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Antti Impinen

RESEARCH

Arrested Drunk Drivers

Trends, social background, recidivism and mortality

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ACADEMIC DISSERTATION

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Abstract

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Despite the recent advances in traffic safety, drunken driving remains a persistent problem in traffic safety. Driving skills have been reported to be impaired even at low blood alcohol concentrations, and intoxicated drivers are overrepresented in traffic accidents. Currently in Finland every fourth fatal traffic accident and every eighth non-fatal injury in traffic involve a drunk driver. Although drunk drivers pose a major threat to traffic safety, they often suffer the negative effects of alcohol use and abuse outside the traffic themselves. Less is known about their social backgrounds and health-related problems.

The aim of this study was to examine the trends, incidence and recidivism of drunken driving during a 20-year period (1988–2007) using the data on all suspected drunken driving in this period. Furthermore, the association between social background and drunken driving, and the mortality of drunk drivers were studied by using administrative register data provided by Statistics Finland. The study was completely register-based and enabled us to analyze tens of thousands of people with almost half million cases of drunken driving and 20,000 deaths during the 20-year period.

There were great changes in the numbers of drunken driving arrests during 1988–2007. In 1989–1991, every year 30,000 drivers were suspected of drunken driving, but the number fell to less than 20,000 by 1994, during the economic recession. These changes also reflect the changes in alcohol consumption. The changes in the arrest incidence of the youngest age groups were especially pronounced, most of all in the age group of 18–19-year olds, who have just recently been able to receive their driver's license. Even though the incidence among youth decreased dramatically, their incidence rate was still twice that of the general population aged 15–84 years. While youth are not prominent in Finnish drunken driving studies on traffic flow, their proportion among arrested drunk drivers and in alcohol-related crashes is high.

The drunken driving arrests occurred mostly during typical drinking times, i.e. nights and weekends. Altogether 63% of all suspected drunken driving took place between Fridays and Sundays. Major national holidays during which drinking is common, namely New Year's Eve, the 1st of May and Midsummer, came up clearly in drunken driving statistics.

Drunken driving was associated with a poor social background among youth and working-aged men and women. For example, a low level of education, unemployment, divorce, and parental factors in youth were associated with a higher risk of being arrested for drunken driving. While a low income was related to more drunken driving among working-aged people, the effect among young persons was the opposite. Owning or being in possession of a car meant more drunken driving for all the other groups, except for working-aged men.

Every third drunk driver got rearrested during a 15-year period, whereas the estimated rearrest rate was 44%. Findings of drugs only or in combination with alcohol increased the risk of rearrest. The highest rearrest rates were seen among drivers who were under the influence of amphetamines or cannabis. There were only few opioid users in the study population. Also male gender, young age, high blood alcohol concentration, and arrest during weekdays and in the daytime predicted rearrest.

When compared to the general population, arrested drunk drivers had significant excess mortality. The greatest relative differences were seen in alcohol-related causes of death (including alcohol diseases and alcohol poisoning), accidents, suicides and violence. Also mortality due to other than alcohol-related diseases was elevated among drunk drivers. Acute alcohol intoxication or other alcohol-related disease or condition was often found to contribute to the death of drunk drivers.

Drunken driving was associated with multiple factors linked to traffic safety, health and social problems. Social marginalization may expose a person to harmful use of alcohol and drunken driving, and the associations are seen already among the youth. Recidivism is common among drunk drivers, and driving under the influence of illicit and/or medicinal drugs is likely to indicate worse substance abuse problems, judging from the high rearrest rates. High alcohol-related mortality in this population shows that drunken driving is clearly an indicator of alcohol abuse. More effective measures of preventing alcohol-related harms are needed, than merely preventing convicted drunk drivers from driving again.

Keywords: Drunken driving, alcohol drinking, socio-economic position, recidivism, mortality

Tiivistelmä

Antti Impinen. Arrested Drunk Drivers: Trends, social background, recidivism and mortality [Poliisin tietoon tullut rattijuopumus: Muutokset, sosiaalinen tausta, uusiminen ja kuolleisuus]. Terveyden ja hyvinvoinnin laitos (THL), Tutkimus 63. 82 sivua. Helsinki 2011.
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Huolimatta liikenneturvallisuuden yleisestä paranemisesta viime vuosina, rattijuopumus näyttäytyy liikenteen alituisena ongelmana. Ajokyvyn on todettu heikentyvän jo matalilla verenalkoholipitoisuuksilla ja rattijuopot ovat yliedustettuina liikenneonnettomuustilastoissa. Tällä hetkellä rattijuoppo on osallisena joka neljännessä kuolemaan johtaneessa ja joka kahdeksannessa henkilövahinkoon johtaneessa liikenneonnettomuudessa. Rattijuopot ovat uhka muille tienkäyttäjille, minkä lisäksi he usein itse kärsivät haitallisen alkoholinkäytön muista seurauksista. Rattijuoppojen sosiaalisesta taustasta ja terveydellisistä ongelmista on olemassa vähemmän tutkimustietoa.

Tämän tutkimuksen tavoitteena oli kuvata alkoholin vaikutuksen alaisena ajamisen muutoksia, ilmaantuvuutta ja uusimista vuosina 1988–2007. Tutkimus perustui kaikkiin tällä ajalla poliisin tietoon tulleisiin rattijuopumustapauksiin. Rattijuopumuksesta epäiltyjen sosiaalista taustaa ja kuolleisuutta tutkittiin yhdistämällä rattijuopumusaineistoa Tilastokeskuksen tietoihin sosiaalisesta asemasta ja kuolemansyistä. Tutkimus perustui täysin virallisiin rekisteriaineistoihin ja sen kuluessa analysoitiin kymmeniätuhansia henkilöitä, lähes puoli miljoonaa rattijuopumustapausta ja 20 000 kuolemantapausta.

Rattijuopumuspidätysten ilmaantuvuudessa tapahtui voimakkaita muutoksia vuosina 1988–2007. Kun poliisin tietoon vuosina 1989–1991 tuli noin kolmekymmentätuhatta rattijuopumusta vuosittain, laski tapausten määrä alle kahdenkymmenentuhannen vuoteen 1994 mennessä. Voimakas lasku tapahtui samanaikaisesti laman ja alkoholinkulutuksen laskun kanssa. Erityisen voimakkaita olivat muutokset 18–19-vuotiaiden, äskettäin ajo-oikeuden saaneiden, ryhmässä. Vaikka tämän ikäryhmän väestöön suhteutettu ilmaantuvuus rattijuopumuspidätyksissä väheni, oli ilmaantuvuus edelleen kaksinkertainen koko 15–84-vuotiaaseen väestöön verrattuna. Vaikka nuorten rattijuoppojen määrä tienvarsitutkimuksissa ei ole ollut suuri, on nuorten osuus rattijuopumuspidätyksissä sekä vakavissa alkoholiin liittyvissä liikenneonnettomuuksissa huolestuttava.

Humalassa ajaminen keskittyi vahvasti öihin ja viikonloppuihin, jolloin alkoholia kulutetaan eniten. Kaikkiaan 63 % pidätyksistä sattui perjantain ja sunnuntain välillä. Kansalliset juhlapyhät, jolloin juominen on yleistä, Uusi Vuosi, Vappu ja Juhannus erottuvat selvästi pidätystilastoissa.

Rattijuopumus oli yhteydessä sosiaalisiin tekijöihin sekä nuorilla että työikäisillä, miehillä ja naisilla. Esimerkiksi matala koulutus, työttömyys, avioero, sekä vanhempien sosiaaliseen asemaan liittyvät tekijät olivat yhteydessä rattijuopumukseen. Vaikka työikäisten matalat tulot olivat yhteydessä rattijuopumukseen, nuorilla tulojen vaikutus oli päinvastainen. Auton omistaminen tai hallinta liittyi kohonneeseen rattijuopumuksen riskiin muilla tarkastelluilla ryhmillä, paitsi työikäisillä miehillä.

Joka kolmas rattijuoppo pidätettiin toistamiseen viidentoista vuoden jaksolla estimoidun uusimisosuuden ollessa 44 %. Mikäli kuljettajan verestä löydettiin lääke- tai huumausaineita, uusintapidätyksen todennäköisyys kasvoi. Eniten uusintapidätyksiä tapahtui kuljettajille, jotka ajoivat amfetamiinien tai kannabiksen vaikutuksen alaisina. Opioideja havaittiin vain vähän tutkimusaineistossa. Lisäksi miessukupuoli, nuori ikä, korkea verenalkoholipitoisuus, sekä keskellä viikkoa tai päiväsaikaan tapahtunut pidätys ennustivat uusintapidätystä.

Muuhun väestöön verrattuna rattijuoppojen kuolleisuus oli korkeaa. Suurimmat suhteelliset erot havaittiin alkoholisyissä (alkoholisairaudet ja tapaturmaiset alkoholimyrkytykset), tapaturmissa, itsemurhissa ja väkivallassa. Myös muu kuin alkoholiin liittyvä tautikuolleisuus oli rattijuopoilla vertailuväestöä korkeampaa. Alkoholipäihtymys tai alkoholisairaus todettiin usein kuoleman myötävaikuttavaksi tekijäksi rattijuopoilla.

Alkoholiin liittyvän rattijuopumuksen havaittiin usein olevan yhteydessä liikenneturvallisuuteen ja terveyteen liittyviin ongelmiin sekä sosiaaliseen asemaan. Sosiaalinen huono-osaisuus oli yhteydessä rattijuopumuksen yleisyyteen ja sosiaalisen aseman vaikutus havaittiin jo nuorilla. Rattijuopumuksen uusiminen oli yleistä ja korkea uusimistodennäköisyys huumeiden ja/tai lääkkeiden käytön yhteydessä saattaa olla merkki vaikeammasta riippuvuusongelmasta. Korkeasta alkoholiin liittyvästä kuolleisuudesta päätellen, rattijuopumusta voidaan pitää eräänä haitallisen alkoholinkäytön indikaattorina. Rattijuoppojen liikenne- ja alkoholihaittojen ehkäisyssä tarvitaan laajempia toimia kuin vain liikenteeseen keskittyvät toimenpiteet.

Avainsanat: Rattijuopumus, alkoholinkulutus, sosio-ekonominen asema, uusintarikollisuus, kuolleisuus

Sammandrag

Antti Impinen. Arrested Drunk Drivers: Trends, social background, recidivism and mortality [Rapporterade fall av rattfylleri: Förändringar, social bakgrund, återfall och dödlighet]. Institutet för hälsa och välfärd (THL), Forskning 63. 82 sidor. Helsingfors 2011.
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Trots att den allmänna trafiksäkerheten har förbättrats under de senaste åren, framträder rattfylleriet som ett ständigt problem i trafiken. Man har konstaterat att körförmågan försämras redan vid låga alkoholhalter i blodet och att rattfyllerister är överrepresenterade i statistiken över trafikolyckor. För närvarande är det rattfyllerister som orsakar var fjärde trafikolycka som leder till dödsfall och var åttonde trafikolycka som leder till personskada. Rattfyllerister är ett hot för andra trafikanter, och dessutom lider de ofta själva av andra konsekvenser som uppstår vid skadlig alkoholkonsumtion. Det finns inte så många forskningsrön kring rattfylleristernas sociala bakgrund och hälsoproblem.

Denna studie syftar till att beskriva förändringar, incidens och återfall när det gäller att köra under påverkan av alkohol år 1988–2007. Studien bygger på alla de fall av rattfylleri som kommit till polisens kännedom under perioden. Den sociala bakgrunden och dödligheten bland personer som misstänks för rattfylleri utreddes genom att rattfyllerimaterialet förenades med Statistikcentralens uppgifter om social ställning och dödsorsaker. Studien baserar sig uteslutande på officiellt registermaterial och tiotusentals personer har analyserats under studiens gång, sammanlagt nästan en halv miljon fall av rattfylleri och 20 000 dödsfall.

Incidensen av fall med personer som anhölls för rattfylleri förändrades kraftigt under perioden 1988–2007. Medan cirka trettiotusen fall av rattfylleri kom till polisens kännedom år 1989–1991, sjönk antalet fall till mindre än tjugotusen fram till år 1994. Den kraftiga minskningen inträffade samtidigt som lågkonjunkturen och minskningen av alkoholkonsumtionen. Särskilt kraftiga var förändringarna i gruppen av 18–19-åringar som nyligen fått körkort. Även om incidensen av fall där personer anhölls för rattfylleri minskade i denna åldersgrupp i relation till befolkningen, var den ändå dubbelt högre än bland hela befolkningen i åldern 15–84 år. Även om antalet unga rattfyllerister inte har varit stort i undersökningar i trafikflödet, utgör unga en oroväckande andel av de fall där en person anhålls för rattfylleri och i samband med allvarliga trafikolyckor som är förknippade med alkohol.

Fallen med berusade förare koncentrerades i hög grad till nätter och veckoslut då alkohol konsumeras som mest. Sammanlagt 63 procent av anhållandena inträffade mellan fredag och söndag. Nationella helgdagar, då det är vanligt att man dricker

alkohol, dvs. nyår, valborg och midsommar, framträder klart i statistiken över anhållanden.

Rattfylleri hör ihop med sociala faktorer både bland unga och personer i arbetsför ålder, liksom också bland män och kvinnor. Till exempel låg utbildning, arbetslöshet, skilsmässa och faktorer som anknyter till föräldrarnas sociala ställning har ett samband med rattfylleri. Även om en låg inkomst var förknippad med rattfylleri bland personer i arbetsför ålder, hade inkomsterna en motsatt inverkan bland unga. Att äga eller inneha en bil hade en anknytning till en förhöjd risk för rattfylleri inom de övriga undersökta grupperna, med undantag för män i arbetsför ålder.

Var tredje rattfyllerist anhölls en gång till under den femton år långa period som var föremål för studien och den estimerade andelen återfall uppgick till 44 procent. Om läkemedel eller narkotika konstaterades i förarens blod, ökade sannolikheten för att personen senare skulle anhållas på nytt. Flest var antalet fall med upprepade anhållanden bland förare som körde under påverkan av amfetamin eller cannabis. Opioider observerades endast i få fall i undersökningsmaterialet. Ytterligare faktorer som prognostiserade att personen senare skulle komma att anhållas på nytt var manligt kön, ung ålder, hög alkoholhalt i blodet och det faktum att anhållandet gjordes mitt i veckan eller dagtid.

Dödligheten bland rattfyllerister var hög jämfört med den övriga befolkningen. De största relativa skillnaderna observerades i fråga om alkoholrelaterade orsaker (alkoholrelaterade sjukdomar, alkoholförgiftning genom olyckshändelse), olycksfall, självmord och våld. Också annan än alkoholrelaterad sjukdomsdödlighet förekom i större utsträckning bland rattfyllerister än bland jämförelsebefolkningen. Alkoholberusning eller en alkoholrelaterad sjukdom fastställdes hos rattfyllerister ofta som en faktor som bidrog till deras död.

Alkoholrelaterat rattfylleri observerades ofta ha ett samband med trafiksäkerheten, hälsorelaterade problem och personens sociala ställning. Social utsatthet var förknippat med förekomsten av rattfylleri och den sociala ställningens inverkan observerades redan hos unga. Återfall i rattfylleri var vanligt och den höga sannolikheten för återfall i samband med användningen av narkotika och/eller läkemedel kan vara ett tecken på ett svårare beroende. Utgående från den höga alkoholrelaterade dödligheten kan rattfylleri betraktas som en indikator för skadlig alkoholkonsumtion. För att förebygga trafik- och alkoholskador på grund av rattfylleri behövs bredare åtgärder än sådana som endast fokuserar på trafiken.

Nyckelord: Rattfylleri, alkoholkonsumtion, socioekonomisk ställning, återfallsbrottslighet, dödlighet

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List of original papers

I Impinen A, Rahkonen O, Ojaniemi K, Lillsunde P, Lahelma E & Ostamo A. Rattijuoppo on yhä useammin 18-vuotias. Suomen Lääkärilehti 2008; 63: 2221–2226.

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III Impinen A, Rahkonen O, Karjalainen K, Lintonen T, Lillsunde P & Ostamo A. Substance Use as a Predictor of Driving under the influence (DUI) Rearrests. A 15-year retrospective study. Traffic Injury Prevention 2009; 10: 220-226.

IV Impinen A, Mäkelä P, Karjalainen K, Rahkonen O, Lintonen T, Lillsunde P & Ostamo A. High mortality among people suspected of drunk-driving. An 18-year register-based follow-up. Drug and Alcohol Dependence 2010; 110: 80-84.

