European Commission

Alcohol 2018

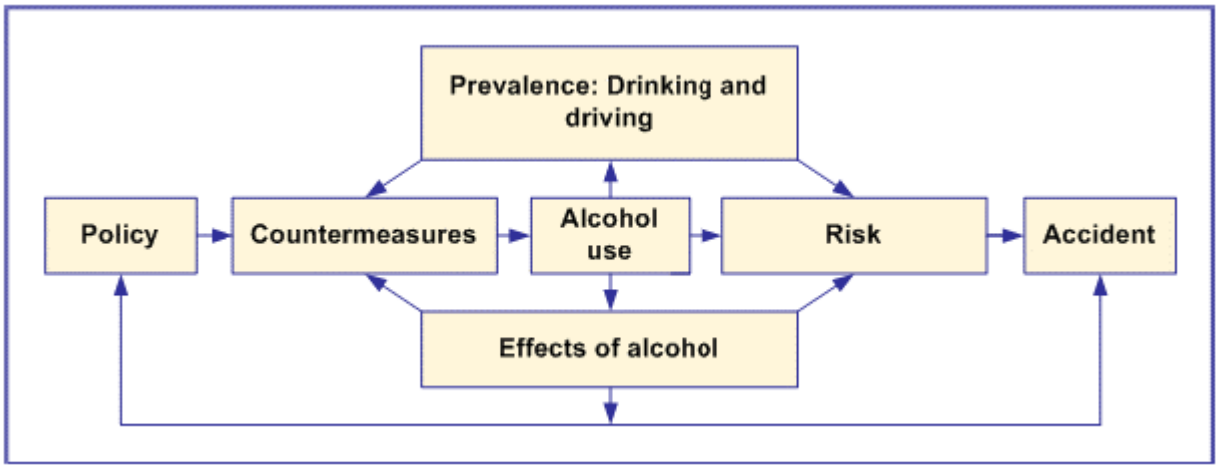
European Road Safety Observatory
www.erso.eu

Transport

CONTENTS

1 Overview

Figure 1: Overview of alcohol related road safety issues



The scope of the problem

About 25% of all road fatalities in Europe are alcohol-related whereas about only 1,6% of all kilometres driven in Europe are driven by drivers with 0,5 g/l alcohol or more in their blood. As Blood Alcohol Concentration (BAC) in the driver increases, the relative crash risk also increases. The increase in relative crash risk accompanying increasing BAC is progressive. Compared to a sober driver, the relative crash risk of a driver with a BAC of 0,8 g/l (still below the legal limit in 2 of the EU Member States) is 2,7 times that of sober drivers. A driver with a BAC of 1,5 g/l has a relative crash risk 22 times that of a sober driver. Not only does the relative crash risk grow rapidly with increasing BAC, but crashes also become more severe. With a BAC of 1,5 g/l the relative risk of a fatal crash is about 200 times larger than for sober drivers.

Why is drinking and driving so dangerous?

Alcohol diminishes driving skills at all levels. The driving task can be divided into three different levels. At the lowest level are tasks dealing with keeping a proper speed and maintaining the correct course (e.g., steering, accelerating, braking, etc.). Most of the skills related to this level, such as tracking performance, reaction times, and visual detection, already begin to deteriorate at a BAC below 0,5 g/l.

At the intermediate level are decisions dealing with manoeuvring a vehicle in traffic. Skills related to this level are dividing attention, scanning capabilities, and information processing in general. These skills also begin to deteriorate at very low BAC levels. As stated above, the main tasks of a driver when driving are to maintain the proper course of the vehicle and to scan the driving environment for information, such as vehicles, traffic signs, and other events. Alcohol-impaired drivers have more difficulty maintaining a proper course for the vehicle and therefore focus more on the driving task than on the environment. Studies show that alcohol impaired drivers are more likely to use their central rather than their peripheral vision. Consequently, they may overlook information on coming events such as sharp bends and oncoming traffic.

At the highest level, comes the decision as to whether one should drive or not. It is well known that after having consumed alcohol, self-control becomes less stringent and that when only slightly inebriated, people are more inclined to think that they are still able to drive safely.

What measures are effective?

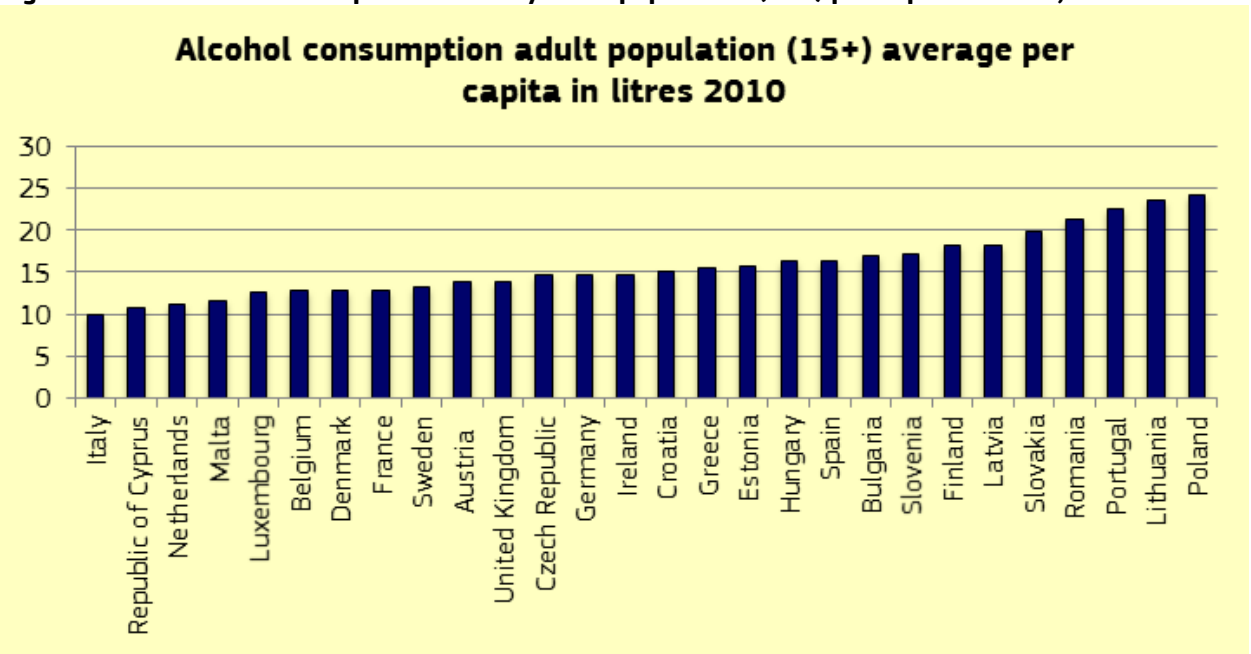
The problem of drink driving is not new and many measures have already been introduced. A very successful measure was the introduction of breath testing devices by the police in the 1970s. However, despite the fact that drink drivers know that they can be caught and that sanctions are tough, and despite considerable change in public opinion regarding drink-driving (most people in Europe nowadays wholeheartedly disapprove of drinking and driving), alcohol-impaired road users are still involved in about a quarter of all fatal crashes in Europe. New and more effective measures are needed.

2 Prevalence and risks associated with alcohol consumption

2.1 Alcohol consumption

Alcoholic beverages are popular throughout Europe. Compared to other global regions, Europe is by far the heaviest drinking region of the world (WHO, 2014). The drinking patterns and the type of drink (wine, beer, and spirits) preferred vary from country to country, but in all EU Member States alcohol consumption is substantial. Figure 2 shows litres of pure alcohol consumed by drinkers aged 15+ per capita (total population) of the EU Members States in 2010.

Figure 2: Consumed litres of pure alcohol by adult population (15+) per capita in litres, 2010



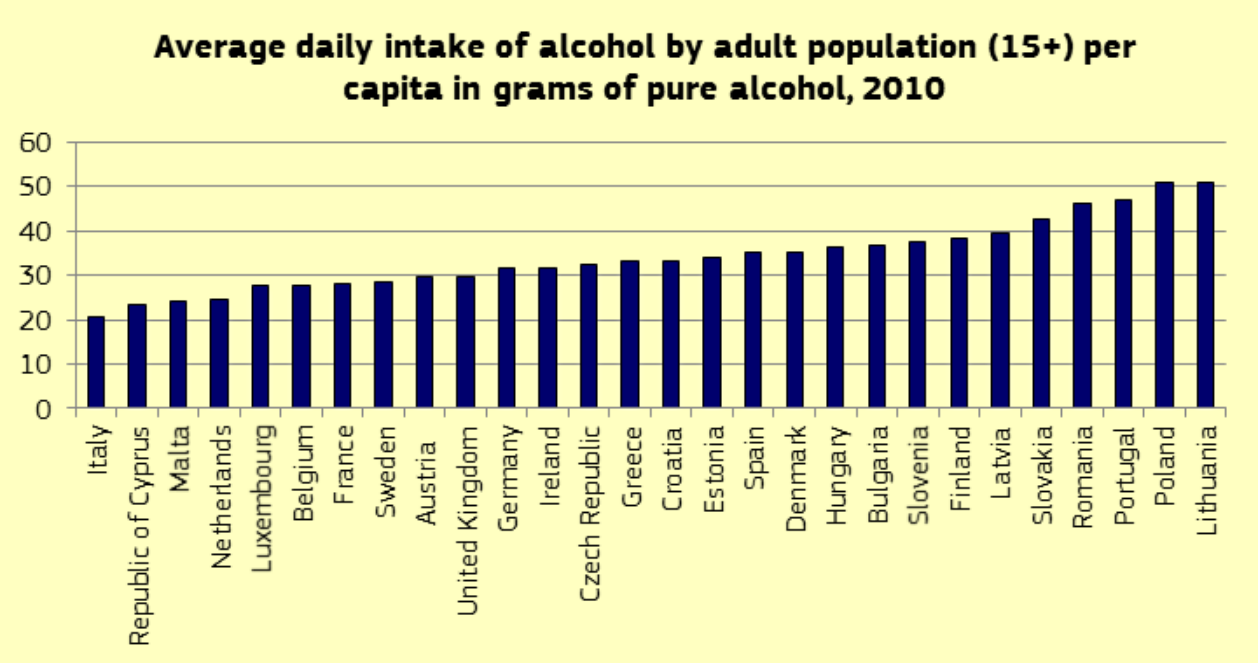
Source: WHO, 2014

Although drinking is popular in all EU Member States, there are some considerable differences between countries. For example, in Italy the alcohol consumption of the adult population per capita is only one half of that of Slovakia. However, data based on sales should take into account that in countries where alcohol is expensive, people may tend to buy alcohol in a neighbouring country where it costs less.

In general, countries from Northern and Western Europe consume less alcohol than countries in Eastern and Southern Europe, although Italy's consumption is below average. In some

countries people tend to drink a regular amount of alcohol every day whereas in other countries people drink less frequently but in higher quantity. Figure 3 presents the average daily intake of alcohol consumed by drinkers' aged 15+ per capita in grams of pure alcohol in the EU Member States.

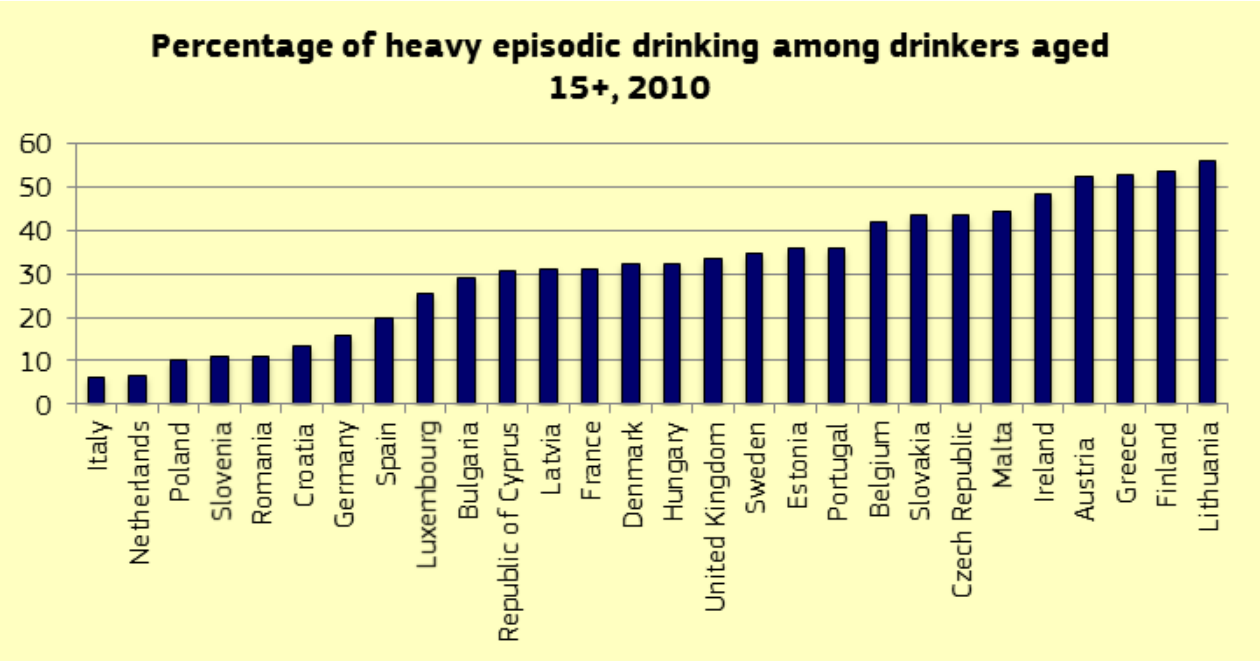
Figure 3: Average daily intake of alcohol consumed by the adult population (15+) per capita in the EU, 2010



Source: WHO, 2014

Worldwide, the prevalence of heavy episodic drinking has increased. Heavy episodic or binge drinking is the consumption of alcohol with the intention of consuming a large volume of alcohol over a short period of time. This trend has been seen within the EU member states. In some of the countries, however, heavy episodic drinking is more prevalent than others. Figure 4 presents the prevalence of drinkers' aged 15+ who consumed at least 60 grams or more of pure alcohol on at least one occasion in the EU member states.

Figure 4: Prevalence (%) of drinkers aged 15+ who consumed at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days, 2010



Source: WHO, 2014

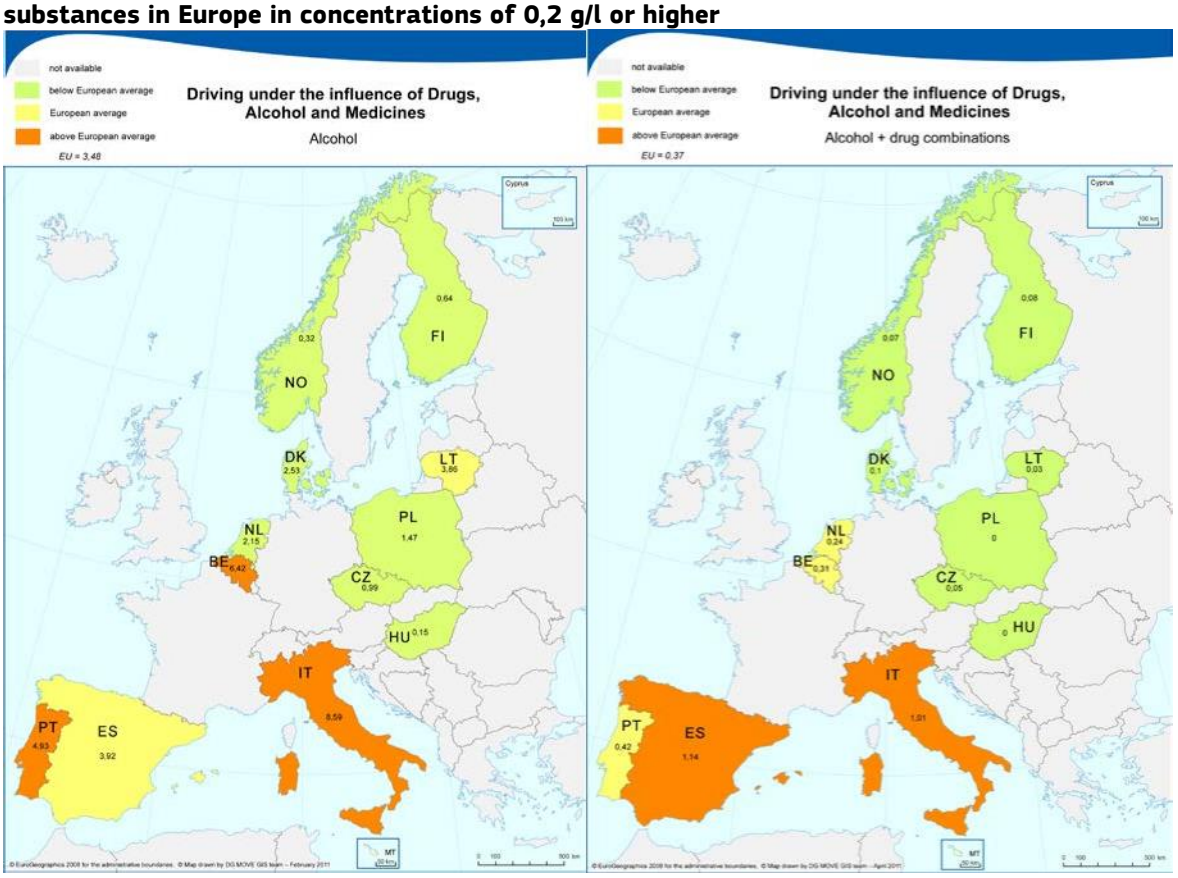
2.2 Drinking and driving

A definitive comparison of the prevalence of drunk driving in EU Member States has not been possible until recently since definitions of drunk driving and applied data collection methods have differed from country to country. In 2011, results from the European research project DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) were published. The main objective of this project was to provide a scientific base for European policy on driving under the influence of psychoactive substances. The project included 13 national prevalence studies.

Alcohol use in EU countries

Figures 5 and 6 present an overview of the alcohol use in EU Member States both for single alcohol use (0,2 grammes/litre (g/l) or higher) and for the use of alcohol (0,2 g/l or higher) in combination with other psychoactive substances (Houwing et al., 2011). The use of other psychoactive substances in combination with alcohol is important for traffic safety since the relative risk for combined use of alcohol and other psychoactive substances is higher than the relative risk for alcohol alone.

