countries.

*Illicit opiates* were most often used by male drivers aged 35 to 49 years, except for Belgium where most users were younger than 25. Illicit opiates were not detected among drivers from Northern European countries (Denmark, Finland, Norway and Sweden) and from Eastern European countries (Czech Republic, Lithuania, Poland and Hungary).

### 4.1.3 Medicines

*Benzodiazepines* were in general most prevalent in drivers aged 50 and above and significantly more prevalent than in the youngest age group (18-24) where they were least prevalent. However, in Italy most benzodiazepines were used by young drivers aged 18-24. In contrast to cannabis, benzodiazepines were drugs that were mainly prevalent in mature female drivers and during daytime. Thus, prevalence was significantly different over the time periods; it was most prevalent in the daytime during weekdays and least prevalent in the evenings of the weekdays.

*Z-drugs* were not found in southern Europe. Most drivers positive for *Z-drugs* were 50 years and older, except for Hungary where all drivers were between 25 and 34 years old. *Z-drugs* were most often detected during daytime hours at weekdays. In none of the countries *Z-drugs* were found in weekend nights.

*Medicinal opioids* were distributed in a similar way as benzodiazepines: their prevalence differed significantly with age, being most prevalent in the age group 50 and above and least prevalent in the youngest age group (18-24). Like benzodiazepines, they were significantly more prevalent by female than by male drivers. In general, the highest prevalence was detected during daytime hours.

#### **4.1.4 Combined use**

*Alcohol in combination with drugs* had a significantly different prevalence among age groups; the age group of 25-34 years had the highest prevalence and the age group of 50 and above the lowest. In general the prevalence for alcohol-drug combinations for male drivers was higher than for female drivers. There was a significant difference in prevalence over the time periods; thus the combination of alcohol and drug(s) was most prevalent in daytime of the weekend and least prevalent in daytime of the weekdays.

*Multiple drug* prevalence was significantly different among countries; it was most prevalent in Spain and Italy and least prevalent in Denmark, Poland and Sweden. Drug-drug combinations were most frequently detected among drivers younger than 50 years. The distribution over the four age groups varied largely between countries. In general multi-drug use was more common among male than among female drivers. There was no significant difference in prevalence over time periods.

## **4.2 Characteristics of accident involved drivers**

Results from the hospital studies of seriously injured drivers and the studies of killed drivers (Isalberti et al., 2011) showed for which age groups, gender and time of the day and week various substances were most prevalent in injured drivers.

As for time periods, in both studies, higher percentage of positives were normally found among drivers involved in accidents occurred at night time, either during the week or the weekend, compared to percentages of positive drivers found among subjects involved in accidents during daytime. Lithuania was the only country in which the lowest percentage of positive drivers was found during week nights.

Although the percentage of drivers involved in multiple-vehicle accidents was higher than the percentage of drivers involved in single-vehicle accident, the percentage of drivers positive for one of the substance groups was higher in single-vehicle accident both for seriously injured drivers and for killed drivers.

A significant difference was found between gender both for seriously injured drivers and for killed drivers. In general, the prevalence in males was higher than in females.

In general more positives were found among males than females. Both for male drivers in the group of seriously injured drivers and in the group of killed drivers, the group aged 25-34 was the one that had the highest percentage of positive subjects, except for seriously injured drivers in Lithuania and killed drivers in Finland.

### **4.2.1 Alcohol**

*Alcohol* was mostly found in the younger age groups of males for seriously injured drivers, whereas in

the sample of killed drivers, alcohol was also present in mature drivers.

#### **4.2.2 Illicit drugs**

*Cannabis* was most prevalent in the younger age groups of male drivers, both for seriously injured drivers and killed drivers.

*Amphetamines, cocaine and illicit opiates* was most prevalent in younger age groups of male seriously injured drivers, whereas the three substance groups were also common in mature killed drivers.

#### **4.2.3 Medicines**

*Benzodiazepines* were mostly present in male drivers in the sample of seriously injured drivers, but were prevalent for all age groups both for seriously injured drivers and killed drivers. The diffusion of this substance group among both gender and all age groups may be explained by the various therapeutic uses, different benzodiazepines being prescribed, among others, for the treatment of anxiety disorder, sleeping disorders and epilepsy.

*Z-drugs* appeared to be more common in northern Europe, and not used at all in southern Europe. Use of these medications was recorded in both genders, and apparently more frequent in the older age groups starting from 35 years.

*Medicinal opioids* were also most prevalent in the Nordic countries. However, there was no clear picture regarding age and gender.

#### **4.2.4 Combined use**

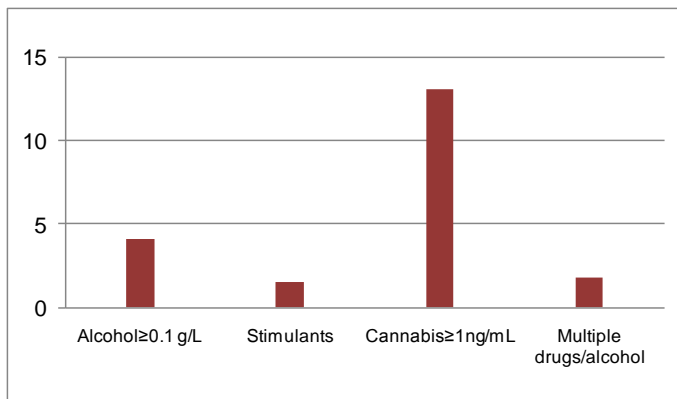
Apart from alcohol, all other substance groups appeared more often in *combination with other drugs* or alcohol than alone, in percentages that may vary from approximately 50% up to 100% of the cases, for different substance groups and in different countries.

In some of the countries, *multiple drug use* was the third most prevalent substance group. Thus, combined use seemed to be a problem for accident involved drivers, whether seriously injured or killed.

### **4.3 General drug users - prevalence and habits**

The main aim of the study that was carried out in Germany (Walter et al., 2011) was to estimate the prevalence of drugs in drivers in traffic. Instead of detecting drugs in the driving population – like road-side surveys do – 200 illegal drug users and 100 matched control persons (non-users of drugs) were queried for four weeks about their driving and drug consumption behaviour by a questionnaire deployed on smart-phones. The questionnaire was filled in daily for 28 days by the persons involved in the study.

The data about drug use and driving not only assessed the frequency of drug driving and other information on the trips, so as time, day, distance and passengers, but data also informed about situations that led to refraining from driving under the influence of drugs. Finally, the study included information on person-related characteristics, so as socio-demographic variables, previous experience and attitudes. Therefore, also individual factors associated with drug driving could be revealed.



**Figure 37** Prevalence of various drugs in persons that declared to be drug users

20.5% of the drug users' drives were under the influence of drugs, with cannabis as the most prevalent drug, followed by alcohol. Other stimulants or multiple drug use only counted for small percentages, as illustrated in **Figure 37**.

The results showed various differences between drug users and non-users, e.g. the time to go to bed, that was at a later time of the evening for drug user than for non-users, and in the same way drug users got up later in the morning compared to non-users. In the evenings, drug users stayed out more often at private locations (i.e. at friends) whereas the non-users more often visited public locations.

In general, drug users were more mobile at night compared to the non-users, who were more mobile at usual rush-hour times indicating a daily working routine. But, compared to non-users that were less mobile during night time, the drug users had less night time trips by car than the non-users. The drug users seemed to compensate by using alternative modes of transportation at these hours.

Regarding alcohol consumption, the drug users consumed alcohol more frequently and in higher doses than the non-users and had the double prevalence of drink driving than the non-users.

High consumption frequency proved to be a striking predictor for frequent drug driving and highly impaired driving in general, since most substance-positive drives and drives with high blood concentrations were made by excessive substance users compared to moderate or heavy drug users.

For alcohol, the subjective feeling of impairment increased with increasing blood alcohol concentration, whereas for cannabis this dependency was only found for moderate to heavy cannabis users. This indicates that especially moderate substance users more realistically judge their intoxication and can be described as being responsible-minded concerning drugs in traffic – derived from less drives under the influence, lower blood concentrations on drug drives and a subjective feeling of impairment dependent on the actual intoxication.

Other influencing factors were the perceived risk of detection by the police, the distance to drive, the availability of alternative transport modes and the presence of companions. The results also indicated that male drivers less often drive under the influence in case they have female companions.

Finally, based on German criminal records and self-reported dangerous traffic situations within the study period, it was demonstrated that the drug users did not seem to be more at risk than the non-users. So, except from driving under the influence, there was no evidence that the drug-users showed risky driver behaviour in traffic.

#### **4.4 Characteristics of drink and drug drivers**

Qualitative interviews on motives to drink and drug driving were carried out in Sweden and Hungary (Forward, 2009) based on a uniform interview guide. But due to very limited possibilities of recruiting drug drivers in Hungary, the results on drug driving are limited to Sweden.

The results showed that the interviewees belonged to a very specific group of people who were addicted to alcohol and or other drugs. Normal sanctions did not prevent their driving while intoxicated and this applied to participants from both Sweden and Hungary, partly because they perceived themselves to have very little control over their behaviour, partly because they did not believe that they would be stopped by the police. Those who had been stopped pointed out that this had happened because the police were carrying out a routine control, and not because they had driven in an unsuitable way.

The interviewees did not believe that alcohol or drugs would impair their driving and therefore they did not perceive any real risks of driving. However, one important difference between drugs and alcohol was that in the first case drugs were believed to make them a *better* driver whereas alcohol did not make them any worse. Thus, drug driving was not regarded as an offence in the same way as drink driving.

Following this, respondents who had been caught for drink driving expressed more feelings of shame than those who had been caught for drug driving. This was partly because of the offence itself but, as mentioned before, had more to do with having to admit to others that they had been drinking and driving and in effect could not control their drinking. Feelings of shame appeared not to be related to a feeling that the act itself could result in an accident but somewhat related to if their friends and relatives disapproved. The same feelings were not expressed by the drug drivers, only later when they were under treatment and they looked back at their life did the feeling of shame and anguish emerge.

The participants whose drinking and driving was related to problems with alcohol would argue that losing the licence or even to be imprisoned would not have helped them to stop re-offending. Instead, it was the treatment programme which had helped them by providing a greater insight into their own problems.

#### **4.5 Confidential interviews**

Driver characteristics were also explored by means of confidential interviews focusing on behavioural causes to accidents while impaired by alcohol and other psychoactive substances (Sardi, 2011). Accidents were included where the driver asked for help because of post-traumatic problems. The interviews indicated that so far, only the improvements in detection of drink driving appear to have produced some clear separation between drinking habits and driving. The improvements, however, have influenced drivers with low alcohol concentrations more than heavier drinkers. Furthermore, no impact on other impairing substances was seen, as the detection completely ignored the worst situation, that is the combined use of alcohol and/or other illicit drugs and medicines.

## 5 Summary of results

In the following, the main results from the various epidemiological studies are summarised.

### **Prevalence of alcohol and/or other psychoactive substances in relation to road safety**

- Alcohol had got the highest prevalence in the driving population (up to app. 4%) as well as in seriously injured and killed drivers in all countries (up to 15-25%)  
There was a higher prevalence of illicit in the Southern part of Europe both in the population and in the driving population
- There was a higher prevalence of medicines in the Northern part of Europe both in the population and in the driving population
- Combined use of alcohol an/or other drugs was more common in accident involved drivers that in the driving population
- There was no clear picture of the distribution of illicit drugs and medicines among injured and killed drivers, however, combined use of alcohol and/or other drugs was much more prevalent in drivers in accidents than in the driving population.

### **Accident risk for driving with alcohol and/or psychoactive substances:**

- The risk of getting seriously injured or getting killed when positive for alcohol of 0.5-0.8 g/L was medium increased of the magnitude of 2-10 times the risk for sober drivers. The risk increased exponentially by alcohol concentration, for alcohol concentrations of 1.2 g/L and above the risk was extremely increased of the magnitude of 20-200 times the risk for sober drivers
- The risk of getting seriously injured or getting killed when positive for most of the illicit drugs and medicines was medium increased of the magnitude of 2-10 times the risk for sober drivers
- The risk of getting seriously injured or getting killed when positive for multiple drugs was highly increased and considerably higher that the risk when positive for a single drug
- The risk of getting seriously injured or getting killed when positive for alcohol in combination with other drugs was extremely increased and comparable with the risk when positive for high alcohol concentrations
- Killed drivers, who were responsible for the accident and positive for high alcohol concentrations, had a highly increased risk compared to the risk of responsible drivers, not positive for alcohol
- Responsible drivers, positive for alcohol, involved in fatal accidents had a risk of about 8 times that of responsible drivers, not positive for alcohol. Those positive for cannabis had a risk of about twice that of drivers not positive for cannabis.