Abbreviations

BAC	Blood Alcohol Concentration
CI	Confidence Interval
DUI	Driving Under the Influence
DUID	Driving Under the Influence of Drugs
EU	European Union
HR	Hazard Ratio
ICD	International Classification of Diseases
KTL	Kansanterveyslaitos, National Public Health Institute (THL since 1.1.2009)
OR	Odds Ratio
THC	Tetrahydrocannabinol
THL	Terveyden ja hyvinvoinnin laitos, Institute for Health and Welfare (KTL until 31.12.2008)
WHO	World Health Organization

1 Introduction

Knowledge about the effects of driving under the influence of alcohol is very consistent. Alcohol impairs a person's driving skills even in low dosages by affecting psychomotor skills, and it increases the risk of both fatal and non-fatal traffic accidents (Blomberg et al., 2009; Moskowitz and Fiorentino, 2000; Ogden and Moskowitz, 2004; Zador et al., 2000). The impairing effect of alcohol is more severe for young and inexperienced drivers than for experienced drivers (Peck et al., 2008).

Roadside studies in Finland have shown that approximately one out of 500 drivers drives while the alcohol in their system exceeds the legal limit. Between 0.4% and 1.1% drivers have a low level of alcohol in their system, i.e. below the legal limit of 0.5 per mille (Portman et al., 2011). Currently 20,000–25,000 cases of drunken driving come to the attention of the Finnish police every year. More than half of them are considered to be cases of aggravated drunken driving, with high blood alcohol concentrations exceeding 1.2 per mille. While driving under the influence of drugs has become an increasingly prevalent and visible problem in Finland (Karjalainen, 2011), alcohol still plays a major part in traffic safety.

Traffic safety in general has improved significantly in Finland during the past decades. Over one thousand people were killed in road traffic accidents every year in the beginning of the 1970s, and more than 600 in the early 1990s. In 2009, altogether less than 300 people died in road traffic, the number being as low as in the 1940s. Meanwhile, the number of drunk drivers in traffic and the number of fatal accidents involving intoxicated drivers has not developed as favorably. As the number of fatal accidents has been falling, the proportion of DUI-related deaths has in fact increased, amounting to 25% of all traffic fatalities, after being under 20% in the beginning of the 2000s (Statistics Finland, 2010). When non-fatal accidents are examined, one eighth of all injuries occur in motor vehicle crashes involving a drunk driver.

It has been estimated that a person is able to drive a vehicle under the influence of alcohol very many times, even several hundreds of times on average, before being apprehended by the police (Portman et al., 2011). A considerable proportion of drunk drivers are rearrested at least once. A substantial group of drunk drivers, especially recidivists, are estimated to be problem drinkers, and as many as a half of the drunk drivers may be alcohol-dependent (Brinkmann et al., 2002; Portman et al., 2009). This strongly suggests that the drinking habits of many drunk drivers differ from those of people who are not convicted of drunken driving. As alcohol use and abuse are affected by a person's social and economic background (Galea et al., 2004), it also is likely that drunken driving is subject to these factors (Baum, 2000).

Traffic safety is the major issue when discussing the harms related to drunken driving, as the connection between these two is evident. Drunk drivers nevertheless suffer the health consequences themselves. Mortality among drunk drivers, compared to other people, is very high, and it is often related strongly to alcohol, e.g. alcohol-related diseases and accidents (Mann et al., 1993; Penttilä et al., 1995; Skurtveit et al., 2002).

Drunken driving is a constant topic in the media and in public debate. People are typically concerned about traffic safety, legal limits of blood alcohol, and the capability of the police to prevent and put an end to drunken driving. Traffic safety and control are nevertheless only one side of a bigger problem of the harmful use of alcohol. Interventions focusing on the abuse of alcohol and other substances could improve road safety as well as prevent other alcohol-related harms.

It is well established that alcohol impairs driving performance, and that drunken driving causes accidents and fatalities. There is less research on the effects of different substances on recidivism, or on the social determinants of drunken driving, or the health outcomes of drunk drivers at the population level.

This study aims to create a comprehensive image of the phenomenon of drunken driving in Finland during the past 20 years, by looking at the problem from the perspective of traffic safety as well as public health. By using the unique data sources available, it was possible to obtain reliable new results on the nature of drunken driving as a problem associated with numerous social and health issues.

2 Use of alcohol and drugs in Finland

2.1 Alcohol in Finland

2.1.1 Alcohol policies

Finland has a long history of a very controlling and restrictive alcohol policy, similar to that in Sweden and in Norway (Österberg et al., 2003). Shortly after Finland gained independence in 1917, a prohibition act came into force in 1919 and lasted until 1932. In the following system, a state alcohol monopoly company, Alko, was given control of the production, import, export and sales of alcoholic beverages. In 1969, a new significantly more liberal Alcohol Act and Medium Beer Act came into effect, increasing the availability of alcohol. The next major change took place when Finland joined the European Union in 1995. This was accompanied by new alcohol legislation that dissolved some aspects of the state monopoly and to some degree freed the private import and sale of alcohol. In 2004, quotas restricting private duty-free passenger import of alcohol from other EU countries were removed. In the same year Estonia became member of EU, creating a new situation. As the consumer prices of alcohol were considerably lower in Estonia than in Finland, a significant increase in private import was anticipated (Österberg, 2005). Consequently, the alcohol tax was lowered in order to maintain the tax base and to support the alcohol industry in Finland; the prices of the alcohol beverages sold in Alko were reduced by 22% (Österberg, 2005). As a result, alcohol-related problems increased greatly (Mäkelä and Österberg, 2009). Because of the increased harms, and also because of the need for more tax revenues, the alcohol tax was raised altogether three times, in 2008 and in 2009 (Karlsson (ed.), 2009).

The Government resolution in 2003 stated that the alcohol-related harms surpass the benefits derived from the manufacture, sales and use of alcohol. By this resolution, the primary objective of alcohol policies in Finland was defined as prevention and reduction of the problems caused by alcohol (Government Resolution on Strategies in Alcohol Policy, 2003). Accordingly, a 4-year Alcohol Programme was launched in 2004. Its main goals were: 1) to significantly reduce the harms caused to children and families; 2) to significantly reduce the risky use of alcohol and the harm caused by it, and; 3) to reverse the increasing trend in alcohol consumption (Ministry of Social Affairs and Health, 2004). Despite the well-meaning aims, these goals were not achieved, and the Program was extended by another 4-year period, 2008–2011.

2.1.2 Changing trends in alcohol use

Alcohol use has undergone a significant change during the past 50 years. In 1968 the annual consumption per capita was 3.6 L of 100% alcohol, while current consumption is over 10 L of alcohol per capita (Mäkelä et al., 2010; National Institute for Health and Welfare., 2010). A rapid rise in overall consumption occurred after the new alcohol act in 1969, when the sale of alcohol, especially of beer, became more liberal. Within one year, the consumption of medium strength beer per capita tripled from 0.5 L to 1.5 L of 100% alcohol (National Institute for Health and Welfare., 2010). The rapid growth in alcohol use continued until the mid-70s, and was followed by more stable increases at the end of the '80s. The current level was reached from the mid-90s until 2005. A greater change on the alcohol market happened when Finland joined the European Union in 1995, as this reduced the control of Alko, the state alcohol monopoly company (Alavaikko and Österberg, 2000). Currently the Finnish alcohol retail sales is still controlled by Alko, which exclusively possesses the rights for the sale of alcoholic beverages over 4.7% of alcohol by volume.

When the drinking cultures of various countries are described, a dichotomous classification is often used to describe drinking habits, i.e., the "wet" and the "dry" cultures. Wet cultures are ones in which drinking alcohol is an integral part of everyday life, while dry cultures are more ambivalent in their attitudes towards drinking, with more abstaining but also heavy drinking at the same time (Grant and Litvak, 1998; Room and Mitchell, 1972). Traditionally the Mediterranean countries have been seen as an example of wet cultures, whereas the Nordic countries represent the dry culture. However, as drinking habits are changing, the division no longer seems to be so clear (Allamani et al., 2000; Leifman, 2001). After the substantial changes that have taken place, the level of alcohol consumption in Finland has been close to the average European level in the first decade of the millennium. The current consumption exceeds that in the traditional Mediterranean wine countries, such as Spain and Italy, where the consumption of alcohol is falling (Mäkelä et al., 2010; WHO Department of Mental Health and Substance Abuse., 2004). In comparison to the other Nordic countries, Finland now consumes more alcohol than any other Nordic country, after its consumption exceeded that of Denmark in 2008 (Jääskeläinen, 2009).

Behind this bigger change in Finnish drinking habits, several smaller trends can be seen within population groups and their patterns of alcohol use. While the overall alcohol consumption has been increasing as described, the greatest relative changes have happened in women's drinking habits (Mäkelä et al., 2010). Even though men still consume three times as much alcohol as women, the alcohol consumption of women has increased 6-fold since 1968, whereas men use twice as much alcohol as in 1968. On the other hand, the absolute increase during the same period has been 10 L per capita for men and 5 L per capita for women. The data collected in the Finnish

drinking habit study show that women now drink alcohol more regularly, consume more alcohol per occasion, and are more seldom abstainers than earlier. Another ongoing trend indicates that the youth are reducing their drinking. According to surveys, the number of young persons practising abstinence is on the increase, and drunkenness among youth is decreasing (Luopa et al., 2010; Luopa et al., 2006; Metso, 2009).

2.1.3 Alcohol-related harms in health

Alcohol is an intoxicant, despite its generally accepted status in European culture. It causes significant harms through volume of lifetime use, and the frequency of drinking in combination with the amount consumed per occasion (WHO Regional Office for Europe, 2009). Alcohol incurs various costs to the society in the EU. For example, in 2003, the total tangible costs due to mortality, traffic accidents, unemployment, crime, and health service costs, were estimated to be €125 billion (€79–220 bn.) (Anderson and Baumberg, 2006). Globally, an estimated 3.8% of all deaths and 4.6% of disability-adjusted life-years are attributable to alcohol (Rehm et al., 2009). Alcohol-related deaths are mostly caused by unintentional as well as intentional injuries, cardiovascular diseases, cancer and cirrhosis of liver (Rehm et al., 2009). There is a relationship between per capita alcohol consumption and the rate of alcohol-related diseases in all countries, but the relationship with the rate of accidents, homicides and suicides is stronger in the Nordic countries than in southern European countries (Norström and Ramstedt, 2005).

In Finland, a total of 11% of all mortality among men and 2% among women were alcohol-related in 1987–2003 (Herttua et al., 2007). After the alcohol tax was lowered in 2004, the number of all alcohol-related deaths increased by 23% during the three-year period of 2004–2006, compared to 2001–2003 (Mäkelä and Österberg, 2009). In 1987–2006, alcohol was found to be a contributing factor in fatal accidents, suicides, and homicides, in about 30–40%, 30% and 50%, respectively, in the form of acute alcohol intoxication or alcohol-related diseases (Impinen et al., 2008). The burden of alcohol on inpatient and outpatient care is not known exactly, but according to a study conducted in an emergency care unit, two thirds of the victims of violence and self-inflicted injuries were intoxicated when admitted to the unit (Nurmi-Lüthje et al., 2008). Alcohol was involved in every fourth accidental injury of patients aged 15 years or older, and in 40–51% of repeated visits (Nurmi-Lüthje et al., 2007). A recent Norwegian study found alcohol in the blood of 27% of injured patients in emergency wards (Bogstrand et al., 2011) and another cross-national study reported a 24% prevalence of alcohol-positive findings in injured patients (Cherpitel et al., 2005).

Alcohol-dependence is prevalent in 4.5% of the Finnish adult population and in 6% of young adults (Pirkola et al., 2005; Suvisaari et al., 2009). The lifetime

prevalence of substance abuse or dependence was 14% in young Finnish adults (Suvisaari et al., 2009) and 15% in US adults (Kessler et al., 2005).

2.2 Drug use

In contrast to the research on alcohol use, the research on drugs is more difficult due to the illegal nature of drug use. At the Finnish population level, the prevalence of drug use has been mainly investigated by drug surveys conducted since 1992. The drug surveys measure self-reported lifetime, one-year and one-month prevalence of using different drugs (Hakkarainen and Metso, 2007). Though the surveys can give a fairly good overall picture of the situation, they are subject to problems leading to underreporting. Especially problem-users are difficult to reach in surveys, and respondents often lie, downplay or forget about their drug use. Also drugs used rarely or drugs used by specific groups may be underestimated (Hakkarainen and Metso, 2007). Another method of studying drug use has been to estimate the number of clients with substance-related visits to units offering treatment for substance users, social services, health care or other services. The problem use of opioids and amphetamines has been estimated by using different administrative registers. These include registries of hospital discharge, crime, DUI (driving under the influence), infectious diseases (hepatitis C) and cause of death registers (Partanen et al., 2007; Vuori et al., 2009).

The current legislation on narcotics in Finland defines illicit drugs and prohibits the use and the possession of drugs, allowing for certain exceptions ([Narcotics act 2008/373]). The legislation was first passed in 1972, after the first wider use of narcotics, mainly cannabis and LSD, arrived in Finland in the 1960s (Hakkarainen, 1992). This was later called the first drug wave, even though drug use and drug problems were not an entirely new phenomenon in Finnish society (Ylikangas, 2009). After this first wave the volume of drug use decreased and stabilized until the 1990s, when the so-called second drug wave landed (Partanen and Metso, 1999). Before this, drug use had mainly meant the use of cannabis, but the second drug wave also brought with it more ‘hard drugs’, such as amphetamine and heroin (Nuorvala et al., 2004; Salaspuro et al., 2003). Earlier, almost all of the clients receiving intoxicant-related treatment in the health services had suffered from alcohol-related problems, but in the beginning of the 2000s, medicines and illicit drugs became more prevalent. This was most clearly seen in patients under the age of 40 years (Nuorvala et al., 2004). The second drug wave seemed to stabilize in the 2000s, however (Hakkarainen and Metso, 2001, 2007).

According to the 2006 drug survey, the lifetime prevalence of drug use at the population level is 16% among men and 12% among women (Hakkarainen and Metso, 2007). This reflected mainly cannabis use, which mostly had not been very

recent, as the one-year and one-month prevalences were low. The most common drugs after cannabis were amphetamine, ecstasy, cocaine and LSD. Among opiate users, the lifetime and one-month prevalences are close to each other, pointing to a large proportion of dependent users. On the population level, 7% had used medicines for non-medical purposes (Hakkarainen and Metso, 2007). The data on clients in substance-related treatment show that alcohol is still the dominant intoxicant among problem users, even though the abuse of medicines and drugs has increased (Nuorvala et al., 2004). The most recent results, however, show a very slight decrease in medicine and drug abuse, in line with population surveys (Nuorvala et al., 2008). The prevalence of the lifetime users of amphetamine and opioids is estimated to be 2% and 1%, respectively, while the prevalence of problem users was estimated to be 0.43–0.74% for amphetamine and 0.13–0.18% for opioids (Hakkarainen and Metso, 2007; Partanen et al., 2007). The prevalence of benzodiazepine use has also increased during the past two decades. The use of sleeping medications has increased in the general population, and especially among elderly people (Klaukka and Peura, 1996), and the use of psychotropics has increased among adolescents (Autti-Rämö et al., 2009). During 2005–2007, the main substances causing fatal poisonings were opioids and antidepressants (Vuori et al., 2009).

3 Drunken driving

3.1 Effects of alcohol on driving performance

A much cited study of the effects of alcohol on driving is the Grand Rapids study of 1964 by Borkenstein (Borkenstein et al., 1974; Borkenstein et al., 1964). This research demonstrated a clear connection between BAC (blood alcohol concentration) and the relative probability of causing a car crash. While the crash risk grew exponentially as a function of BAC, this study also showed a small dip in crash risk at low BAC levels. More recent studies nevertheless indicate that even low doses of alcohol impair driving performance (Blomberg et al., 2009; Moskowitz and Fiorentino, 2000; Ogden and Moskowitz, 2004).