Figures 5 and 6: Prevalence of alcohol alone and alcohol in combination with other psychoactive substances in Europe in concentrations of 0,2 g/l or higher



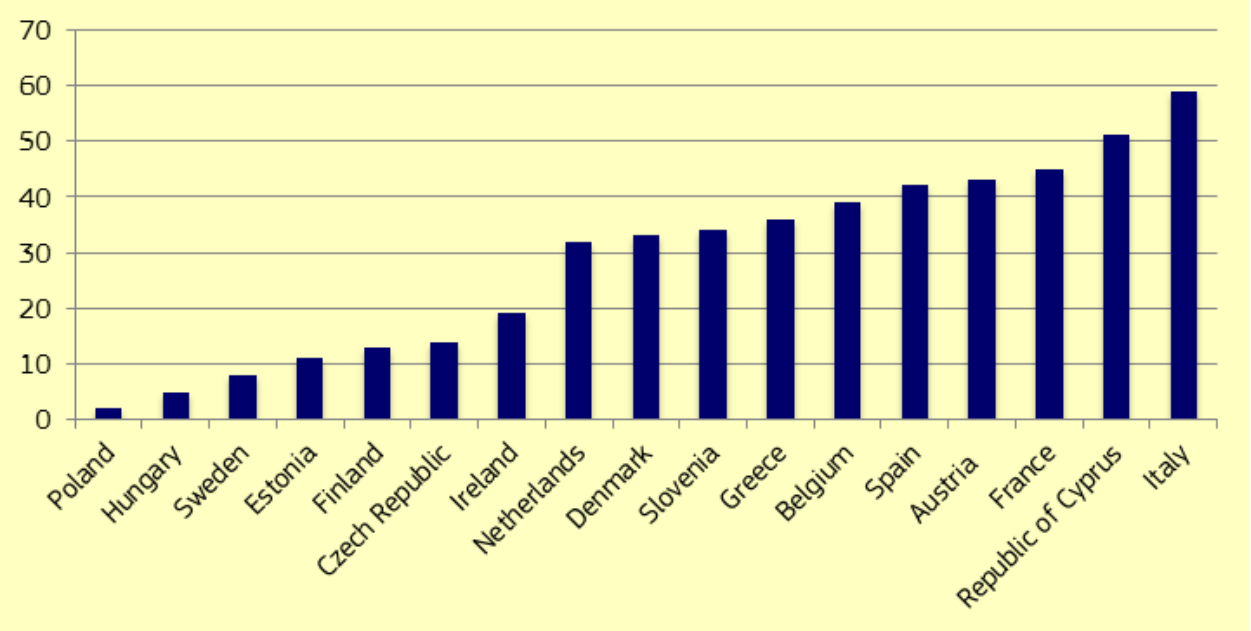
Source: DRUID Deliverable 2.2.3: prevalence of alcohol and other psychoactive substances in drivers in general traffic.

Based on the results of the prevalence studies, a weighted mean of the prevalence of alcohol use in European traffic was calculated. It was estimated that 3,85% of European drivers drove with a BAC of 0,2 g/l of which 3,5% with alcohol alone and 0,35% with alcohol in combination with other psychoactive substances. For 0,5 g/l and higher, the average prevalence of alcohol alone is 1,5% and 0,16% for alcohol in combination with drugs and medicines.

Survey data on drunk driving behaviour is also available. In 2010, the SARTRE 4 survey of driver opinion and reported behaviour was conducted in 17 participating European countries. Around one thousand drivers completed questionnaires in each country in a face-to-face interview. Some of the questions were about drink driving behaviour but those questions referring to driving over the legal limit are not mentioned here, as few drivers will admit to illegal behaviour even though anonymity is guaranteed.

The SARTRE 4-questionnaire asked: "Over the last month, how often have you driven a car having drunk even a small amount of alcohol" (SARTRE 4, 2012, p.422). Figure 7 shows, in ascending order, the percentage of drivers in each participating EU member state that reported to have combined drinking and driving.

Figure 7: Percentage of respondents that reported to have driven with any amount of alcohol in the past month



Source: SARTRE 4

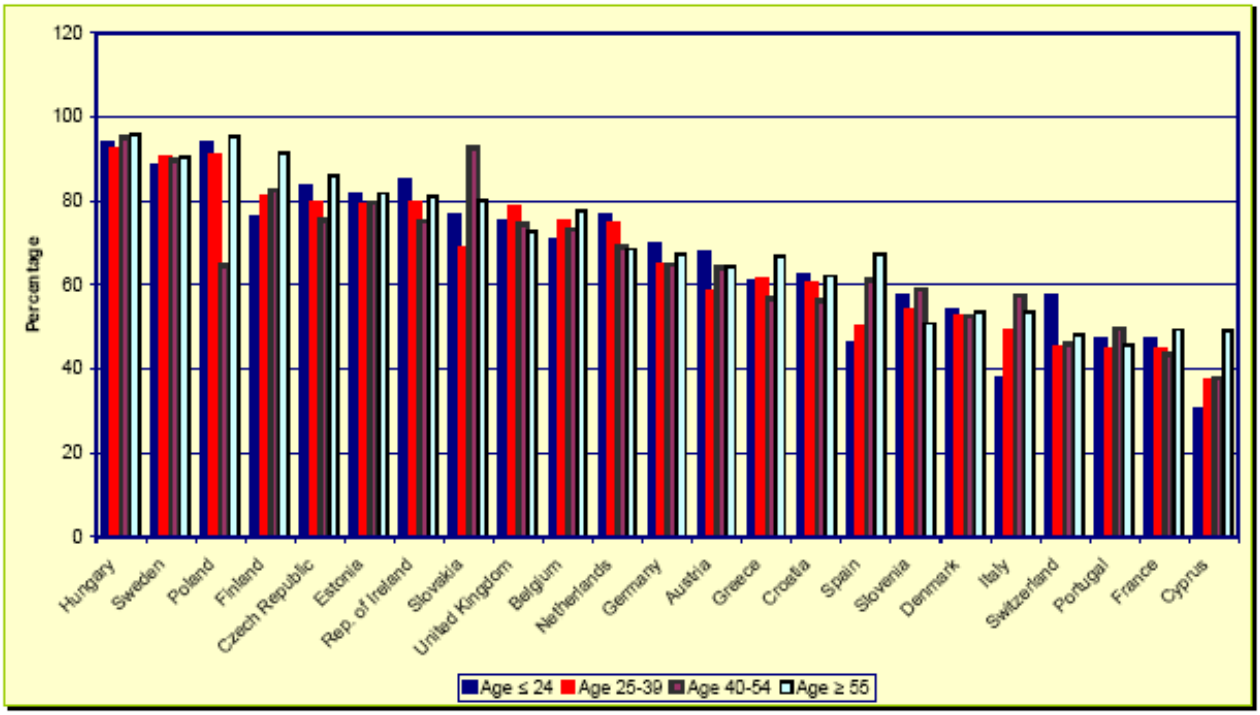
In general, countries in Southern Europe (e.g., Italy, Cyprus, and Spain) had higher rates of self-reported alcohol use when driving than countries in Northern and Eastern European countries (e.g., Poland, Hungary, Sweden, Estonia, Finland, and Czech Republic,). In Italy, for example, the majority of drivers said that they have driven with some amount of alcohol in the past month, whereas in Poland more than 95% reported not to have consumed even the smallest amount of alcohol before driving. The overall rates have decreased since the previous SARTRE 3 report. However, the ranking of countries has not changed.

Is drinking and driving more prevalent in certain age groups?

The number of respondents per age group is not available for the SARTRE 4. Instead, the results of the SARTRE 3-questionnaire are presented in Figure 8 as well as Figure 9. The SARTRE 3-questionnaire was administered in 2002, as with SARTRE 4, to 23 participating European countries. The SARTRE 3-questionnaire asked: "How many days per week do you drive after drinking even a small amount of alcohol?"

Figure 8 shows the percentage of drivers per age group that replied "never" or "non-drinker" to the question "How many days per week do you drive after drinking even a small amount of alcohol?"

Figure 8: Percentage of respondents that answered "Never/Non-drinker" to the question "How many days per week do you drive after drinking even a small amount of alcohol?" by age band



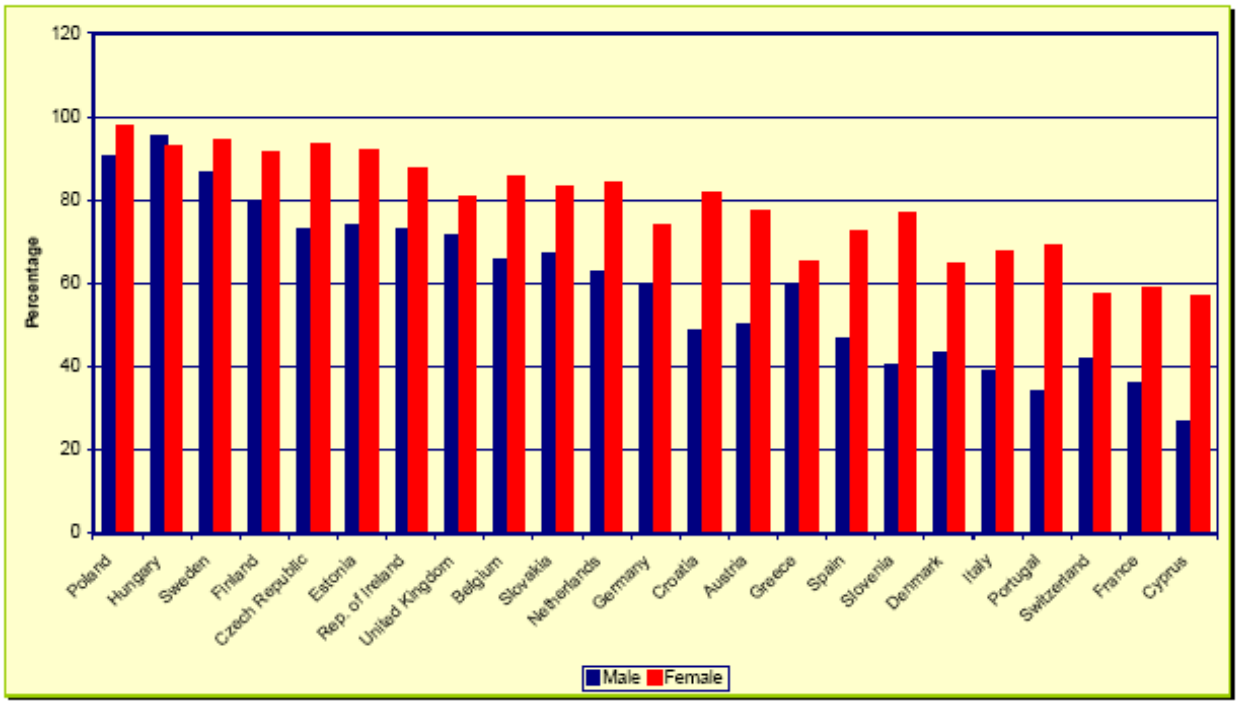
Source: SARTRE 3

In most countries the difference between age-groups is quite moderate. People tend to think that young drivers combine drinking and driving most often, but Figure 8 shows that for most countries the opposite is the case. There are however exceptions. In Italy, Cyprus, Finland, and Belgium young drivers say that they drink and drive more often than in any other age group.

Do men combine drinking and driving more often than women?

Figure 9 shows the percentages of men and women that say that they never drink and drive, either because they are total abstainers or because they never combine drinking and driving.

Figure 9: Drivers that say that they never drink and drive or never drink at all by gender



Source: SARTRE 3

In all countries except Hungary, more women than men responded that they do not drink and drive. In Cyprus and Portugal more than twice as many women than men responded that they don't drink and drive.

2.3 The legal limit

The legal limit is not the same in all EU Member States. In Table 1 the legal limits in the 28 EU Member States are presented. Some EU Member States have different penalties for different limits and have different limits for novice drivers and professional drivers. These limits are mentioned in Table 1.

Table 1: Legal BAC limits (g/l) for the general driving population EU

Country	Standard	Commercial drivers	Novice drivers
Austria	0,5	0,1	0,1
Belgium	0,5	0,2	0,5
Bulgaria	0,0	0,0	0,0
Croatia	0,5	0,0	0,0
Cyprus	0,5	0,2	0,2
Czech Republic	0,0	0,0	0,0
Denmark	0,5	0,5	0,5
Estonia	0,2	0,2	0,2
Finland	0,22	0,22	0,22
France	0,5	0,5*	0,2
Germany	0,5	0,0	0,0
Greece	0,5	0,2	0,2
Hungary	0,0	0,0	0,0
Ireland	0,5	0,5	0,2
Italy	0,5	0,0	0,0
Latvia	0,5	0,5	0,2
Lithuania	0,4	0,0	0,0
Luxembourg	0,5	0,2	0,2
Malta	0,8	0,8	0,8
Netherlands	0,5	0,5	0,2
Poland	0,2	0,2	0,2
Portugal	0,5	0,2	0,2
Romania	0,0	0,0	0,0
Slovakia	0,0	0,0	0,0
Slovenia	0,5	0,0	0,0
Spain	0,5	0,3	0,3
Sweden	0,2	0,2	0,2
United Kingdom	0,8	0,8	0,8

* 0,2 Legal BAC limit (g/l) for bus/coach drivers
Source: EC DG-Move, 2018

It is only possible to accurately estimate the prevalence of drivers that are over the legal limit in a particular country when random roadside breath tests are carried out in a systematic way. The roadside breath tests carried out by the police are not suitable for the assessment of the prevalence as most of these tests are not random, but are purposely carried out at particular times (weekend nights) and in particular spots (in the vicinity of bars and discos) with increased percentage of offenders. Except for 12 of the 13 countries that participated in the prevalence studies in the DRUID project, no other recent real random samples from breath tests are available. In the DRUID prevalence study (Houwing et al., 2011) on the basis of real random roadside breath tests (all hours of the day, all days of the week) carried out between 2007 and 2009, it was estimated that of all the car kilometres driven annually, a little less than 1,65% is driven by drivers with 0,5g/l (the legal limit in most EU countries) or more alcohol in their blood. In order to get accurate estimates about the prevalence of drunk driving in EU countries, and in order to monitor the prevalence of drinking driving, it is necessary for all EU Member States to carry out the same standardized random breath tests for research purposes.

2.4 Crashes and injuries

Drinking drivers are clearly over-represented in road traffic crashes. Alcohol-related crashes are also severe. In Germany for example, the severity of drunk-drive crashes (expressed as fatalities per 1.000 injury crashes) is nearly twice as high as that of crashes in general (Sweedler et al., 2004). Unfortunately, systematic testing all road users involved in crashes for alcohol is rare in EU countries. Therefore, alcohol-related crashes are underreported in official statistics.

Alcohol-related crashes are often based on official statistics that might be available from each country. Results from the DRUID study (Isalberti et al., 2011), for example, on the prevalence of alcohol and other psychoactive substances in injured and killed drivers show that in Finland, Norway, Portugal and Sweden the prevalence of killed drivers positive for alcohol of 0,5 g/l and above ranged between around 16% and 35%. Furthermore, in France from a sample of 7.458 fatal crashes that happened within a two-year period (2001-2003), 28,6% (95% confidence interval; 26,8% - 30,5%) appeared to be attributable to drivers that had alcohol in their blood (OFTD, 2005).

A recent meta-analysis combined the results of the above European DRUID project (2006-2011), the French SAM-study (2001-2003) and the European IMMORTAL project to show the percentage of alcohol intoxicated drivers who had a BAC level of 0,5 g/l or higher in 11 European countries (Belgium, Denmark, Italy, Lithuania, the Netherlands, Finland, Sweden, and Norway) (Ecorys, 2014). The percentage of injured drivers that was positive for alcohol above 0,5 g/l varied between 14,9% in Norway and 38,2% in Belgium. The median score was 23,6% of injured car drivers. More so, the prevalence of killed drivers positive for alcohol of 0,5 g/l or above ranged between 19% in Denmark and 60,9% in Lithuania. The media score for killed car drivers was 29,3%. Table 2 provides an overview of the results of the DRUID prevalence study, the Sam-study, and the European research project IMMORTAL among killed and injured drivers for alcohol, where data are available.

Table 2: Prevalence of alcohol (BAC 0,5+) among seriously injured and killed drivers

Country	Seriously Injured Drivers	Fatally Injured Drivers
Belgium	38,2%	
Denmark	17,8%	
Germany		19%
France		28,6%
Italy	20,6%	
Lithuania	16,1%	*
Hungary		31,1%
The Netherlands	28%, 26,5%	
Portugal		35,1%
Finland	30,2%	29,3%
Sweden	16,3%	
Norway	14,9%	23,8%

*The prevalence of fatally injured drivers in Lithuania is removed because of the high likelihood of selection bias
Source: Ecorys, 2014

More recently, the European Transport Safety Council published officially recorded numbers of drunk-driving fatalities for 30 European countries for 2001 to 2010. The median percentage of road deaths attributed to alcohol for 2005 is 11,1%, for 2008 is 8,7%, and for 2010 is 13,5% (ETSC, 2010). Table 3 presents an overview of the percentage of road deaths attributed to

alcohol for the 28 European member states in 2005, 2008 and 2010. Note that information was not available for all countries.