### **Characteristics of drink and drug impaired drivers:**

- Drivers do not think that alcohol impairs their driving, and they think that drugs improve their driving and normal sanctions do not prevent impaired driving and are mainly
- Drink drivers feel more ashamed that drug drivers. They are mainly worried that their friends disapprove their behaviour
- Drug drivers do not feel ashamed, but after treatment, they would look back with shame
- Rehabilitation helps drivers from residivism
- Drink driving with high concentrations and drug driving seems to be associated with addicted users, whereas moderate users are more responsible
- Although drug drivers go up later in the morning and go to bed later in the night than those who do not take drugs, the drug users drive less than other driver groups in the late hours

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# Annex 1 Deliverable 2.1.1

## Prevalence of Psychoactive Substances in the General Population

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### Executive summary

This report has been produced under the integrated European project Driving Under the Influence of Drugs, Alcohol and Medicines (DRUID) (Sixth Framework Program - Contract No TREN-05-FP6TR-S07.61320-518404-DRUID).

The use of psychoactive substances can influence people's motor and cognitive performance, and, consequently, be a hazard to traffic safety. Alcohol is a well-known contributor to road accidents, but other substances, such as illicit drugs and psychoactive medicines, can also adversely affect the fitness to drive, and, therefore, endanger traffic safety.

The aim of this study was to describe the consumption of some frequently used medicines with CNS side effects (i.e. opioids, antipsychotics, anxiolytics, hypnotics and sedatives, antidepressants, drugs used in addictive disorders, and antihistamines for systemic use), in a non-hospitalised EU population, over the years 2000 to 2005, and the use of illicit drugs (i.e. cannabis, amphetamines, ecstasy, LSD, cocaine and crack cocaine, and opioids) in standard age ranges, in Europe, in a retrospective data collection over the years 1994 until 2006.

Data on national medicine use were requested by means of a questionnaire that was sent via two international scientific networks (i.e. the Post-Innovation Learning through Life-events of drugs - PILLS - and the European Drug Utilization Research Group - EuroDURG -) or, when possible, directly via public websites. Data on illicit drug use were provided by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and were based on the outcomes of population-based surveys that are regularly performed in the EU Member States and Norway.

Data on medication use were finally provided by 12 EU countries. Based on these data, a considerable increase in consumption was only seen for the antidepressants, and, in particular, for the selective serotonin reuptake inhibitors. A slight increase, decrease or no increase was seen for the rest of the selected medication groups. Limitations were encountered when comparing the data on driving impairing medicines between countries, and, therefore, a cross-national comparison could not be fully performed.

Despite the fact that tracking trends in illicit drug use was difficult, the EMCDDA data showed that cannabis was the most frequently used illicit drug in Europe, followed by cocaine. Furthermore, the EMCDDA data also indicated that, in some EU countries, in these last years, the use of some forms of synthetically produced drugs rose and almost reached the cocaine use levels, especially among younger age groups.

The outcomes of this study showed a moderately stable use for most psychoactive medicines and illicit drugs; however, on the other hand, the current results also showed a relatively high use of the selected medication and drug groups. In view of the observed utilization trends and the fact that the both licit and illicit drugs can represent a risk for road traffic safety, it is recommended that further research be undertaken to improve and harmonize data collection techniques as well as to increase

the existing knowledge of the association between non-alcoholic drugs and medicines and road traffic accident risk.

# Annex 2 Deliverable 2.2.1

## Motives behind risky driving - driving under the influence of alcohol and drugs

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### Executive summary

In-depth interviews were carried out in Sweden and Hungary involving thirty drink drivers and sixteen drug drivers (40 men and 6 women). The interviews were carried out according to a fixed interview guide with opportunities for spontaneous comments. The interviews dealt with respondents' attitudes towards driving whilst under the influence of alcohol or drugs from a general point of view, including perception of risk and social norms.

The results showed that we are dealing with a very specific group of people who were addicted to alcohol and or other drugs. Thus normal sanctions did not prevent them from driving while intoxicated and this applied to participants from both Sweden and Hungary. One important reason was that they perceived themselves to have very little control over their behaviour but also that they did not believe that they would be stopped by the police. Those who had been stopped pointed out that the reason was because the police were carrying out a routine control, and not because they had driven in an unsuitable way.

Indeed they did not believe that alcohol or drugs would impair their driving and therefore they did not perceive any real risks of driving. However, one important difference between drugs and alcohol was that in the first case drugs were believed to make them a *better* driver whereas alcohol did not make them any worse. Thus, drug driving was not regarded as an offence in the same way as drink driving.

With regard to the sanction itself the most severe was licence revocation although this mainly applied to drink drivers. Drug drivers very rarely had a driving licence in the first place and their fear was to be caught with the possession of drugs. Drink drivers, especially those who were in employment and who mixed with people who disapproved of drinking and driving, experienced a great deal of pressure from people around them not to drink and drive. Many times they could hide from others that they had a problem with alcohol but by losing their licence it became more difficult. The same pressure was not perceived by the drug drivers who regarded themselves as deviant and mixed with like-minded. The drug drivers lived a life where the rules of society did not apply. Their main preoccupation was to support their drug taking and by doing so they would do almost anything. With regard to social norms some differences between the two countries were detected with regard to drinking and driving. In Hungary the level of tolerance towards the offence was greater and it was also perceived as more normal to drink and drive.

Respondents who had been caught drinking and driving expressed more feelings of shame than drug drivers. This was partly because of the offence itself but, as mentioned before, more to do with having to admit to others that they had been drinking and driving and in effect could not control their drinking. Feelings of shame appeared not to be related to a feeling that the act itself could result in an accident but somewhat related to if their friends and relatives disapproved. The same feelings were not expressed by the drug drivers, only later when they were under treatment and they looked back at their life did the feeling of shame and anguish emerge.

The participants whose drinking and driving was related to problems with alcohol would argue that losing the licence or even to be imprisoned would not have helped them to stop re-offending. Instead,

it was the treatment programme which had helped them by providing a greater insight into their own problems.

It could be concluded that the perceived likelihood of detection was not great. Therefore, and in accordance with the deterrence theory, sanctions would not deter the participants from drinking while intoxicated. The results therefore indicate that a different approach is needed. Freeman et al. (2005) pointed out that it is important to focus on the underlying issues that directly influence the behaviour such as the abuse of alcohol or drugs. This would also be in accordance with some other findings, which have suggested that remedial interventions – especially those combining psychotherapy, education, and any follow up – can reduce recidivism and crashes, even for relatively high risk drivers (Donovan, Queisser, Salzberg & Umlauf, 1985).

# Annex 3 Deliverable 2.2.2

## Prevalence of psychoactive substances and consumption patterns in traffic, based on a smartphone survey in Germany

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### Executive summary, Part 1

The present study was conducted within Work Package 2 of the EU-funded project DRUID (Driving under the influence of drugs, alcohol, and medicines) in order to estimate the prevalence of psychoactive substances within the German driver population and to identify preventive and promotive circumstances of drug driving. The results serve as major input to the discussion on drug driving, rehabilitation and prevention.

The regular approach to estimate prevalence rates is to conduct a roadside survey. By the present study a new methodological approach was implemented. Instead of detecting drugs in the driving population – like roadside surveys do – a sample of regular drug users out of the regular driving population were queried for four weeks about their driving and drug consumption behaviour.

In total the sample consists of 200 drug users and 100 controls out of the normal driving population stratified for sex, age (18-24-year-olds, 25-29-year-olds, 30-39-year-olds) and residence (rural, urban and city area). To capture real-time data about drug consumption and driving a repeated-entry diary technique was applied. A questionnaire was installed on smartphones and was filled in daily for 28 consecutive days. All activities were listed in chronological order with the focus on drug consumption and driving. Encrypted data were transmitted via GPRS and the Internet. Immediately after reception, data were checked for consistency by study assistants. In case of inconsistencies or peculiarities, the entries were discussed by phone and corrected if necessary.

The reported drug consumption and driving data were comparable to existing drug prevalence and mobility data of the general German population. The synchronisation of the data about drug use and driving not only offers to assess the frequency of drug driving (i.e. prevalence rates for the general German driving population) and the situational aspects of such incidences (e.g. time, day, distance, companions). It also enables the investigation of situations that lead to refraining from driving under influence and therefore have a preventive effect on drug driving. Furthermore, an extended diagnostic part was included in the study to gather person-related characteristics (e.g. socio-demographic information, relevant previous experiences, personality variables and attitudes). Thus, individual factors that are associated with a tendency to drug drive can be specified.

The results show differences between users and controls on several variables. The users go to bed later at night and get up later in the morning compared to controls. In the evening and at night they stay out more often at private locations (i.e. at friends') whereas controls more often visit public locations like restaurants, clubs, etc. In general, users are more mobile at night compared to controls, who are more mobile at usual rush-hour times indicating that the controls' days proceed more along a daily working routine. Even if controls are less mobile at night, they conduct more drives as driver whereas users more often use alternative modes of transportation at that time. Compared to controls, drug users consume alcohol more frequently and in higher doses. At the same time they drive more than twice as often under the influence of alcohol than controls.

For defining a drive as being under influence, BACs and THC blood plasma levels were calculated

using the information given by the subjects in their daily reports about the consumed amount of alcohol and cannabis and the time delay between consumption and driving. For the BAC calculation the Widmark formula was applied (Widmark, 1932), for the calculation of THC blood plasma levels the elimination curve determined by Sticht (G. Sticht, personal communication, December 2009). A drive was classified as under influence if the corresponding BAC was 0.01% or higher and the THC blood plasma level was 1ng/ml or higher, respectively. For all other substances the doubled half life (Schulz & Schmoldt, 2003; Passie, Seifert, Schneider & Emrich, 2002; Prisinzano, 2005) was used to define a drive as a drive under influence: Drives within the doubled half life time after consumption were classified as drug-positive.

Averaged per person, 20.5% of the users' drives were under the influence of drugs. The most prevalent drug found while driving was cannabis. The mean percentage of drives under the influence of cannabis alone was 13.1% (total: 14.8%). On average, 4.1% of the users' drives were under the influence of alcohol (total: 5.4%) and 1.5% under the influence of stimulants (amphetamine, ecstasy, cocaine – total: 2.2%). The mean percentage of drives under the influence of multiple drugs was 1.8% (cannabis/alcohol, cannabis/stimulants, alcohol/stimulants, cannabis/heroin, cannabis/alcohol/stimulants), most of which under the influence of alcohol and cannabis. The cut-off values for defining a drive as drive under influence are rather low ( $BAC \geq 0.01\%$ ,  $THC \text{ blood level} \geq 1 \text{ ng/ml}$ ). When applying higher cut-off values, like a BAC of 0.05% and a THC blood level of 4ng/ml, the mean percentage of drives under influence within the user sample drops by around 40% from a previous 20.5% to 13.1%.

Via existing mobility measures and prevalence data for drug use in Germany (ESA 2006; Kraus, Pfeiffer-Gerschel & Pabst, 2008 / "Mobilität in Deutschland" – MID 2008; for more information see <http://www.mobilitaet-in-deutschland.de/engl%202008/index.htm>) the survey results were extrapolated into alcohol and THC prevalence rates for the general German driving population. According to this estimation, the prevalence for THC-positive drives ( $THC \text{ blood plasma level} \geq 1 \text{ ng/ml}$ ) in Germany is 0.14% (95% CI: 0.09% - 0.22%). For the 18-24-year-old German population the prevalence for alcohol-positive drives ( $BAC \geq 0.01\%$ ) is 1.57% (95% CI: 0.52% - 2.7%) and 3.3% (95% CI: 1.63% - 5%) for 25-39-year-olds.

Compared to the results of the German roadside survey (Cannabis: 0.57%; alcohol: 18-24-year-olds: 3.76%; 25-49-year-olds: 5.48%) from 1994 (Krüger et al., 1996) the prevalence rates found within the present study seem fairly low. However, amendments to traffic regulations for drink and drug driving within the last few years might serve as an explanation for changed prevalence rates for drives under influence in Germany. In 1998, the legal BAC limit for driving a motor vehicle in traffic was lowered from 0.08% to 0.05%. Moreover, the 0.00% BAC limit for novice drivers was introduced in 2007. A positive trend concerning alcohol drives within the last years can also be shown by other traffic related indicators. Alcohol-related accidents (Vorndran, 2009) or alcohol related records at the Central Register of Traffic Offenders (Federal Motor Transport Authority – Jahresbericht 2004, Jahresbericht 2009) decreased within the last few years. Furthermore, it was not until 1998 that a law was introduced in Germany that makes driving under the influence of illegal substances prosecutable in the first place. Since then the screening of illegal drugs in traffic has become more prevalent and the detection devices more precise. So, the probability of being detected while driving under the influence of an illegal drug has become higher. Because of the higher deterrence effect, drug users may have altered their drug driving behaviour towards more conformity with the law within the last few years.