Drunk drivers are greatly overrepresented among road traffic accidents that lead to injuries or fatalities, compared to alcohol prevalence in traffic. Impairment due to alcohol or drugs also substantially raises the risk of a fatal accident (Drummer et al., 2004; Perneger and Smith, 1991; Zador et al., 2000); impairment also increases the severity of a non-fatal crash (Smink et al., 2005; Vaez and Laflamme, 2005). In Finland, every fourth fatality and every eighth injury in road traffic accidents is involving a drunk driver (Statistics Finland, 2010). The involvement of alcohol in fatal road traffic accidents in high-income OECD countries varies from 20% in the UK (Clarke et al., 2010), 21% in France (Biecheler et al., 2008), 22% in Sweden (Jones et al., 2009), to 23–26% among US drivers of personal vehicles (Fell et al., 2009; Subramanian, 2005)

Youth are often over represented in fatal vehicle crashes involving alcohol (Clarke et al., 2010; Subramanian, 2005). In Finland, drivers aged 18–20 years have a twice as high mortality rate in traffic injuries than drivers in any other age group. The traffic injury mortality of 15–20-year-old car passengers is nearly three times as high as that of passengers in any other age group (Statistics Finland, 2010). In 2009, one third of the drunk drivers involved in a fatal accident, and more than one third involved in a non-fatal injury, were under 25 years old (Statistics Finland, 2010). Young inexperienced drivers are estimated to be affected more by alcohol than older and more experienced drivers (Keall et al., 2004; Peck et al., 2008), which partly explains their large numbers in alcohol-related crashes. When alcohol is involved, the relative risk of a fatal crash is especially increased for young men aged 16–20 years (Zador et al., 2000). On the other hand, it is possible that drinking and driving is just one aspect of a risky driving style among young drivers (Bingham et al., 2009; Laapotti and Keskinen, 2008).

3.2 Alcohol testing and Finnish DUI legislation

The work against drunken driving is a century-long story. The first known accident of a drunk driver in Finland occurred in 1907, and criminalization of drunken driving came into effect in 1926 (Voipio, 1963; Österberg, 1987). After the World War II there was concern about the increase in drunken driving, as the number of vehicles in use was growing after the war (Alha, 1963). The clinical testing of intoxication of suspected drunk drivers was first organized in 1952 (Alha, 1963), and in 1959 blood alcohol testing became mandatory (Voipio, 1963). However, not until 1977 were there statutory BAC limits which made drunken driving an offence as such (Österberg, 1987). The first limits for drunken driving were 0.5 per mille (g/kg), and for aggravated drunken driving 1.5 per mille. In 1977 all alcohol and drug analyses for suspected DUI cases were transferred to the National Public Health Institute. The limit for aggravated drunken driving was lowered to 1.2 per mille in 1994. Besides blood alcohol testing, evidential breath alcohol testing was introduced in 1998, with legal limits of 0.25 and 0.60 mg/l of alcohol in exhaled air, which were changed to 0.22 and 0.53 mg/l in 2003 ([Criminal Code of Finland 2002/1198]). After the rapid rise in the cases of driving under the influence of drugs (DUID) a zero-tolerance law for drugs in traffic was introduced. It prohibited the operation of any motor vehicle while there are illicit drugs or their metabolites in the driver's blood ([Criminal Code of Finland 2002/1198], ; Lillsunde and Gunnar, 2005; Ojaniemi et al., 2009). Finnish legislation on DUID is based on both zero-tolerance and impairment laws on alcohol and drugs. Driving under the influence of certain psychoactive medication is permitted when the driver has a prescription for them and driving ability is not impaired by the medication.

The Finnish police has right to perform random breath alcohol screening in traffic. Police officers will also perform screening breath tests in all cases in which there is reason to suspect DUI. This includes all reckless driving and traffic accidents, and minor fender-benders. If screening tests suggest driving under influence of alcohol and/or drugs, further blood tests or evidential breath tests are required. During the investigation, the driving license of a DUI offender is revoked, and a temporary driving ban will be imposed if the driver is proven guilty of DUI. Other consequences may include fines, imprisonment or confiscation of the vehicle.

From time to time, there is public discussion on the appropriate legal limit of BAC. Instead of the current limit of 0.5 per mille, it has been suggested that 0.2 per mille would be a better limit or, alternatively, the limit for youth should be lowered to 0.2 per mille. There is strong evidence from natural experiments in the US that lowering the BAC limit from 1.0 to 0.8 has indeed improved road safety (Fell and Voas, 2006; Mann et al., 2001; Wagenaar et al., 2007). Furthermore, two international reviews conclude that lowering of the limit from 0.8 to 0.5 per mille in the Netherlands, France, Austria, Denmark and Australia has affected traffic safety

positively (Fell and Voas, 2006; Mann et al., 2001). In the Danish case, however, the survey showed reduced drinking and driving, but the number of alcohol-related crashes did not fall, and alcohol-related fatal accidents even increased (Bernhoft and Behrensdorff, 2003). There is also evidence that a legal limit of 0.2 per mille has had a positive effect in Sweden (Mann et al., 2001). And in Japan, lowering the legal limit of BAC to 0.3 and increasing the penalties of drunken driving significantly decreased the number of impaired drivers and alcohol-related crashes (Desapriya et al., 2007; Desapriya et al., 2006b). The effect was observed for adults and young drivers. In a Norwegian survey, drunken driving was reduced after lowering the BAC limit from 0.5 to 0.2, but no significant improvements in road safety were observed (Assum, 2010). Various youth-specific laws have been used to reduce the road traffic accidents of young persons, most notably, a lower BAC limit for youth. Youth-specific laws regarding a minimum drinking age and zero-tolerance of drinking and driving have been found effective (Voas et al., 2003). However, a higher BAC limit that follows a period of a lower BAC limit has been found problematic, because young persons are suddenly allowed to drink more alcohol than earlier (Senserrick, 2003).

3.3 Prevalence and trends of drunken driving

When the prevalence of drunken driving is examined in Finland, we may refer to drivers arrested by the police, to roadside studies of drivers in traffic flow, or to fatal and non-fatal accidents involving a drunk driver. All of these data provide different information, and they are all subject to different kinds of selection. The number of arrested drivers depends on police activity, and the severity of impairment affects both the chance of arrest and of traffic accidents. These data are therefore likely to have selection bias on the drivers included. Studies in traffic flow probably give a reliable picture of the prevalence of drunken driving, as all drivers are stopped and given a screening breath test. Despite this, roadside studies are limited as to the time and place of testing. Especially during the weekends and during the night-time the proportion of drunk drivers may be very high. International comparisons of the prevalence of drunken driving are especially difficult because of the different methods used in roadside studies, and the different DUI legislation in different countries, which often means that the reported BAC levels vary. Furthermore the BAC per mille may sometimes be measured as grams of alcohol per one kilogram of blood, or grams of alcohol per one liter of blood, which differ slightly.

Since the end of the 1980s the Finnish society has changed in many respects and also in regard to factors affecting DUI. The changes in alcohol consumption were discussed earlier, but additionally, the number of registered motor vehicles and driving licenses has grown. In 1990 there were 2.2 million registered cars in traffic,

and by 2009 the number had grown to 3.2 million (Finnish Transport Safety Agency, 2010b). Also the number of driving licenses has increased especially among women and elderly people (Finnish Transport Safety Agency, 2010a).

According to statistics, in 1989–1991 there were almost 30,000 cases of DUI caught by the police every year in Finland (Niemi, 2010; Statistics Finland). The numbers decreased sharply as the Finnish economy declined to a recession in the beginning of the 1990s. During the past few years, the police have caught 19,000 – 24,000 cases of drunken driving annually. In addition, around 3,000 drivers are caught driving under the influence of drugs. In 2010 there were altogether 21,000 cases of DUI known to the police, more than half of these cases were aggravated. This meant a 9% decrease in aggravated DUI and an 11% decrease in non-aggravated DUI from 2009. The number of registered DUI offences was lowest since the mid-1990s.

In the annual roadside studies carried out in the Uusimaa region, the proportion of drunk drivers (BAC 0.5 per mille) has ranged from 0.19–0.28% of all tested drivers in 1990–2008 (Portman et al., 2011). Of all tested drivers, 0.01–0.08% had a BAC over the limit of aggravated DUI. After the legal limit of aggravated DUI was lowered from 1.5 to 1.2 per mille, the proportion of drivers with aggravated DUI doubled from 0.03–0.06%. No specific trends were observed in drunken driving exceeding the legal limit of 0.5 per mille. However, the proportion of drivers with some alcohol, less than 0.5 per mille, was 0.4% in the mid-1990s, increased in the early 2000s reaching 1.1% in 2005, and then fell again to 0.5–0.7% (Penttilä et al., 2004; Portman et al., 2011). The testing has been performed in the same manner during the 20-year study period. It has taken place on Tuesdays and Saturdays at all hours in selected locations. Drivers entering from either one or both directions have been stopped and tested, depending on the traffic (Portman et al., 2011).

Similar studies have been conducted also in other countries. A Swedish study found a proportion of 0.24% exceeding the legal BAC limit of 0.2 per mille when the testing was conducted between 7 am and 11 pm on all week days (Forsman et al., 2007). In Norway 0.3% of the drivers exceeded the legal BAC of 0.2 at randomly selected locations and times (Gjerde et al., 2008). A German study reported 0.55% of randomly selected drivers exceeding the BAC of 0.8 per mille in Germany when weekends and night-times were oversampled (Vollrath, 2000). In the US 2.2% of drivers exceeded the BAC of 0.8 per mille in the night-time and 0.1% in the daytime (Compton and Berning, 2009). In the US study, the corresponding proportions for BAC of 0.5 were 4.5% and 0.1% of the tested drivers, while a BAC below 0.8 per mille is not considered illegal. In a Canadian study, randomly selected drivers were stopped at night-time: 8% tested alcohol-positive, 4% exceeded a BAC of 0.5 per mille, and 2.5% exceeded the illegal BAC of 0.8 (Beirness and Beasley, 2010). A comparison of 15 countries, conducted by the European Traffic Police Network in 2005–2009, estimated that the prevalence of drunken driving was lowest in Finland, Sweden and Norway (0.1–0.7%) whereas the average results from the UK, Denmark,

Greece, France and Italy were multiple times higher (Niemi, 2010). International comparisons, however, should be interpreted very cautiously, as they are subject to different legislations and BAC limits.

Even though there are more female drivers in the traffic than earlier, drunken driving in Finland is still a very masculine phenomenon. Only one tenth of drunk drivers are women, but the proportion of women among all drunk drivers is increasing (Rajalin, 2004).

3.4 Prevalence and trends of drugged driving

The legislation preceding 2003 required that the police must be able to provide evidence of the driver's impairment in court in drugged driving cases. The prosecution process became more precise with the new zero-tolerance law of 2003, when the use of medicinal drugs under narcotic control and the use of illicit drugs were banned, with the exception of prescribed medicines. In addition, the law still prohibited impaired driving due to any substance, if the impairment could be proven (Lillsunde and Gunnar, 2005). In Finland, the observed effect of the zero-tolerance law was very similar to Swedish experiences, where the number of arrested drugged drivers increased substantially (Ellermaa et al., 2005; Ojaniemi et al., 2009). Zero-tolerance in itself neither increased nor decreased the number of drugged drivers in traffic. Actually the most important factor behind the observed increase was the increased activity of the police in arresting and prosecuting the drugged drivers (Ellermaa et al., 2005; Holmgren et al., 2008; Jones, 2005). In Switzerland, an increase in cocaine use in traffic was observed after a similar zero-tolerance law, even though comparison with earlier studies was limited, as these were not country-level studies (Senna et al., 2010). A study from the Netherlands estimated that if the Netherlands were to adopt stricter legislation, the number of DUID offences would rise (Smink et al., 2001).

Alcohol is the most common substance found in people arrested for DUI in Finland. However, the prevalence of illicit or medicinal drugs has increased substantially since the end of the 1970s (Lillsunde et al., 1996), and the most recent increase has occurred since the 2003 zero-tolerance law (Ojaniemi et al., 2009). Benzodiazepines, amphetamines and cannabinoids are the drugs found most commonly. Poly-drug findings are very common, ranging from 70–88% of all drug samples in 1987–2007. Benzodiazepines were found in the 5 most common poly-drug combinations. Altogether benzodiazepines are found in 76%, amphetamines in 46% and cannabis in 28% of all cases of suspected drugged driving. Alcohol was found in every third case, but it decreased to every fifth in 2007. (Karjalainen et al., 2010).

The prevalence of drugs in traffic has increased also in the other Nordic countries (Holmgren et al., 2007; Jones, 2005; Mørland, 2004) and in several other countries, e.g. in Switzerland (Augsburger and Rivier, 1997; Senna et al., 2010). In a Nordic comparison, benzodiazepines were found most commonly, with the exception Denmark where THC was the most common substance (Christophersen et al., 1999). Benzodiazepines have been found also frequently in Germany (Krüger et al., 1995), Luxemburg (Appenzeller et al., 2005), Scotland (Officer, 2009), and the Netherlands (Smink et al., 2001). Later studies from the Nordic countries have again confirmed the widespread use of benzodiazepines among DUID cases (Christophersen and Mørland, 2008; Gjerde et al., 2008; Jones, 2005; Ojaniemi et al., 2009). Amphetamine also has been reported to be a dominant illegal drug among DUID cases in Finland as well as in Sweden (Holmgren et al., 2007) and alongside with cannabis in Norway (Christophersen and Mørland, 2008). The most frequently detected illicit substances among DUID offenders elsewhere include THC in Scotland (Officer, 2009), Canada (Beirness and Beasley, 2010), the Netherlands (Smink et al., 2001), Switzerland (Senna et al., 2010) and Luxemburg (Appenzeller et al., 2005), and also cocaine in Canada, the Netherlands and Switzerland. The Swiss study additionally reported a low frequency of benzodiazepines.

3.5 Social background as a risk factor

Alcohol use and abuse are affected by several social factors. Typically, a poor social background is associated with more harmful consequences of alcohol use (Galea et al., 2004; Suvisaari et al., 2009). A poor social background is therefore likely to be connected with drunken driving. In a Finnish birth cohort study on all live births in Northern Finland in 1966, a single-parent family background was associated with drunken driving (1–2 times) and recidivism (3 or more times) of drunken driving (Sauvola et al., 2001). Another study with the same cohort found that drunken driving was associated with poor school performance in adolescence, and educational underachievement in early adulthood (Riala et al., 2003). An association between low education and drunken driving has also been reported in Estonian (Eensoo et al., 2005) and Australian (Baum, 2000) studies comparing convicted drunk drivers with a control population, and in a US study comparing recidivist drunk drivers with other drunk drivers (C'De Baca et al., 2001). In the Australian study, drunken driving was also associated with unemployment, low occupational status and low income (Baum, 2000). Similar results have been found in Finland: There are more students and persons in leading occupational positions among non-recidivist drunk drivers, and more unskilled workers among recidivist drunk drivers (Pikkarainen et al., 1995). Recidivist drunk drivers are also less frequently married than non-repeat offenders (C'De Baca et al., 2001). Another Finnish birth cohort

study, including 10% of the birth cohort of 1981, showed an association between drunken driving among youth with a low parental education, divorce of parents, death of a parent, living in a small community, not living with parents and not being in a regular relationship (Elonheimo et al., 2010; Sourander et al., 2006). While poor social conditions in general indicate more drunken driving, some studies also connect alcohol abuse among youth with a higher socio-economic status (Humensky, 2010) and a higher income (Kouvonen and Lintonen, 2002).

In a Finnish roadside study (Portman et al., 2011) conducted in 1990–2008, over half of the drunk drivers were married or cohabiting. The proportion of those who were divorced was 16% for men (n=178/1050) and 23% for women (n=25/108). The corresponding annual averages for the 15–64-year-old population in the same period were 9% and 11%, respectively (Statistics Finland). The male drunk drivers were most commonly blue-collar or lower white-collar workers. During 1996–2008, 11% of male (n=79/697) and 23% of female (n=14/62) drunk drivers were unemployed, while in the same period the average annual unemployment rate was 6.6% and 5.6%, respectively (Statistics Finland).