Table 3: Percentage of road deaths attributed to alcohol

Country	2005	2008	2010
Austria	7,3	7,7	5,8
Belgium	3,5	5,7	4,7
Bulgaria	4,9	4,2	
Czech Republic	5,5	7,9	13,5
Denmark	25,7	22,9	25,1
Estonia	37,9	41,7	30
Finland	23,5	27,9	23,5
France	28,8	28,3	30,8
Germany	10,7	7,5	7,0
Hungary	12,8	11,1	8,3
Ireland	29,8		
Italy	2,0	4,3	
Latvia	21,7	18,4	10,1
Lithuania	13,7	11,0	10,7
Luxembourg			34,4
Netherlands	4,4	3,3	2,8
Poland	8,4	8,6	6,9
Portugal	4,7	5,5	
Republic of Cyprus	22,5	23,2	43,3
Romania	7,3	8,7	8,2
Slovakia	6,2	4,0	0,8
Slovenia	37,0	36,0	35,5
Spain	28,2	28,0	31,0
Sweden	11,1	9,7	16,1
United Kingdom	16,5	15,8	13,5

Source: ETSC, 2010

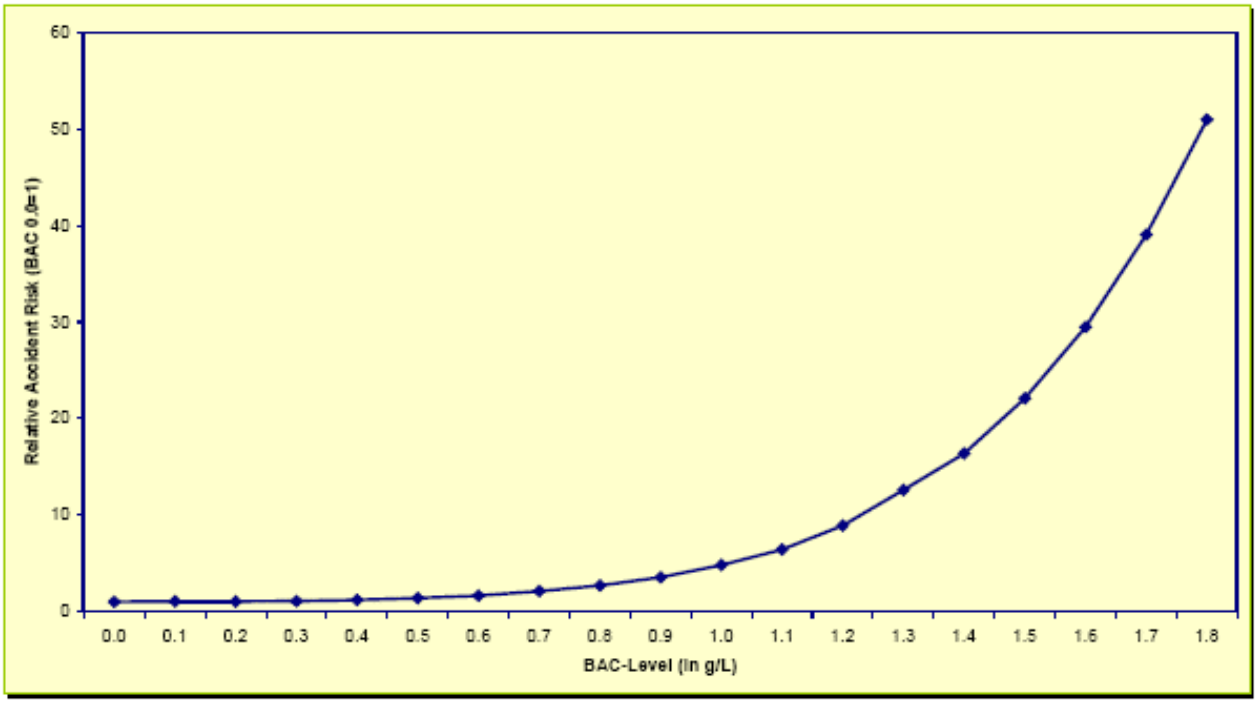
It is also possible to estimate the number of drinking drivers that have been involved in road traffic accidents on the basis of the number of drivers admitted to hospital after an accident and tested for alcohol. In one sample, for example, of all severely injured drivers that had ended up in hospital, 42,5% in Belgium and 29,6% in the Netherlands had alcohol in their blood (Legrand et al. 2012). Drinking drivers not only kill themselves, but they also kill other road users. Based on the above-mentioned research in the Netherlands and Belgium, the hospital records indicate a larger prevalence of annual traffic fatalities that are attributable to alcohol. Not only drunk driving but also drinking and walking, drinking and riding, and drinking and cycling cause fatalities. For instance, Fredriksson et al. (2012) examined all fatal crashes in Sweden where a bicyclist was killed after being hit by the front of a car, and found that 12% of all fatally injured bicyclists were under the influence of alcohol (BAC level that exceeds 0,3 g/l). In view of the above, the estimate made by the European Commission that one quarter of all annual road fatalities in the European Union are due to alcohol, is probably an under-estimate. If one assumes that the prevalence of drivers with a BAC of 0,5 g/l or more is around 1% of the total driver population in Europe (as is estimated for the Netherlands), then 1% of the drivers is responsible for around 25% of the road fatalities in Europe.

Relative crash risk

Relative crash risk is calculated on the basis of epidemiological studies. To estimate the relative risk for drinking drivers of crash involvement, the distribution of BAC levels in the

entire driver population (measured in random roadside breath tests) is compared with the distribution of BAC levels among drivers involved in crashes. These so-called case-control studies have been repeated many times and the results are very similar. A much-cited one is the Grand Rapids study by Borkenstein (1974). Borkenstein and colleagues were the first to carry out an in-depth case-control study. With the aid of modern techniques it is possible to control for even more confounding factors than in the Grand Rapids study. A methodologically sound modern case-control study is the study by Compton (2002). The results of this study are shown in Figure 10.

Figure 10: Relative rate for drink drivers to be involved in a crash as their BAC-level increases. The rate of a sober driver is set at 1



Source: Compton et al, 2002

The relationship between relative crash rate and BAC-level is exponential. From Figure 10 it can be concluded that, for example, the crash rate per kilometre driven for a driver with an 0,8 g/l BAC limit (still the legal limit in the United Kingdom and Malta) is approximately 2,7 times higher than the rate for a sober driver. In a more recent case control study information was collected from crash-involved and non-crash involved drivers for 20 months in Virginia Beach, Virginia. As reported by Compton and Berning (2015), the relative crash risk adjusted for age and gender for drivers with a BAC 0,5 g/l is approximately 2 times higher than for drivers at zero BAC. At 0,8 g/l BAC the adjusted relative risk of crashing is approximately four times higher than that of drivers at zero. At a BAC of 1,0 g/l the adjusted risk increases to 6 times, and at 1,5 g/l BAC drivers are at least 12 times as likely to crash.

A difference between Figure 10 and the often cited but old 'Borkenstein curve' is, that the 'Borkenstein curve' had a small dip in relative crash rate for low BAC-levels between 0,0 g/l and 0,5 g/l. but the 'Compton curve' has not. Another difference is that the 'Compton curve' is steeper than the old 'Borkenstein curve'.

The curve for involvement in only fatal crashes is different from the curve for crash involvement in general. Up to BAC 1,0 g/l the rise in rate of crash involvement in general and the rise in rate of involvement in a fatal crash is more or less the same. Above this level the rise in rate for fatal crashes is much steeper than the rise in rate for all crashes. The relative crash rate for a driver with a BAC of 1,5 g/l is about 22, but the relative crash rate for fatal crashes with that amount of alcohol in the blood is about 200 (Simpson & Mayhew, 1991). Thus, with increasing BACs not only the crash risk increases, but also the severity.

The increase in crash rate with increasing BACs is not the same for all age groups. In the United States, based on the crash data between 1996 and 1998, Peck et al. (2008) outlined the relative crash rate by BAC and age group as shown in Table 4:

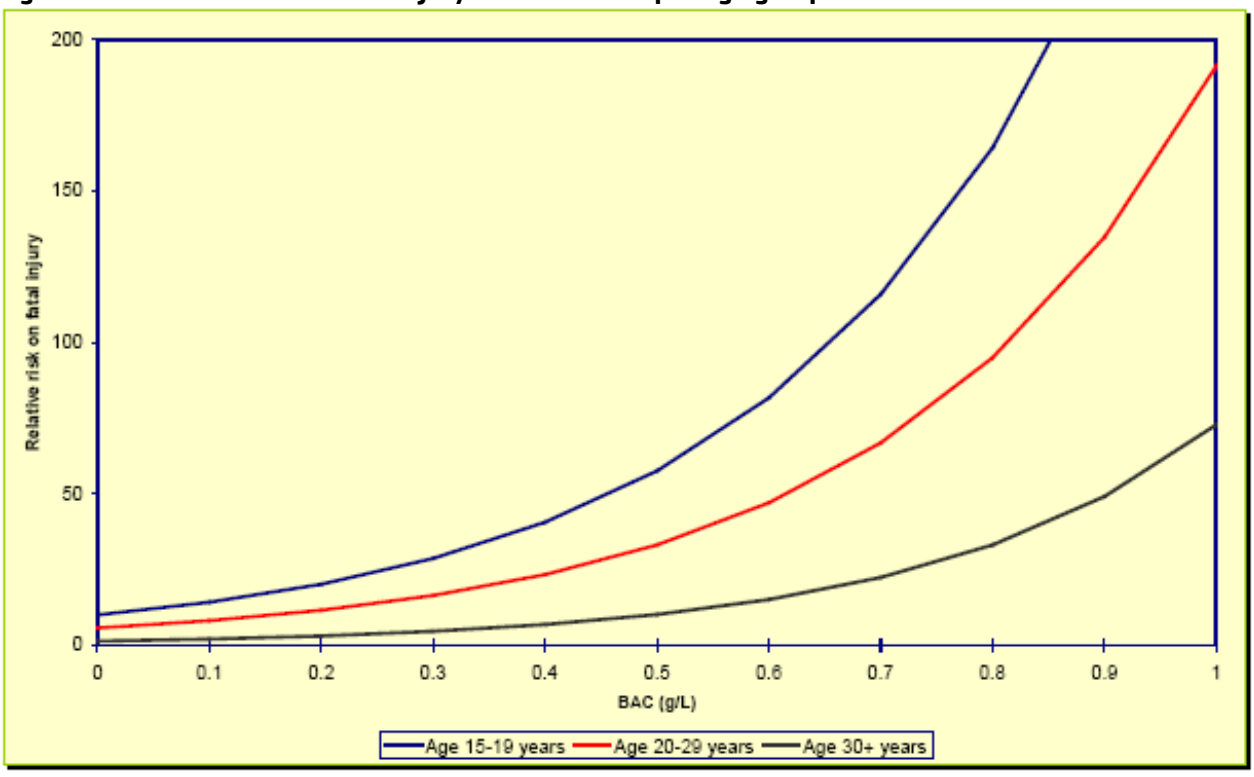
Table 4: Relative crash rate by BAC levels (g/l) and age group

	Relative Crash Rate			
Age	**BAC 0,0**	**BAC 0,1– 0,3**	**BAC 0,4 – 0,7**	**BAC 0,8 & above**
Under 21	1,00	1,42	1,26	27,4
21-24	1,00	0,86	0,78	4,62
25-54	1,00	0,80	1,05	5,72
55+	1,00	0,71	0,60	5,36

Source: Peck et al., 2008

As shown in Table 4, low doses of alcohol (lower than 0,5 g/l) have a far more devastating effect on young drivers (under 21) than on older drivers. Further results are shown in a New Zealand study in Figure 11 (Keall et al., 2004).

Figure 11: Relative rate of fatal injury and BAC-level per age group



Source: Keall et al., 2004

Alcohol is not the only substance that impairs driving skills. In particular, when illicit drugs are combined with alcohol, the effects are devastating.

The results of the DRUID report (Schulze et al., 2011), based on 15 participating European countries, for example, revealed that the relative risk of BAC 0,5-0,79 g/l for injury was 3,64 (95% confidence interval; 2,31-5,72) and for death was 45,93 (95% confidence interval; 23,02-91,66) when only alcohol was consumed. When alcohol was combined with illicit drugs, the relative risk for injury was 28,82 (95% confidence interval; 18,41 – 45,11) and for death was 31,52 (95% confidence interval; 16,83 – 59,05). In another case-control study in Belgium (Gjerde et al. 2011) it was found for fatally injured drivers, that the relative risk of drivers (adjusted for time period, season, gender and age group) that were intoxicated by both alcohol and drugs (risk of 352,9; 95% confidence interval; 70,9 – 1.762,2) was more than five times the risk of driving intoxicated by only alcohol (risk of 68,6; 95% confidence interval; 36,5-129,0).

Developments over time

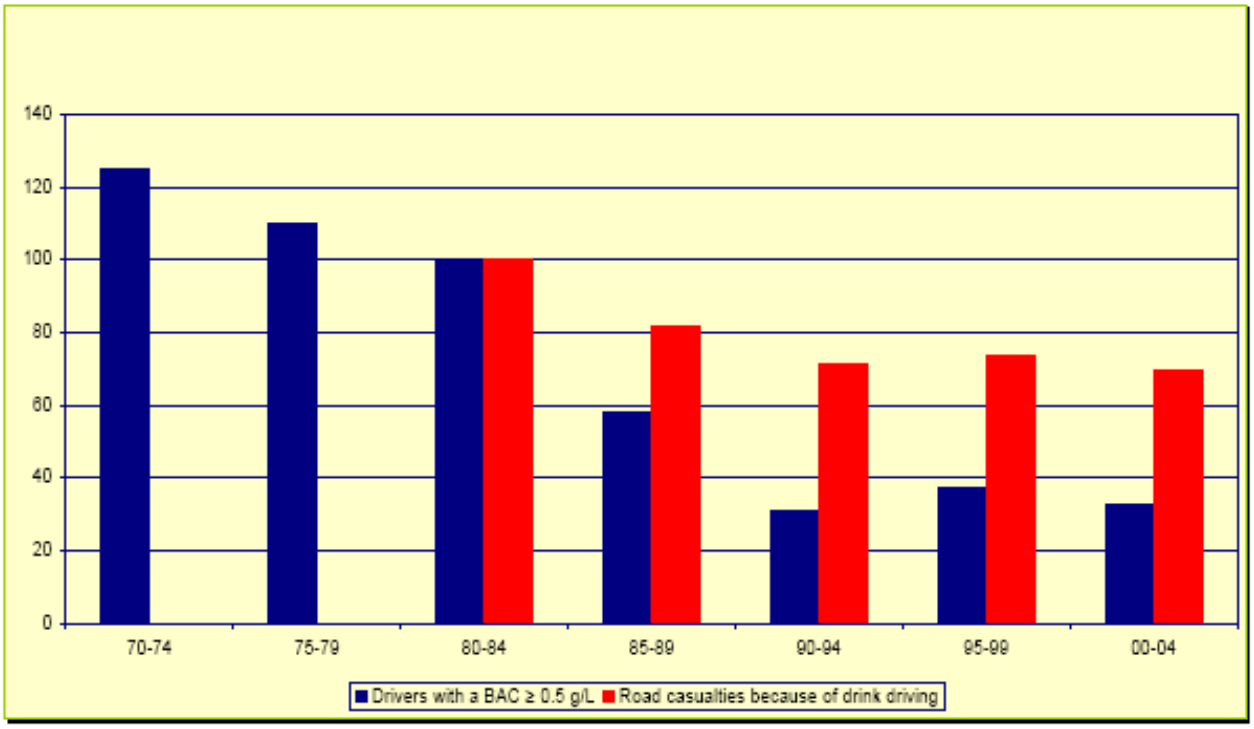
Is the drinking and driving problem in Europe increasing or decreasing? To answer this question the annual proportion of all fatalities and injuries in all EU Member States that are attributable to alcohol over a long period of time is needed. Some EU Member States have quite reliable statistics about prevalence and the number of fatalities attributable to alcohol, but most EU Member States have not.

Sweedler et al. (2004) analysed a large number of studies on the drinking and driving problem in various countries over the past decades. They conclude that improved laws, stricter enforcement, and public awareness brought about by citizens' concern during the 1980s, led to dramatic decreases in drinking and driving in the industrialized world. The decreases amounted to about 50% in Great Britain, 28% in the Netherlands, 28% in Canada, 32% in Australia, 39% in France, 37% in Germany, and 26% in the United States. Some of these decreases may be due in part to changes in lifestyle, demographic shifts, and economic conditions. In most countries the decreases reversed in the early 1990s and drinking and driving began to increase. By the middle of that decade the increases stabilized and the rate of drinking and driving began to decrease once more. These decreases were much less dramatic than those in the 1980s. At the end of the 1990s and early in the new century, the numbers vary. In some countries like France and Germany (Germany until 2002) drinking and driving continued to decrease while in other countries (Canada, the Netherlands, Great Britain, and the United States), there was stagnation and in some cases there was a small or even a large increase, as was the case in Sweden. A major part of the increase in Sweden could be related to a changing culture concerning alcohol consumption, in which everyday consumption in accordance with “continental” European habits is more common. The changing distribution between different types of beverages, in which the consumption of wine and beer is increasing and that of hard liquor is decreasing, supports this explanation. Further support is found in the fact that drinking is changing from being a weekend activity to becoming an everyday activity (OECD, 2006; 2013). As an example, a quantitative development for the Netherlands is presented in Figure 12.

Figure 12 indicates that in the Netherlands both the proportion of all drivers that drive with a BAC over the legal limit (BAC ≥ 0,5 g/l) in the Netherlands, and the proportion of casualties due to drink driving, are declining. However, drinking driving seems to decrease faster than the

number of crashes that involve drinking drivers. A possible explanation is that drinking driving has decreased, but that the number of drivers that drive while being intoxicated by both alcohol and illegal drugs has increased. As already mentioned, in combination with drugs, even small quantities of alcohol (quantities below the legal limit) can lead to a large deterioration in driving skills. Another possible explanation is that, at least, in the period 2000-2004 the number of drivers exceeding the legal BAC limit decreased, but the number of hard-core drinking drivers (drivers with high BACs) has not. This relatively small group of hard-core drink drivers is probably responsible for many casualties.

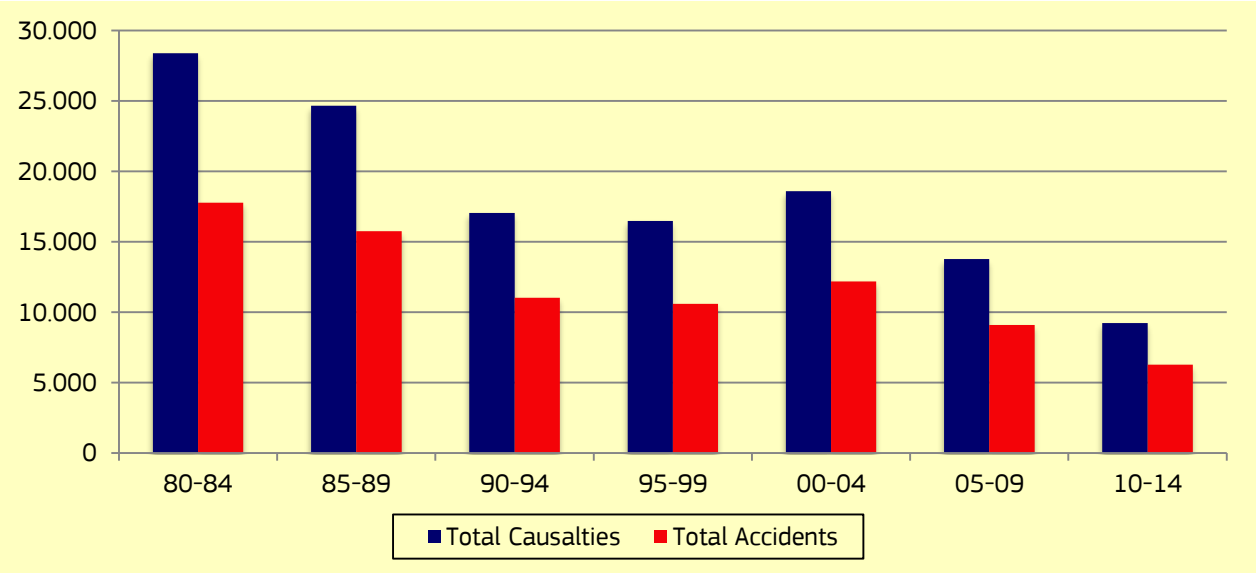
Figure 12: Indexed development in the Netherlands of the proportion of drivers with a BAC ≥ 0,5 of the entire driver population and the proportion of road casualties (fatal and seriously injured) due to drunk driving of all casualties (80-84=100)



Source: Wegman, F. & Aarts, L. (Ed.), 2005
Note: Some of the estimates used to produce Figure 12 were rather speculative. Both the number of drivers with a BAC of 0,5 or more and the number of casualties (fatalities and severely injured road users) because of drinking and driving (the drunk drivers themselves, their passengers and/or the occupants of the vehicles, and pedestrians they crash into) were indexed at 100 for the period 1980-1984. It was not possible to estimate the proportion of casualties due to drinking driving for the periods 1970-1974 and 1975-1979.