But who then is contributing to the occurrence of DUI? Does every drug user commit drives under influence or is it a special sub-group that particularly shows unlawful behaviour in traffic by drug driving? When considering drives with a positive THC blood level of 4ng/ml and higher and/or drives with a positive BAC above the legal limit only 20% of all users were responsible for 80% of all

substance-positive drives and **19% of all users had no substance-positive drives** at all.

A striking predictor for frequent drug driving and highly impaired driving in general is a high consumption frequency. Excessive substance users especially commit most substance-positive drives and have higher substance blood levels while driving compared to moderate or heavy drug users. Moreover, the subjective impairment for alcohol was found to be dependent on the substance blood level while driving: the higher the BAC while driving, the higher the subjects felt impaired. For cannabis this dependency was only found for moderate to heavy cannabis users. These findings indicate that especially moderate substance users more realistically judge their intoxication and can be described as being responsible-minded concerning drugs in traffic – derived from less drives under influence, lower blood levels while driving under influence and a subjective feeling of impairment dependent on the actual intoxication. Further on, it was found that the height of the valid BAC limit for driving (0.00% for novice and young drivers, 0.05% for all other drivers) has an effect on the frequency of BAC-positive drives. If the lower limit applies, controls drive less often under the influence of alcohol.

Other factors of influence are the perceived risk of being stopped by police, the distance, the availability of alternative modes of transportation and the presence of companions. The more probable a person thinks a police stop could occur, the more often the person decides against drug driving. Moreover, a drive under influence occurs less likely, the longer the distance is that needs to be travelled. In rural areas and bigger cities the probability of driving under influence rises compared to smaller cities. In smaller cities the persons can walk or use the bike to cover the rather short distances. Even if in bigger cities the availability of public transport in general is high, this offer is limited especially at times when drug driving is most prevalent, i.e. at night and on weekends. The results also suggest that female companions while driving lower the probability of drives under influence, especially when the driver is male.

The present study could also demonstrate that the users seem not to be more at risk in road traffic than the controls. This statement is based (1) on the records that are stored in the German Central Register of Traffic Offenders and (2) on self-reported dangerous traffic situations within the study period. So, except from driving under influence, there is no evidence to suggest that the DUI offenders also show problematic behaviour according to other traffic-related measures.

When conducting the study, two challenges were faced – the recruitment of the subjects and the implementation of the new method of using smartphones as study devices. Much effort had to be spent on a transparent picture of the study in the public and on a broad and intense recruitment strategy. Thus, the final sample comprises of 200 regular drug users who were willing to participate in the study and who reported their illegal behaviour, namely their drug use. Random sampling was not viable, but the comparison of the sample with confounding population parameters showed that it reflects the general population quite satisfactory. The new method was developed in an iterative process. The developmental work consisted of the conceptual design of the rather complex smartphone questionnaire, the planning and organising of the study schedule and the intense and comprehensive control of the data for data inconsistencies immediately after receiving them.

All in all it seems that the new method implemented by the present study does not have too many restrictions compared to the complex design of roadside surveys. Instead it establishes a database for not only quantifying the drug driving prevalence, but also for analysing mediating and modifying factors.

## **Executive summary, Part 2**

The present study was conducted within Work Package 2 (Epidemiology) of the EU-funded project



DRUID (Driving under the influence of drugs, alcohol, and medicines) in order to estimate the prevalence of psychoactive substances within the German driver population and to identify preventive and promotive circumstances of drug driving. The results serve as major input to the discussion on drug driving, rehabilitation, and prevention.

The final sample consists of 195 drug users and 100 controls out of the normal driving population, stratified for sex, age (18-24-year-olds, 25-29-year-olds, and 30-39-year-olds), and residence (rural, urban, and city area). To capture real-time data about drug consumption and driving, a repeated-entry diary technique was applied. A questionnaire was installed on smartphones and was filled in daily for 28 consecutive days. All activities were listed in chronological order. The synchronisation of the reported information about drug use and driving enabled the identification of drives under influence. Furthermore, an extended diagnostic part was included in the study to gather person-related driver characteristics (e.g. socio-demographic information, relevant previous experiences, major mental diseases, psychometric performance measures, personality variables, information about the social context, attitudes, knowledge about legislation, and information about the subjective sanction severity).

Prevalence rates estimated by the survey results of the present study and identified situational factors of drug driving were reported in Walter, Hargutt and Krüger (2011). The methodological procedure is also described there. This report focuses on person-related factors of drug driving, i.e. the characteristics of drug impaired drivers.

To assess any psychological problems of the subjects, the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) was conducted (Wittchen, Zaudig & Fydrich, 1997). In addition, the subjects were queried about previous psychological health problems diagnosed by physicians. The number of diagnoses per person (Substance Use Disorders excluded) was marginally higher for users compared to controls (particularly due to a higher frequency of Major Depression with Recurrent Episodes, Bipolar Disorders, AD(H)D, and Borderline Personality Disorder). The users were more often diagnosed with Lifetime Drug Abuse or Drug Dependence. Heavy and excessive users especially reported more clinically significant impairment or distress due to substance use and expressed a higher intention to change/stop substance consumption. In general, users reported being less satisfied with their personal life situation and being less aware of a healthy way of living as compared to controls.

Because alcohol and cannabis were quite often used by the subjects of the present study, it was tried to specify distinct consumption patterns that affect the probability that someone drives under influence. The basic idea was that if someone restricts his consumption to weekends and nights, the probability that this person would drive under influence should be rather low. For cannabis as well as for alcohol, it was possible to show this relation. What the consumption pattern of a person looks like, is to a great extent connected to the consumption intensity. Excessive and to some part heavy users more often consume at all times of the day and on all days of the week, whereas moderate users restrict their consumption for the most part to weekends and evenings/nights.

The psychometric performance of driver aptitude was assessed by the application of the computer-based Act & React Test System (ART) 2020 Standard test battery, developed by the Austrian Road Safety Board (ARSB). Seven sub-tests of the test battery were applied, which measure the following performance dimensions: coordination capacity (LL5, PVT, SENSO), concentration and attention capacity (Q1), reaction capacity (RST3), stress resistance (RST3), memory capacity (GEMAT3), and intelligence (MAT). Five of the seven tests can be assigned to the performance dimensions listed in the German Driver's Licence Ordinance ("Fahrerlaubnis-Verordnung", FeV). The analysis produced

only small effects, indicating that acute cannabis intoxication partly affects the psychometric performance of driver aptitude and that negative long-term performance effects of heavy lifetime drug use exist (while light lifetime drug use has no negative impact). It has to be pointed out that, of the 39 parameters measured by the applied tests, only five turned out to be significantly different between the study groups. Another seven only showed trends. Furthermore, the recommended evaluation procedure according to the "Guidelines for Expertise on Driver Aptitude" ("Begutachtungs-Leitlinien zur Kraft-fahreignung"; Lewrenz, 2000) resulted in high overall failure rates of 58% to 69%, no matter which study group is considered (control group included). This indicates that the recommended evaluation procedure is neither sensitive nor specific enough to make clear assumptions about a possible relation between the degree of drug use – as operationalised in the present study – and psychometric performance.

According to evidence from a literature review that was conducted prior to the study (Walter et al., 2011), questionnaires that specify personality dimensions with a supposed relevance to the context of drug use and drug driving were applied. It turned out that drug use seems to be associated with some crucial personality dimensions (e.g. sensation seeking, hyperactivity/impulsivity, less self-control, rather unconventional behaviour, etc.) and drugs seem to be misused to solve personal problems (e.g. psychological and social problems due to hyperactivity/impulsivity, feelings of distress). A less precise but similar difference was found for users who commit many drives under influence compared to users who never or only sometimes drive under influence. Users at high risk of driving under influence reported more symptoms of hyperactivity/impulsivity in their childhood as well as more negative psychological and social after-effects of hyperactivity/impulsivity, and that psychoactive substances have a relieving effect on these symptoms. Users who committed many drives under influence expressed to have less positive coping strategies and believe much more pronounced that life and the occurrences therein rely on fate and fortune compared to users who rather seldom drive under influence.

Social learning and Social Control Theory stress the influence of parents and peers on the development of problematic behaviour (Bahr, Hoffmann & Yang, 2005). By the pre-sent study it could be demonstrated that the higher the subjects grade their parents' alcohol consumption, their peers' and partner's drug use, and their peers' impaired driving, the more they themselves are involved in drug use and drug driving, respectively. Further on, subjects who often drive under influence say that their friends have a less adverse attitude towards impaired driving compared to subjects who do not drive under influence or do it rather infrequently. Users surveyed in the present study indicated that their relationship to their parents is worse compared to controls, especially those who commit impaired driving quite often. These findings are in line with Social Control Theory (Hirschi, 1969, cited in Bahr et al., 2005) which stresses the positive impact of a good relationship between parents and children on the development of conventional values and the rejection of deviant behaviour. Users also stated that their parents' way of raising them was too lenient or lenient compared to controls. According to their statements, the users' fathers' have a higher job position which could indicate that they were less involved in bringing up the child. Moreover, the users more often stated that their parents lived apart or were divorced compared to controls. These findings indicate a decreased supervision by the parents and suppose a lack of strength in parenting which in turn is associated with a higher tendency of children to behave delinquently (Bahr, Maughan, Marcos, & Li, 1998; Hirschi, 1969, cited in Bahr et al., 2005).

Based on Ajzen's (1985) theory of planned behaviour, prevention measures should focus on attitudinal changes because attitudes influence behaviour. Drug users have a less adverse attitude towards drug driving compared to controls, especially when it comes to driving under the influence of cannabis and stimulants. For controls it was found that a more restrictive legislation has an effect on their attitude

towards driving after the consumption of one beer. Controls for whom the zero-tolerance for alcohol applies find it more condemnable than those for whom the 0.05% BAC limit applies. Users who themselves drive often under influence less often mind going along with an impaired driver, whereas users who rather seldom drive under influence are more indisposed. The decision to drive under influence is stated to mainly depend on characteristics of drug intake (amount, type and effect of consumed drug, time of drug consumption). Users who rather seldom drive under influence stated a higher priority of the time of drug use compared to users who often drive under influence. This corresponds to the result shown in Walter et al. (2011) that moderate alcohol or cannabis users who commit fewer drives under influence compared to heavy and excessive users also have lower BACs and THC blood plasma levels while driving under influence. Also quite relevant in the process of deciding whether or not to drive under influence are in the users' view the density of police controls, whether or not passengers could be endangered, and the possible option to ride along with another person. Many users, and to some part controls as well, stated that they would appreciate a threshold for driving under the influence of cannabis. The most frequently specified reasons were the long traceability of the substance in body fluids and a feeling of injustice compared to persons who drink and drive (because of the different legal approaches). Most subjects accept the implementation of the zero-tolerance for young and novice drivers for driving under alcohol influence for safety reasons or would not mind if it applied to every driver. Users accept the zero-tolerance to a lower degree compared to controls. This confirms their rather liberal attitude towards driving under substance influence. Heavy and excessive alcohol users especially take the view that the legal BAC limit should be higher than 0.05% and that they can drink higher amounts of alcohol and still drive safely as compared to moderate alcohol users. For users obeying the law is a less important ethical principal than for controls. On this score no differences based on consumption intensity or the degree of driving under influence could be found.

There are numerous findings that support the effectiveness of sanctioning and police enforcement by deterring from high risk road user behaviour. The success of these strategies depends on the deterrence threat they create. Important characteristics here are a high surveillance level, a quick and efficient sanctioning, severe, strict and consistent sanctions, and pertinent knowledge on behalf of the road user (Krisman & Schöch, 2011; Zaal, 1994). Experienced drivers had a better knowledge of the alcohol-related traffic legislation than young and novice drivers. The sanction for violations against the 0.00% BAC limit was rated almost as high as the sanction for violations against the 0.05% BAC limit, although it is actually lower. Users had a better knowledge of the legal consequences that are imposed when getting caught while driving under the influence of illegal drugs than controls. The consequences for drug offences were in general assessed to be lower than the real consequences that have to be expected. A positive effect of the subjective risk of being stopped by the police on drug driving was proved within the framework of the present study and is reported in Walter et al. (2011). This report refers to an effect of the subjective sanction severity on the occurrence of drives under influence, albeit the effect is rather small and is only marginally significant for the sanction that is imposed for violations against the 0.05% BAC limit. The more severe a person perceives the sanction, the less often the person commits the offence.