3.6 Recidivism of DUI

A considerable proportion of drunk drivers are recidivists (LaBrie et al., 2007; Pikkarainen et al., 1995; Portman et al., 2009; Portman et al., 2011; Skurtveit et al., 1998). Although most of the people who drive under the influence are arrested only once, there is also a subpopulation of those who are caught driving under the influence again and again. Repeatedly arrested drivers who often have a high BAC are sometimes called persistent drunk drivers or hard-core drunk drivers. When comparing rearrest rates, it should be borne in mind that study designs may vary, and the rearrest rates are directly subject to the follow-up times used. Results from Finnish studies conducted in the 1990s revealed rearrest rates of 38% in 5 years, and of 51% in 19 years, 66% in 23 years, and also a very high number of drivers were rearrested within one year (Pikkarainen et al., 1995; Seppä, 1992). Self-reported recidivism has been almost 38% among all alcohol-positive drivers, and 20% among drivers with a low, under 0.5 per mille BAC (Pikkarainen and Penttilä, 1995). More recent Finnish studies have shown re-arrest rates of 33% during a 10-year period (Portman et al., 2009) and of 50% during a 17-year period (Portman et al., 2011) in a sample of 132 drivers. In other countries, the rearrest rates from the shortest to the longest follow-ups have been 13% for known first-time offender and 16% for previously known recidivists in 2 years in the USA (McCartt and Northrup, 2004), 20% in 3 years in Norway (Gjerde et al., 1988), 21% in 4 years in the USA (Lapham et al., 1997), 16% in 6 years (LaBrie et al., 2007), 45% in 9 years in Norway (Skurtveit et al., 1998), and rates between 21–48% in various follow-up times in

parts of the USA (Centers for Disease Control and Prevention, 2010). As a large share of all drunken driving goes undetected, this is the minimum estimate for recidivism. Therefore, instead of speaking of recidivism, we should often speak of rearrests.

Drivers arrested while driving under the influence of drugs often have higher rearrest rates than drunk drivers. In a Norwegian group of drugged and drunk drivers, the 7-year rearrest rates were 57% and 28%, respectively, and the 15-year rearrest rates were 71% and 40%, respectively. 21% of drugged drivers were rearrested the same year in which they were first arrested (Christophersen et al., 2002). Poly-drug use was an important factor of rearrest. In Sweden, the rearrest rates of drivers with alcohol, illicit drugs (mainly amphetamines) and prescribed medicines (mainly benzodiazepines) were 14%, 68% and 17%, respectively, during a 4-year period after the zero-tolerance law on drugs came into effect (Holmgren et al., 2008). However, in the 1980s, a Norwegian study with a 3-year follow-up showed rearrest rates for alcohol, amphetamine or THC, and diazepam to be 20%, 6% and 50%, respectively (Gjerde et al., 1988).

A high BAC of a drunk driver is associated with an increased probability of recidivism (C'De Baca et al., 2001; Lapham et al., 1997; Pikkarainen and Penttilä, 1995; Skurtveit et al., 1998). In Finnish roadside studies, the risk of recidivism was 2.5 times higher for drivers with a BAC exceeding 1.2 per mille compared to a BAC of 0.5–1.2 per mille (Portman et al., 2009). Also, a polynomial curve has been reported, indicating that drivers with a high and a low BAC are most likely to repeat their DUI offence (Marowitz, 1998). While the high BAC levels may be a sign of alcohol-dependence, the high rearrest rates of drivers with zero-BAC reported by Marowitz may indicate drugs other than alcohol. The probability of recidivism for an extremely high BAC, exceeding 3.0 per mille, started to decrease, which may be explained by higher rates of illness or death in this group preventing further driving (Marowitz, 1998). More strict sanctions for certain BAC levels may also affect the recidivism rate, as drivers with higher BAC levels have to answer to these sanctions (McCartt and Northrup, 2004).

Identifying a recidivist and preventing recidivism is not an easy task. There are several risk factors associated with recidivism. Nochajski and Stasiewicz classify them into demographic characteristics, criminal history, alcohol and drug-related variables, and personality and psychiatric variables. They have also come to the conclusion by previous literature that the recidivists are a very heterogeneous group (Nochajski and Stasiewicz, 2006).

3.7 Health-related harms

Drunken driving is a major threat to traffic safety. Drunk drivers are at an increased risk of getting into traffic accidents, and they are considerably overrepresented in the statistics on fatal accidents (Blomberg et al., 2009; Hingson and Winter, 2003; Zador et al., 2000). In Finland, one fourth of fatal traffic accidents and one eighth of non-fatal traffic accidents are caused by a drunk driver (Statistics Finland, 2010), whereas one in 500 drivers has a BAC exceeding 0.5 per mille (Portman et al., 2011). Some studies have concluded that drunk drivers involved in non-fatal traffic accidents suffer more serious injuries than other injured drivers (Desapriya et al., 2006a; Vaez and Laflamme, 2005). There is also evidence contradicting this, as some studies have not found any correlation between intoxication the severity of injuries (Smink et al., 2008) or increased in-hospital mortality of injured drivers (Koval et al., 2008). On the other hand, the treatment times of minor injuries in emergency departments were found to be longer and more expensive when alcohol was involved in a crash leading to injury (Lee et al., 2009).

Drunk drivers suffer a substantial excess mortality from other causes than road traffic accidents only, when compared to a population with no recorded drunken driving (Karlsson et al., 2003; Mann et al., 1993; Penttilä et al., 1995; Pikkarainen and Penttilä, 1995; Skurtveit et al., 2002). The highest excess mortality is caused by alcohol-related diseases, accidents, violence, and suicides (Mann et al., 1993; Penttilä et al., 1995). Among the accidents, especially poisonings by alcohol or alcohol combined with psychotropic drugs were common (Penttilä et al., 1995). An observed high BAC of an arrested driver predicted higher mortality (Skurtveit et al., 2002), and the mortality patterns of drunk drivers are very similar to those of alcoholics (Mann et al., 1993). Standardized mortality ratios (SMR) between 1.7 and 3.7 have been reported for all-cause mortality (Mann et al., 1993; Skurtveit et al., 2002). In Finland, 20–64-year-old drunk drivers were reported to have doubled mortality, and the mortality was even higher in the younger age groups (Pikkarainen and Penttilä, 1995). Driving under the influence of illicit and/or medicinal drugs is associated with even higher excess mortality (Hausken et al., 2005; Karjalainen et al., 2009). Drivers who use alcohol combined with medicinal drugs have a very high mortality (Hausken et al., 2005; Karjalainen et al., 2009). Assigning convicted drunk drivers to alcohol rehabilitation has been noted to reduce total mortality and significantly reduce mortality by accidents and violence compared to a control group not in rehabilitation (Mann et al., 1994).

Drunk drivers also have more hospitalizations than the general population. Diagnoses of alcohol and drug use and attempted suicide entail the highest relative risks (RR) of hospitalization (Karlsson et al., 2003).

4 Aims of the study

This study is register-based, taking the viewpoint of public health and traffic safety on drunken driving and problems related to it. The general aim was to examine drunken driving on the population level, based on records of arrested drunk drivers.

The specific aims were:

1) To examine and describe the trends and changes in the patterns of drunken driving in various demographic groups
2) To study the association between social background and drunken driving
3) To define how substances detected from a driver affect rearrest rates, and what other factors predict future recidivism
4) To study mortality of drunk drivers and to evaluate the contribution of alcohol according to the cause of death.

Aims 1 and 3 were studied using data on all drunken driving arrests. The examined unit of the trend study was an arrest, while the unit of the rearrest study was an arrested person. Aims 2 and 4 were studied using a 50% sample of persons in drunken driving data compared with data on the general population. The data were combined with administrative registers of social factors and mortality. The unit examined in these two studies was a person.

Arrested drunk drivers are a selected sample of all drunken driving. Roadside studies enable better estimation of the prevalence of drunken driving, and may be able to better describe the population driving under the influence. Arrested drunk drivers may display more risk-taking behavior, or may be inexperienced or impaired drivers, which factors will cause them to be arrested more easily. Roadside studies, however, ignore a large part of risky drivers, such as teenagers who are not encountered in traffic as often.

5 Material and Methods

5.1 The data on arrested drunk drivers

Up until the end of 2008, all DUI-related blood alcohol testing in Finland was performed centralized at the National Public Health Institute, KTL (National Institute of Health and Welfare, THL, since 1.1.2009). The owner of the data is the Police Department of the Ministry of the Interior, but it has been governed and maintained by KTL/THL. The electronic records on drunken driving cases are available since April 1988. Additionally, all data on evidential breath testing were recorded in the THL/KTL database since 1998. The electronic data on drugged driving exists from 1977, but were not utilized in this study in parts going beyond the records of drunken driving. After the beginning of the evidential breath testing, the proportion of the results obtained from breath testing has been steadily growing and currently constitutes more than a half of all testing. If evidential breath testing is not available, or the suspect is unwilling or incapable of giving it, a blood sample is taken. Most typical causes of arrest are random breath test (30%), tip-off (18%), traffic accident (12%), a suspect manner of driving (11%), and traffic violation such as speeding (11%) (Niemi, 2010).

Altogether the data on DUI included almost a half million cases of suspected DUI from the years 1988–2007, an annual 25,000 cases on average. The number of suspected drunken driving cases with an alcohol-positive finding with no drugs detected was 460,000. The number of drunken driving arrests ranged between 19,000 in 1994 and 31,000 in 1990. During the 2000s the number of drunken driving cases increased, reaching 25,000 arrests in 2007. Altogether 440,000 cases of suspected drunken driving in 1989–2007 were analyzed in Study I. The data on rearrested drivers in Study III included 195,000 people with 340,000 DUI arrests in 1993–2007. There were 32,000 cases of drugged driving in 1977–2007, but only the first arrests of 4253 persons in 1993–2007 were used in this study (Study III). The number of drugged driving cases increased substantially after the zero-tolerance law in 2003. The data did not include information on possible conviction, so it remains data on suspected drunken driving only. The data used in the different studies are shown in Table 1.

Table 1 – Use of different data in the study

Original paper	Topic	Data used	Years
Study I	Trends of drunken driving	Drunken driving arrests (N = 440,624 cases)	1989–2007
Study II	Social background of drunk drivers	50% sample of drunk drivers (N = 81,125 persons), reference population (N = 86,279 persons), population census, employment statistics	1993–2007
Study III	DUI rearrests	Drunk and drugged drivers (N = 194,932 persons and 341,366 cases)	1993–2007
Srtudy IV	Mortality of drunk drivers	50% sample of drunk drivers (N = 112,398 persons), reference population (N = 115,019 persons), causes of death statistics (N=19,519 deaths), employment statistics	1988–2006

5.1.1 The 50% random sample of arrested drunk drivers

Due to confidentiality regulations, it was not possible to combine the full data set with other registers, as the possible new combined data were considered to contain too sensitive information on health, income and other personal issues. A 50% simple random sample was drawn from all persons in the data on suspected DUI. If a person was selected to the sample, all of his/her cases of DUI were included. The 50% sample consisted of 126,945 persons with 240,904 cases of drunken driving. The sample of drunk drivers was used in Studies II and IV to analyze the social background and mortality of drunk drivers. The sample was combined with other data by using the personal identification code numbers. All sampling and combining of the data were performed by Statistics Finland.

5.1.2 Reference population

To analyze the causes exposing to DUI behavior and the consequences of DUI in Studies II and IV, another random sample of the general population with no DUI record was drawn. The inclusion criterion was that the person in the reference group had no DUI record. The references were matched for age and sex to get a similar population structure in both groups; the reference group had the same number of people as the random sample of drunk drivers. Also the year of entry to the data was

considered same. No further matching was used in order to fully model the differences.

5.2 Official Registers

Official register is the term used for register data maintained by Finnish register authorities. The maintenance of some of these data is stipulated and regulated by law. All of the following register data are maintained and provided by Statistics Finland.

5.2.1 Population census and employment statistics

The population census and the employment statistics include individual-level information on social and demographic factors of the population. The longitudinal census data covering these social and economic variables have been formed for every fifth year for the period 1970–2000 (Statistics Finland). In this study, the information utilized is from years 1970–1985. Since 1987, the social and demographic variables were obtained from the annual employment statistics describing the economic activity of the population. The population for the statistics consists of the people residing permanently in Finland on the last day of the year (Statistics Finland). The information in these data was used in Studies II and IV.

5.2.2 Cause of death statistics

The cause of death statistics are annual individual-level data covering all the deaths of people residing permanently in Finland. Thus it does not necessarily cover all deaths of Finnish citizens, but does include deaths abroad when the person's permanent residence is in Finland, and also the deaths of foreign citizens living in Finland. The statistics is based on death certificates issued by a physician. The cause of death is recorded according to ICD-9 between 1987 and 1995, and according to ICD-10 since 1996 (Statistics Finland). When death is sudden or unexpected or due to unnatural causes, the law requires a post-mortem examination (Act on the Inquest into the Cause of Death 1973/459). A more thorough medico-legal autopsy is performed to every fourth deceased person. In the case of death due to external causes, such as accidents, homicides and suicides, medico-legal autopsies are performed in 87.2%, 98,3% and 99.5% of the cases, respectively (Lunetta et al., 2007). The mortality data were used in Study IV.

5.3 Measurements of variables

5.3.1 DUI data

Data on DUI are based on blood and urine samples analyzed at KTL/THL in 1988–2007, and on evidential breath testing since 1998. If a person is unwilling or incapable of giving an evidential breath sample, a blood sample is taken. All cases with negative findings from both alcohol and drugs were excluded from this study. Only motorized road traffic was analyzed in the study, and for example all water traffic was excluded. All cases with findings of any other substance than alcohol were classified as driving under the influence of drugs (DUID). Similarly, a person was considered a drunk driver if there was no previous history of DUID in the data, while a person with even a single case of DUID was considered a drugged driver. Study I covered all drunken driving cases with no drugs detected, Studies II and IV covered all drunk drivers with no history of DUID, and Study III analyzed both drunken and drugged drivers. Separate persons were identified by their personal ID code numbers in Studies II, III and IV. In Study I, only separate cases were analyzed. The data did not contain information on possible conviction of DUI; the data therefore point to suspicion of DUI, as there is no proof of culpability.

The BAC result used in the analyses was the result of the test with a technical reduction, according to the accuracy of the method. In this study, the alcohol concentrations of all drunk drivers were estimated by converting evidential breath test results to blood alcohol results, using a coefficient of 2.27, assuming that 0.5 per mille and 1.2 per mille (g/kg) of alcohol in blood equal 0.22 mg/l and 0.53 mg/l of alcohol in exhaled air. Drugs were tested from blood or urine until 2003, and from blood only from 2003 onwards. This somewhat affected the substance findings, as metabolites of drugs, especially cannabinoids, can be detected for a longer time from urine than from blood. Concentrations of drugs found in blood or urine were analyzed in the laboratory, but the findings were categorized as positive or negative in this study. The drugs found were classified into four main categories which were; amphetamines, cannabinoids, benzodiazepines and opioids. Any other drugs found were not analyzed in the study.

The data on DUI also included information on vehicle type, date and time of arrest, and evidential breath or blood sample, cause of apprehension, as well as other clinical and demographic data. The data also included information on the time of the event as estimated by the police. Often this time was shortly before the time of the arrest. Whenever this information was available, it was used as primary information on date and time. When the time of the event was missing, the time of arrest was used. Otherwise the date and time of the evidential breath or blood sample was used.

5.3.2 Social background

Information on social background was utilized from 1993–2007 in Study II and from 1988–2006 in Study IV. The data on social background was obtained from the population census and/or from employment statistics. The age and sex of a driver which were used in the analyses were also from these data. The value of the variable was taken from the year prior to the suspected first drunken driving in order to achieve the status preceding the drunken driving. If the value from the preceding year was not available, the value from the same year was used if possible. The variables analyzed were:

Education: High (tertiary), medium (upper secondary / post-secondary non-tertiary) or low (less than medium level education or unknown)
Marital status: Married, single, divorced, widowed
Labor market status: Employed, unemployed, student/pupil, conscript, on work disability pension, on old age pension, other pension, other
Socio-economic position: Upper white-collar, lower white-collar, blue-collar, farmer, entrepreneur
Income subject to state taxation: Classified as zero-income and quartiles by age group, sex and year
Household type: Living alone, living with other people
Ownership or possession of a car: Yes, no
Level of urbanization of residential community: Urban, semi-urban, rural
Education of mother: Similar to own education
Education of father: Similar to own education
Income of mother: Classified as zero-income and quartiles by age group and year
Income of father: Classified as zero-income and quartiles by age group and year

Own and parental education in this data was the highest achieved degree of education. When no medium level education existed, the variable was coded as missing. This was a problem regarding parental variables, as it was impossible to distinguish a low level of education and a possibly deceased person, as both data would be coded as missing. Income was income subject to state taxation rounded to the closest 1000 euro. For purposes of analysis, the income was divided into zero-income and quartiles separately for age group, sex and year, in order to ensure a reasonable comparison of income. Zero-income was coded as missing information, which again may affect interpretation of the parental income. Socio-economic position was available annually for the years 2004–2006. Before this, it was recorded every fifth year in 1970–2000. The last known socio-economic position preceding the drunken driving was used. Possession of a car could mean either that the person was a registered car owner, or was registered as a main driver of a car owned by someone else (e.g. a company car). Possession of a car was positive if either one of these criteria was true, and negative if neither was true.