This decrease in road causalities has been noted in other European countries, such as Poland, Slovenia, and the United Kingdom (OECD, 2013). As an illustration of more recent trends, Figure 13 presents the estimated number of reported drink drive accidents and casualties in Great Britain from 1980 to 2014 according to the United Kingdom National Statistics. The total number of accidents attributed to alcohol decreased by approximately 68% from the periods 1980-1984 to 2010-2014. Similarly, the total number of causalities has decreased by 65% during the same time period.

Figure 13: Estimated number of reported total drunk drive accidents and causalities for Great Britain, 1980-2014



Note: The prevalence is presented by average for each time period.
Source: UK Department for Transport, 2014

2.5 Characteristics of alcohol-impaired drivers

The characteristics of drivers impaired by alcohol differ from those of the average driving population in several ways. A Canadian study (Macdonald & Mann, 1996) showed that drivers under the influence of alcohol were more often alcohol dependent, drank excessively, were more often aggressive, impulsive and depressed, had more often negative attitudes to laws, and experienced more often stress. The authors concluded that these problems had more to do with their alcohol use than their driving under the influence. These characteristics have continuously been found in various countries (Dahlem & White, 2006; Klimkiewicz et al. 2014; Panayiotou, 2015, Voas and Lacey, 2011).

Alcohol impaired drivers are also less tending to wear seatbelts (Bogstrand et al. 2015; Phillips & Brewer 2011) and are more likely to commit traffic violations (Ferguson et al., 1999; Glitsch, 2003; Pasa et al. 2013). Ferguson et al. (1999) state that the following groups drive more often under the influence of alcohol:

1. young males with a lower social-economic status;
2. persons who have problems with alcohol use or who drink more often;
3. persons with insufficient knowledge and deviating attitudes towards drink driving; and
4. persons with an extensive background of criminal behaviour or who commit a lot of traffic offences.

Although males are the majority of drunk drivers, the rate of conviction for female drunk drivers is increasing in some countries (Beuret et al. 2012; Robertson et al. 2014). Some authors posit this increase to the changes in the socio-legal climate, mechanisms of social control and social control policies (Robertson et al. 2014). One British study, for example, asked female drunk drivers about this increasing trend and posited some of the change to the cultural shift of social acceptability of women drinking alcohol, the differing biological rates of alcohol consumption, the increased accessibility and availability of alcohol, drink industry's

targeting of women, and the lack of prevention messaging targeting women (Beuret et al. 2012). Interestingly, the characteristics of female drunk drivers differ slightly from male drunk drivers (Robertson et al. 2014). One Sweden-based study, for example, examined the BAC levels of drunk drivers and found that female drunk drivers were older than male drunk drivers, and that this demographic group had higher BAC levels than younger female drunk drivers (Jones & Holmgren, 2009).

Another interesting finding is that the characteristics of first time offenders show more resemblance with repeated offenders than with drivers who did not commit offences. This is contrary to the impression that most drivers who are caught for the first time are social drinkers (Rauch et al., 2010).

3 Effects of alcohol consumption

The effects of alcohol on mental and physiological functions are numerous. Alcohol leads to both acute impairments and chronic impairments. Acute impairments are immediate but transient, whereas chronic impairments mostly develop gradually and are persistent. Overall, alcohol has an effect on driver capabilities.

3.1 Acute impairments due to alcohol consumption

Alcohol is easily absorbed in the bloodstream. The direct effects on the central nervous system (brain, spinal cord and the nerves originating from it) are the most noticeable. In the first place alcohol functions as a depressant of the central nervous system. This is to say that after having consumed low quantities of alcohol, social inhibition starts to get less stringent and one begins to act and feel more emotionally. Cognitive, visual, and motor functions also begin to deteriorate after small quantities of alcohol have been consumed.

Even with BAC as low as 0,3 g/l, most people can divide their attention less adequately and are less vigilant than without alcohol. With a BAC just above 0,5 g/l, most people start to get perception problems and to perform less well on cognitive tasks and tracking tasks. Reaction times get longer. Motor impairment can be observed in most people with a BAC of 1,5 g/l and higher. Alcohol has a strong motivational and emotional impact especially on young people, who become more euphoric, more impulsive and start to show-off with more risk-taking behaviour. After consuming large quantities of alcohol people can become aggressive. High doses of alcohol lead to alcohol poisoning which can cause brain damage and death. There are not only acute effects because of brain dysfunctions due to alcohol, but also other parts of the body are affected. An important acute effect in relation to road safety is that the muscles weaken. This means that in case of a crash, the injuries will be more severe if a road user has consumed alcohol.

The strength of the acute impacts of alcohol is dependent upon weight and sex. If a heavy in weight man consumes the same quantity of alcohol as a light in weight woman (and both are not regular drinkers), the man will be slightly less adversely affected than the woman. The reason for this is that alcohol dilutes itself in the water volume of the body and muscle tissue contains more water than fat tissue. On average men have more muscle and less fat than women.

Absorption of alcohol from a healthy adult body occurs at an average rate of about 8 grams per hour. This means that it takes about one hour and thirty minutes for one consumed glass (100 ml) of wine (12%) or one consumed glass (275 ml) of beer (5%) to be absorbed.

The maximum BAC-level a person has after having consumed alcohol can roughly be estimated with the help of the 'Widmark formula'. This formula can be given as follows:

BAC-level (in g/l) = (Alcohol dose in grams) / (Body weight in kilograms x R)

R = the whole body alcohol distribution ratio:
R= 0,55 for females
R= 0,68 for males
Example: A man that weighs 80 kilogrammes has consumed three cans of beer in a short period of time. Each beer can contains 33 cl beer and the volume percentage of alcohol in that beer is 5%. What would his maximum BAC-level be?

Calculation: The man has consumed (3x33cl) 1 litre beer. As the alcohol concentration of that beer is 5%, he has consumed 50 ml pure alcohol. 1ml alcohol = 0,789 grams alcohol. Thus the man has consumed (50 x 0,789) 39,45 grams alcohol. His maximum BAC-level now is: 39,45/(80 x 0,68) = 0,73 g/l

The formula can be refined by also taking the rate of absorption of alcohol from the body in time into account. It must be stressed that the 'Widmark formula' is a rough indicator only.

Acute effects can still occur even if the alcohol has completely disappeared from the body. If alcohol has been consumed excessively, this will lead to a hangover. A hangover is the result of dehydration, low-blood sugar, and poisoning. The symptoms of a hangover are: headache, thirst, vertigo, nausea, insomnia, and fine tremors of the hand. The psychological symptoms include: acute anxiety, guilt, depression, irritability, and extreme sensitivity.

3.2 Chronic impairments due to prolonged alcohol consumption over time

Daily consumption of no more than about 30ml of pure alcohol for men, and about 20ml pure alcohol for women, will cause no health problems. Above these quantities there is an increasing health risk. Almost all organs of the body can be affected. Alcohol can have an impact on the following organs: liver, digestive system, heart and circulatory system, the bones, and the brain and nervous system. The diseases stemming from chronic alcohol abuse include: liver cirrhosis, Korsakoff's psychosis, cancer, strokes, pancreatitis, gastritis, high-blood pressure, fertility problems, and impotence. Heavy drinking is also closely linked with social problems (at home and at work) and even psychiatric illness (violence, suicide).

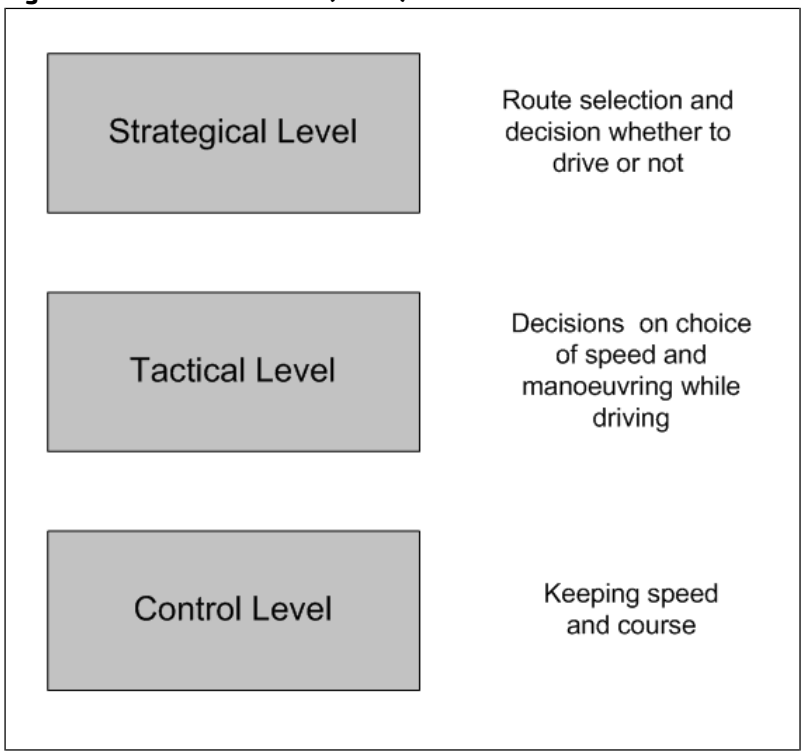
3.3 Effects on driver capabilities

An overview of studies carried out in laboratories, driving simulators and instrumented vehicles concluded that most skills related to the driving task already start to deteriorate at a BAC-level as low as 0,2 g/l (Moskowitz & Robinson, 1987). Recent studies have found similar results,

proving reliable evidence that deterioration occurs below a BAC level of 0,5 g/l (Liu & Ho, 2010; Moskowitz et al. 2000; Tzambazis & Stough, 2000).

The driving task can be divided in three subtasks using the model of Michon.

Figure 14: Michon's model (1985)



The first group of sub-tasks includes the tasks on the operational level. These are the actions that have to be carried out to keep speed and course. They include steering, changing gear, accelerating, braking but also other manual and mostly fully automated actions for manoeuvring and keeping the vehicle in an optimum operational state (i.e. switching on the windscreen wipers) while driving.

The second group of subtasks includes the tasks at the tactical level. These are the decisions taken when participating in traffic - e.g. the application of the rules of the road (i.e. I have to yield for that other car) and decisions concerning manoeuvres that include other road users (i.e. now I can safely overtake that other car).

The third group includes the tasks at the strategic level - e.g. vehicle choice and route choice. Here, the decision concerns whether the driver will drive or not after having consumed alcohol.

Alcohol affects task performance at all three levels. However, the overwhelming majority of the research that has been carried out is on the effects alcohol has on the tasks at the operational level and the tactical level. For a recent overview, see Caird et al. (2005). For the operational level of the driving task, the review's conclusions are:

- Tracking performance (keeping course) starts to deteriorate at a BAC as low as 0,18g/l. Reductions in performance with respect to keeping a constant distance behind a leading

vehicle (keeping headway) starts at a BAC of 0,54g/l when the leading vehicle keeps a constant speed. When the leading vehicle changes speed, reductions in performance start at a BAC as low as 0,3g/l.

- Reaction times when driving get longer. There is a difference between a driver's capability to carry out simple reaction time tasks and choice reaction time tasks. In a simple reaction time task a driver has to press a key as quickly as possible after a stimulus (auditory or visual) has been presented. In a choice reaction time task a driver has to respond differently to two stimuli by pressing one key for event A and a separate key for event B. Choice reaction time begins to deteriorate at a BAC of 0,6g/l, but for simple reaction time tasks the BAC is considerably higher before significant prolonged reaction times appear.
- Reactions on a visual detection task (perception) when driving starts to decrease significantly at a BAC of 0,8g/l.

At the tactical level:

- Decreases in the ability to divide attention between the driving task and another task start at BACs between 0,3 and 1g/l (depending on the complexity of the second task). When drivers have to divide their attention between driving and another task (i.e. having a conversation with a passenger) and this ability starts to deteriorate because of alcohol, subjects tend to focus on one of the two tasks at the expense of the other.
- When BAC increases, drivers tend to fix their eyes more on the central visual field and fewer eye movements are made to the peripheral view. When under the influence of alcohol, drivers use fewer sources in the visual field to obtain information about the environment, take longer to recognize and respond to aspects that present vital information about their environment (i.e. street signs) and focus their attention on aspects occurring in the central field of vision often at the cost of peripheral information.
- The increase in the number of mistakes and prolonged reaction times when drivers are confronted with a complex secondary task, even when small quantities of alcohol are consumed, indicates that alcohol causes information processing to be hampered.

The impact of alcohol on the performance of a driver at the strategic level cannot be studied in driving simulators or instrumented vehicles. However, according to the Theory of Planned Behavior (TPB) (Ajzen, 1991), alcohol must have a significant impact on the strategic level. The TPB states that intentions are influenced by three mechanisms: attitudes, subjective norms, and perceived behavioural control (PBC). Attitudes towards certain behaviour reflect the degree of positive or negative evaluation the individual has towards performing it (i.e. drinking and driving is dangerous). Subjective norms refer to the perceived social pressure to engage or not engage in certain behaviour. This reflects a driver's 'significant others' would think about the intended behaviour (i.e. my friend would disapprove when I drive while I am drunk). PBC reflects the perceived ease or difficulty of undertaking a given behaviour (i.e. if I wanted to, I could easily drive safely when I am drunk). Alcohol consumption leads to loss of self-control and thus it has an effect on PBC. After having consumed alcohol a driver is much more inclined to think that he or she can easily drive safely.

4 Measures

A measure is effective when it leads to either a substantial reduction of the crash or crash injury rate associated with alcohol consumption or to a substantial reduction of the number of kilometres driven while the driver is drunk (the prevalence). The measures to reduce drink driving can be categorized in four separate groups. These groups are:

Reducing the availability of alcohol
- Limiting points of sale
- Increasing prices
- Raising the minimum drinking age

Separating drinking from driving
- Alcohol ignition interlocks
- Designated driver programmes
- Public transport

Police enforcement
- Legal limits
- Amount of (random) roadside breath tests
- Sanctions

Education and information (which support proven interventions)
- Education programmes on alcohol in schools and in driver training
- Driver improvement courses (rehabilitation courses)
- Public campaigns
- Promotion of safety culture

4.1 Reducing the availability of alcohol

Increasingly, steps are being taken by countries aimed at reducing the negative aspects of alcohol consumption. Research and experience show that it is possible to discourage alcohol consumption by increasing the price of alcohol (higher taxes), restricting the sale of alcohol in time (restricting the opening hours of the places where alcohol can be bought and where it can be consumed) and place (especially banning the sale of alcohol in petrol stations and transport cafes). Another measure in this category is raising the minimum drinking age (i.e. in the U.S. alcohol is not for sale for people younger than 21).

Of all the measures mentioned in this category, all but one evaluation studies examine changes in the general drinking age. These studies have all been carried out in the United States. From these studies Elvik et al. (2009) conclude that raising the drinking age (from 18 to 21) leads to a decrease of 24% of all fatal crashes involving drivers of 18 to 21 years of age and a 31% decrease of injury crashes in this age group. One study did focus on the physical availability of alcohol through the restriction of the sale of alcohol. Schofield and Denson (2013) found an association between longer business hours with increased drunk driving charges among first-time drunk driving offenses but not among repeat offenders.

4.2 Separating drinking from driving

Alcohol interlocks (See also ERSO Vehicle Safety and eSafety web texts, aic.tirf.ca, and www.interlocksymposium.com)

Alcohol ignition interlock systems are automatic control systems which are designed to prevent driving with excess alcohol by requiring the driver to blow into an in-car breathalyser before starting the ignition. The system is designed to detect and measure the driver's BAC level, which is connected to the vehicle's ignition. It registers the BAC level and the vehicle will be prevented from starting if the level exceeds a predetermined limit. The alcohol ignition interlock can be set at different levels and limits.

The fitment of alcohol interlocks is a well-established feature of mandatory rehabilitation schemes for excess alcohol offenders. Several Member States as well as road transport operators are now promoting and including the voluntary fitment of alcohol interlocks in passenger cars and in commercial and passenger transport operations.

In EU countries, Sweden uses them on a large scale in rehabilitation programs as well as for general preventive use in commercial vehicles. Countries are increasingly using mandatory alcohol interlocks in rehabilitation of offender programmes and for school buses. For example, other member states that use alcohol interlocks with rehabilitation programmes or in some commercial vehicles include Finland, Belgium, France, and the Netherlands.

Effectiveness of alcohol interlocks in Rehabilitation programmes

Alcohol interlocks have an important role to play within rehabilitation programmes. Large scale quantitative research on alcohol ignition interlocks in use has shown that alcohol interlocks are 40 to 95% more effective in preventing drink driving recidivism than traditional measures such as license withdrawal or fines (ICADTS, 2001; SUPREME, 2007; Elder et al., 2011; Voas and Lacey 2011). A literature review (UK Department for Transport, 2004) showed a recidivism reduction of about 28-65% in the period where the alcohol interlock is installed compared with the control groups who were not using the alcohol interlock. According to a methodologically sound evaluation study on the installation of an alcohol ignition interlock in cars of offenders, the recidivism in this group dropped by about 65% in the first year after installation (Beck, 1999).

Research shows that while alcohol interlocks are installed in the vehicle, they reduce recidivism among both first offenders and repeat offenders, including hardcore offenders (also known as persistent/chronic drinkers and repeat offenders who repeatedly drive after drinking with extremely high blood alcohol concentrations and are resistant to change this behavior). More than 10 evaluations of interlock applications have reported reductions in recidivism ranging from 35-90% (Voas and Marques 2003; Vezina 2002; Tippetts and Voas 1997; Coben and Larkin 1999) with an average reduction of 64% (Willis et al. 2005).