The results of the present piece of work (Deliverable 2.2.2 – Part I and Part II) were integrated in a model that shows dependencies of different societal, behavioural, and legal variables that are relevant in the context of developing measures to combat driving under influence.

The following insights can be drawn that might be relevant for the discussion about drug driving and associated prevention and rehabilitation measures:

- Target group: Prevention and rehabilitation measures should be addressed to the main target group of heavy and excessive users. A therapeutic approach to reach the target group of risky drug users might be an appropriate approach to reduce drug driving.
- Social influence: Friends and family members of exposed persons should be addressed and

should be made aware of their influence and responsibility in the developing process of problematic behaviour.

- Information about risks: Information about the real risks and the real extent of drug driving should be disseminated to prompt attitudinal changes towards more responsible and safety-oriented attitudes.
- Information about enforcement: The more likely a person perceives a police stop to occur, the more often the person decides against driving under influence. By an increase in media coverage about changes in enforcement practices and the effectiveness of enforcement strategies, the deterring effect of police enforcement can be further enhanced (Krisman & Schöch, 2011).
- Information about sanctions: Dissemination activities should explicitly address the consequences that are to be expected in the case of drug offences because subjects are often not aware of the different sanctioning stages according to the StVG, the StGB, and the FeV, respectively.
- Scientific-based information: It is important to design media activities that provide information about sanctions and enforcement with a scientifically based foundation. By doing so the social acceptance and public awareness of the measures might increase much more than in the cases where the reasons for the measures remain concealed (Krisman & Schöch, 2011).
- Information harmonised with characteristics of target-group: Campaigns should address the personal needs of the recipient and should provoke emotions to increase the willingness of the recipient to seriously consider the safety topic in question (Gelau & Pfafferott, 2009). The present piece of work provides characteristics of persons at risk of driving under influence. From this knowledge suggestions for designing prevention measures can be deduced.

Through the present study it was possible to create a database for not only quantifying the drug driving prevalence, but also for analysing mediating and modifying factors that serve as major input on rehabilitation and prevention. Collecting data about drug use and driving over a multi-week time period, enabled the identification of behavioural patterns that help to better understand the phenomenon of drug driving. Furthermore, an attempt was made to find person-related characteristics, like personality variables and the social context of a person, that explain why a person uses drugs or drives under influence and another person does not. All in all, the present study provides a very large amount of information on understanding drug use and driving under influence of psychoactive substances. The new methodological approach of collecting data through a repeated-entry diary technique by using smartphones as study devices has proved to be a promising method and should serve as a standard to which future studies should aspire.

# Annex 4 Deliverable 2.2.3

## Prevalence of alcohol and other psychoactive substances in general traffic

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### Executive summary

**Introduction.** DRUID (Driving under the Influence of Drugs, Alcohol and Medicines) aimed to combat the problem of driving under the influence of psychoactive substances by providing a solid scientific base for European policy makers. It brought together experienced organisations in Europe to assemble a co-ordinated set of data resources and measures. DRUID is an integrated European research project which consisted of different sub-projects (Work Packages) that were aimed at different topics such as the prevalence and risk of psychoactive substances, enforcement, classification of medicines, rehabilitation of offenders and withdrawal of driving licenses ([www.druid-project.eu](http://www.druid-project.eu)).

The main objective of WP2 of DRUID was to assess the situation in Europe regarding the prevalence and risk of the use of illicit drugs, alcohol and psychoactive medicinal drugs by drivers.

The main aim of this study was to obtain more insight in the use of psychoactive substances among drivers in European traffic. Thirteen countries participated in this study by conducting roadside surveys according to a general design. In total almost 50,000 randomly selected drivers participated between January 2007 and July 2009.

1. Belgium (BE)	6. Hungary (HU)	11. Poland (PL)
2. Czech Republic (CZ)	7. Italy (IT)	12. Portugal (PT)
3. Denmark (DK)	8. Lithuania (LT)	13. Sweden (SE)
4. Spain (ES)	9. Netherlands (NL)	
5. Finland (FI)	10. Norway (NO)	

All participating countries are members of the European Union (EU) except for Norway, which is associated with the European Union as a member of the European Economic Area (EEA).

Participants, i.e. drivers of passenger cars and vans, were randomly selected using a stratified multi-stage sampling design. In the first stage, one or more regions per country were selected. These regions were meant to be representative for the country with regard to substance use and traffic distribution. Within the selected regions smaller research areas were selected, and within these areas, survey locations were selected, where subjects were stopped at random, and were requested to participate in the study. With regard to days of the week and times of the day, the study population sample was stratified into eight time periods over the week, for each of the survey areas. The time periods did not overlap each other and covered all the days of the week and all times of the day.

**Method.** All hours of the day and all days of the week were covered by four time periods: weekdays (04.00-21.59), weeknights (22.00-03.59), weekend days (04.00-21.59), and weekend nights (22.00-03.59).

All countries have used a StatSure Saliva Sampler device for saliva collection, except for the Netherlands, where saliva was collected by means of ordinary spit cups.

Blood samples were collected in Belgium, Italy, the Netherlands and Lithuania. All four countries used glass tubes for the collection containing sodium fluoride and potassium oxalate.

Extraction of the substances was based on liquid-liquid (LLE) or solid phase (SPE), chromatographic separation was performed by gas chromatography (GC) or Liquid chromatography (LC), detection was done by mass spectrometry.

In total 23 substances have been included in the core substance list at the beginning of the project. The list of core substances was based on discussions between all partners.

For each substance an analytical cut-off has been selected based on the lowest limit of quantitation (LOQ) that could be measured by all toxicological laboratories that were involved in the analysis of the substances. LOQ's reflect the lowest concentrations for substances at which quantitative results can be reported with a high degree of confidence. For the final results presented in this report, equivalent cut-offs, and not the LOQ's, are used for analysis of the core substances to correct for differences in concentrations of substances in blood and in saliva.

The distribution of the study population sample by time periods was not proportionate to the distribution of the general driving population over these periods. This was unavoidable since in many of the thirteen countries the researchers had to take into account the preferences of the police who were needed to stop the drivers from moving traffic. Weight factors were applied to correct for this disproportion based on the ratio by time period between the distribution of traffic and the distribution of the participants.

## **Main results**

- Alcohol is still by far the number one psychoactive substance on European roads, followed by illicit drugs and medicinal drugs.
- On a European level alcohol is estimated to be used by 3.48% of the drivers, illicit drugs by 1.90% of the drivers, medicinal drugs by 1.36% of the drivers, drug-drug combinations by 0.39% of the drivers and alcohol-drug combinations by 0.37% of the drivers.
- For illicit drugs THC is the most frequently detected drug in traffic, followed by cocaine. Amphetamines and illicit opiates were less frequently detected.
- Illicit drugs were in general mainly detected among young male drivers, during all times of the day but mainly in the weekend
- Medicinal drugs were in general mainly detected among older female drivers during daytime hours.
- Benzodiazepines were the most prevalent medicinal drug in traffic, z-drugs were less prevalent. However, considerable differences between countries were present.
- The use of substances among drivers in the general driving population in Europe (prevalence) varies very much per country, but general patterns can be distinguished on the level of European regions:
  - The medicinal drugs Z-drugs and medicinal opiates and opioids were in general relatively frequently detected in Northern European countries.
  - Illicit drugs, alcohol and benzodiazepines are relatively frequently detected in Southern European countries.
  - In Eastern Europe the prevalence of alcohol and drugs was relatively low compared to the other European regions.
  - In Western Europe, drug use is more or less on the European average.

Figures 1–6 on the following pages provide geographical presentations as a summary of the main findings.

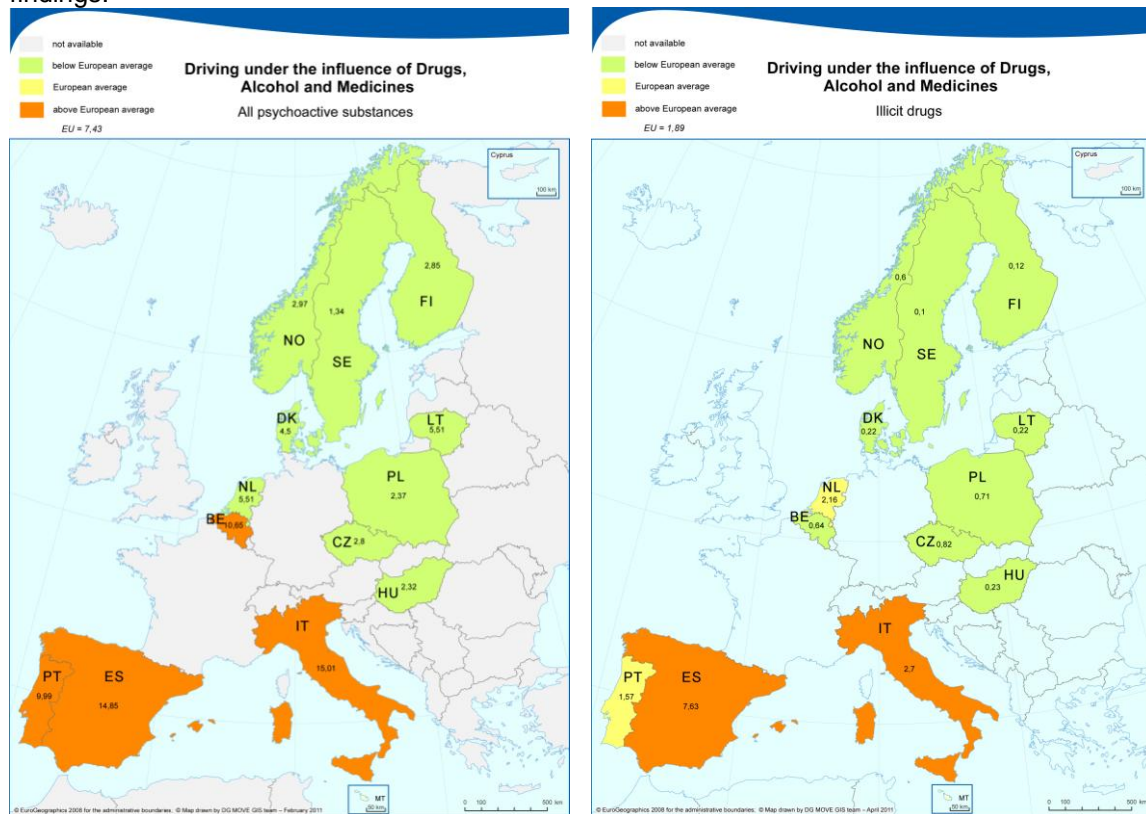


Figure 1 and 2. Geographical presentation of psychoactive substance use and illicit drug use by car drivers in the EU

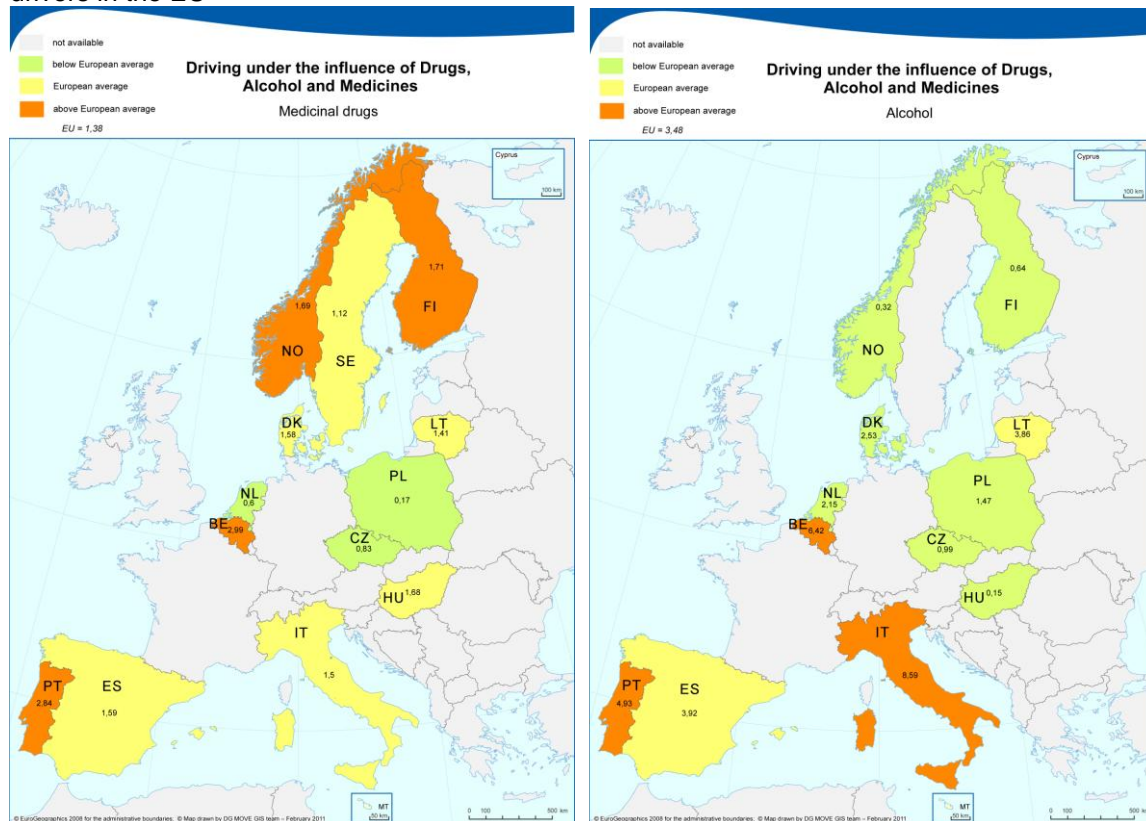


Figure 3 and 4. Geographical presentation of medicinal drug and single alcohol use by car drivers in the EU