5.3.3 Mortality

Cause of death statistics provided data on mortality in 1988–2006 (Study IV). The cause of death is classified according to ICD-9 (International Classification of Diseases) in 1988–1995, and according to ICD-10 from 1996 onwards. Statistics Finland use a 54-class time series classification which is comparable throughout the period analyzed in this study. The data also included information on alcohol as a contributing factor of death, as estimated by the physician providing the death certificate, or the forensic pathologist performing the medico-legal autopsy. The contribution of alcohol was classified into three categories: acute alcohol intoxication, other alcohol-related condition, or no alcohol involved in the death. The mortality follow-up started when drunk driver was arrested for the first time. The reference subjects were entered in the follow-up on June 31st of the according year. The exact date of death was not provided because of confidentiality regulations, so only the year of death was known. For the purpose of measuring the follow-up time up to mortality, the date of death was assumed to be July 1st. There were negative values for follow-up times in 364 cases, which were therefore left out of the analysis.

5.4 Statistical methods

Trends in drunken driving (Study I) were investigated by computing the incidence rate of suspected drunken driving by age and sex. The number of cases was proportioned to the population of the group corresponding in age and sex, and measured as cases per 1000 people.

Study II on social determinants focused on how different social factors are associated with drunken driving. The data on drunk drivers was compared with an age- and sex-matched population with no history of drunken driving. Drunken driving was treated as a binary response variable, and logistic regression models were fitted to the data. Initial univariate models with a single variable were fitted for all social factors. Variables were added to the model one by one to control the effect of confounding variables, until a full model with all social variables was fitted to the data. The results are reported as odds ratios and 95% confidence intervals (95% CI).

The recidivism of DUI (Study III) was studied according to the substances detected at the first arrest of a DUI suspect. Analyses were performed separately for two substance classifications. In the first classification the groups were: alcohol only, drugs only, or alcohol and drugs combined. In the second classification the main substance groups were: alcohol only, benzodiazepines only, cannabinoids only, amphetamines only, and opioids only. Only drugs from one main group were allowed in the findings to ensure better estimation of the differences between drugs. Findings of alcohol were allowed in all groups in the second classification. Methods

of survival analysis were used to estimate risk of rearrest according to the follow-up time between the first and possible second arrest. Kaplan-Meier estimates were computed for rearrest times in the different groups, and Cox regression models were fitted to the data. When no second arrest occurred by December 31st 2007, the observation was considered censored in the analysis. The figures of Kaplan-Meier estimates were used to illustrate the cumulative rearrest rates in different substance groups. Observed rearrest rates as well as Kaplan-Meier estimated rearrest rates are reported. The observed rearrest rate equals the proportion of persons encountered in the data twice or more, whereas the Kaplan-Meier estimated rearrest rate considers the individual follow-up time (Clayton and Hills, 1993). The observed rearrest rate can be interpreted as the minimum rate of rearrests, whereas Kaplan-Meier method estimates rearrest rates as if all subjects were followed until the end of the study period. The Cox regression results on risk factors were reported as hazard ratios and their 95% confidence intervals.

The mortality of drunk drivers (Study IV) was studied by comparing suspected drunk drivers to an age- and sex-matched population with no history of drunken driving. The mortality of both populations was computed as deaths per 100,000 person-years for both sexes, according to the main groups of cause of death. The Cox regression model adjusted for age, marital status and education was used to estimate hazard ratios with 95% CI. The contribution of alcohol was reported as a percentage of acute alcohol intoxications and other alcohol-attributable deaths for the cases and reference population by sex. The Cox regression adjusted for age, sex, marital status and education was also computed for deaths in which alcohol was a factor contributing to death. Cox regression was also used to model how age, BAC, education, marital status, day and time of arrest, and possible previous arrests affected the risk of death among the DUI suspects.

5.5 Ethical approval of study

The study was conducted following the guidelines of good study practices. The study design and all data operations were done in compliance with the ethical approval of the institutional review committee of KTL/THL. The data on suspected drunk drivers is governed by the policing department of the Ministry of the Interior, which approved the use of the data for the purposes of this study. Approval was also obtained from Statistics Finland, and all of the data merging and operations requiring personal ID code numbers were performed by Statistics Finland, which is the official register authority and supplier of most of the additional data. Additionally, a statement by the Data Protection Ombudsman was requested.

6 Results

6.1 Trends in drunken driving in Finland, 1989–2007

The trends in drunken driving (Study I) were analyzed from data containing all the drunken driving cases that have come to the attention of the police. All cases with drugs involved were excluded from the data. From 1989–2007 there were 440,624 cases of drunken driving known to the police. Up until 1998 all the BAC results were obtained from blood tests, but after 1998 the number of evidential breath alcohol tests has grown. In 1999–2007, almost half of the cases of drunken driving were verified from evidential breath tests. In 2007 the proportion of breath tests was 60%. The mean BAC was 1.62 per mille and the mean breath alcohol level was 0.57 mg/l, which equals approximately a BAC of 1.29 per mille. If a driver is unwilling or incapable of giving an evidential breath sample, a blood sample is taken. This means that a blood sample is typically obtained from the most impaired drivers. On average, women had 0.09 per mille lower BAC and 0.03 g/l lower breath alcohol (approximately 0.07 per mille in BAC) than men. The lowest alcohol concentrations were found in persons under 20 and over 70 years, whereas the highest concentrations were among 30–59-year-olds.

The number of cases ranged from 19,580 in 1999, to 30,335 in 1990 (Fig. 1). Altogether 91% of the suspects were men. The most common vehicle was a passenger car or a van, followed by mopeds which comprised 5% of all cases. The mean age of the arrested drivers was 36 (median 35) years, and there were no major differences between the sexes. Drivers who had turned 18 in the past few years formed the biggest group. Drivers under 15 or over 75 years were very rare. In 1989–1991 there were about 30,000 annual cases of drunken driving. This was followed by a 35% reduction in cases between 1991 and 1994 when the consumption of alcohol simultaneously decreased by 14%. After 1999 there was a steady growth in the number of cases, which reached 25,000 in 2007. This was the highest number since 1992. The proportion of women almost doubled from 6% to 11% in 1989–2007. The proportion of female drunk drivers was highest among 18–50-year-olds.

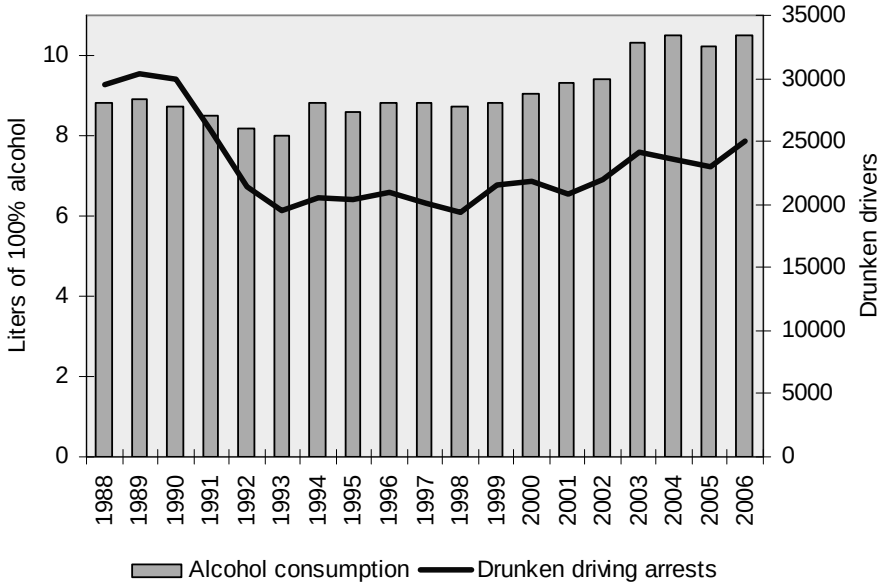

Figure 1 – Number of suspected drunken driving cases and alcohol consumption of 100% alcohol in 1989–2007

In monthly examination, the biggest number of the cases was encountered in June and July, which is the typical holiday season in Finland. Least drunken driving was detected between December and February. Drunken driving concentrated mostly to the weekend nights (Fig. 2). Altogether 16% of the cases occurred on Fridays, 28% on Saturdays and 19% on Sundays. The numbers increased starting from 7 pm, and most arrests took place between 10 pm and 4 am. The fewest cases were observed at 6–8 am, and another peak was observed in the morning hours 9–11 am. In day-by-day examination of a year, extremely high numbers of cases were found during the following national holidays: 1st of May, Midsummer, New Year's Eve and New Year's Day.

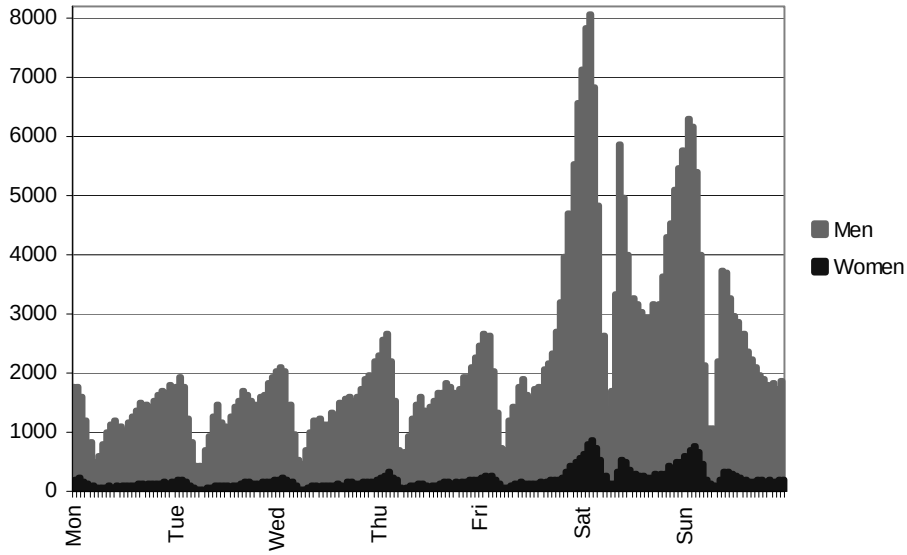

Figure 2 – Time of arrest according to day and hour in 1989–2007 (Source: Impinen et al. Rattijuoppo on yhä useammin 18-vuotias. Suomen Lääkärilehti 2008; 63: 2221–2226.)

The incidence of drunken driving was 5.6/1000 person-years in 1989–2007. Age-specific investigation was carried out in the age groups of 15–17, 18–19, 20–29, 30–39, 40–49, 50–59, 60–69 and 70–84-year-old people (Fig. 3). The incidence rate was clearly highest (13.6/1000) among 18–19-year-olds, i.e. the age group that has just recently got their driver's license. Their incidence rate was more than double that of the overall population aged 15–84 years. The observed changes in time were also strongest within this age group. Incidence rates generally decreased with increasing age. The age group of 15–17-year-olds was an exception, as their incidence (6.8/1000) was on the same level as that of the 40–49-year-olds (6.5/1000). The incidence rates developed differently in the different age groups. The most rapid changes occurred in the youngest age groups whose incidence fell dramatically in the early 1990s, and rose again in recent years, especially among women. The incidence of 50-year-old and older people has been growing steadily during the entire period. Among these people, the increase in detected drunken driving might well be explained by the overall increased driving, especially among women.

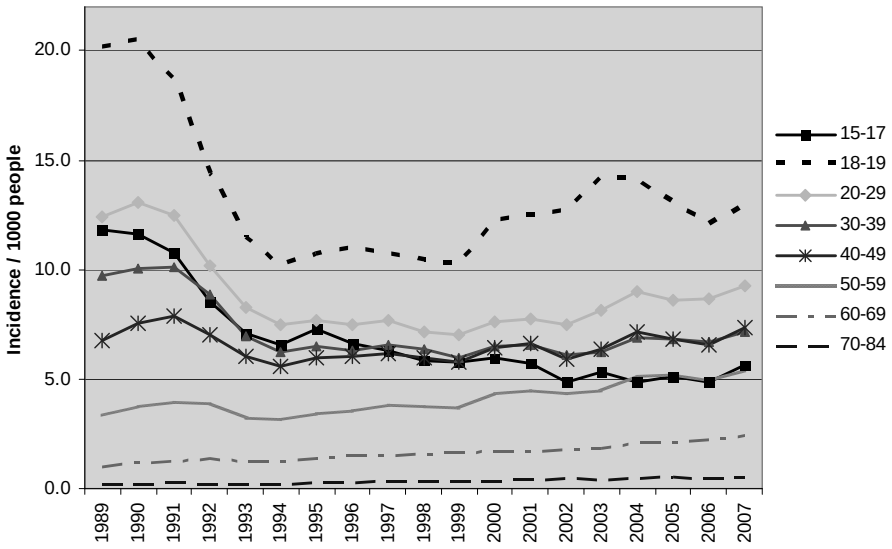

Figure 3 – Incidence of drunken driving arrests per 1000 population by age group, 1989–2007 (Source: Impinen et al. Rattijuoppo on yhä useammin 18-vuotias. Suomen Lääkärilehti 2008; 63: 2221–2226.)

6.2 Social background as a risk factor for drunken driving

The data on social factors in Study II included 81,125 persons suspected of drunken driving in 1993–2007, and 86,279 controls for them with no previous history of DUI. The first arrest of each suspect was analyzed. In order to analyze only the first cases of drunken driving, all drivers with a previous history of DUI in 1988–1992 were excluded from the data. The drivers in this study thus had no previous record of DUI, during at least five years prior to the arrest. Of the suspects, 87% were men and 28% were rearrested during the study period. One third of the first-time offenders were between 15 and 24 years of age, and two thirds were between 25 and 64 years of age. The mean BAC was 1.4 per mille for both sexes.

The association between social background and drunken driving was studied by logistic regression models separately for both sexes, and for young persons aged 15–24 years, and for the economically most active population aged 25–64 years. The results are presented as odds ratios (OR).

6.2.1 Social determinants among youth

The results of fully adjusted logistic regression models are presented for young men and young women are given in Figure 4. Among young persons, parental variables were statistically significant for both sexes. The mother's or father's low income was associated with higher odds of drunken driving. The lowest income quartile of the mother meant an odds ratio of 1.9 for men and 1.7 for women. Similarly, odds for the father's income were 2.2 for men and 2.0 for women. The association between income and drunken driving attenuated when the other variables were adjusted for. Statistically significant odds remained for the two lowest income quartiles in men. A low and a medium level of parental education were also associated with higher odds of drunken driving. When adjusted for other variables, the odds attenuated but remained significant.

The level of urbanization had some association with drunken driving. Subjects living in an urban environment had a slightly lower odds of drunken driving (men: 0.9; women: 0.7) in the final models. Adjusting for other variables had only little effect.

Education functioned similarly in men and women. The highest odds were among 20–24-year-olds with no secondary education (men: 2.4; women: 2.4). When the subject's labour market status and income were adjusted for, the odds for education increased among women (3.3). Subjects with a low education committed more drunken driving offences after the age of 20 than did others with the same income level.

Unemployment was associated with high odds for drunken driving. Long-term unemployment (>12 months for the 2 past years) had higher odds (men: 2.8; women: 4.8) than shorter unemployment in the univariate model. Student status was associated with less drunken driving for men (0.8). In the univariate model, being a conscript in the defence forces was connected with lower odds for drunken driving (0.7). When income was adjusted for, the conscripts, however, showed elevated odds for drunken driving (1.3). Low odds for conscripts can therefore be seen as a consequence of low income, which in this age group was a protective factor. Being outside the work force for other reasons was also a risk factor for drunken driving after income was adjusted for (men: 1.5; women: 1.3).

Own income among young persons had a reverse association with drunken driving compared to the parents' income. A higher income was associated with higher odds of drunken driving. There was a gradient by income group, and it was significant for both men and women.