A more recent study commissioned by the Centers for Disease Control and Prevention (CDC) that involved a systematic review of 15 scientific studies found that while interlocks were installed, the re-arrest rate of offenders decreased by a median of 67% compared to groups who did not have the device installed (Elder et al. 2011). A Swedish study (Bjerre and Torsson 2008) revealed that the frequency of annual DWI offenses decreased by approximately 60%

among offenders who completed a two-year interlock program. Similar reductions were found two to four years after removal of the device.

Research indicates that alcohol interlocks need to be fitted permanently to have an effect, for after removal of the lock recidivism increases again (Bax et al., 2001; Elder et al., 2011; Voas and Lacey 2011). Specifically, existing studies converge at the finding that once the device is removed, recidivism rates return to levels comparable to rates of those who did not have an interlock installed (Beirness 2001; Beirness et al. 1998; Jones 1993; Popkin et al. 1993; Coben and Larkin 1999; Marques et al. 2001; DeYoung 2002; Raub et al. 2003). As a consequence of increased recidivism following the removal of the alcohol interlock, several studies have reported that employing alcohol interlocks may be necessary as a long-term or permanent condition of driving for repeat offenders (DeYoung 2002; Rauch and Ahlin 2003; Raub et al. 2003; Beirness et al. 2003).

More recent studies have begun to note declines in recidivism that are maintained following the removal of the interlock. For example, a Swedish study (Bjerre and Torsson 2008) found that the frequency of annual DWI offenses decreased by approximately 60% among offenders who completed a two-year interlock program. Similar reductions were found two to four years after the removal of the device. A New Mexico study found that offenders who participated in the interlock program had a 39% lower recidivism rate following the removal of the device than those offenders who never had the device installed (Marques et al. 2010). Rauch et al. (2011) found similar results in Maryland. Offenders who participated in a two-year administrative interlock program had a 36% reduction in DWI recidivism during the two-year intervention and a 26% reduction in DWI recidivism during the two-year post-intervention period. A recent Canadian evaluation of the interlock program in Nova Scotia relied on conviction and collision records, self-administered questionnaires, monthly charge-, conviction-, and collision- counts, and interlock logged events (Vanlaar et al. 2014, 2015). Two intervention groups were compared to two control groups. One intervention group consisted of voluntary interlock participants while the other consisted of mandatory interlock participants. Control groups were composed of either eligible offenders or offenders without an opportunity to participate in the program. Results from this study suggest that the interlocked offenders were less likely to re-offend, even after device removal. It was not possible to definitively conclude what the reasons were for this finding; the authors speculate that the post-interlock effect may be due to the elaborate treatment and rehabilitation program in Nova Scotia that interlocked offenders have to participate in while on the interlock (Vanlaar et al. 2014, 2015).

No conclusive research is available that establishes a correlation between the use of alcohol interlocks and the prevention of alcohol-related crashes. When compared to DWI arrests, alcohol-related crashes are an infrequent occurrence and the low rate of interlock installation (approximately 20%) makes it difficult to create a pool of data for analysis purposes (Fieldler et al. 2012). The few studies that have examined the effects of interlocks on crashes report that alcohol-related crashes decrease while the interlocks are installed in vehicles (Elder et al 2011). Preliminary research by Marques et al. (2010) found that as interlock installation rates increased in New Mexico, the frequency of alcohol-related crashes decreased. A systematic review of literature that was conducted for the CDC's Guide to Community Preventive Services revealed limited evidence that alcohol-related crashes decrease while the interlock device is installed (Elder et al. 2011). Overall, the crash rates for those with interlocks were similar to that of the general driving population but greater than those offenders who drove with

suspended licenses (Guide to Community Preventive Services 2011; Bjerre 2005; DeYoung et al. 2005). Recently, Vanlaar et al. (2014, 2015) did find an effect on crashes in the evaluation of Nova Scotia's interlock program, but it was not significant at the 5% level; rather, a small decrease in crashes associated with the interlock program was found to be significant at the less rigorous 10% significance level. In particular, the study produced some weaker evidence showing that there was a permanent decrease in the number of alcohol-related crashes with fatal and serious injuries due to the interlock program.

According to Goodwin et al. (2013), the preponderance of evidence suggests that interlocks are a highly effective method for preventing alcohol-impaired driving – and possibly crashes – while they are installed.

Benefits to cost of alcohol interlocks in the Netherlands and in Czech Republic
The results of cost benefit analyses for implementing alcohol interlocks for drivers caught twice with a BAC between 0,5g/l and 1,3g/l and for drivers caught with a BAC above 1,3g/l are:
For the Netherlands, the reduction of 35 traffic fatalities annually is valued at 4,8 million per death, leading to a benefit of 168 million Euros. Benefit/cost ratio = 4,1
For the Czech Republic, the 8 fatalities prevented are counted at 1,1 million Euro/death, leading to estimated benefits of 9 million Euro/year. Benefit/cost ratio = 1,6
For Norway, the benefits are calculated as 5,5 deaths less per year a rate of 5,9 million Euro per death, or at 32,5 million Euro /year. Benefit/cost ratio = 4,5
For Spain, the reduction with 86,5 deaths/year at 800.000 Euro per death would imply benefits of 69 million Euro/year. Benefit/cost ratio = 0,7

Source: IMMORTAL, 2005

Research has shown that participation rates will be lower if an imposed alcohol interlock programme is preceded by a long-term license suspension (Beirness, 2001; Goodwin et al., 2013; Voas and Lacey 2011). Another factor that influences participation rate is the cost of the program for the participant. An evaluation of the Californian alcohol interlock programme (DeYoung, 2002) found that one of the main reasons for courts not to order instalment of the alcohol ignition interlock was that many offenders seemed unable to pay for an alcohol interlock. Other reasons for not ordering alcohol interlocks were that they did not believe that it would be an effective measure, as many offenders owned no vehicle, and that the monitoring of offenders was time consuming. The participation rates of voluntary alcohol interlock programmes were low as well. Low participation was attributed mainly to the low detection risk of driving while suspended that outweighed the inconvenience and costs associated with the participation in an alcohol interlock programme.

The difficulty associated with the detection of unlicensed drivers makes the decision not to install an interlock and instead drive without a license seem like a low-risk option for offenders (Voas et al. 2010). Recent research also suggests that judges do not consistently impose alcohol interlock sentences and that offender non-compliance is common. A California study revealed that of 775 DWI offenders sentenced to install an alcohol interlock as a condition of probation, 191 offenders (approximately 25%) did not have the device installed (DeYoung 2002). Similar results were found in Florida as only 25,6% of arrested offenders installed a mandatory interlock (Marques et al. 2010).

Research also indicates that repeat offenders are less likely to install an alcohol interlock compared to first offenders (Voas and Tippetts 1997). Offenders fail to install alcohol interlocks for various reasons: to avoid compliance, inconvenience, embarrassment, and cost.

In order to remedy low participation and compliance rates, offenders can either be offered incentives (e.g., reduced fines, reductions in hard suspension periods) or face a more unpleasant alternative (e.g., house arrest, vehicle impoundment). And in this regard, some U.S. states have made the alternatives to interlocks more undesirable – e.g., house arrest with electronic monitoring; other states allow offenders to shorten (or eliminate) the license suspension period if they are willing to operate an interlock-installed vehicle (Voas and Lacey 2011; Goodwin et al., 2013). Compliance can also be increased through the use of close supervision and monitoring of offenders (Zador et al. 2011).

Finally, research has also shown how important it is to ensure good monitoring of compliance with program rules. Vanlaar et al. (2013, 2014, 2015) and Casanova Powell et al. (2014) used different data and methodologies and both concluded that interlock programs can benefit from strong monitoring in that offenders will be more compliant with program rules while on the interlock when program monitoring is stronger. Important features of good monitoring include collecting and reviewing of interlock log data, graduated responses to instances of non-compliance as well as rewarding instances of good behaviour, regular visual inspection of the device and establishing a face-to-face rapport with interlock clients.

In light of the available evidence, expert recommendations for a set of criteria to maximise the effect of alcohol interlock programmes specify that: participation of the programme should be obligatory, the programmes should fall under administrative law, the driving license should clearly identify that a person is only allowed to drive a vehicle with an alcohol interlock, the compliance to the programme should be properly enforced and the contents and duration of the programme need to be tailored to the characteristics of the target groups (Beirness & Robertson, 2002).

Alcohol interlocks use in commercial and passenger transport operations

There has been no evaluation of the impact that alcohol interlocks used in commercial transport have on road safety but Swedish companies report that fitting alcohol interlocks has prevented excess alcohol consumption amongst fleet drivers. Some 23% of municipalities and 18% of county councils have stipulated the need for alcohol interlocks when purchasing new public and private transport vehicles. Some 70.000 alcohol interlocks are in use in Sweden in trucks, buses and taxis on a voluntary basis.

4.3 Designated driver programmes

Another means of separating drinking from driving is not offering alcohol to drivers in restaurants, discos, pubs, bars etc. One way of doing this is the so-called 'designated driver programme'. Here, a designated driver who has to abstain from alcohol is appointed before a group of people decides to drive in one car to a certain place where they are about to drink and the designated driver has to abstain from alcohol. To compensate for this inconvenience the designated driver is very often offered free soft drinks.

Effectiveness of designated driver programmes

It is very difficult to evaluate the effectiveness of designated driver programmes because designated drivers are informally determined and somewhat imprecisely defined (Goodwin et al., 2013). Ditter et al. (2005) carried out a systematic review of the sparse available studies and found only one evaluation of a designated driver programme. This was the "Pick-a-Skipper" campaign in Western Australia. Telephone surveys indicated a 13 percentage point increase in people always selecting a designated driver and these people were also more likely to report awareness of the 'Skipper' concept. However, there was no significant change in self-reported drinking and driving or riding with an alcohol-impaired driver. Ditter et al. found more evaluations of small-scale designated driver programmes (i.e. a particular disco that has a designated driver programme). Some positive effects were found but overall the effects were quite modest. More recently, Watson and Watson (2014) report results from an outcome evaluation of the "Skipper" designated driver program. Self-reported survey results showed that awareness of the program in the intervention area was quite high four months following its introduction in a provincial city in Queensland and that this was maintained at 16 months. They also found an increase in the proportion of people participating in designated driver as a passenger. However, the authors report that it is less clear whether the Skipper program impacted other behaviours of interest, such as drink driving, or involvement in alcohol-related crashes.

In a review from Australia, Nielson and Watson (2009) concluded that designated driver programs can successfully increase awareness and use of designated drivers, but evidence for changes in alcohol-related crashes is inconclusive. They also observe that the lack of supportive evidence does not necessarily mean that such programs should be discouraged but rather it highlights the need for them to be better implemented and evaluated. And in this regard, other reviews of designated driver programs note that such programs may have unintended consequences – e.g., encourage heavy drinking by passengers – and are fraught with impediments – e.g., designated drivers often drink, for example, because groups of drinkers may designate a driver after drinking has commenced or at the end of a night of drinking (Voas and Lacey 2011).

Public transport

This category refers mainly to efficient and cheap public transport to get people from places where alcohol is consumed without having to drive. These transport modes include taxis, subways, buses and ride service programs. A few studies have evaluated ride service programs and have reported reductions in injury crashes and alcohol-related crashes but not in crashes overall (Goodwin et al., 2013). According to Decina et al. (2009), a model alternative transportation program should be continually available, free to users and convenient and easy to use.

4.4 Police enforcement

The enforcement of the legal limit for excess alcohol is the most commonly used method to reduce drunk driving. The effective element of police enforcement is deterrence and the effectiveness of deterrence depends on the driver's perception of the risk of detection and the severity of the ensuing penalty.

A distinction can be made between general deterrence and specific deterrence. The aim of general deterrence is to motivate all drivers not to break the rules by creating fear of sanctions and by conveying the impression that the chance of being caught is high. The aim of specific deterrence is to improve the attitudes and behaviour of drivers once they are caught in order to prevent recidivism. For this purpose, severe sanctions like suspension of the driving license ("I will never drink and drive again because the temporary loss of my driving license has been a horrible experience.") and remedial treatment programmes are used. Well-known remedial treatment programmes are for instance compulsory driver rehabilitation courses for offenders.

Effectiveness of police enforcement

As mentioned previously, the effect of police enforcement is based on three elements: the level of the legal limit, the risk of being caught when exceeding the limit, and the severity of the sanctions. The effects of these elements will be dealt with separately.

Low legal limits

The prevailing public health and road safety message is that it is better not to drink any alcohol and drive. However, most countries introduce specific thresholds for excess alcohol which allow enforceable limits and 0,5g/l is most commonly used in Europe. The World Health Organisation states that a legal limit for the general driving population of 0,5g/l is the highest legal BAC limit that can be supported by a combination of crash injury and behavioural research (Peden et al., 2004).

A meta-analysis of studies carried out by Elvik et al. (2009) on reducing the existing BAC limit for all drivers in a country from 0,8g/l to 0,5g/l found a reduction of 2% in fatal crashes and a reduction of 13% in injury crashes. Allsop (2005) estimates that in the United Kingdom 65 lives would be saved annually if the legal limit for the general driver population is reduced from 0,8g/l to 0,5g/l.

In the United States, some states have established lower BAC limits for drivers with one or more DWI offences. A few studies have shown that lowering the BAC limit reduces the proportion of repeat offender drivers in fatal crashes (Goodwin et al., 2013).

Some countries have introduced lower limits of 0,2g/l for the general driving population and/ or for young drivers and professional drivers. The main rationale for a 0,2g/l limit rather than zero is: 1) to take account of the possibility of inaccuracy in breath testing devices at these low levels, and 2) the fact that alcohol can be present in the mouth without having consumed alcohol.

For young drivers, the crash rate starts to rise significantly at very low levels and the introduction of lower limit has resulted in road safety improvements. For example, after implementing a BAC limit of 0,1g/l in Austria for novice drivers, there was a 16,8% fall in fatal crashes involving drivers with a BAC-level of 0,8g/l or more (Bartl & Sturmvoll, 2000). Zero tolerance laws, making it illegal for any driver younger than 21 to have a positive BAC level, have also been shown to reduce injuries and fatalities in studies conducted in Australia and the United States (Voas and Lacey 2011).

In a review of studies on the effects of lowering the legal BAC limit, Voas and Lacey (2011) concluded that in general, lowering the BAC legal limit reduces drinking-driver fatal crashes,

whether the change is from 1,0 to 0,8g/l BAC or from 0,8 to 0,5g/l for adults, or from 0,5 to 0,2g/l BAC. The implementation of BAC limits of a maximum of 0,2g/l was recommended by the European Commission for those drivers and riders who have a much higher crash risk, either because of their lack of experience and/or the type of vehicles they drive, and also for drivers of large goods and passenger carrying vehicles, and also for drivers of vehicles carrying dangerous goods. (Commission Recommendation 2001/115/EC of January 2001).

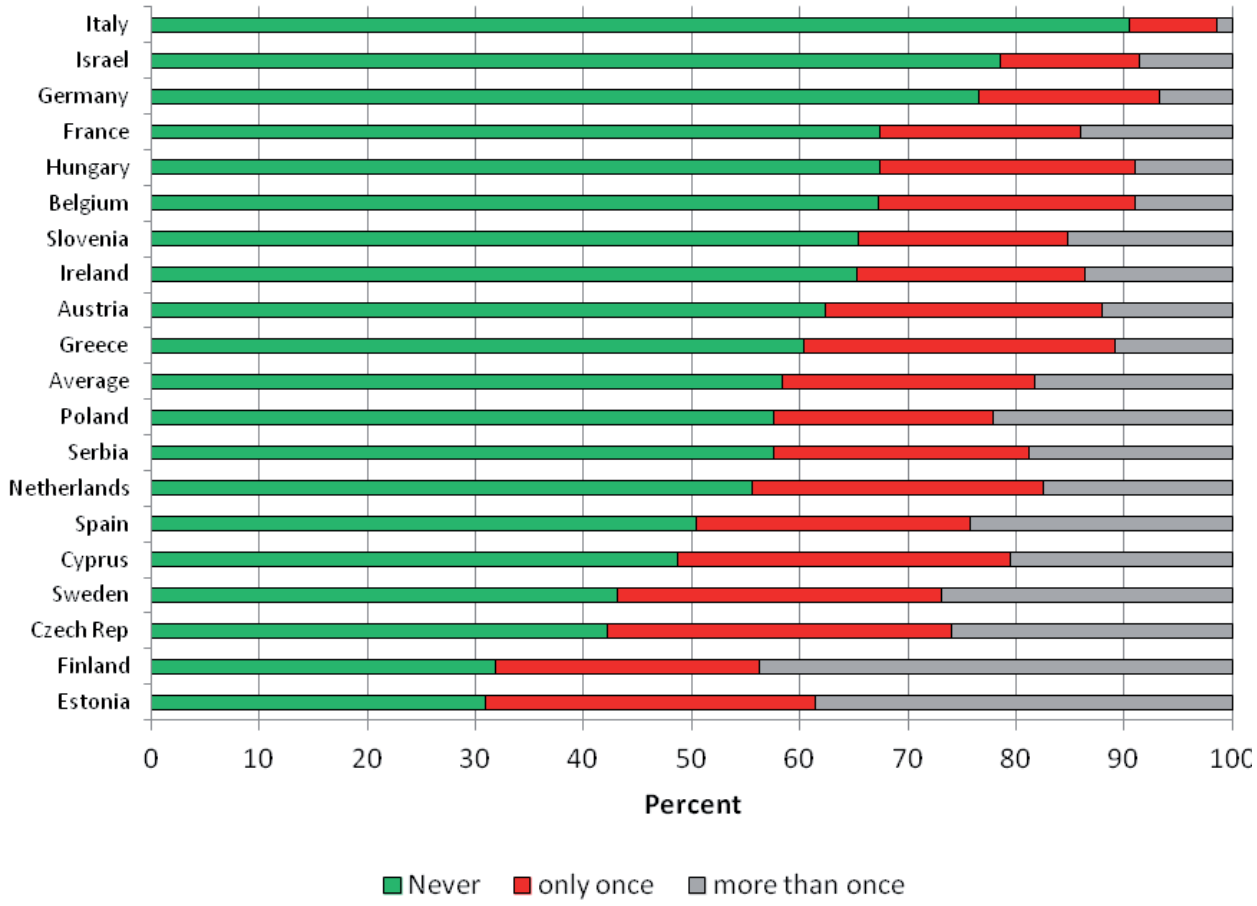
Amount of (random) roadside breath tests

Some countries provide for random roadside breath testing. Others require 'reasonable cause for suspicion' (i.e. the smell of alcohol or erratic driving) before a police officer can test a driver. Both systems are effective, but random breath testing (RBT) is twice as effective as testing only after suspicion (Henstrig, 1997; Voas and Lacey 2011). After each doubling of the number of RBTs in the Netherlands, the number of drink driving offenders decreased by approximately 25% (Mathijssen, 2005). The effectiveness of RBT can be enhanced when it is targeted in the vicinity of places where alcohol is consumed and at times when the prevalence of drink driving is high, i.e. in weekend nights, and when publicity accompanies enforcement campaigns. Research and experience suggest that highly-visible RBT (to deter) combined with targeted RBT that is not clearly visible (to detect) is the most effective (ETSC, 1999).