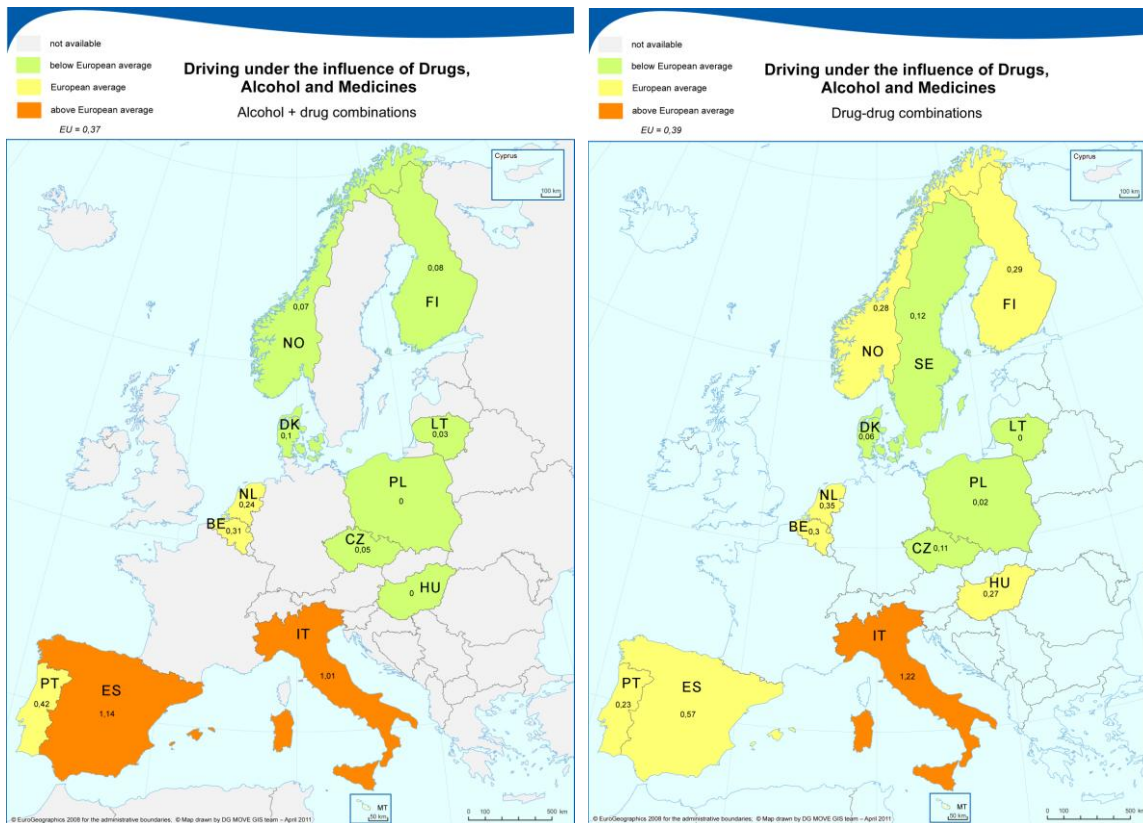


Figure 5 and 6. Geographical presentation of alcohol and drugs and drug-drug combinations by car drivers in the EU

A more detailed overview of the findings is presented in the table 4.3. This table shows the prevalences per substance group and per country as well as the estimated European means. The European mean can be used to distinguish per substance whether a country prevalence is around, below or above this European mean. The table presents the spread of the prevalence around the estimated European mean. A yellow colour of a particular prevalence value indicates that the European mean lies within the 95% confidence interval of the prevalence. A green coloured value indicates that the confidence interval suggests that it is below the European mean, and a red coloured value indicates that the confidence interval suggests that it is above the European mean.



**Table 4.3. Estimated European prevalence of psychoactive substances; prevalence in percentage; 95% confidence intervals in italics**

		Inhabitants (million)	negative	amphetamines	cocaine	THC	illicit opiates	benzodiazepines	Z-drugs	medicinal opiates and opioids	alcohol	alcohol-drugs	drugs-drugs
Northern Europe	DK	5.4	95.52 <i>94.72 - 96.2</i>	0.02 <i>0 - 0.16</i>	- <i>-</i>	0.2 <i>0.09 - 0.43</i>	- <i>-</i>	0.47 <i>0.28 - 0.79</i>	0.32 <i>0.17 - 0.59</i>	0.79 <i>0.53 - 1.18</i>	2.53 <i>2.02 - 3.15</i>	0.1 <i>0.03 - 0.3</i>	0.06 <i>0.02 - 0.24</i>
	FI	5.3	97.15 <i>96.58 - 97.63</i>	0.05 <i>0.02 - 0.19</i>	0.03 <i>0.01 - 0.16</i>	0.04 <i>0.01 - 0.17</i>	- <i>-</i>	0.79 <i>0.56 - 1.13</i>	0.36 <i>0.21 - 0.6</i>	0.56 <i>0.37 - 0.85</i>	0.64 <i>0.43 - 0.94</i>	0.08 <i>0.03 - 0.23</i>	0.29 <i>0.16 - 0.52</i>
	NO	4.7	97.03 <i>96.67 - 97.36</i>	0.06 <i>0.02 - 0.13</i>	0.06 <i>0.03 - 0.14</i>	0.48 <i>0.36 - 0.64</i>	- <i>-</i>	0.84 <i>0.67 - 1.05</i>	0.69 <i>0.54 - 0.88</i>	0.16 <i>0.1 - 0.27</i>	0.32 <i>0.23 - 0.46</i>	0.07 <i>0.03 - 0.15</i>	0.28 <i>0.19 - 0.42</i>
	SE	9.1	98.66 <i>98.34 - 98.92</i>	0.07 <i>0.03 - 0.17</i>	- <i>-</i>	0.03 <i>0.01 - 0.12</i>	- <i>-</i>	0.19 <i>0.11 - 0.33</i>	0.31 <i>0.2 - 0.48</i>	0.63 <i>0.46 - 0.86</i>	NA	NA	0.12 <i>0.06 - 0.25</i>
	<b>Total N-EU</b>	<b>93.3</b>	<b>97.32</b>	<b>0.05</b>	<b>0.02</b>	<b>0.16</b>	<b>0.00</b>	<b>0.51</b>	<b>0.40</b>	<b>0.56</b>	<b>1.20</b>	<b>0.05</b>	<b>0.17</b>
Eastern Europe	CZ	10.3	97.2 <i>96.39 - 97.83</i>	0.36 <i>0.17 - 0.72</i>	- <i>-</i>	0.46 <i>0.25 - 0.86</i>	- <i>-</i>	0.62 <i>0.36 - 1.07</i>	- <i>-</i>	0.21 <i>0.08 - 0.52</i>	0.99 <i>0.65 - 1.53</i>	0.05 <i>0.01 - 0.28</i>	0.11 <i>0.03 - 0.38</i>
	HU	10.1	97.68 <i>97.04 - 98.18</i>	- <i>-</i>	0.04 <i>0.01 - 0.21</i>	0.19 <i>0.08 - 0.44</i>	- <i>-</i>	1.5 <i>1.11 - 2.03</i>	0.07 <i>0.02 - 0.26</i>	0.11 <i>0.04 - 0.32</i>	0.15 <i>0.06 - 0.38</i>	- <i>-</i>	0.27 <i>0.13 - 0.54</i>
	LT	3.4	94.49 <i>93.09 - 95.61</i>	0.22 <i>0.07 - 0.66</i>	- <i>-</i>	- <i>-</i>	- <i>-</i>	1.41 <i>0.9 - 2.23</i>	- <i>-</i>	- <i>-</i>	3.86 <i>2.93 - 5.06</i>	0.03 <i>0 - 0.36</i>	- <i>-</i>
	PL	38.2	97.63 <i>97.11 - 98.05</i>	0.05 <i>0.01 - 0.18</i>	- <i>-</i>	0.57 <i>0.38 - 0.85</i>	0.09 <i>0.04 - 0.25</i>	0.14 <i>0.06 - 0.31</i>	- <i>-</i>	0.03 <i>0.01 - 0.15</i>	1.47 <i>1.14 - 1.9</i>	- <i>-</i>	0.02 <i>0 - 0.14</i>
	<b>Total E-EU</b>	<b>96.7</b>	<b>97.57</b>	<b>0.09</b>	<b>0.01</b>	<b>0.47</b>	<b>0.06</b>	<b>0.52</b>	<b>0.02</b>	<b>0.08</b>	<b>1.10</b>	<b>0.01</b>	<b>0.07</b>
Southern Europe	ES	44.5	85.15 <i>83.87 - 86.34</i>	0.11 <i>0.04 - 0.3</i>	1.49 <i>1.12 - 1.97</i>	5.99 <i>5.22 - 6.87</i>	0.05 <i>0.01 - 0.2</i>	1.4 <i>1.05 - 1.87</i>	- <i>-</i>	0.19 <i>0.09 - 0.41</i>	3.92 <i>3.3 - 4.66</i>	1.14 <i>0.83 - 1.58</i>	0.57 <i>0.36 - 0.89</i>
	IT	59.1	84.99 <i>82.95 - 86.82</i>	- <i>-</i>	1.25 <i>0.78 - 2.01</i>	1.15 <i>0.7 - 1.89</i>	0.3 <i>0.12 - 0.78</i>	0.97 <i>0.57 - 1.67</i>	- <i>-</i>	0.53 <i>0.25 - 1.09</i>	8.59 <i>7.19 - 10.23</i>	1.01 <i>0.59 - 1.71</i>	1.22 <i>0.75 - 1.97</i>
	PT	10.6	90.01 <i>89.04 - 90.91</i>	- <i>-</i>	0.03 <i>0.01 - 0.16</i>	1.38 <i>1.07 - 1.8</i>	0.15 <i>0.07 - 0.33</i>	2.73 <i>2.27 - 3.29</i>	- <i>-</i>	0.11 <i>0.04 - 0.27</i>	4.93 <i>4.29 - 5.64</i>	0.42 <i>0.26 - 0.67</i>	0.23 <i>0.12 - 0.44</i>
	<b>Total S-EU</b>	<b>128.6</b>	<b>85.52</b>	<b>0.04</b>	<b>1.23</b>	<b>3.06</b>	<b>0.19</b>	<b>1.30</b>	<b>0.00</b>	<b>0.36</b>	<b>6.43</b>	<b>1.01</b>	<b>0.87</b>
Western Europe	BE	10.6	89.35 <i>88.18 - 90.41</i>	- <i>-</i>	0.2 <i>0.09 - 0.43</i>	0.35 <i>0.19 - 0.64</i>	0.09 <i>0.03 - 0.28</i>	2.01 <i>1.57 - 2.59</i>	0.22 <i>0.1 - 0.47</i>	0.75 <i>0.5 - 1.13</i>	6.42 <i>5.59 - 7.36</i>	0.31 <i>0.16 - 0.58</i>	0.3 <i>0.16 - 0.58</i>
	NL	16.4	94.49 <i>93.81 - 95.1</i>	0.19 <i>0.1 - 0.36</i>	0.3 <i>0.18 - 0.5</i>	1.67 <i>1.34 - 2.07</i>	0.01 <i>0 - 0.09</i>	0.4 <i>0.25 - 0.62</i>	0.04 <i>0.01 - 0.15</i>	0.16 <i>0.08 - 0.32</i>	2.15 <i>1.78 - 2.6</i>	0.24 <i>0.13 - 0.42</i>	0.35 <i>0.22 - 0.56</i>
	<b>Total W-EU</b>	<b>181.4</b>	<b>92.46</b>	<b>0.12</b>	<b>0.26</b>	<b>1.15</b>	<b>0.04</b>	<b>1.03</b>	<b>0.11</b>	<b>0.39</b>	<b>3.83</b>	<b>0.27</b>	<b>0.33</b>
<b>Weighted European mean</b>		<b>500.0</b>	<b>92.57</b>	<b>0.08</b>	<b>0.42</b>	<b>1.32</b>	<b>0.07</b>	<b>0.90</b>	<b>0.12</b>	<b>0.35</b>	<b>3.48</b>	<b>0.37</b>	<b>0.39</b>

**Recommendations.** The results of this study can generally be used in selecting overall activities and target groups in the policy field of psychoactive substance use in traffic across Europe. The results indicate, however, that the prevalence of psychoactive substances by gender, age and time period varies largely per country. Therefore, recommendations for national activities regarding, e.g., policy issues, enforcement, education or campaigns, should primarily be based on the results of the country reports, rather than on the general report.