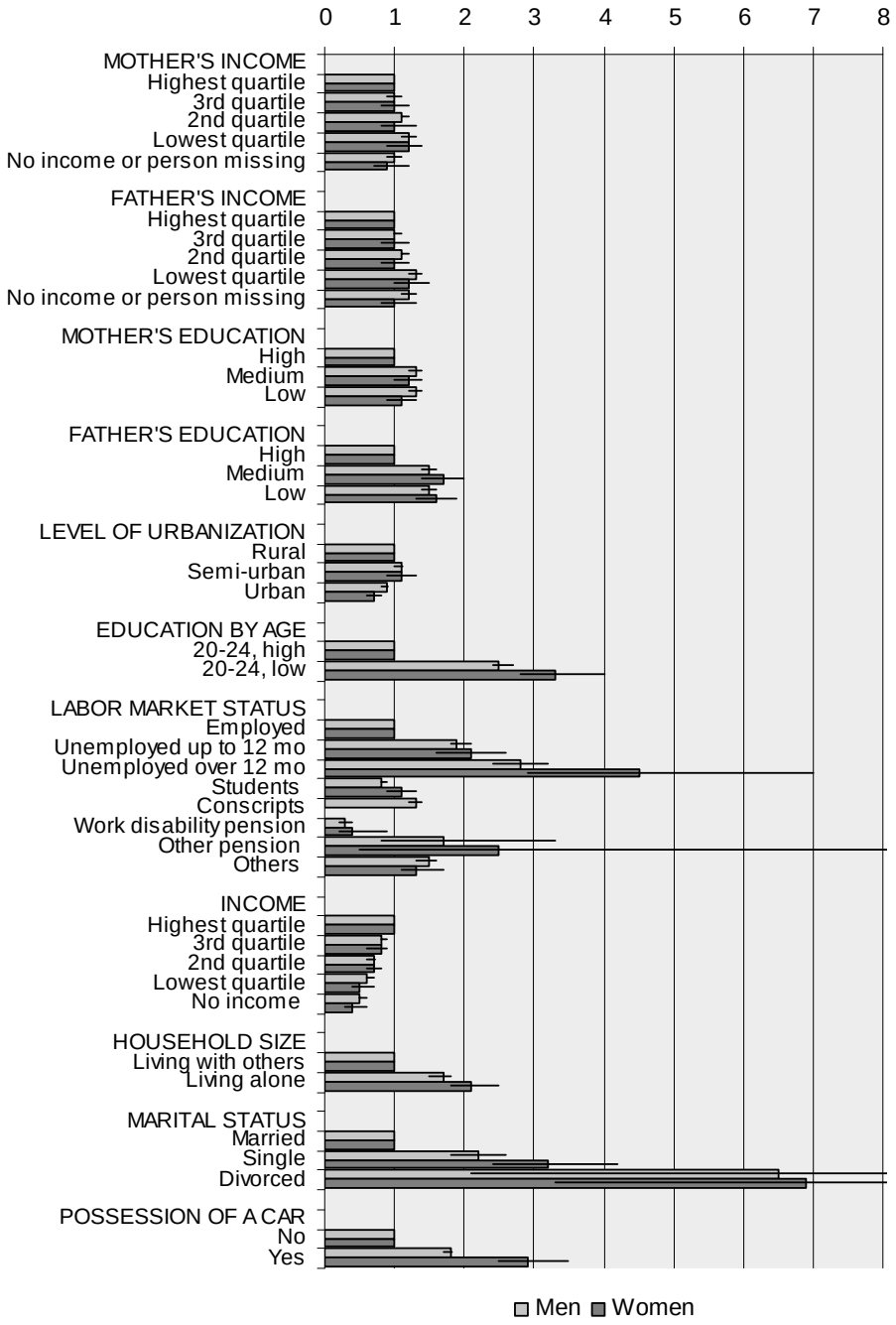

Figure 4 –Fully adjusted odds ratios of social factors for drunken driving for 15–24-year-old men and women with 95% CI

Living with other people was associated with lower odds for drunken driving than living alone (men: 1.7; women: 2.1). Being married was associated with less drunken driving than other marital statuses. Being single had odds of 3.2 for women and 2.2 for men. The highest odds were found among divorced persons (men: 6.5; women: 6.9).

6.2.2 Social determinants of working-aged persons

The results of fully adjusted logistic regression models for working-aged men and women are given in Figure 5. An urban living environment was associated with less drunken driving than a rural environment. The difference was small but statistically significant.

The odds for education were gradual. A low education (men: 2.2; women: 2.1) or medium level of education (men: 1.9; women: 2.0) was associated with more drunken driving. The odds for education attenuated after other variables were adjusted for (men: 1.3–1.5; women: 1.4–1.9).

Socio-economic position was associated with drunken driving among both sexes. In the univariate model, blue-collar workers (men: 2.5; women: 2.9) and entrepreneurs (men: 2.4; women: 2.6) had the highest odds for drunken driving. After adjusting for education, the odds for blue-collar workers (men: 1.5; women: 1.6) and entrepreneurs (men: 1.6; women: 1.7) attenuated. Lower white-collar men as well as women also had odds of 1.5, but these odds attenuated to 1.1 after adjusting for all other variables. The results were the opposite for farmers in the univariate model (men: 1.3; women: 1.2) and the final model (men: 0.9; women: 0.9). After adjusting for education, it appeared that farmers do not commit more drunken driving offences than people in other occupations with the same level of education.

In regard to labour market status, long-term unemployment had the strongest initial association with drunken driving (men: 3.3; women: 3.8). When other variables were adjusted for, especially income, long-term and short-term unemployment did not differ from each other. Being on work disability pension was associated with elevated odds of drunken driving (men: 1.2 women: 1.3). Other types of pensions and being outside the work force for other reasons meant higher odds of drunken driving for men, but not for women.

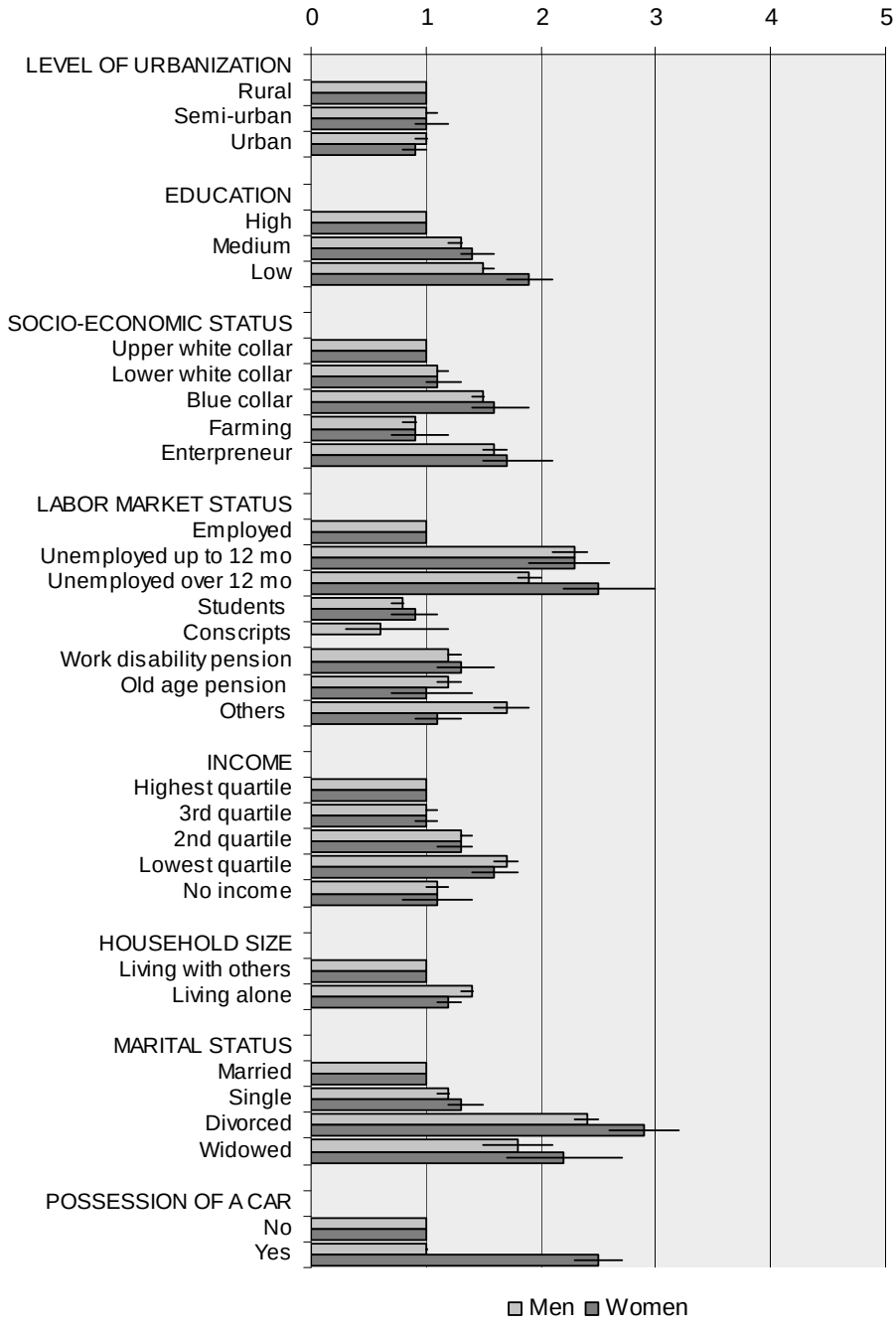

Figure 5 –Fully adjusted odds ratios of social factors for drunken driving for 25–64-year-old men and women with 95% CI

The odds ratios for drunken driving had a gradient with income, lower income showing higher odds; the odds ratios for the lowest income quartile were 3.0 for men and 2.5 for women. After adjusting for all variables, only the two lowest quartiles showed elevated odds of drunken driving, whereas the group with no income showed no difference compared to the two highest quartiles. The income level of working-aged people had an opposite impact compared to the income level of youth.

Living alone was a risk factor for drunken driving in the univariate (men: 1.9; women: 1.7) and adjusted models (men: 1.4; women: 1.2). Being single meant higher odds than being married in the univariate (men: 1.7; women: 1.7) and adjusted models (men: 1.2; women: 1.3). Being divorced (men: 2.4; women: 2.9) or widowed (men: 1.8; women: 2.2) was associated with the highest odds of drunken driving in the final models, while the odds in univariate models were even higher.

For women, the possession of a car had high odds in the univariate model (2.7) as well as in the fully adjusted model (2.5). Among men the association was negligible, however.

6.3 Recidivism of DUI during a 15-year period

In 1993–2007 there were 194,932 people with a total of 341,366 cases of DUI suspected by the police. 68% of the arrested persons had only one recorded DUI offence, 15% had three or more DUI arrests, 5% had six or more, and 1% had at least 11 arrests. Rearrested drivers comprised 61% of all cases. The highest number of DUI offences recorded for one person was 71.

The mean and median age of drivers with only one arrest was 36 years, and their mean BAC was 1.3 per mille; 14% of them were women. Rearrested drivers were younger with a higher BAC. Their mean age was 34 (median age 33) years, and mean BAC 1.5 per mille at the time of the first arrest; 8% of them were women. DUI recidivism was more prevalent among men, and the proportion of women decreased as the number of rearrests increased. The rearrest rates fell with increasing age. They were 37%, 33%, 33%, and 17% in the age groups of under 18, 18–29, 30–49, and over 50 years, respectively.

6.3.1 Effect of alcohol, drugs or combined use on rearrests

The observed rearrest rates varied, depending on the substances found. Drivers with alcohol-only, drugs-only and combined use of drugs and alcohol had rearrest rates of 31% (n=183,725), 44% (n=5544) and 43% (n=2803), respectively. Benzodiazepine users with no finding of alcohol had a low rearrest rate, and these cases were few. The rapid rearrest of drivers with drugs-only and drivers with combined drug and alcohol use can be seen from the Kaplan-Meier plots of rearrest, whereas drivers

with alcohol-only were rearrested after a longer period of time (Fig. 6). The estimated lower quartile survival times (i.e. time after which 25% of the subjects were rearrested) were 1438 days for alcohol only, 464 days for drugs only, and 565 days for combined users. Estimated rearrest rates for alcohol-only, drug-only and combined drug and alcohol were 44%, 58% and 58%, respectively. Besides the substance used, the Kaplan-Meier plots revealed that the risk factors for quicker rearrest were young age, male sex, and being caught during Monday to Friday, and between 12 noon to 12 midnight.

A Cox regression model of rearrest times was constructed, using substance group, sex, age, time of day, and weekend as covariates. Hazard ratios (HR) describe the relative risk between the different groups (Fig. 7). The reference levels for hazard ratios were alcohol users, female drivers, age 60 years or older, being caught between 12 midnight and 6 am, and being caught during the weekend. Drugs-only (HR=1.7) or drugs combined with alcohol (HR=1.6) were associated with higher rearrest rates than alcohol only. Men (HR=1.7) had a higher rearrest risk than women. If the first DUI arrest happened when the driver was under 18 years old, the rearrest occurred sooner (HR=2.4). Those aged 18–29 years (HR=2.2) and 30–59 years (HR=2.1) did not differ significantly from the youngest age group. DUI during weekends was associated with a lower hazard than DUI between Monday and Friday (1.2). The hour of occurrence also had an effect on rearrest times: DUI between 12 noon and 6 pm (HR=1.1) or 6 pm and 12 midnight (HR=1.2) indicated a slightly higher recidivism risk.

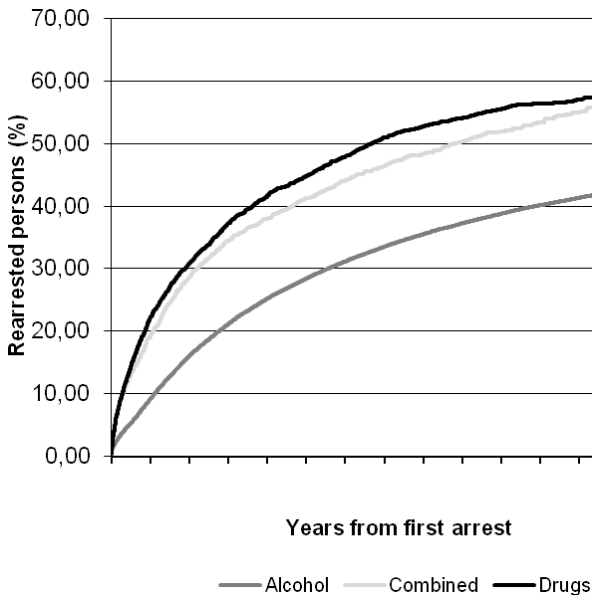

Figure 6 – Kaplan-Meier estimates of rearrest times by alcohol, drugs or combined use

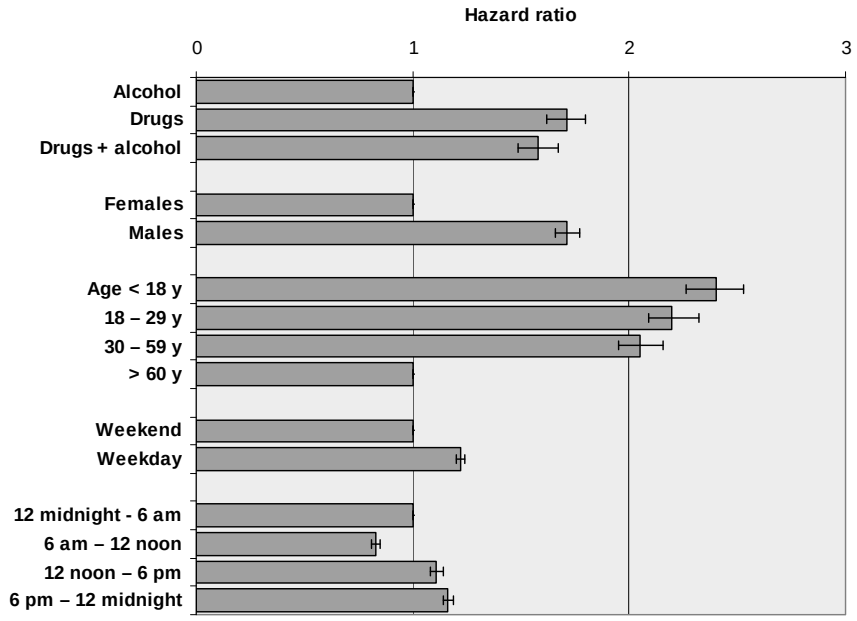

Figure 7 – Hazard ratios of recidivism for alcohol, drugs or combined use

6.3.2 Effect of specific substance groups on rearrests

The detected substances were analyzed more specifically. The substance groups were alcohol-only, benzodiazepines, amphetamines, cannabinoids and opioids. Except for the possible involvement of alcohol, all poly-drug use across substance groups was excluded. As poly-drug use was quite common, some substance groups were rather small. Benzodiazepines were found most commonly alone or with alcohol. Rearrests were most common among the users of amphetamines (50%; N = 756) and cannabis (36%; N = 527) alone or with alcohol (Fig. 8). Benzodiazepines users were rearrested sooner after the first DUI (34%; N = 2847) than users of alcohol only, but there was no difference in the long run. Opioids (24%; N = 123) were the most rare substance found, and opioid users did not differ significantly from alcohol-only users. The estimated rearrest rates for amphetamines, cannabis, benzodiazepines and opioids were 78%, 62%, 45% and 36%, respectively.