The ESCAPE Project (Mäkinen et al., 2003) reports that the Finnish police have pursued a systematic DUI (Drinking Under the Influence) surveillance, including random breath testing and extensive use of publicity, for over a quarter of a century. In Finland, the risk of being caught for drink driving has increased considerably since 1977 when the police were first empowered to carry out random breath testing and were equipped with pocket-size Alcometer breath analysers. In 2003, some 40% of drivers were tested annually in Finland and the number of those caught for excess alcohol had fallen within a decade from 0,33% to 0,14%. Penalties for drinking and driving were gradually reduced.

The risk of being controlled for alcohol differs substantially between EU Member States. One of the questions in the SARTRE 4-questionnaire (2012) was: "In the past 3 years, how many times have you been checked for alcohol?" The results are shown in Figure 15.

Figure 15: Self-reported frequency of alcohol controls over the past 3 years



Source: SARTRE 4

Cestac and Delhomme (2012) reported that about 3 in 5 of the car drivers (58%) have not been checked for alcohol when they have been behind the wheel in the past 3 years. Further 23% only once, and the remaining 18% more than once. Almost none of the drivers in Italy had been checked on alcohol in the past three years as opposed to just one 1 in 3 in Finland and Estonia.

Cestac and Delhomme also observed that in 2002 the SARTRE 3 project found 71% of drivers were never checked and in the SARTRE 4 in 2010 only 58%, which could suggest more police activity.

According to Ferris et al. (2015), research considers Australia to have the most successful random breath testing program in terms of alcohol-related traffic reductions in comparison to other countries. They report that an Australian survey in 2011 found 80% of those surveyed had seen a random breath testing program in operation in the last six months and 37% had been breath tested. Peek-Asa (1999) reported that, on average, random breath testing in Australia reduced alcohol-related fatalities by 33% and alcohol-related injuries by 17%. The degree of effectiveness across Australian states depends on the type of program implemented. Faulks et al. (2010) note that the initial success of random breath testing rested on high levels of testing, sustained operations and strong media campaign support, while long term success was linked to sustained testing levels and innovation.

Sanctions

Fines have some effect, but studies show that these effects are not sustained. According to Goodwin et al. (2013), although most U.S. states impose fines, studies suggest that fines appear to have little effect on reducing alcohol-impaired driving. They also observe, however, that fines do support the DWI enforcement system financially and, in this regard, support the objective of making the system self-funding – i.e., provide a means for restitution to the community (Voas and Lacey 2011).

A Canadian case-crossover study of general police enforcement (Redelmeier, 2003) found that the fatal crash rate in the month after conviction was about 35% lower than in a comparable month with no conviction. However, 3-4 months after the conviction drivers drove in as unsafe a manner as they did before the conviction. When the severity of the conviction increased (more demerit points), the effect on the relative rate reduction increased, but this was not sustained. However, if the conviction was very severe (two of these types of convictions would be enough to lose one's driving license), the effect on the reduction of the relative crash rate was small again. Voas and Lacey (2011) observe that there have been many research studies on DW enforcement but more work is needed on enforcement methods, especially to develop more effective low-cost high-visibility programs that can more readily carried out by local police agencies. According to these authors, an effective DWI enforcement system creates and maintains the public's concern with the impaired driving problem and supports police activities as well as other prevention activities that reduce impaired driving.

According to Voas and Lacey (2011), for the last century, driver licence suspension has been the most widely used and most effective sanction for impaired driving. In a meta-analysis by Elvik & Vaa (2004) it was found that driving licence suspension leads to a reduction of all crashes by 18%, thus very effective. However, if enforcement is weak, drivers who have lost their driving licence may start to drive illegally. In this regard, Voas and Lacey (2011) observed that licence suspension is only partially effective because up to 75% of suspended offenders drive illegally. And Goodwin et al. (2013) have observed that some DWI offenders continue to drive with a suspended licence, and many DWI offenders do not reinstate their licence when they are able to do so. Voas and Lacey (2011) reference a report on a U.S. study that found that fewer suspended DWI drivers drove illicitly in jurisdictions where the penalties for DWI were perceived as relatively high compared to those in jurisdictions in which this illegal behaviour was perceived to be relatively low.

Withdrawal of the driving licence can be sanctioned either with or without conditions such as alcohol interlocks, exclusion of specific types of vehicles or medical examinations. After the period of withdrawal, a license is only re-granted after a new driving licence application is made. This is different from suspension where a driver gets his driving license back at the end of the suspended period. And, in this regard, the National Transportation Safety Board (2013) observed that although driver licence suspensions are an effective means of reducing alcohol-impaired traffic fatalities such laws could be strengthened by requiring individuals arrested for DWI install an alcohol ignition interlock as a condition of licence reinstatement. A recent study including a questionnaire and a literature study (Bukasa et al., 2011) concludes that there were significant reductions in recidivism rates from driving licence measures with a duration of 3 months to 12 months. For driving licence measures with a duration longer than 12 months an increase of recidivism rates was often found. Furthermore, the best effects were visible when driving licence sanctions were combined with additional treatment or rehabilitation measures.

This was also the conclusion of a recent study that examined the contribution of remedial programs and roadside licence suspension to drinking and driving deterrence in Ontario, Canada. Ma et al. (2015) found strong converging evidence that remedial alcohol education/treatment programs in combination with other sanctions can produce substantial increases in road safety.

Penalty point systems for alcohol are included in the legal practice of a number of European countries. However, there are many differences between these systems regarding the number of points collected or deducted and sanctions applied. The effectiveness of penalty point systems in general is estimated as modest. But it can be increased by increasing the general and specific deterrence effect (SWOV fact sheet penalties in traffic). According to Goodwin et al. (2013), however, most evidence suggests there is a population of drivers for whom increasing penalties do not seem to have the desired deterrent effect.

In the United States alcohol anklets or bracelets are being imposed by courts as a measure to reduce recidivism among convicted drivers. The anklet is part of a non-invasive alcohol monitoring system that samples an offender's perspiration every 30 minutes to ensure compliance to sobriety. According to Voas and Lacey (2011), devices of this type can potentially keep DWI offenders from driving while impaired, yet minimally affect their employment or their families. In a review of the limited research on such electronic monitoring systems, Goodwin et al. (2013) reported that recidivism was reduced by one-third in an electronic monitoring program in Los Angeles County, California.

Imprisonment seems to be less effective according to Elvik et al (2009). A change in Norway and Sweden from imprisonment to a graduated tariff of fines and licence suspension had led to reduction of all crashes by 4%. Voas and Lacey (2011) also reported on evaluation studies that found remedial interventions (treatment and educational programs) to be more effective than traditional punitive sanctions, such as jail terms and fines, in reducing recidivism and alcohol-related crashes, particularly when combined with license restrictions.

Very short (48-hour) jail sentences for first offenders, however, may be effective and the threat of jail may be effective as a deterrent (Goodwin 2013). The threat of a substantial jail sanction can motivate offenders to participate in treatment programs and to comply with interlock and other sanction requirements (Voas and Lacey 2011).

4.5 Education and information

Information and awareness about the dangers of drinking and driving, walking and cycling need to be available at an early age in order to encourage healthy attitudes and is a recommended curriculum topic in both primary and secondary schools. In secondary schools, programmes that aim to shock and confront students with the effects of alcohol are being introduced increasingly. One example is the Traffic Informers programme. Traffic Informers are people who have been seriously disabled in a road crash where they at fault (i.e. they were drunk) and who inform students about the circumstances of their crash and how the consequences of the crash have affected their lives. Another example are so called 'road shows' .These are plays in which the destructive consequences of road crashes are presented in an emotionally charged and moving way.

These types of fear-based campaigns confront people with depictions or associations of negative consequences of risky behaviours by capitalizing on their fears (SWOV 2009; Robertson and Pashley 2015). It takes advantage of the emotions of a target audience, and may rely on graphic imagery (e.g., crash footage, injuries) to scare and shock individuals, or use messages that attempt to invoke shame or guilt.

In the U.S. another approach is adopted for programmes based on social norms. This theory suggests behaviour is influenced by (often inaccurate) perceptions of how other members of their social group think and behave (Yanovitzky 2004). This phenomenon is similar to the 'bandwagon effect' described by McAllister & Studlar (1991) which predicted that personal beliefs are strengthened if it is believed that others share the same attitudes and perceptions towards the behaviour. It suggests that a person's social perceptions may have a more powerful effect on behaviour than the risks to health or safety (Robertson and Pashley 2015). Here, nothing is communicated about the dangers. Instead students are told in a positive manner and based on research that the overwhelming majority of the students do not drink and drive. Often these messages are combined with positive strategies to avoid drinking and driving. The assumption is that most students want to conform to what is considered normal in their social environment.

The dangers of drinking and driving also need to be addressed in formal novice driver training.

Public campaigns using mass media also aim at raising awareness of the dangers of drinking driving and are intended to change attitudes and behaviour. Some public campaigns only inform about the dangers of drinking and driving. These dangers can be presented in a quite neutral way but they can also be presented in a shocking manner and dwell on the dire consequences. There are also public campaigns with the explicit intention to raise the perception of the risk of getting caught. Another category is use of a positive message that the more and more people do not drink and drive and promote strategies to avoid drinking and driving e.g. the so-called Bob-campaigns in Belgium and the Netherlands (http://en.wikipedia.org/wiki/Bob_campaign).

While it is essential to concentrate the development of a campaign on the target audience, it is also important to consider other audiences who could potentially help influence the primary population (Delhomme et al. 2009; Robertson and Pashley 2015). For instance, a campaign that targets distracted driving or impaired driving behaviours among teens may also benefit from materials or messages that resonate with parents of teen drivers. This would potentially allow a campaign to influence the target audience on multiple fronts, as the behaviour of parents can shape the behaviour of teens. Understanding the environment and socio-demographic variables that are present in the local context can help to identify all populations, including those that could assist in developing effective campaigns.

Education programmes in schools and in basic driver training

The effect of having the subject of drinking and participating in traffic in the curriculum of primary and secondary schools is very difficult to evaluate in terms of a road safety effect. Similarly, the effects of including reference to the drinking and driving problem in basic driver training are unknown. Voas and Lacey (2011), however, reported on one U.S. study in which the authors (Shope et al. 1996) concluded that their findings suggested that a high-school-based alcohol prevention program can positively affect subsequent driving, particularly for students

who do not use alcohol regularly. The curriculum that was evaluated emphasized social pressures resistance training, immediate effects of alcohol, risks of alcohol misuse, and social pressures to misuse alcohol. This suggests that such subjects can be usefully included in the school curriculum and in the curriculum of basic driver training to help encourage sympathetic attitudes, not least, to anti-drinking and driving measures.

Parents have a strong effect on the development of attitudes of adolescents towards drinking and driving. A study on the effect of socialization on drinking behaviour among adolescents showed strong associations between alcohol-specific socialization (particularly of enforcing (Vorst, van der, et al., 2005) rules) and adolescent alcohol use. Although parents strongly differentiated their socialization practices between children, no differences in associations between alcohol-specific socialization and drinking were found between older and younger adolescents.

Driver improvement courses on alcohol (rehabilitation courses)

More is known about the effects of driver rehabilitation courses on alcohol for convicted drivers. These mandatory courses are not intended for drivers that have a disease-status alcohol problem. For these drivers therapy would be more suitable. According to Bartl (2002), various evaluations of driver rehabilitation courses for excess alcohol offenders (not being problem drinkers) indicate that the recidivism rate can be reduced by 50% compared to control-groups without course participation. The variation of recidivism rates is quite large, though. In general it was found that drivers with a high risk of recidivism were male; young and had a lower educational level. Furthermore, a positive relation was found between prior offences and recidivism risk (Boets et al. 2008). Ma et al. (2015) recently evaluated a remedial alcohol education/treatment program implemented in Ontario, Canada called “Back on Track”, for individuals convicted of alcohol-impaired driving. This program was associated with a 21% decrease in drinking driving recidivism in the three years following the alcohol-impaired driving prohibition.

A recent review of the research on effective remedial programs for drinking and driving offenders suggests that remedial programs for drink drivers are generally effective in reducing repeat drink driving convictions (Robertson and Pashley 2014). However, the extent to which these reductions can be achieved is less clear, with studies reporting broad variations in reductions in recidivism ranging from less than 10% to close to 80%. This may be the result of differing methodological designs of studies as well as the availability of indicators to measure reductions in drink driving behaviors as well as program outcomes. There has also been limited research to investigate the most effective program features that are essential to effectiveness.

In the recently conducted DRUID project a standard was prepared for good practice rehabilitation courses. This standard includes the existence of a national quality management body, a definition of the operative tasks of this quality management body, a multidisciplinary approach in case of prior driver assessment, objective, valid and reliable tools in driver assessment and evaluation of driver rehabilitation programmes. Out of the 90 Driver Rehabilitation programmes that were validated only 5 met these criteria (Bukasa et al. 2009).

Robertson and Pashley (2014) have more recently identified the following best practices and recommendations for remedial drink driver interventions:

- Adopt delivery mechanisms, structure, format and content of remedial programs that is informed by research and the characteristics of the targeted drink driving population.
- Incorporate high-quality, structured staff qualification, training and educational practices.
- Use an evidence-based assessment tool to identify appropriate services for drink drivers.
- Provide access to aftercare and follow-up services.
- Ensure coordination of activities between the sentencing authority and remedial programs.
- Develop a program evaluation component to inform operations and increase effectiveness.

Public campaigns

Overall public campaigns seem to be effective. In a review of research on road safety campaigns on different road safety issues, Robertson and Pashley (2105) found that overall many have shown a range of positive outcomes and demonstrated that road safety campaigns can change perceptions and reduce crashes. One of the most prominent studies involves a European meta-analysis of 437 effects extracted from 228 international studies conducted in 14 countries during the past 30 years. It revealed that road safety campaigns generally:

- reduced the number of road incidents by approximately 9%;
- increased seatbelt use by 25%;
- reduced speeding by 16%;
- increased yielding behaviour by 37%;
- increased risk comprehension by about 16% (Phillips et al., 2009).

Public campaigns, however, are not generally effective in isolation (Delhomme, 1999). The effects can differ quite substantially. Such campaigns are more effective when first a study is carried out on how the target group can best be addressed, and when the public campaign is linked with other measures (enforcement and education). Robertson and Pashley (2015) also report on a European meta-analysis that examined 119 effects extracted from 67 international studies. The meta-analysis revealed insight into the features of campaigns that contribute to effectiveness in terms of crash reductions. These features included:

- drinking and driving campaigns;
- shorter duration (less than one month);
- personal communication;
- roadside delivery, use of roadside media, or delivered in proximity to the behaviour occurring;
- combined emotional/rational message has a stronger influence than a purely rational message;
- accompanied by enforcement;
- combined with mass media (Phillips et al., 2011).

There are indications that fear-arousing public campaigns regarding drink-driving (i.e. a TV-spot in which a driver who has been drinking crashes into another vehicle and dies) are not so effective. The effectiveness of such approaches is unclear and what is known is that individuals react differently to fear-based campaigns depending on their characteristics, as well as how the fear appeals are used (Robertson & Pashley 2015). There is evidence that shows that fear-based approaches can work under specific circumstances. Campaigns that describe or demonstrate coping mechanisms (i.e., strategies that tell individuals how to avoid

or cease a negative behaviour safely) invoke greater change than those that only use fear and shock (Cismaru et al. 2009; Tay & Watson 2002; Wundersitz et al. 2010). Ultimately, research points to the fact that behaviour change likely occurs from the willingness of individuals to adopt the recommended change and the available coping mechanisms, rather than the strength of the fear appeal itself (SWOV 2009; Robertson & Pashley 2015).

Harré et al. (2005) discovered that a group that had watched fear-arousing clips of drinking and driving showed more crash-rate optimism subsequently than a group that had watched non-fear arousing clips. Crash-rate optimists believe that crashes might happen to others, but not to them. In many industrialized countries, attitudes towards drink driving have substantially changed over the past decades (from something that is not seen as so dangerous to something that is considered to be a crime and unacceptable). This is probably caused by a combination of public campaigns and police enforcement.

Promotion of safety culture

When a driver has to drive for work, his or her employer can also take measures to prevent driving under the influence of alcohol. Measures of this type are mostly headed under the name 'safety culture' with Safe System representing its new paradigm. See ERSO Work Related Road Safety web text.

A company can be said to have a safety culture when in all sections of the company, safety is considered to be of the utmost importance, and that the safety aspect is given weight to in all management decisions in all procedures and in all actions.
http://erso.swov.nl/knowledge/content/60_work/strategies_measures_and_their_implementation.htm.

In particular, a company with a safety culture:

- Adopts the long term Safe System goal towards the elimination of death and serious injury and sets interim targets towards these.
- Has a clear safety policy and the management not only promotes this policy but also leads by example.
- Analyses crashes, risk factors and near misses made in the past, and is willing to learn from these crashes and near misses.
- Takes and monitors measures that tackle the root causes of serious and fatal injury risk in road traffic crashes.

A new ISO 39001 standard on road traffic safety (RTS) management systems encourages organisations of all types and sizes towards these ends. See ERSO Work Related Road Safety web text.

An example is the use of alcohol interlock devices as part of commercial company fleet policies in Sweden. The precise effects of the establishment of a safety culture in a company on drinking and driving are not known.

In the United States, the Occupational Safety and Health Administration (OSHA), the National Highway Safety Administration (NHTSA) and the Network of Employers for Traffic Safey (NETS) have produced a white paper on Guidelines for Employers to Reuce Motor Vehicle Crashes,

including those resulting from alcohol and drug impaired driving. The 10 step program to improve traffic safety performance and minimize the risk of motor vehicle crashes includes:

- Senior Management Commitment and Employee Involvement
- Written Policies and Procedures
- Driver Agreements
- Motor vehicle record checks
- Crash reporting and investigation
- Vehicle selection, maintenance and inspection
- Disciplinary action system
- Reward/Incentive Program
- Driver training/communication and regulatory compliance.