Alcohol is still the most prevalent substance in traffic, as well as it is among injured and killed drivers (Isalberti et al., 2011). Therefore, with regard to enforcement on psychoactive substances it is recommended that this would remain to be mainly focused on alcohol use among drivers. Since enforcement of drug driving legislation is costly in terms of time and money, selective drug testing is recommended above random drug testing. However, drug enforcement should not go at cost of alcohol enforcement (Veisten et al., 2010).

The thirteen roadside surveys that were conducted within the DRUID-project provided a very valuable insight in the prevalence of psychoactive substances among car drivers in Europe. In the near future new legislations on drug driving will be applied in several European countries (e.g. the Netherlands) and the results from the DRUID project may affect future policies towards drink and drug driving. Therefore, it would be very valuable to monitor if these changes will indeed have a positive effect on the use of psychoactive substances in traffic. National roadside surveys on the prevalence of substance use in traffic on a regular, say, annual or bi-annual base would be a helpful tool to monitor the trend of drink and drug driving. It is recommended that these monitoring surveys would be carried out in more countries than the thirteen European countries that participated in the DRUID roadside surveys, in order to get a more representative European overview.

Since the main purpose of this roadside survey would be to monitor the trend of drug driving, the number of samples per country might be smaller than in the present study. A power study should be conducted to estimate the required number of samples from randomly selected car drivers.

In order to compare the results from new roadside surveys in Europe with the data collected in DRUID it is recommended to follow the study design guidelines from the DRUID roadside surveys (See annex 1) as much as possible.

It is recommended to collect saliva samples when the roadside surveys are solely used for monitoring the prevalence of drug use in traffic, since higher non-response rates are to be expected when collecting blood samples.

If the roadside survey is part of a case-control study, it is recommended to use the same sample collection method at the roadside as is used in the hospital, in order to be able to make good comparisons between cases and controls.

Furthermore, in order to reduce non-response researchers should invite the participants of the survey before the police tests the driver for alcohol.

It is mandatory to have permission of the various national Medical Ethics Commission to conduct a roadside survey like this. The process of getting this permission can take a lot of time in some countries, this should be taken into account when planning future prevalence studies on psychoactive substances.

# Annex 5 Deliverable 2.2.4

## Prevalence study: Main illicit psychoactive substances among all drivers involved in fatal road crashes in France

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B Laumon, INRETS, scientific adviser for the SAM project)

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### Executive Summary

**Introduction.** In 1999, in France, before considering change in the drug legislation, the government wished to know more on the effect of illicit drugs on the risk of road crashes. A systematic screening of illicit drug on all drivers involved in fatal crashes, was hence made compulsory. We estimate prevalences of alcohol, cannabis, amphetamines, cocaine, and opiates. We provide them for drivers of all vehicles types, as well as for car drivers only. We also provide estimates of prevalences in the general population through the careful selection of a control group.

**Material and Method.** A total of 10,728 drivers were involved in fatal road crashes in France between October 2001 and September 2003. After exclusion of drivers with missing data on alcohol, cannabis, age, or with age below 18, some 10,519 drivers remain in the dataset. The subset of car drivers contains 7,455 of them. Drivers involved in fatal crashes include killed drivers, injured and non-injured drivers.

Drug dosage is conducted on blood samples. Commonly defined DRUID thresholds are used to define positivity: alcohol ( $\geq 0.1\text{g/L}$ ), cannabis ( $\geq 1\text{ ng/ml}$ ), amphetamines ( $\geq 20\text{ ng/ml}$ ), cocaine ( $\geq 10\text{ ng/ml}$ ), opiates ( $\geq 10\text{ ng/ml}$ ). Prevalences are also provided according to age and sex.

Since a responsibility study is later conducted on car drivers involved in fatal accidents, we estimate the prevalence of alcohol and illicit drugs on responsible drivers and non-responsible ones. Responsibility is assessed with a method adapted from Robertson and Drummer's. From the group of non-responsible drivers, we choose a control group as close as possible to the general driving population.

**Results.** In all drivers involved in fatal crashes, alcohol prevalence is estimated at 25.9%, THC prevalence at 6.9%, amphetamines at 0.6%, cocaine at 0.5% and opiates at 0.9%. prevalences of alcohol and cannabis are highest in moped users. Prevalences are higher in men than in women, at all ages. In men, prevalence of cannabis is higher at younger age, whereas in women prevalence of alcohol is highest in the 35-49 year old group. Among drivers who are positive to cannabis, 47% are (also) positive to alcohol.

Prevalence of cannabis is 8.7% in drivers responsible for the crash and 3.8% in non-responsible ones. Prevalence of alcohol is 35.6% in drivers responsible for the crash and 9.4% in non-responsible ones. In the control group, prevalence of cannabis is 2.8%, prevalence of alcohol is 5.0%.

**Discussion.** For all the substances except cannabis, the commonly defined DRUID thresholds are higher than the French thresholds in use in 2001-2003. We hence very likely miss a high proportion of

those between the two thresholds. This means that the estimated prevalences should be considered as lower bounds.

Prevalence of alcohol in our control group using the French threshold (2.7%) is close to the prevalence of the whole driving population, estimated in another study (2.5%); this supports the choice we made for the control group and hence the generalisation of its prevalences to the whole driving population. Prevalences of alcohol and cannabis are higher in the drivers responsible for the fatal crashes compared to the non-responsible drivers or to the control group. It is only a descriptive and univariate analysis; this will be better analysed in the responsibility study.

# Annex 6 Deliverable 2.2.5

## Prevalence of alcohol and other psychoactive substances in injured and killed drivers

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- THL - National Institute for Health and Welfare, Finland
- IBSR – Institut Belge pour la Sécurité Routière, Belgium
- UKHB – University of Copenhagen, Denmark
- TFA-UNPD - Università di Padova, Italy
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- TMI - Institute of Forensic Medicine Mykolas Romeris University, Lithuania

### Executive Summary

**Introduction.** The European Integrated Project DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) is a part of the 6th Framework Program, the European Community Framework Program for Research, Technological Development and Demonstration. The objective of DRUID is to give scientific support to the EU transport policy by providing a solid basis to generate harmonised, EU-wide regulations for driving under the influence of alcohol, drugs and medicine. This study is a part of Work Package 2, Epidemiology, of the DRUID project. The objective of the study is to assess the situation in Europe regarding the prevalence of alcohol and other psychoactive substances in drivers who have been injured/killed in traffic accidents.

Part 1 of this report presents the general results of the hospital & killed driver studies. After a short introduction, the representativeness of the populations in the EU countries as well as the representativeness of hospitalised and killed driver samples are addressed. An overview of the non-response issues in the various countries is also included. Based on the toxicological findings, a general summary of the prevalence of drug use is given for the 9 participating countries. This is followed by a discussion and a conclusions part.

Part 2 and 3 of this report include all the country reports. In this part more detailed information regarding study design, methods, representativeness of the sampling and results on a national level can be found.

**Material and Method.** A cross-sectional survey was conducted to determine the prevalence of drugs in injured (sampled between October 2007 and May 2010) and killed (sampled between January 2006 and December 2009) drivers in 9 European countries. In order to be able to compare the 10 different studies (Finland performed an injured driver study and a killed driver study), a uniform design was developed for all participating countries (see Annex 1). Obligatory inclusion criteria were: Driver of a motorized vehicle, injured in an accident on a public road or in the direct vicinity of a public road, only primary admissions to the hospital (no referrals), because of traumatological reasons with a time

interval between the accident and sampling of less than 3 hours and a injury severity being MAIS 2 or higher. Each country could decide upon additional national criteria.

A total of 3570 seriously injured drivers and 1293 killed drivers were sampled in this study. For the general outcomes, among all subjects sampled, a selection was made to obtain relatively similar sub-populations of seriously injured (MAIS  $\geq 2$ ) and killed drivers. The analysis focuses on drivers of personal cars and vans.

Drug dosage was conducted on blood samples. Extraction was based on liquid-liquid (LLE) or solid phase (SPE) extraction, chromatographic separation was performed by gas chromatography (GC) or liquid chromatography (LC): *High Performance (HPLC) or Ultra Performance (UPLC)*. Detection was done by mass spectrometry (MS) or nitrogen/phosphorus detection (NPD). Commonly defined DRUID thresholds were used to define positivity (part 1, 2.2. toxicology). Prevalence data were also provided according to age and gender.

## Results

In the **injured drivers** study, among car and van drivers (n= 2492), the highest number of subjects was sampled in Denmark (33.7%), followed by Italy (27.1%). Disregarding the Belgian data (classification of road type based on speed limit), 26.5% of drivers were sampled on urban roads, 29.2% on rural roads and 44.3% on unknown type of road. 76.9% of the accidents occurred during daytime (50.9% on a weekday, 26% in weekends). More than 50% of the drivers were sampled in the first or fourth quarter. For Italy there was a higher proportion in the second quarter and a lower one in the fourth quarter compared to other countries. Males accounted for 69.9%, females for 29.5% (0.6% unknown). 79.7% of the study population was between 18 and 49 years old. The use of safety belt was known for only 17.8% of the sampled drivers (Belgium and the Netherlands) and of these approximately 72% were using a safety belt. Overall 90.8% of the study population was driving a personal car and 5.8% a small van (3.4% unknown). 32.3% was involved in a single-vehicle accident and 37.3% in a multi-vehicle collision (30.4% unknown). The most prevalent MAIS scores were 2 and 3.

In the **killed drivers** study, among car and van drivers (n= 1118), the highest number of subjects was sampled in Finland (43.2%), followed by Portugal (25.5%). 63.5% of the population was sampled on rural roads, 10.1% on urban roads (26.4% unknown). 78% of the accidents occurred during daytime (53% on a weekday, 25% in weekends). The distribution by quarter of the year was equal between all countries, with the highest percentage in the third quarter. Males accounted for 83%. The highest proportion was found in the group 50 years and older. Overall 70.8% of the study population was driving a personal car. 30.9% was involved in a single-vehicle accident and 43.5% in a multi-vehicle collision (25.6% unknown).

Toxicological data were analysed according to two criteria.

- Distribution of positive drivers among sampled subjects (mutually exclusive groups): a subject can be part of one group only, independently of the number of substances taken.
- Prevalence of substance groups use among sampled drivers: data give an indication of how many people use the different substance groups among the sample population and the same subject may appear under several substance groups.

The percentages of drivers positive for one or more substances (mutually exclusive) varied from around 28% up to 53% in the different countries, as shown in the table below.