The second Cox regression model was fitted with a different categorization of drugs, including BAC of the drivers (Fig. 9). Otherwise the second Cox regression model was similar to the first one with three substance groups. The cases with alcohol only formed the baseline hazard. Hazard ratios for the different drugs were 1.5 for benzodiazepines, 1.6 for cannabinoids, 4.6 for amphetamines, and 0.8 for opioids. In model 2 the male-to-female hazard was 1.7. Compared to the oldest age group, the hazard ratio in the other age groups varied from 2.0–2.7. The risk for rearrest was also higher if the first arrest had taken place during a weekday (HR=1.2). The risk of rearrest attenuated in line with an increase in blood alcohol level up to twofold when BAC exceeded 2.0 per mille. For benzodiazepines, the estimated risk of rearrest was higher compared to alcohol-only at the beginning of the follow-up, but leveled later. This may lead to overestimation of the hazard associated with benzodiazepines.

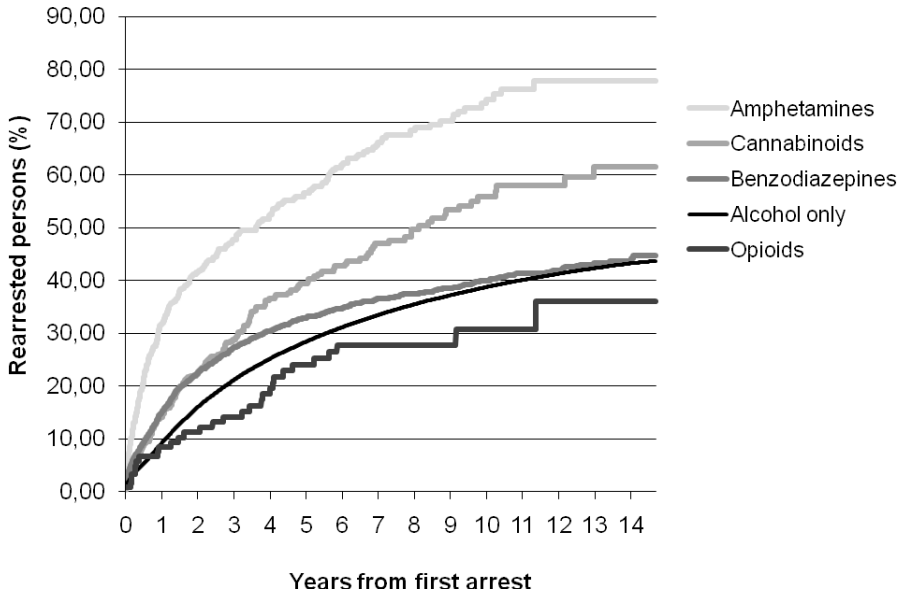

Figure 8 – Kaplan-Meier estimates of rearrest times for substances detected

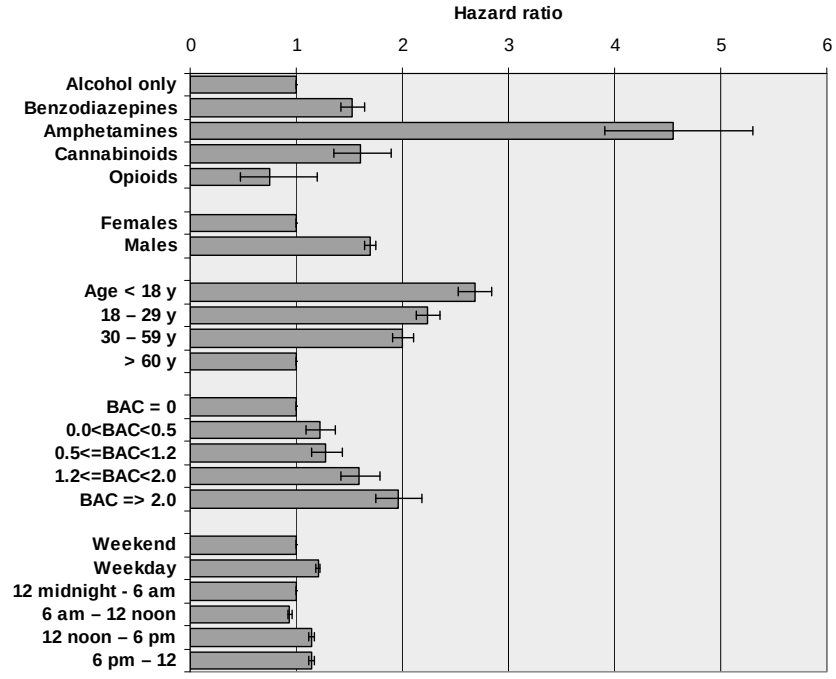

Figure 9 – Hazard ratios of recidivism for substance detected

6.4 Mortality among drunk drivers

The cause-specific mortality was analyzed for altogether 112,398 drivers arrested for suspected drunken driving in 1988–2006, and 115,019 people with no registered drunken driving. 88% of the arrested drivers were men with a mean age of 35 years at the time of their first arrest, and the mean age of the women was 34 years. Mean BAC was 1.4 per mille, and 59% of the drivers exceeded the BAC limit of aggravated drunken driving. Every third driver was rearrested during the study period. During the follow-up, 14,665 of the arrested drivers (13% of all arrested drivers) died, while 4854 deaths occurred among the reference population (4% of all references). Although the two study populations were matched for age and sex, the deceased drunk drivers were younger than the deceased references.

6.4.1 Mortality among suspects

The most common causes of death among drunk drivers were alcohol-related causes (i.e. alcohol-related diseases and accidental alcohol poisoning), diseases of the circulatory system, accidents (including traffic accidents), suicides and neoplasms (i.e. cancers) (Table 2). The most common causes of death among the references were diseases of the circulatory system, neoplasms, other diseases, accidents and alcohol-related causes. Alcohol-related causes were more typical among women suspected of drunken driving than among men suspected of drunken driving. Every third death of a female suspect was caused by alcohol, while every fifth death of a male suspect was caused by alcohol. The arrested male as well as female drivers had a higher mortality rate than their references, due to all observed causes of death. Among the suspects, the mortality of the men was almost twice as high as that of the women, and among the referents, almost three times as high as that of the women.

The differences in mortality between the suspected drunk drivers and the reference population are measured by hazard ratios (HR) (Table 3). Drunken driving was associated with a higher HR for all observed causes, ranging from 1.5 for neoplasms to 8.0 for alcohol-related causes for men, and from 1.2 for neoplasms to 33.2 for other than traffic accidents for women. The highest hazard ratios among men were observed for alcohol-related causes (HR=8.0), violence (HR=6.8), and accidents other than traffic accidents (HR=5.5). Among women, the highest hazard ratios were for accidents other then than traffic accidents (HR=33.2), violence (HR=22.2), and alcohol-related causes (HR=16.8). Although some high hazard ratios observed among women had wide confidence intervals (CI), all the differences were nevertheless statistically significant. Hazard ratios for all-cause mortality were 2.8 for men and 4.5 for women.

Table 2 – Mortality (per 100,000 person years) by cause of death for the cases and the reference population

	Men		Women	
	Cases	Referents	Cases	Referents
Neoplasms	176	111	79	66
Diseases of the circulatory system	353	163	109	36
Alcohol-related causes[1]	351	36	273	16
Other diseases	153	64	92	33
Traffic accidents	61	9	37	5
Other accidents	224	33	122	3
Suicides	205	34	113	10
Violence	36	4	24	1
Other causes	26	4	18	1
All causes	1584	458	865	172
All causes, N	13 750	4650	915	204

[1]Including alcohol-related diseases and accidental alcohol poisoning

Table 3 – Hazard ratios (HR) with 95% CI by cause of death for drunk drivers. Adjusted for age, marital status and education

	Men			Women		
	HR	95% CI		HR	95% CI	
Neoplasms	1.5	1.4	1.7	1.2	0.9	1.7
Diseases of the circulatory system	1.8	1.7	1.9	2.8	2.0	4.0
Alcohol-related causes[1]	8.0	7.1	8.9	16.8	10.5	26.9
Other diseases	2.0	1.8	2.3	2.7	1.8	3.9
Traffic accidents	3.8	3.0	4.8	2.5	1.0	6.5
Other accidents	5.5	4.9	6.2	33.2	12.2	90.3
Suicides	4.6	4.1	5.2	8.8	4.8	16.1
Violence	6.8	4.9	9.7	22.2	2.9	168.0
Other causes	5.1	3.6	7.3	15.9	2.1	122.6
All causes	2.8	2.7	2.9	4.5	3.9	5.3

[1]Including alcohol-related diseases and accidental alcohol poisoning

Also a more detailed 54-class cause of death classification was examined. Male drunk drivers had 32 causes of death that were significantly elevated in 51 classes, whereas for 19 causes, no differences were in observed in hazard ratios using, 95% CI. Among female drunk drivers, 11 causes were significantly elevated and for 37 causes there was no statistically significant difference with 95% CI. The highest

observed hazard ratios were in poisoning/overdose for men (HR=10.3) and women (HR=45.2).

6.4.2 Contribution of alcohol to deaths

Alcohol as a factor contributing to death (i.e. acute alcohol intoxication, alcohol-related diseases, or other alcohol-attributable causes) was examined among suspected drunk drivers and the reference population (Table 4, Table 5). Alcohol-related diseases and alcohol poisonings were excluded, as they are always alcohol-related by definition. Among other causes of death, alcohol was found to be a contributing factor in almost one out of three deaths among drunk drivers; acute alcohol intoxication in 12% of deaths, and other causes attributable to alcohol in 18%. Among the reference population, the corresponding percentages were 4% and 9%. The highest involvement of acute alcohol intoxication was observed among external causes of death. Other alcohol-attributable causes were commonly found among external causes of death, as well as in diseases of the circulatory system, and in diseases other than neoplasms. The highest estimated differences among the two populations were in neoplasms (HR=14.2), traffic accidents (HR=10.2), and in the group 'Other causes' (HR=9.5) which mainly included external causes of undetermined origin.

Table 4 – Alcohol as a factor contributing to death (% of deaths)

	Acute alcohol intoxication (%)		Other alcohol-attributable death (%)	
	Case	Reference	Case	Reference
Neoplasms	0.1	0.0	3.7	0.4
Diseases of the circulatory system	6.8	1.3	20.7	8.7
Other diseases	3.4	0.7	26.7	8.5
Traffic accidents	33.2	8.9	14.9	11.9
Other accidents	25.5	16.7	39.4	34.5
Suicides	31.3	17.5	21.2	17.5
Violence	38.8	41.0	28.4	17.9
Other causes	26.1	7.9	28.6	23.7
All causes[1]	12.1	3.6	17.5	8.6

[1]Direct alcohol-related causes excluded

Table 5 – Hazard ratios (HR) with 95% CI by cause of death for drunk drivers when alcohol contributed to death. Adjusted for age, marital status and education

	Hazard ratios		
	Estimate	95% CI	
Neoplasms	14.2	5.6	35.7
Diseases of the circulatory system	4.7	4.0	5.6
Other diseases	6.1	4.7	8.0
Traffic accidents	10.2	6.5	16.1
Other accidents	7.2	6.2	8.5
Suicides	7.1	5.9	8.6
Violence	8.2	5.3	12.7
Other causes	9.5	5.2	17.3
All causes[1]	7.3	6.8	7.8

[1]Direct alcohol-related causes excluded

6.4.3 Risk factors of mortality

The arrested drivers were additionally analyzed for risk factors of mortality (Fig. 10). The analyzed variables included personal factors (education and marital status) and information on arrest (BAC, weekday, hour, and first arrest). Age-adjusted analyses were carried out separately for both sexes. Low education was associated with a higher risk of mortality for men (HR=1.4) and also for women (HR=1.2). For men, not being married was associated with higher mortality (HR=1.3-1.4), but for women there were no significant differences. If the arrest took place on a weekday, the HR was higher (HR=1.3) than for drivers arrested on weekends. The lowest HR was noted for drivers arrested between 12 midnight and 4 am, and between 4 am to 8 am among men. The highest hazard ratios were associated with arrests that took place between 12 noon to 8 pm for men (HR=1.6–1.7) and for women (HR=2.6). The relationship between mortality and BAC was not linear. A low BAC (under 0.5 per mille) had a higher HR than BAC levels of 0.5–1.2 for both sexes, and of 1.2–2.0 for men. High BAC levels (2.0 or more) were again associated with higher HR among both men (HR=1.3) and women (HR=1.5).

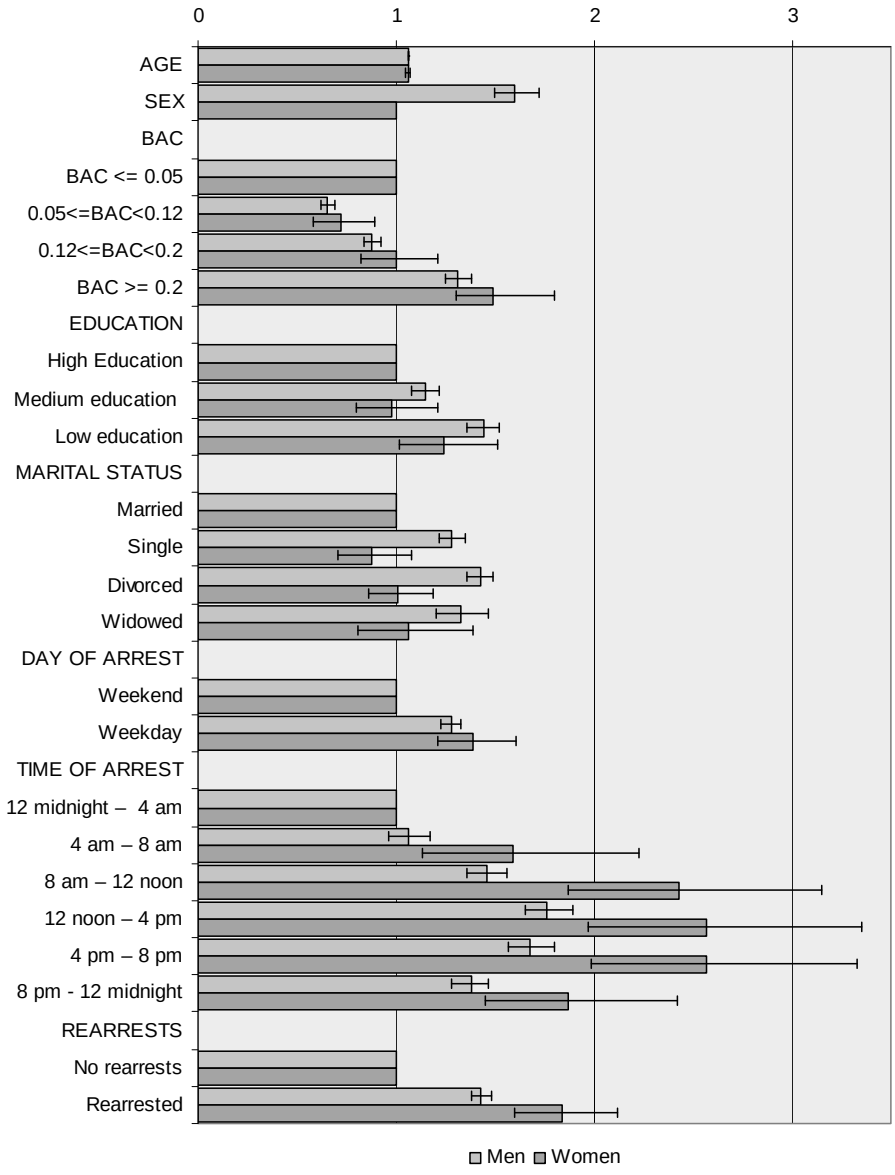

Figure 10 – Age-adjusted hazard ratios for mortality of drunk drivers with 95% CI

7 Discussion

7.1 Main results

During the years 1989–2007, the general road safety in Finland alongside with the number of arrested drunk drivers improved. The economic peak years at the turn of the 1990s also witnessed a culmination point of drunken driving. When the recession set in only a little later, these figures rapidly fell. Especially pronounced were the changes among the youngest drivers, mostly in the age group of 18–19-year-olds. Great changes were noted also in the group of 15–17-year-old youngsters, who are legally allowed to drive only mopeds. However, during the 2000s the incidence of drunken driving among youth was slightly rising again. In the older age groups, there was steady growth in incidence. The proportion of female drunk drivers doubled during the period, so that in 2007 every ninth drunk driver was a woman. Our data do not cover the period of the latest recession which hit the world in 2009 and 2010, but the most recent statistics from police show that the number of drunken driving cases in 2010 was at its lowest level in 15 years.