4.6 Summary of effective measures

The problem of drink driving is not new and many measures have been taken. A very successful measure was the introduction of breath testing devices by the police back in the 1970s. Despite the fact that drinking drivers now know that they can be caught and that sanctions are tough, and despite public opinion regarding drinking and driving having hardened considerably, alcohol-impaired road users are still involved in about a quarter of all fatal crashes in Europe. New and better measures are needed.

Depending upon the circumstances, the effectiveness of new measures may vary from country to country. However, in general it can be stated that the following measures are effective:

- Random breath tests for all drivers and not only for 'suspected' drivers to raise the perception of the risk of being caught by carrying out more random roadside breath tests (especially at times and locations where drinking and driving is expected). However it must be noted that an increase in random roadside breath tests is less effective in countries where those test are already carried out on a large scale than in countries where random roadside breath testing is carried out occasionally (Elvik, 2001).
- A legal limit for the experienced driver of 0,5g/l or lower and a legal limit for novice drivers of 0,2g/l or below. However it must be noted that a very low legal limit (lower than 0,5g/l) for the experienced driver can be counterproductive. This is the case when the energy spent on enforcement of low levels is at the expense of the energy on enforcement of higher levels.
- Alcohol ignition interlocks installed in the cars of severe first time offenders and all recidivists in combination with a driver rehabilitation course.
- Better public campaigns combined with police enforcement and education programmes (for all age groups) based on scientific research which can help to encourage sympathetic attitudes to action on drinking and driving.
- Restrict the availability of alcoholic beverages, especially for young novice drivers. This can be done by raising the age limit for buying alcohol and by banning the sales of alcoholic beverages in petrol stations and transport cafes.
- Improve the recording of the prevalence of drinking and driving and the involvement of drinking drivers in crashes in all EU Member States in order to monitor the effects of measures.

- In the long run it may be possible to equip all cars with fraudulent-proof, user-friendly alcohol ignition interlocks that cause no inconveniencies for non-drinking drivers.

When developing a policy to combat the drinking and driving problem in a country, it is important not to single out any one measure since a package of interrelated measures will offer the best results. The focal point of such a package is the legal limit(s) which ultimately gives drivers guidance about society's perception of safe drinking and driving levels.

4.7 Public support for measures

There is public support for stringent measures to combat drinking and driving. In the SARTRE 4-questionnaire (Cestac and Delhomme 2012) an overwhelming majority of interviewed car drivers (84%) wanted more severe penalties for drinking drivers in their country. The differences between the EU Member States were small. The agreement for more severe penalties for drinking and driving, however, actually decreased slightly from 8 years before when 88% of interviewed car drivers agreed to the implementation of much more severe penalties (SARTRE 3, 2004)

Of all drivers, 45% of SARTRE 3 (2004) respondents believed that there should be a BAC-limit of 0g/l. In Eastern Europe 60% of the respondents are of the opinion that there should be a BAC- limit of 0g/l, but only 26% of the respondents in Southern Europe are in favour of this. The percentages for northern and western European countries are respectively 47% and 43%. In Eastern Europe more drivers prefer a zero BAC-limit than in other parts of Europe. This is not so surprising as a couple of countries in Eastern Europe already have a BAC-limit of 0g/l.

Among car drivers interviewed in SARTRE 4 (Cestac and Delhomme 2012), 59% of them think that the alcohol limit should be less than present (i.e. no alcohol at all + less alcohol than at present), 46% think drivers should not drink any alcohol at all before driving. However 8% thought drivers are allowed to consume 3 to 4 units of alcohol before driving.

The lower the national BAC-limit is, the more drivers interviewed in SARTRE 3 think that they can drink less alcohol to stay under the legal limit. 70% of the drivers of countries with a legal limit of 0g/l (Czech Republic, Hungary, and Slovakia) stated that they may not drink any alcohol at all to remain under the legal limit. In countries with a legal limit of 0,2g/l (Estonia, Poland, Sweden) 33% of the driver population think that they cannot drink at all before driving. When the legal limit is 0g/l, 28% of the drivers nevertheless think that they remain under the legal limit after having consumed the equivalent of one glass of wine (175ml of wine with an alcohol percentage of 12%) or beer (0,5 litre of beer with an alcohol percentage between 3-3,5%). When the legal limit is 0,2g/l 64% of drivers think they remain under the legal limit after one glass of wine or one glass of beer. When the legal limit is 0,5g/l 78% of the drivers think that they remain under the legal limit after having consumed the equivalent of one glass of wine or one glass of beer. In countries with a BAC of 0,8g/l, 42% of the drivers think that they can legally consume more than one glass of wine or one glass of beer before driving and in Cyprus (legal limit of 0,9g/l until 2006) 31% of the drivers also estimate that they can drink more than one glass of wine or one glass of beer.

Similar results were found in the more recent SARTRE 4 project. In Hungary and Czech Republic where legal BAC limit for driving is zero, 95% and 74% of drivers respectively understand that they should not drink any alcohol at all when driving. In France (91%), the Netherlands (88%), Belgium (77%), Slovenia (77%), Italy (75%), Finland (74%), Austria (72%), Israel (71%), Spain (71%), Greece (69%) and Cyprus (66%), all countries with a 0,5g/l BAC limit apart from Germany, two thirds or more believe that they can drink 1-2 units before driving and still remain under the legal limit. In Austria with legal BAC limit of 0,5g/l, 26% think they can drive after 3 or more units and still being under the limit.

Most drivers (82%) interviewed in all countries in SARTRE 3 are 'very' or 'fairly' in favour of a BAC-limit of 0g/l for novice drivers. In SARTRE 4 a strong support for no alcohol at all when driving is found in participating countries such as Poland (92%), Hungary (90%) and Ireland (67%). By contrast, in the Czech Republic 21% of drivers want the current BAC (0,0g/l) to be increased, in Italy 17% want the current BAC (0,5g/l) to be increased and in Cyprus 15% want the current BAC (0,5g/l) to be increased.

According to Cestac and Delhomme (2012), comparing the SARTRE 3 and SARTRE 4 data car drivers in support of a ban of alcohol when driving (no alcohol at all) have increased in Czech Republic (+20%-points), Hungary(+17%- points), Poland (+17%-points), Ireland (+10%-points), Slovenia (+9%-points), Estonia (+8%-points), Spain (+8%-points), Austria (+6%-points), Germany (+4%-points), Belgium (+3%-points), Greece (+3%-points) and Italy (+3%-points); less drivers are in support of no alcohol at all when driving on the road in the Finland (-8%-points), Sweden (-5%-points), the Netherlands (-3%-points), France (-3%-points) and Cyprus (-1%-points).

When asked in the SARTRE 3 project if an alcohol ignition interlock should be installed in all cars, one third of the drivers is 'very much' in favour of this and 25% of the drivers is 'fairly much' in favour of this. In Sweden, France, Portugal, and Greece 70% is 'fairly much' to 'very much' in favour of this but only 30% of the drivers in Germany, Austria, and Greece approve of this technological support. An alcohol-interlock in the car for recidivist drivers is approved by 84% (i.e. “very” or “fairly“) of the SARTRE 4 interviewed drivers. The support is high in Sweden (96%), Finland (95%), the Netherlands (89%), Slovenia (89%) and Ireland (89%) and less than 70% support this measure in Austria and Israel.

The majority of drivers interviewed in SARTRE 3 (77%) are 'very much' to 'fairly much' in favour of courses like the driver rehabilitation courses for offenders. There is not much difference between the countries on this subject although support in eastern countries is a little bit less.

References

Ajzen, I. (1991) The theory of planned behavior. In: Organizational Behavior and Human Decision Processes, 50, p. 179-211.

Allsop, R.E. (2005) How much is too much?-Lowering the legal drink-drive limit. In: Proceedings of the Brake Conference on Drink and Drug Driving, London, May 2005.

Bartl, G. & Sturmvoll, G. (2000) Description of post licensing measures in Austria. In: Bartl,G. (Ed.). DAN-Report. Results of the EU-project: Description and Analysis of Post Licensing Measures for Novice Drivers.

Bartl, G. (2001) EU-Project DAN. In: Proceedings of 7. Internationaler Kongress on Driver Improvement 8-10 October 2001.

Bartl, G. Assailly, J.-P. Chatenet, F. Hatakka, M. Keskinen, and E. & Willmes-Lenz, G. (2002) EU-Project "ANDREA": Analysis of driver rehabilitation programmes. Kuratorium für Verkehrssicherheit KfV, Institut für Verkehrspsychologie, 2002, 403 p., 60 ref.

Bax, C. (Ed.); Käri, O., Evers, c., Bernhoft, I.M. & Mathijssen, R. (2001) Alcohol interlock implementation in the European Union: feasibility study. Final report of the European research project. D-2001-20, SWOV, Leidschendam.

Beck, K., Rauch, w., Baker, E. & Williams, A. (1999) Effects of ignition interlock license restrictions on driver on multiple alcohol offences: a random trial in Maryland. In: American Journal of Public Health, 89, p. 1696-1700.

Beirness, D.J. & Robertson, R.D. (2002) Best practices for alcohol interlock programs: findings from two workshops. In: 16th International Conference on Alcohol, Drugs and Traffic Safety T2002 (Vol. 1, pp. 119-124). Montreal.

Beirness, D.J. (2001) Best Practices for Alcohol Interlock Programs. Ottawa: Traffic Injury Research Foundation.

Beirness, D.J., Simpson, H.M., Robertson, R.D. (2003) International symposium on enhancing the effectiveness of alcohol ignition interlock programs. Traffic Injury Prevention 4(3): 179-182.

Beirness, D.J., Simpson, H.M., Mayhew, D.R. (1998) Programs and policies for reducing alcohol-related motor vehicle deaths and injuries. Contemporary Drug Problems 25: 553-578.

Beuret, C., Corbett, C., & Ward, H. (2014) Drinking among British women and its impact on their pedestrian and driving activities: women and alcohol: phase 2: survey results.

Bjerre, B. (2005) Primary and secondary prevention of drinking and driving by the use of Alcolock device and program: The Swedish experience. In P. Marques (Ed.) Alcohol Ignition Interlock Devices. Volume II: Research, Policy, and Program Status. International Council on Alcohol, Drugs, and Traffic Safety (ICADTS), Oosterhout, the Netherlands.

Bjerre, B., & Thorsson, U. (2008) Is an alcohol ignition interlock programme a useful tool for changing the alcohol and driving habits of drink-drivers? Accident Analysis and Prevention, 40(1), 267-273.

Boets, S., Meesmann, U., Klipp, S., Bukasa, B., Braun, E., Panosch, E., Wenninger, U., Roesner, U., Kraus, L. & Assailly, J.P. (2008) State of the Art on Driver Rehabilitation: Literature Analysis and Provider Survey: DRUID Driving Under the Influence of Drugs, Alcohol and Medicines.

Bogstrand, S. T., Larsson, M., Holtan, A., Staff, T., Vindenes, V., & Gjerde, H. (2015) Associations between driving under the influence of alcohol or drugs, speeding and seatbelt use among fatally injured car drivers in Norway. Accident Analysis & Prevention, 78, 14-19.

Borkenstein, R.F., Crowther, R.F., Shumate, R.P., Ziel, W.B. &Zylman, R. (1974) Die Rolle des alkoholisierten Fahrers bei Verkehrsunfällen (grand-rapids-studie); 2. Auflage. In: Blutalkohol, Vol. 11, supplement 1, p. 1-132.

Buikhuisen, W. & Jongman, R.W. (1972) Traffic perception under the influence of alcohol. Quarterly Journal of studies on Alcohol, 33, 800-806.

Bukasa, B., Braun, E., Wenninger, U., Panosch, E., Klipp, S., Boets, S., Meesmann, U., Roesner, U., Kraus, L., Gaitanidou, L., Assailly, J.P. & Billard, A. (2009) Validation of Existing Driver Rehabilitation Measures: DRUID Driving Under the Influence of Drugs, Alcohol and Medicines.

Bukasa, B., Salamon, B., Klipp, S., Krismann, M., Larsen, L., Krasovec, B., Merc, K., Zlender, B. & Schnabel, E. (2011) Recommendations on Withdrawal: DRUID, Driving under the Influence of Drugs, Alcohol and Medicines.

Casanova Powell, T., Hedlund, J., Leaf, W., & Tison, J. (2015) Evaluation of state ignition interlock programs: Interlock use analysis from 28 states, 2006-2011. (Report NO. DOT HS 812 145). Washington DC: National Highway Traffic Safety Administration, & Atlanta: Centers for Disease Control and Prevention.

Cestac, J., and Delhomme P (ed.) (2012) European Road Users' Risk Perception and Mobility: The SATRE 4 Survey. France: IFSTTAR.

Cismaru, M., Lavack, A. M., and Markewich, E. (2009) Social marketing campaigns aimed at preventing drunk driving: A review and recommendations. International Marketing Review, 26(3): 292-311. doi: 10.1108/02651330910960799.

Coben, J.H., and Larkin, G.L. (1999) Effectiveness of Ignition Interlock Devices in Reducing Drunk Driving Recidivism. American Journal of Preventative Medicine 16(1S): 81-87.

Compton, R.P., Blomberg, R.D., Moskowitz, H., Burns, M., Peck, R.C. & Fiorentino, D. (2002) Crash rate of alcohol impaired driving. Proceedings of the sixteenth International Conference on Alcohol, Drugs and Traffic Safety ICADTS, Montreal.

Compton, R.P. and Berning, A. (2015) Drugs and Alcohol Crash Risk. Traffic Safety Facts: Research Note. Washington, D.C.: National Highway Traffic Safety Administration.

Craid, J.K, Lees, M. & Edwards, C. (2005) The Naturalistic Driver Model: a Review of Distraction, Impairment and Emergency. California PATH Research Report UBC-ITS-PRR- 2005-4, Cognitive Ergonomics Research Laboratory CERL, Berkley.

Dahlen, E. R., & White, R. P. (2006) The Big Five factors, sensation seeking, and driving anger in the prediction of unsafe driving. Personality and Individual Differences, 41(5), 903-915.

Decina, L.E., Foss, R.D., Tucker, M.E., Goodwin, A., and Sohn, J. (2009) Alternative Transportation Programs: A Countermeasure for Reducing Impaired Driving. Washington, D.C.: National Highway Traffic Safety Administration.

Delhomme, P. (ed.) (1999) GADGET-Project, deliverable 4: evaluated road safety media campaigns: an overview of 265 evaluated campaigns and some meta-analysis on crashes. RR-00-006-FR, INRETS, Arcueill.

Delhomme, P. De Dobbeleer, W., Forward, S., and Simoes, A. (2009) Manual for designing, implementing and evaluating road safety communication campaigns. Brussels: Belgian Road Safety Institute.

Department for Transport (2004) The effects of breath alcohol ignition interlock devices in cars, London.

DeYoung, D.J. (2002) An Evaluation of the Implementation of Ignition Interlock in California. Journal of Safety Research, 33(4), 473-482.

Ditter, S.M., Elder, R.W., Shults, R.A., Sleet, D.A., Compton, R. & Nicholson, J.L. (2005) Effectiveness of designated driver programs for reducing alcohol-impaired driving. In: American Journal of Preventive Medicine, Vol. 28 (5S), p.280-287.

Ecory (2014) Study on the prevention of drink-driving by the use of alcohol interlock devices. Final Report. European Commission, DG for Mobility and Transport. Rotterdam.

Elder, R.W., Voas, R., Beirness, D., Shults, R.A., Sleet, D.A., Nichols, J.L., Compton, R. (2011) Effectiveness of ignition interlocks for preventing alcohol-impaired driving and alcohol-related crashes: A community guide systematic review. American Journal of Preventive Medicine 40 (3): 362-376.

Elvik, Høye, Vaa, Sørensen (2009) The Handbook of Road Safety Measures (2nd edition).

Elvik, R. (2001) Cost-Benefit analysis of Police Enforcement. Working Paper 1 of the ESCAPE-project. Technical Research Centre of Finland (VTT).

ESCAPE (2003) Traffic enforcement in Europe: effects, measures, needs and future. Final report of the ESCAPE consortium. Technical Research Centre of Finland (VTT).

ETSC (1995) Reducing traffic injuries resulting from alcohol impairment. Brussels.

ETSC (1999) Police enforcement strategies to reduce traffic casualties in Europe, Brussels. EU IMMORTAL Project (2005) European Commission, Brussels.

ETSC (2015) Blood alcohol content (BAC) drink driving limits across Europe. Brussels. Available from: http://etsc.eu/blood-alcohol-content-bac-drink-driving-limits-across-europe/

Faulks, I., and Irwin, J. (2007) Alcohol, drugs, and traffic safety in Australia: Initiatives and indicators T2007. Seattle, Washington.

Fieldler K, Brittle C, Stafford S. (2012) Case studies of ignition interlock programs. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration (DOT HS 811 594).

Ferguson, M., Sheehan, M., Davey, J. & Watson, B. (1999) Drink-driving rehabilitation: the present context. Queensland: Centre for Accident Research and Road Safety.

Ferris, J., Devany, M., Sparkes-Carroll, and Davis, G. (2015) A National Examination of Random Breath Testing and Alcohol-related Traffic Crash Rated (2000-2012). Australia: Foundation for Alcohol Research and Education.

Fredriksson, R., Bylund, P. O., & Öman, M. (2012, October) Fatal Vehicle-to-Bicyclist Crashes in Sweden–an In-Depth Study of injuries and vehicle sources. In Annals of Advances in Automotive Medicine/Annual Scientific Conference (Vol. 56, p. 25). Association for the Advancement of Automotive Medicine.

Gjerde, H., Normann, P. T., Christophersen, A. S., Samuelsen, S. O., & Mørland, J. (2011) Alcohol, psychoactive drugs and fatal road traffic accidents in Norway: a case–control study. Accident Analysis & Prevention, 43(3), 1197-1203.

Glitsch, E. (2003) Alkoholkonsum und Strassenverkehrsdelinquenz. Eine Anwendung der Theorie des geplanten Verhaltens auf das Problem des Fahrens unter Alkohol unter besonderer Berücksichtigung des Einflusses von verminderter Selbstkontrolle. Schriften zum Strafvollzug, Jugendstrafrecht und zur Kriminologie, 17.

Goodwin, A., Kirley, B., Sandt, L., Hall, W., Thomas, L., O'Brein, N., & Summerlin, D. (2013) Countermeasures that Work: A Highway Safety Countermeasures Guide for State Highway Safety Offices. Seventh Edition. Washington, D.C.: National Highway Traffic Safety Administration.