<b>MUTUALLY EXCLUSIVE GROUPS - Percentage of drivers positive for the substance groups</b>										
<b>Toxicological finding</b>	<b>Seriously injured drivers</b>						<b>Killed drivers</b>			
	<b>BE (325)</b>	<b>DK (831)</b>	<b>FI (47)</b>	<b>IT (676)</b>	<b>LT (385)</b>	<b>NL (186)</b>	<b>FI (459)</b>	<b>NO (165)</b>	<b>PT (285)</b>	<b>SE (141)</b>
Negative	47.4	69.7	55.3	68.0	72.2	66.1	57.7	60.0	52.3	69.5
Alcohol only	30.2	14.1	25.5	18.5	15.3	25.3	24.4	18.2	38.9	15.6
Amphetamine only	0.9	1.0	0.0	0.0	0.3	1.1	0.7	1.2	0.0	2.1
Benzoyllecgonine only	0.0	0.0	0.0	0.7	0.3	1.1	0.0	0.0	0.0	0.0
Cocaine	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0
THCCOOH only	0.6	1.6	0.0	0.4	0.3	0.0	N.A.	N.A.	1.1	0.0
THC	1.5	0.6	2.1	1.6	0.3	0.5	0.0	1.8	0.0	0.7
Illicit opiates only	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Benzodiazepines only	1.5	1.2	0.0	0.4	2.3	0.0	5.2	1.8	0.7	0.0
Z-drugs only	0.9	0.5	2.1	0.0	0.0	0.5	1.7	1.2	0.0	2.8
Medicinal opioids only	1.2	2.5	0.0	1.8	5.7	0.5	1.5	0.6	0.7	0.7
Alcohol + drug combination	13.2	5.4	10.6	4.6	2.3	4.3	7.2	7.9	6.0	4.3
Drug + drug combination	2.5	3.5	4.3	2.5	0.8	0.5	1.5	7.3	0.4	4.3
<b>Total</b>	100	100	100	100	100	100	100	100	100	100

As expected, alcohol was the most common toxicological finding, both in the seriously injured and in killed drivers (range 17.7 - 42.5% and 19.0 - 44.9% respectively for the injured and killed drivers study). In the prevalence of use, among all seriously injured drivers, after alcohol, THC (range 0.5-7.6%) and benzodiazepines (range 0-10.2%) were the most common findings. In the killed drivers study, among all sampled subjects, the most prevalent substances after alcohol were benzodiazepines (range 1.4-13.3%), followed by amphetamine (range 0-7.4%) and THC (range 0-6.1%). These results are shown in the table below.

To be able to give a better view on sporadic/single or chronic use of cannabis, a distinction between THC and THCCOOH was made.

<b>PREVALENCE OF USE OF SUBSTANCE GROUPS - Percentage of drivers positive</b>										
	<b>Positive seriously injured drivers</b>						<b>Positive killed drivers</b>			
	<b>BE</b>	<b>DK</b>	<b>FI</b>	<b>IT</b>	<b>LT</b>	<b>NL</b>	<b>FI</b>	<b>NO</b>	<b>PT</b>	<b>SE</b>
Alcohol ( $\geq 0.1$ g/L)	42.5	19.7	32.1	23.1	17.7	29.6	31.4	25.4	44.9	19.0
Alcohol ( $\geq 0.5$ g/L)	38.2	17.8	30.2	20.6	16.1	28.0	29.3	23.8	35.1	16.3
Amphetamines	2.6	4.2	3.7	0.1	0.5	2.1	2.1	7.4	0.0	6.6
Benzoyllecgonine*	1.4	0.7	0.0	2.8	0.3	2.7	0.0	0.6	0.7	0.7
Cocaine	2.3	0.6	0.0	2.7	0.3	2.1	0.0	0.0	0.7	0.7
Cocaine and/or benzoyllecgonine	3.8	1.3	0.0	5.4	0.5	4.8	0.0	0.6	1.4	1.3
THCCOOH**	2.3	5.3	0.0	1.3	0.3	1.1	N.A.	N.A.	4.2	0.0
THC	7.6	1.3	5.7	3.7	0.5	0.5	1.3	6.1	0.0	1.3
THC and/or THCCOOH	9.9	6.6	5.7	5.1	0.8	1.6	1.3	6.1	4.2	1.4
Illicit opiates	0.6	0.5	0.0	2.1	0.3	0.0	0.0	0.0	0.0	0.0
Benzodiazepines	7.3	6.7	10.2	0.7	3.6	0.0	13.3	9.7	1.8	3.9
Z-drugs	1.7	1.2	3.8	0.0	0.0	0.5	3.0	4.4	0.0	3.2
Medicinal opioids	3.3	4.2	4.0	3.7	7.8	0.5	2.1	1.7	2.1	4.1

\* Benzoyllecgonine but negative for cocaine

\*\*THCCOOH but negative for THC

## Highlights

### *Seriously injured drivers*

- The percentage of subjects testing positive for at least one psychoactive substance ranged between 28 and 53%.
- Alcohol (cut-off = 0.1 g/L) was the most common finding with the highest percentage of positives found in Belgium (42.5%), where 50.6% of the male injured drivers tested positive. Among the positives, 90.5% had a blood alcohol concentration equal to or above 0.5 g/L. The mean and median values of ethanol were respectively 1.59 g/L and 1.60 g/L
- The majority of drugs appeared to be used in combination with other psychoactive substances.
- Among the illicit drugs, amphetamine use appeared to be more common in northern Europe, while cocaine use seemed to be more prevalent in southern Europe. No cases of cocaine/benzoyllecgonine were recorded in Finland.
- Approximately 9.9 % of the seriously injured drivers in Belgium tested positive for cannabis (THC and/or THCCOOH).
- No positive findings for Z-drugs were recorded in Italy and Lithuania.
- Lithuania had almost a double amount of positive subjects for medicinal opioids compared with the other countries in the study.

### *Killed drivers*

- The percentage of subjects testing positive for at least one psychoactive substance ranged between 31 and 48%.
- Alcohol (cut-off = 0.1 g/L) was the most common finding with the highest percentage of positives found in Portugal (44.9%). Among the positives, 87.3% had a blood alcohol concentration equal to or above 0.5 g/L. The mean and median values of ethanol were respectively 1.61 g/L and 1.67 g/L.
- In Portugal no subjects were found positive for the amphetamine group.
- The majority of drugs appeared to be used in combination with other psychoactive substances.
- No drivers tested positive for cocaine in Finland.
- Subjects positive for THC (alone or in the presence of THCCOOH) were only found in males.
- Norway had the highest percentage of positive findings for THC (6.1%).
- In Portugal no subjects tested positive for Z-drugs.
- Sweden had a double amount of subjects positive for medicinal opioids compared with the other three countries.

Comparing the two Finnish datasets percentages in the seriously injured and in the killed drivers studies, similar findings were observed for most substance groups.

## Discussion.

*Non response.* The non response in the six countries involved varies between 0% and 8.5% for the surveys on injured drivers. The missing cases in the studies on killed drivers varied between 5.7% and 41%.

*Representativeness.* Every country made several efforts to have a representative driver sample. These efforts resulted in a high participation rate in the injured driver surveys and in a maximum of 41% missing cases in the killed driver studies. Concerning the representativeness of the population in the EU countries: the Southern EU Member States are the best represented (54%), followed by the Northern Member States (29%) (due to the absence of the United Kingdom which alone accounts for



63% of the Northern Europe population). The Western Member States are only represented for 15% since large Member States like Germany and France, accounting together for 80% of Western Europe population, did not participate. Finally, the Eastern EU Member States are not represented in this study.

*Remarks.*

- The selection of countries was based on the institutes that participated in DRUID and based on their experience in organising hospital studies. During the negotiation progress, it was asked by the European Commission to also include southern and eastern European countries. Because of difficulties in organising previous similar studies, some countries decided not to participate in this DRUID-survey. Sweden and Hungary were at the beginning involved in the hospital study. Because of problems in cooperation with hospitals, these countries were allowed to change their involvement. Instead of a hospital study, Sweden performed a killed driver study and Hungary a responsibility study on killed drivers.
- In the killed drivers study the prevalence of cannabis use in Norway and Finland may have been underestimated due to the fact that samples were not analysed for THCCOOH.
- A sample was considered positive for alcohol when the concentration was at or above the DRUID cut-off, which was set at 0.1 g/L. In most countries the legal cut-off for alcohol is 0.5 g/L. For the injured drivers study 9.5% of alcohol positive samples was found to have a concentration in the range 0.1-0.49 g/L. For the killed drivers study the percentage of positives in the same concentration range was 12.7.
- Samples were considered positive if a substance was found at or above the set DRUID cut-offs. For this reason, the data give an estimate of the prevalence of substance groups among the sampled populations, which is likely to be conservative, because samples that tested positive but below the set cut-off were considered as negative.

# Annex 7 Working paper D 2.2.6

## Characteristics of accident Involved Drivers Under the Influence, Results from confidential interviews

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### Executive summary

The European Commission decided to fund new studies into the causes of road accidents, independent of any legal investigations, especially when the causes of those accidents constituted criminal acts, as is the case when the driver is driving under the influence (DUI). Italian law permits such an absolute separation if and when a health professional assists their patient, as in the case of alleviation of Post-Traumatic Stress Disorder (PTSD). This intervention implies the description of every single detail of the traumatic event for a positive health outcome. Therefore, psychologists carried out confidential interviews with persons who were emotionally involved in 241 road accidents and were able to identify the characteristics of the drivers who caused these accidents.

In Italy, official road accident statistics are produced by the Police. However, the sample described here also includes accidents not recorded by the Police, allowing a separate analysis on a group of accidents not previously studied. The interviews also provide a detailed description of accidents that involve driving under the influence, which is not always recorded in the Police figures. When an accident had been recorded by the Police, the interviewees always described the official reports as a more or less appropriate account of the same accident. The comparison between the two accounts of the same group of accidents provides a statistical confirmation to a hypothetical estimate produced by researchers of the Epidemiology Department of the Italian Health Ministry on the real prevalence of DUI, much higher than reported by statistics derived from Police reports. In the course of a neutral offer of psychological support, those who were believed to have blood alcohol concentrations over the alcohol limit were involved in accidents twelve times more frequently than is reported in statistics derived from Police reports, where only 2% of the road accidents were attributed to the effect of alcohol.

Even greater is the differential for the prevalence of driving under the influence of drugs and medicines, which was only 0.3% in the official statistics, but was found in just over a quarter of cases in our sample. These confidential interviews also enable comparisons between the role of the impairing substance(s) as part of lifestyle (i.e. general use of substances), driving style (i.e. use of substances before driving), and as a contributing cause of the accident - all three for the same driver. These results provide a baseline for an evaluation of existing policies and their future adaptation to the drivers' characteristics. So far, only the improvements in Blood Alcohol Concentration detection appear to have produced some clear separation between drinking habits, drinking-and-driving behaviour and this cause of accidents. Unfortunately, this improvement has been stronger for the lighter drinkers, with little effect on the heavier drinkers. Even the impact on DUI of other impairing substances is widely ignored, as well as the worst mode of consumption - mixing alcohol, prescribed medicines, and illegal drugs. These results suggest that further research is needed to better understand the ways in which these factors affect DUI behaviour.

Examining the interviews, it appears that the law against DUI is seldom enforced, therefore hiding DUI in the official statistics. These guilty drivers prefer to be blamed for other accident causes, even when another driver is the real culprit, so distorting further the official statistics on the causes of such accidents. The use of confidentiality in interviews therefore appears to be an important way to answer

to the request of the Commission to determine the real causes of road accidents, independently from legal processes and all the related official records. Ironically, this separation from legal processes could also help to improve criminal prosecutions, by enabling a better understanding of the consequences of the accidents.

# Annex 8 Deliverable 2.3.1.

## Relative accident risk of patients using psychotropic medicines in the Netherlands: A pharmacoepidemiological study.

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### Executive Summary

This Deliverable is part of the European Union (EU) project Driving Under the Influence of Drugs, alcohol and medicines (DRUID).

The consumption of psychoactive substances can influence people's motor and cognitive performances, and, therefore, affect people's ability to drive safely. Alcohol is a well-known risk factor for motor vehicle collisions, but the use of other substances (i.e. illegal and legal drugs) can also play an important role in endangering traffic safety. Therefore, special efforts must be taken in order to obtain a better knowledge on psychoactive substance use and driving impairment, and, consequently, improve road safety.

The aim of this study was to assess the association between traffic accident risk and psychotropic medication exposure by means of a case-control study.

A record-linkage database was used to perform the current study, in the Netherlands, between 2000 and 2007. The data came from three sources: pharmacy prescription data, police traffic accident data, and driving license data. Cases were defined as adults, who had a traffic accident between 2000 and 2007 and were driving, and received medical assistance. Controls were defined as adults, who had a driving license and had no traffic accident during the study period. Four controls were matched for each case; the matching was by sex, age within five years, zip-code, and date of the accident. The following medicine groups were included in order to cover the most frequently prescribed psychotropic medicines and medicines with central nervous system (CNS) side effects that are known to be of relevance for traffic safety: opioids, antipsychotics, anxiolytics, hypnotics and sedatives, antidepressants (antidepressants as a total group, sedative antidepressants, and SSRIs), and antihistamines for systemic use. Various variables, such as age, sex, medicine half-life, mono and combination therapy, alcohol use were considered for the analysis.