Harré, N., Foster, S. & O'Neill, M. (2005) Self-enhancement, crash-rate optimism and the impact of safety advertisements on young drivers. In: British Journal of Psychology, Vol. 96, p.215-230.

Henstridge, J., Homely, R. & Mackay, P. (1997) The long-term effects of random breath testing in four Australian States: A Time Series Analysis. Canberra, Australia: Federal Office of Road Safety.

Houwing, S., Hagenzieker, M. & Mathijssen, R. (2011) Prevalence of alcohol and other psychoactive substances in drivers in general traffic. Part 1: General results and part 2: Country reports: DRUID Driving Under the Influence of Drugs, Alcohol and Medicines.

International Council on Alcohol, other Drugs and Traffic safety (ICADTS) Working Group Report 1 on Alcohol Ignition Interlocks, 2001, http://www.icadts.org/reports/AlcoholInterlockReport.pdf

Isalberti, C., Van der Linden, T., Legrand, S.-A., Verstraete, A., Bernhoft, I.M., Hels, T., Olesen, M.N., Houwing, S., Houtenbos, M. & Mathijssen, R. (2011) Prevalence of alcohol and other psychoactive substances in injured and killed drivers: DRUID Driving under the Influence of Drugs, Alcohol and Medicines.

Jones, B. (1993) The effectiveness of Oregon's ignition interlock program. In: H.-D. Utzelmann , G. Berghaus, G. Kroj (Eds.) Alcohol, Drugs and Traffic Safety – T-92: Proceedings of the 12th international conference on alcohol, drugs and traffic safety, Köln, Germany, 28 September – 2 October 1992. Köln: Verlage TÜV Rheinland GmbH, Vol. 3, pp. 1460-1465.

Jones, A. W., & Holmgren, A. (2009) Age and gender differences in blood-alcohol concentration in apprehended drivers in relation to the amounts of alcohol consumed. Forensic science international, 188(1), 40-45.

Keall, M., Frith, W. & Patterson, T. (2004) The influence of alcohol, age and number of passengers on the night-time rate of driver fatal injury in New Zealand. Accident Analysis & Prevention, 36 49-61.

Keigan, M. & Tunbridge, R.J. (2003) The incidence of alcohol in fatally injured adult pedestrians. TRL Report 579, Transport Research Laboratory TRL, Crowthorne.

Klimkiewicz, A., Jakubczyk, A., Wnorowska, A., Klimkiewicz, J., Bohnert, A., Ilgen, M. A., Brower, K.J & Wojnar, M. (2014) Violent behavior and driving under the influence of alcohol: Prevalence and association with impulsivity among individuals in treatment for alcohol dependence in Poland. European addiction research, 20(3), 151-158.

Krüger, H. -P. & Vollrath, M. (2004) The alcohol-related crash rate in Germany: procedure, methods and results. In: crash Analysis & Prevention, Vol. 36, p. 125-133.

Laumon, B., Gadegbeku, B., Martin, J-L, Biecheler, M-B & the SAM Group (2005) Cannabis intoxication and fatal road crashes in France: population based case-control study. In: British Medical Journal.

Legrand, S. A., Houwing, S., Hagenzieker, M., & Verstraete, A. G. (2012) Prevalence of alcohol and other psychoactive substances in injured drivers: comparison between Belgium and the Netherlands. Forensic science international, 220(1), 224-231.

Liu Y-C, Ho CH. Effects of different blood alcohol concentrations and post-alcohol impairment on driving behavior and task performance. Traffic Inj Prev 2010;11(4):334–41.

Ma, T., Byrne, P.A., Haya, M., and Elzohairy, Y. (2015) Working in tandem: The contribution of remedial programs and roadside licence suspensions to drinking and driving deterrence in Ontario. Alcohol Analysis and Prevention. 85:248-256.

Macdonald, S. & Mann, R.E. (1996) Distinguishing causes and correlates of drinking driving. Contemporary Drug Problems, 23, 259-290.

Marple-Horvat, D.E., Cooper, H.L., Gilbey, S.L., Watson, J.C., Mehta, N., Kaur-Mann, D., Wilson, M. & Keil, D. (2007) Alcohol Badly Affects Eye Movements Linked to Steering, Providing for Automatic in-Car Detection of Drink Driving. Neuropsychopharmacology, 33(4), 849-858.

Marques, P.R., Tippetts, A.S., Voas, R.B., Beirness, D.J. (2001) Predicting repeat DWI offenses with the alcohol interlock recorder. Accident Analysis and Prevention 33(5): 609-619.

Marques, P.R., Voas, R.B., Roth, R., & Tippetts, S.A. (2010) Evaluation of the New Mexico Ignition Interlock Program. DOT HS 811 410. Washington, D.C.: National Highway Traffic Safety Administration.

Mathijssen, M.P.M. (2005) Drink driving policy and road safety in the Netherlands: a retrospective analysis. In: Transportation Research Part E 41 p. 395-408.

McAllister, I., and Studlar, D. T. (1991) Bandwagon, underdog, or projection? Opinion polls and electoral choice in Britain, 1979-1987. The Journal of Politics, 53: 720-740.

Michon, J.A. (1985) A critical review of driver behavior models: What do we know, what should we do. In: Schwing, R. & Evan, L.A. (Eds.), Human behavior and traffic safety (pp. 487-525). New York: Plenum Press.

Moskowitz H, Burns M, Fiorentino D, Smiley A, Zador P. Driver characteristics and impairment at various BACs. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration, 2000; Report No.: DOT HS 809 075.

Moskowitz, H. & Robinson, C. (1987) Driving-related skills impairment at low blood alcohol levels. In: Noordzij, P. & Rosbach, R. (Eds.), Alcohol, drugs and traffic safety - T8, p. 79-86. Excerpta Medical Elsevier Science Publisher. Amsterdam.

National Transportation Safety Board. (2013) Reaching Zero: Actions to Eliminate Alcohol-Impaired Driving. Safety Report NTSB/SR-13/01. Washington, DC: NTSB.

Nielson, A.L.., and Watson, B. (2009) The effectiveness of designated driver programs. Journal of the Australasian College of Road Safety, May, 32-37.

OECD (2006) Young Driver Risks and Effective Counter-Measures. Paris.

OSHA, NHTSA, and NETS. (nd). Guidelines for Employers to Reduce Motor Vehicle Crashes. Washington, D.C. U.S. Department of Labor, Occupational Safety and Health Administration.

OFDT (2005) Étude 'Stupéfiants et crashes mortels de la circulation routière' (SAM); Éléments de conclusion. Observatoire Français des Drogues et des Toxicomanies (OFTD). Saint-Denis La Pleine Cedex, France.

Panayiotou, G. (2015) The bold and the fearless among us: elevated psychopathic traits and levels of anxiety and fear are associated with specific aberrant driving behaviors. Accident Analysis & Prevention, 79, 117-125.

Pasa, G. G., Sousa, T., Guimaraes, L., & Pechansky, F. (2013, August) Risk behavior, sensation seeking and impulsivity: study comparing drunk drivers with sober drivers. In Proceedings of the 20th International Conference on Alcohol, Drugs and Traffic Safety (T2013).

Peden M, Scurfield R, Sleet D, Mohan D, Hyder A, Jarawan E, Mathers C eds. (2004) World Report on Road Traffic Injury Prevention, World Health Organization and World Bank (Washington), Geneva.

Peek-Asa, C. (1999) The effect of random alcohol screening in reducing motor vehicle crash injuries. American Journal of Preventive Medicine (1S), 57-67.

Phillips, R. O., Ulleberg, P., and Vaa, T. (2009) Meta-analysis of the effect of road safety campaigns on accidents. A Theoretical Approach to Assess Road Safety Campaigns: Chapter 2. pp 25-45.

Phillips, D. P., & Brewer, K. M. (2011) The relationship between serious injury and blood alcohol concentration (BAC) in fatal motor vehicle accidents: BAC= 0,01% is associated with significantly more dangerous accidents than BAC= 0,00%. Addiction, 106(9), 1614-1622.

Phillips, R. O., Ulleberg, P. and Vaa, T. (2011) Meta-analysis of the effect of road safety campaigns on accidents. Accident Analysis and Prevention 43: 1204-1218.

Popkin, C.L., Stewart, J.R., Beckmeyer, J., Martell, C. (1993) An evaluation of the effectiveness of interlock systems in preventing DWI recidivism among second-time DWI offenders. In: H.-D. Utzelmann , G. Berghaus, G. Kroj (Eds.) Alcohol, Drugs and Traffic Safety – T-92: Proceedings of the 12th international conference on alcohol, drugs and traffic safety, Köln, Germany, 28 September – 2 October 1992. Köln: Verlage TÜV Rheinland GmbH, Vol. 3, pp. 1466-1470.

Preusser, D.F. (2002) BAC and fatal crash rate. In: ICADTS 2002 Symposium Report 'The Issue of Low BAC', p. 937.

Raub, R.A., Lucke, R.E., and Wark, R.I. (2003) Breath Alcohol Ignition Interlock Devices: Controlling the Recidivist. Traffic Injury Prevention 4: 199-205.

Rauch, W.J. and Ahlin, E.M. (2003) Characteristics and Benefits of a Successful Ignition Interlock License Restriction Program. In Beirness, D.J. and Robertson, R.D. (2005). Alcohol Interlock Programs: Enhancing Acceptance, Participation and Compliance. Proceedings of the Fourth International Symposium of Alcohol Ignition Interlocks, Hilton Head, South Carolina, October 27-28, 2003. Ottawa: Traffic Injury Research Foundation.

Rauch, W., Zador, P.L., Ahlin, E.M., Howard, J.M., Frissell, K.C., & Duncan, G.D. (2010) Risk of alcohol-impaired driving recidivism among first offenders and multiple offenders. American Journal of Public Health, 100(5), 919-924.

Rauch, W.J., Zador, P.L., Howard, J.N., and Duncan, G.D. (2011) Effects of administrative ignition interlock license restrictions on drivers with multiple alcohol offenses. Journal of Experimental Criminology 7 (2): 127-148.

Redelmeier, D.A. Tibshirani, R.J. & Evans (2003) Traffic-law enforcement and risk of death from motor-vehicle crashes: case-crossover study. In: The Lancet, Vol. 361, June 28 2003, pp. 2177-2182.

Robertson, R.D., Marcoux, K. D., Holmes, E. A., & Vanlaar, G. M. (2011) State of Knowledge: Female Drunk Drivers. Traffic Injury Research Foundation.

Robertson R.D, and Pashley, C.R. (2014) Report on Effective Remedial Programs for Drinking Driving Offenders. Ottawa, Ontario: Traffic Injury Research Foundation.

Robertson, R.D., and Pashley, C.R. (2015) Road Safety Campaigns: What the Research Tells Us. Ottawa, Ontario: Traffic Injury Research Foundation.

SARTRE 3 report (2004) European drivers and road rate, Report on principal results. INRETS, Paris.

SARTRE 4 report (2012) European drivers and road rate, Report on principal results. IFSTTAR, France.

Schofield, T. P., & Denson, T. F. (2013) Temporal alcohol availability predicts first-time drunk driving, but not repeat offending. PloS one, 8(8), e71169.

Schulze, H., Schumacher, M., Urmeew, R., Alvarez, J., Bernhoft, I. M., de Gier, H. D. G., & Zlender, B. (2012) Driving under the influence of drugs, alcohol and medicines in Europe — findings from the DRUID project. European Monitoring Centre for Drugs and Drug Addiction.

Shope, J. T., Copeland, L. A., Maharg, R., and Dielman, T. E. (1996) Effectiveness of a high school alcohol misuse prevention program. Alcoholism: Clinical and Experimental Research, 20, 791–798.

Simpson, H.M. & Mayhew, D.R. (1991) The hard core drinking driver. Traffic Injury Research Foundation of Canada, Ottawa.

SUPREME (2007) Summary and publication of best practices in road safety in the Member States, SUPREME, Thematic report: Vehicles, CEC, Brussels, June 2007

Sweedler, B.M, Biecheler, M.B., Laurell, H., Kroj, G., Lerner, M., Mathijssen, M.P.M., Mayhew, D. & Tunbridge, R.J. (2004) Worldwide trends in alcohol and drug impaired driving. In: Traffic Injury Prevention Volume 5, Issue 3. p. 175-184.

SWOV. (2009) SWOV Fact sheet: Fear-based information campaigns. Leidschendam, the Netherlands. Institute for Road Safety Research.

Tay, R. and Watson, B. (2002) Changing drivers' intentions and behaviours using fear-based driver fatigue advertisements. Health Marketing Quarterly, 19(4): 55-68.

Tippetts, A.S. and Voas, R.B. (1997) The effectiveness of the West Virginia interlock program on second drunk-driving offenders. In: C. Mercier-Guyon (Ed.) Alcohol, Drugs and Traffic Safety – T97. Proceedings of the 14th International Conference on Alcohol, Drugs and Traffic Safety, Annecy, France, September 21-26, 1997. Annecy: CERMT, Vol.1, pp. 185–192.

Tzambazis K, Stough C. Alcohol impairs speed of information processing and simple and choice reaction time and differentially impairs high-order cognitive abilities. Alcohol, Alcohol 2000;35(2):197–201.

UK Department for Transport, (2014) Reported drinking and driving (RAS51). Available from: https://www.gov.uk/government/statistical-data-sets/ras51-reported-drinking-and-driving

Vanlaar, W., McKiernan, A., Robertson, R. (2013) Behavioral Patterns of Interlocked Offenders: Phase II. Ottawa: Traffic Injury Research Foundation.

Vanlaar, W., Mainegra Hing, M., Robertson, R. (2014) Nova Scotia Alcohol Ignition Interlock Program: Outcome Evaluation, Executive Report. Prepared for the government of Nova Scotia. Ottawa, Ontario: Traffic Injury Research Foundation.

Vanlaar, W., Mainegra Hing, M., Robertson, R. (2015) Nova Scotia Alcohol Ignition Interlock Program: Outcome Evaluation, Technical Report. Ottawa, Ontario: Traffic Injury Research Foundation.

Venzina, L. (2002). The Quebec Alcohol Interlock Program: Impact on Recidivism and Crashes. In: D.R. Mayhew & C. Dussault (Eds.) Alcohol, Drugs and Traffic Safety 0 T2002. Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety. Montreal, August 4-9, 2002. Quebec City: Societe de l'assurance automobile du Quebec, pp. 97-104.

Voas, R. and Tippetts, A.S. (1997) Requiring Interlocks for Reinstatement: The Florida Example. Paper presented at the 7th Annual International Ignition Interlock Symposium, Bachelor Gulch, Colorado, October 22nd – 24th.

Voas, R.B. and Marques, P.R. (2003) Commentary: Barriers to Interlock Implementation. Traffic Injury Prevention 4(3): 183-187.

Voas, R.B., Tippetts, S.S., Fisher, D., & Grosz, M. (2010) Requiring suspended drunk drivers to install alcohol interlocks to reinstate their licenses: Effective? Addiction, 105, 1422-1428.

Voas, R.B. and Lacey, J.C. (2011) Alcohol and Highway Safety 2006: A Review of the State of Knowledge. Washington, D.C.: National Highway Traffic Safety Administration.

Vorst, H. van der, Engels, R.C., Meeus, W., Deković, M. & Van Leeuwe, J. (2005) The role of alcohol-specific socialization in adolescents' drinking behaviour. Addiction, 100(10), 1464-1476.

Watson A., and Watson, B. (2014) An outcome evaluation of the "Skipper" designated driver program. Accident Analysis and Prevention 66: 27-35.

Wegman, F. & Aarts, L. (ed.) (2005) Door met Duurzaam Veilig. Stichting Wetenschappelijk Onderzoek Verkeersveiligheid SWOV, Leidschendam.

Willis, C., Lybrand, S., and Bellamy, N. (2005) Alcohol Ignition Interlock Programmes for Reducing Drink Driving Recidivism (Review). The Cochrane Database of Systematic Reviews (4).

WHO (2014) European Status Report on Alcohol and Health 2014: World Health Organization

World Advertising Research Centre (2005) http://www.warc.com.

Worldwide Brewing Alliance (2006) Drinking and driving Report 2005.

Wundersitz, L. N., Hutchinson, T. P., and Woolley, J. E. (2010) Best practice in road safety mass media campaigns: A literature review. Centre for Automotive Safety Research. Adelaide, Australia.

Yanovitzky, I. (2004, November 6-10) Defensive processing of alcohol-related social norms messages by college students. Paper presented at The 132d Annual Meeting of APHA. American Public Health Administration (APHA), Washington, D.C.

Notes

1. Country abbreviations

	Belgium	BE		Italy	IT		Romania	RO
	Bulgaria	BG		Cyprus	CY		Slovenia	SI
	Czech Republic	CZ		Latvia	LV		Slovakia	SK
	Denmark	DK		Lithuania	LT		Finland	FI
	Germany	DE		Luxembourg	LU		Sweden	SE
	Estonia	EE		Hungary	HU		United Kingdom	UK
	Ireland	IE		Malta	MT			
	Greece	EL		Netherlands	NL		Iceland	IS
	Spain	ES		Austria	AT		Liechtenstein	LI
	France	FR		Poland	PL		Norway	NO
	Croatia	HR		Portugal	PT		Switzerland	CH

2. This 2018 edition of Traffic Safety Synthesis on Alcohol updates the previous versions produced within the EU co-funded research projects SafetyNet (2008) and DaCoTA (2012). This Synthesis on Alcohol was originally written in 2008 by Willem Vlakveld, SWOV and then updated in 2012 by Sjoerd Houwing, SWOV and in 2015 by Dan Mayhew and Leanna Ireland, TIRF.

3. All Traffic Safety Syntheses of the European Road Safety Observatory have been peer reviewed by the Scientific Editorial Board composed by: George Yannis, NTUA (chair), Robert Bauer, KFV, Christophe Nicodème, ERF, Klaus Machata, KFV, Eleonora Papadimitriou, NTUA, Pete Thomas, Un.Loughborough.

4. Disclaimer
This report has been produced by the National Technical University of Athens (NTUA), the Austrian Road Safety Board (KFV) and the European Union Road Federation (ERF) under a contract with the European Commission. Whilst every effort has been made to ensure that the matter presented in this report is relevant, accurate and up-to-date, the Partners cannot accept any liability for any error or omission, or reliance on part or all of the content in another context.
Any information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use that may be made of the information contained therein.

5. Please refer to this Report as follows:
European Commission, Alcohol, European Commission, Directorate General for Transport, February 2018.


E
R
S
O
European
Road
Safety
Observatory
www.erso.eu