3963 cases and 18828 controls were selected for the case-control analysis. Due to the lack of complete data on drivers' characteristics of cases and controls (e.g. co-morbidities; annual mileage; risky behavioural tendencies; etc.) and driving conditions of controls (e.g. season; weather conditions; time of the day; alcohol use; etc.), only crude odds ratios were calculated and reported in this deliverable. These latter showed a positive association between the risk of having a traffic accident and the exposure to at least one psychotropic medication [Crude OR=1.28 (95% CI: 1.12 - 1.46)]. This association was found to be higher in combination therapy users [Crude OR=1.55 (95% CI: 1.20 - 2.02)] and SSRI users [Crude OR=1.76 (95% CI: 1.38 - 2.24)]. The highest risk groups were new users (although the association was not statistically significant), intermediate and long half-life benzodiazepine users (the association was statistically significant only for hypnotic intermediate half-life users), female users (the association was statistically significant only for hypnotic, antidepressant, and SSRIs users), and young/middle-aged users (the association was statistically significant only for anxiolytic, antidepressant, and SSRIs users).

The crude ORs of this study indicated that psychoactive medications can constitute a problem in traffic safety. Therefore, both health care providers and patients should be properly informed and aware of the potential risks associated with the use of these medications.

# Annex 9 Deliverable 2.3.2

## Responsibility study: Main illicit psychoactive substances among car drivers involved in fatal road crashes in France

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### Executive summary

**Introduction.** In 1999, in France, before considering change in the drug legislation, the government wished to know more on the effect of illicit drugs on the risk of road crashes. A systematic screening of illicit drug on all drivers involved in fatal crashes between October 2001 and September 2003 was hence made compulsory.

The objective of this analysis is to evaluate the relative risk of being responsible for a fatal crash while driving under the influence of alcohol and the main illicit psychoactive substances, among car drivers, and to explore the dose-response relationship of cannabis and/or alcohol.

**Material and method.** Drivers involved in fatal road crashes, whether killed, injured or non-injured have been tested for alcohol and illicit drugs. Within the DRUID project, a responsibility analysis restricted to car drivers is conducted. In total, 7455 car drivers, with known drug and alcohol concentrations, are included. The study belongs to the framework of case-control studies in which the health event studied is “being responsible for a fatal crash”. Responsibility is assessed with a method adapted from Robertson and Drummer. Cases are thus the 4946 car drivers who are responsible for the crash; the controls are 1986 car drivers selected from the 2509 non-responsible car drivers. The control group is chosen in order to be as close as possible to the driving population. For alcohol and illicit drugs, positivity is defined, from a blood dosage, according to DRUID common thresholds: for alcohol: 0.1g/L, cannabis: THC  $\geq$  1 ng/ml, amphetamines: 20 ng/ml, cocaine: 10 ng/ml and opiates: 10 ng/ml.

**Results.** Among car drivers, positive cannabis detection is associated with increased risk of responsibility. A significant dose effect is identified. The effect of cannabis remains significant after adjustment for age, sex and alcohol: adjusted odds ratio 1.89 [1.43-2.51]. For alcohol ( $\geq$ 0.1 g/l), crude and adjusted odds ratios of responsibility are very similar, and much higher than those associated to cannabis: adjusted odds ratio 8.39 [6.95-10.11]. No interaction is statistically significant between alcohol and cannabis. In other words, the odds ratio of responsibility associated to positivity to both cannabis and alcohol is merely the product of the respective odds ratios of cannabis and alcohol:  $1.89 \times 8.39 = 15.86$ . For amphetamine, cocaine and opiates, adjusted odds ratios of responsibility are not significantly different from 1.

**Discussion.** The study finds similar odds ratios for alcohol as previously published. For cannabis, the significant odds ratio of 1.89 together with the significant dose-response effect indicate a causal relationship between cannabis and road crashes. There is no interaction between alcohol and cannabis on the higher risk of causing road crashes; in other words, there is merely a multiplicative effect between the two.

# Annex 10 Deliverable 2.3.3

## Relative risk of impaired drivers who were killed in motor vehicle accidents in Finland

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### Executive summary

This study is a part of an integrated European Union (EU) project DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines). The present study described killed drivers impaired by alcohol (n=211) or legal (prescribed) medicines (n=46) and compared their accidents with those of non-impaired killed drivers (n=689). The main aim of the study was to estimate the relative risk of crash responsibility in motor vehicle accidents of impaired and matched non-impaired killed drivers. Relative risk for crash responsibility was studied in four different exposed groups compared to their matched non-exposed groups. The exposures were: alcohol in collision accidents in which a driver was killed (41 exposed and 41 non-exposed killed drivers), alcohol in all accidents in which a driver was killed (75 exposed and 75 non-exposed killed drivers), medicine in collision accidents in which a driver was killed (23 exposed and 23 non-exposed killed drivers), and medicine in all accidents in which a driver was killed (28 exposed and 28 non-exposed killed drivers). The study utilized the database of Traffic Accident Investigation Teams in Finland from the period of 2002 to 2006 (1,108 killed drivers).

About 29 percent of all killed drivers had alcohol and 9 percent had some legal medicine in their blood at the time of the accident. Most alcohol-impaired drivers were heavily drunk: 77 percent of them had a blood alcohol content [BAC] of 1.2 ‰ or more. Drink-drivers were more often male, and younger, than sober drivers. Drink-drivers had single-vehicle accidents more often than sober drivers, and their accidents more often occurred during the evening and at night. Vehicle handling errors, anticipating errors, and suicides, were more typical risk factors for drink-drivers' accidents than for sober drivers' accidents. 93 percent of drink-drivers were the most responsible party compared to 68 percent of sober drivers in collision accidents (OR 6.6, 95% CI 1.8 – 31.7). Considering all accidents, the figures were 97 percent compared to 72 percent (OR 16.7, 95% CI 4.4 – 110.8), and drivers under 36 years were the most responsible party more often than drivers 36 years and older.

Compared to killed drivers with no medicine in their blood, those with medicine were typically middle-aged, were more often suffering from some chronic disease, and were more often tired at the time of the accident. 87 percent of drivers with medicine in their blood were recorded as the most responsible party in collision accidents compared to 52 percent of non-medicine drivers (OR 9.5, 95% CI 2.0 – 72.5). Considering all accidents, the figures were 89 percent compared to 50 percent (OR 10.4, 95% CI 2.2 – 75.4). The present results concerning the effect of medicine on crash responsibility should be treated with caution for several reasons. Firstly, the number of studied drivers was low. Secondly the recorded medicines included a variety of medicines at a variety of concentration levels. Further, it was not possible to differentiate the role of background diseases from the role of medicine in the analysis of crash responsibility.

# Annex 11 Deliverable 2.3.4

## Responsibility study: Psychoactive substances among killed drivers in Germany, Lithuania, Hungary and Slovakia.

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### Executive summary

**Introduction.** Within the framework of the DRUID-project WP2 was concerned with the collection of epidemiological data to substance use in the driving population. As a part of WP2 the present study which was conducted in Germany, Lithuania, Hungary and Slovakia was to contribute to knowledge on substance use among killed drivers and estimate relative risks among fatally injured drivers responsible for a fatal traffic accident when driving under the influence of alcohol and/or other psychoactive substances. In addition in-depth analysis of accidents of killed drivers tested positive for psychoactive substances was carried out with the purpose of analyzing the contribution of human failure patterns under influence to accident causation.

**Material & Method.** Data of killed drivers was sampled prospectively by means of a database established within the DRUID-framework in the years 2008 and 2009 and increased by retrospective data. The analysis included 483 subjects, 18 years and older, killed within 10 hours after being involved in a traffic accident. Responsibility analysis was conducted with the method proposed by Robertson and Drummer (1994) which allocated the 483 subjects in 419 cases and 64 controls. Subsequently a toxicological analysis was carried out where the 23 DRUID-core substances as well as several other additional substances were screened for. An in-depth analysis of 20 killed drivers was carried out by means of a systematic accident causation catalogue.

**Results.** 43% of the killed drivers were tested positive for psychoactive substances at the time of the accident (alcohol  $\geq 0.1$  g/L and/or detection of licit/illicit drugs in blood sample). 85% of positively tested subjects were under the influence of alcohol. The majority of subjects who consumed alcohol were severely intoxicated (blood concentrations  $\geq 1.2$  g/L), a condition more frequently found in East-European samples. Licit and illicit drugs were detected in 13% and 10% of positive subjects, respectively, whereas the most frequently found licit/illicit drugs were benzodiazepines and cannabis (3.7% and 2.5% of whole sample). Due to in particular a low number of controls the results of odds ratio (OR) calculations were in most cases not significantly different from one and therefore the corresponding analysis did not show an effect of the respective substance on the risk of being responsible for a fatal accident. However, there were three exceptions. In the Slovakian subsample adjusted (age, gender) OR for subjects with blood concentrations of alcohol  $\geq 1.2$  g/L were 8.16 (95% CI 1.15 – 58.11). For the whole sample effects remained significant for subjects with alcohol  $\geq 0.1$  g (OR=4.57, 95% CI 2.02 – 10.38) as well as dose-dependent for alcohol  $\geq 1.2$  g/L (OR=20.84, 95% CI 3.10 – 140.16). The corresponding confidence intervals are wide and therefore the precision of estimate is poor.

**Discussion.** Alcohol was by far the most widely used substance among the killed drivers who in the majority of cases were severely intoxicated. Licit and illicit drugs were involved in less than 15% of subjects with a positive toxicological analysis, however, restricting the sample to killed drivers possibly yields lower figures than found when analyzing all drivers. In terms of preventive measures and



legislative consideration alcohol should be emphasized as a key substance which presents a permanent threat to road safety in Europe. In order to establish a solid database on the use of psychoactive substances among drivers with a sufficient number of subjects for epidemiological analysis continuation of the prospective sampling of fatally injured drivers is on all accounts desirable. Future improvements of the database should involve inclusion of injured/non-injured drivers and an extended list of screened substances. In this way continuous data to the use of psychoactive substance among the driving population could be provided, presenting a useful tool to monitor the use of psychoactive substances in traffic and support legislative and preventive measures.

# Annex 12 Deliverable 2.3.5

Risk of injury by driving with alcohol and other drugs

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## Executive summary

The objective of this deliverable is to assess the risk of driving with alcohol, illicit drugs and medicines in various European countries. In total nine countries participated in the study on relative risk of serious injury/fatality while positive for psychoactive substances. Six countries contributed to the study on the relative risk of getting seriously injured: Denmark, Finland, Lithuania, Italy, Belgium and the Netherlands. Four countries contributed to the study on the relative risk of getting killed: Finland, Norway, Sweden and Portugal.

The risk for a driver of getting seriously injured or killed in an accident while positive for a given substance was calculated as the ratio between the odds for a driver of being seriously injured/killed in an accident while positive for a given substance and the odds of being seriously injured/killed while negative. The odds ratios were calculated by means of logistic regression using the SAS 9.2 procedure proc logistic.

Data from the case study population consisted of samples from the hospital studies of seriously injured drivers and those of killed drivers (Isalberti et al., 2011). In total, 2,490 seriously injured drivers and 1,112 killed drivers were included. Data from the control population came from the roadside surveys in the same countries; in total, the control sample to the seriously injured drivers consisted of 15,832 drivers, and the control sample to the killed drivers consisted of 21,917 drivers. Control samples were weighted for the national distribution of traffic in each of eight time periods of the week (Houwing et al., 2011). The relative risk estimates were adjusted for age and gender.

An estimation of the overall relative risk by substance group is given. These risk estimates are based on the odds ratios estimated separately for each country, together with aggregated odds ratios estimated on the basis of all countries' data together or a subset of countries. In the estimate is also taken into account the imprecision of the odds ratios of getting seriously injured and killed as expressed by the confidence intervals of the odds ratio estimates.

The main finding of this report is that the highest risk of getting seriously injured or killed is associated with driving with high alcohol concentrations (above 1.2 g/L) and alcohol combined with other psychoactive substances. These two groups indicate extremely high risks of about 20-200 times that of sober drivers. Other high risk groups are drivers with medium blood alcohol concentrations (between 0.8 g/L and 1.2 g/L), multiple drug use and amphetamines. The risks indicated for this group are about 5-30 times that of sober drivers. Medium increased risk was found for alcohol concentrations between 0.5 and 0.8 g/L, for cocaine, benzoylecgonine, illicit opiates and medicinal opioids. Risk for this group was estimated to about 2-10 times that of sober drivers. The risk associated with benzoylecgonine that is not an active agent might be caused by sleep deprivation after cocaine consumption. The risk associated with cannabis seems to be similar to the risk when driving with a low

alcohol concentration (between 0.1 g/L and 0.5 g/L), which is slightly increased of about 1-3 times that of sober drivers.