The arrests of drunken driving concentrated strongly to the weekends and night-time hours. The highest peaks of drunken driving were seen on Friday and Saturday nights, and on the following mornings. The summer holiday season also meant more drunken driving than the winter months. When the entire year was observed, the major national holidays, New Year's Eve, the 1st of May, and Midsummer showed distinctive peaks in drunken driving.

In general, poor social position was found to be associated with increased drunken driving among youth and working-aged people of both sexes. The findings were mainly similar across all groups, with some exceptions. A low educational level, unemployment, living alone and not being married were associated with increased drunken driving in all groups studied. Among youth, parental factors, such as the parents' low education and low income level, were also significant for drunken driving. Among working-aged people, upper white-collar socio-economic position was associated with least drunken driving, whereas blue-collar work or being an entrepreneur meant higher odds of drunken driving. Although low income of working-aged people was associated with more drunken driving, the association was the opposite among youth, i.e. a higher income meant more drunken driving. The data on arrested drunk drivers also showed that possession of a car was connected with drunken driving among youth and among women. Such a connection did not exist for working-aged men.

It was observed that every third first-time drunk driver was rearrested during a 15-year period, and an estimated 44% of them could be rearrested, taking the follow-up time into account. Drug use alone or combined with alcohol increased the estimated rearrest rates up to 60%. Especially amphetamine users had high rearrest rates soon after their first arrest, and the estimated 15-year rearrest rate was nearly 80%. A high rearrest rate was also associated with cannabis use, for which the estimated rearrest was almost 60%. Alongside findings of how alcohol and drugs are connected with DUI, personal and arrest-related risk factors for recidivism were male gender, young age at the time of first arrest, high BAC, arrested between Monday and Thursday, and arrested between 12 noon and 12 midnight. Drivers who were over 60 years of age at the time of their first arrest had a significantly lower rearrest rate than the others.

Drunk drivers suffered from high mortality when compared with the population with no known drunken driving. Mortality was higher in all eight main groups of cause of death. Mortality due to direct alcohol-related causes (including alcohol diseases and accidental alcohol poisoning) was almost nine times higher among drunk drivers. The risk of suicide, accidents and homicides was also high. Relative differences between drunk drivers and reference population in deaths by neoplasms and diseases of the circulatory system were smaller, but the absolute differences in mortality were substantial, as these are the most common causes of death among reference population.

Alcohol is often a factor contributing to the death of drunk drivers. The external causes often include acute alcohol intoxication and/or some other alcohol-related condition among both drunk drivers and the reference population. Alcohol intoxication was observed more rarely in deaths from diseases, as an other alcohol-related condition was quite common among drunk drivers. Although alcohol was commonly involved in deaths from external causes also among the reference population, their deaths due to these causes were much less likely than among drunk drivers.

7.2 Young drivers as a risk group for serious incidents

Finnish roadside studies show us a different picture of drunken driving than the data on arrested drivers. While there was a considerable decrease in the number of arrested drivers in the beginning of the 1990s, the roadside testing performed in the Uusimaa region during the past 20 years did not reveal any significant trends in drunken driving or in aggravated drunken driving as a whole (Portman et al., 2011). Changes were observed only in alcohol-positive findings below the legal BAC limit of drunken driving, which became more prevalent in the beginning of the 2000s (Penttilä et al., 2004). The incidence, as well as absolute numbers of drunken driving

arrests were high among young people. People aged 18–19 years were over twice as likely to be arrested for drunken driving than the general population, and drunken driving arrests among 15–17-year-olds were common. These age groups were rare in the roadside studies, as most of the drunk drivers encountered in them were 30–59 years old (Portman et al., 2011).

The differences between arrested drunk drivers and the drunk drivers in the roadside studies are not necessarily contradictory, as the selection for the two data works in a different way. Drunk drivers are arrested because of random breath testing only in 30% of the cases, while the rest of the arrests are often due to other traffic control measures, traffic accidents, and tip-offs (Niemi, 2010). This means that drunk drivers with other risky driving habits or very severe impairment will be arrested more often than the others. The age distribution of arrested drunk drivers resembles that of fatally injured drivers more than that of drunk drivers in roadside studies. Changes in suspected drunken driving are subject to police activity. The person-hours used by the police affect the number of arrests (Niemi, 2010), but they cannot explain all the changes, because random breath testing and other traffic control catches only a half of drunken driving.

Other ongoing stable trends prevail in the driving population as well as in alcohol use. First of all, the Finnish population is aging rapidly. Also, the drinking habits of younger birth-cohorts differ from those of the preceding cohorts, as younger cohorts consume more alcohol than older ones (Mäkelä et al., 2010). It is more common for women to drink alcohol, and now there are fewer abstainers among women. Younger age-cohorts among women also get a driver's license more often (Finnish Transport Safety Agency, 2010a). As a result, the incidence of drunken driving is growing steadily in the older age groups, especially among women. While the proportion of arrested female drivers doubled in 20 years, men are still mainly responsible for drinking and driving.

7.3 Social background linked with drunken driving

A poor social position has been found to contribute to use and abuse of alcohol and other substances (Galea et al., 2004; Suvisaari et al., 2009), and it has also been found to be linked with increased drunken driving. The earlier findings on social background and drunken driving have been very similar to this study. A low level of education has consistently been found to be related to drunken driving (Baum, 2000; C'De Baca et al., 2001; Eensoo et al., 2005). A connection to unemployment and low occupational status have also been reported (Baum, 2000). In Finland, a leading position in work life, as well as student status have been found to be protective factors, whereas unskilled workers have been overrepresented (Pikkarainen et al., 1995). There were fewer married persons among recidivist drunk drivers than

among non-repeat offenders (C'De Baca et al., 2001). An overrepresentation of divorced and unemployed persons was also noted among drunk drivers in a Finnish roadside study (Portman et al., 2011).

Low income has been reported to be connected with drunken driving (Baum, 2000), which was also seen for working-aged people in this study. For young persons the connection was the opposite, however, as a high income was associated with more drunken driving. Although this observation has not been reported earlier, it has been shown that working and having a higher income is associated with more drinking for young persons (Kouvonen and Lintonen, 2002). A better socio-economic position may also be connected with more substance use (Humensky, 2010). Young persons aged 15–24 years with a good income are apparently in work life, while students typically have a low income. It is therefore reasonable to believe that some of these employed young people have no aspiration for further education.

There are several other factors related to the background of young people, namely parental factors and living conditions. In Finland, low parental education has previously been found to correlate and predict drunken driving later (Elonheimo et al., 2010; Sourander et al., 2006). Also the person's own poor school performance in adolescence and educational underachievement in early adulthood were connected with drunken driving (Riala et al., 2003). Though only the level of education was measured in Study II, the findings still support each other. Living in a small community, not living with one's parents, and not having a stable relationship were connected with drunken driving for young people in a Finnish cohort study (Elonheimo et al., 2010). Living alone was found to be a risk factor in Study II, but a steady relationship could be indicated only by marital status. While an urban environment (living in a big city) was connected with less drunken driving, semi-urban (medium-sized communities) and rural (small communities) did not differ from each other.

Possession of a car (as car owner or primary driver of a car) has not been previously studied alongside the social background of drunken driving. As anticipated, possession of a car was associated with drunken driving for young persons and for women, but this association was not found for working-aged men. Drunken driving was equally common among men, regardless of whether they possessed a car or not. As only the first drunken driving offences were analyzed, it is not likely that the association is caused by sanctions for drunken driving. Although driving with a stolen car is one possibility, it is unlikely that it would explain the total difference as compared to the other groups. Also driving a car owned by a family member or the employer could explain this.

The association between alcohol abuse and social position has been documented earlier. Also some aspects of social background have been connected with drunken driving, but no overall role of these factors has been studied in various subpopulations. While typical studies are able to examine few hundred or few thousand subjects convicted of drunken driving, we were able to study 80,000 drunk

drivers. Some of the associations discovered were novel, such as parental income, possession of a car, or living alone, as well as accounting for age and sex. Drunken driving is in many ways linked with poor social position, e.g., in terms of education, employment, income, etc. However, it is difficult to say whether a poor social position leads to drunken driving, or drunken driving weakens a person's social position. Often both factors may influence each other and worsen possible marginalization.

7.4 Drug use affecting rapid rearrests

Every third drunk driver was rearrested during a 15-year period, and the estimated rearrest rate, accounting for drop-outs from the follow-up, was 45%. A recent Finnish roadside study found a rearrest rate of 50% in a group of 132 drivers arrested for drunken driving in 1996–1997 (Portman et al., 2011); the rate is very similar to earlier results among drunk drivers (Pikkarainen et al., 1995; Seppä, 1992). Depending on the follow-up time, recidivism rates of 13–48% have been reported in the USA (Centers for Disease Control and Prevention, 1994; LaBrie et al., 2007; Lapham et al., 1997; McCartt and Northrup, 2004), and rates of 20–45% in Norway (Gjerde et al., 1988; Skurtveit et al., 1998).

Drug involvement, with or without alcohol, substantially increased the risk of rearrest in DUI. In specific examination, the highest rates were associated with amphetamines and cannabis. A group with benzodiazepines was similar to drunk drivers, as detected opioid users were very few. A Norwegian study reported almost twice as high rearrest rates for drugged drivers compared to drunk drivers (Christophersen et al., 2002). A Swedish study also reported very high rearrest rates for drivers with drugs (mostly amphetamine), whereas the rates for prescribed medicines (mostly benzodiazepines) were slightly higher than those for drunk drivers (Holmgren et al., 2008).

Similar risk factors for rearrests were found in the present study and in Finnish roadside studies, such as high BAC exceeding 1.2 per mille, and arrest during Tuesday afternoons (Portman et al., 2011). The roadside studies also reported biomarkers indicating that high consumption of alcohol and being divorced were risk factors (Portman et al., 2009). Male gender is commonly found to be a risk factor for drunken driving, and it has also been reported to be a risk factor for recidivism (Christophersen et al., 2002; Lambert, 2010; Nochajski and Stasiewicz, 2006; Vaez and Laflamme, 2005). Several earlier studies have also demonstrated the connection between high BAC and recidivism (C'De Baca et al., 2001; Marowitz, 1998; Portman et al., 2009; Skurtveit et al., 1998) and between high BAC and alcohol dependence (Brinkmann et al., 2002). The higher recidivism of drivers who are arrested during weekdays and in the daytime (Lambert, 2010; Portman et al.,

2011) might relate to the same fact. While drinking during the weekends and at night is common and often of a social nature, heavy drinking during non-typical drinking hours may indicate an alcohol problem. There is a connection between recidivism and being arrested for DUI at untypical drinking times.

The actual recidivism rate is difficult to estimate, as a large part of DUI goes undetected. The observed rate of rearrests can therefore be considered to be a minimum estimation of true recidivism. The effect of different drugs detected from drivers is difficult to assess, as a large part of drugged driving includes poly-drug use (Karjalainen et al., 2010). Although rearrest rates for different substances may tell us about the severity of dependence, they might also tell us about the different impairing effects of different substances. The high rearrest rates of amphetamine users may be a consequence of the stimulating effect of amphetamines, leading to an erratic driving style which does not easily go unnoticed by the police. While the rearrest rates for cannabis users was very high, it should be borne in mind that an estimated 99% of people who have experimented with any illicit drug, have also tried out cannabis (Hakkarainen and Metso, 2007). Therefore cannabis is likely to be used by other drug users also.

The results show that recidivism is a substantial problem among drunken drivers. A high recidivism rate is a big problem especially for alcohol-dependent people and drug-users. However, about a half of all drunken driving is done by drivers who will not get rearrested. Strategies concentrating solely on hard-core drunk drivers have therefore been criticized for simplifying the problem or even using a scapegoat (Chamberlain and Solomon, 2001). After all, only a small proportion of drunken driving offences are committed by a group of multiple offenders, and a division into 'hard-core drunk drivers' and 'the others' is rather artificial. According to the results of this study, even if we were to eliminate all recidivism, we would still be left with the major part of drunken driving.

7.5 High mortality of drunk drivers

A high mortality has previously been reported for drunk drivers in Finland (Penttilä et al., 1995) and the USA (Mann et al., 1993) in the 1990s, and more recently also in Norway (Skurtveit et al., 2002) and Sweden (Karlsson et al., 2003). Similarly, a high mortality has been observed for drugged drivers in Finland (Karjalainen et al., 2009) and in Norway (Hausken et al., 2005; Skurtveit et al., 2002). Mann also describes the patterns of mortality among drunk drivers to be very similar to those of alcoholics, namely, direct alcohol-related causes, suicides and accidents (Mann et al., 1993). Alcohol-related diseases, accidents including poisonings and overdoses, and suicides were also reported in Finland and Norway (Penttilä et al., 1995; Skurtveit et al., 2002). Likewise, in the Swedish study the relative risk of hospitalization among

drunk drivers was elevated in diagnoses linked with alcohol, narcotics, attempts of suicide, psychoses, traffic accidents and other external causes (Karlsson et al., 2003).

The mortality data show that alcohol abuse is a huge problem among drunk drivers. A part of the excess mortality, e.g. due to alcohol-related diseases and alcohol poisonings, is directly caused by alcohol, whereas other causes may be linked to alcohol more indirectly. While acute alcohol intoxication is often a contributing factor in external causes, many accidents and violent incidents can be related to risk-taking behavior. The large number of suicides, on the other hand, points to mental health problems, which generally have comorbidity with substance abuse problems (Suvisaari et al., 2009). The excess mortality caused by cancers and diseases of the circulatory system may relate to alcohol, but these diseases are also a possible indication of other unhealthy life-styles, such as smoking, poor diet, or low level of physical activity.

The highest hazard ratios of mortality among drunk drivers are seen in alcohol-related causes and in external causes. The hazard ratios for other than alcohol-related diseases range from 1.5–2.0 for men and 1.2–2.7 for women. Because diseases of the circulatory system and cancers are the most common causes of death among the reference population, these diseases also accumulate substantial excess mortality among drunk drivers. The mortality of male drunk drivers is higher than that of female drunk drivers. However, when drunk drivers are compared to the reference population, the mortality seems to be even higher in women. For example, the hazard ratio of dying from alcohol-related causes was 17-fold for women, while the corresponding hazard ratio for men was 8-fold. The health harms related to drunken driving seem to be more hazardous to women than to men.

7.6 Preventing drunken driving in Finland

Measures against drunken driving can be classified according to their aims and levels. The target can be on the individual level or public level, on the one hand, and on alcohol use or driving, on the other. Public level measures aim to prevent drunken driving beforehand, through legislative action and alcohol policy, DUI legislation, and police enforcement, while individual level measures are typically sanctions for convicted drunken drivers, license revoking, alcohol-ignition interlocks, vehicle confiscation, imprisonment, or treatment for substance abuse. Typical consequences for drunk drivers in Finland include fines and a temporary license revoke of 1–3 months. Confiscation of the vehicle is also possible, but it has been used rarely.

7.6.1 Law enforcement

The prevention of drunken driving is a cost-effective way of decreasing alcohol-related harm (Anderson et al., 2009). Successful alcohol policies, as described in Section 2.1, may work toward this goal, as drunken driving is associated with alcohol consumption. The most commonly used direct measure against drunken driving is a statutory BAC limit. It has been shown to be an effective (Fell and Voas, 2006; Mann et al., 2001) and cost-effective (Anderson et al., 2009) method of restraining drunken driving. Effective enforcement of BAC laws is needed, as the perceived risk of being caught prevents drunken driving more effectively than the severity of punishments (Benson et al., 1999; Desapriya et al., 2007; Sen, 2001). There is strong scientific evidence supporting BAC limits of 0.5 per mille, or even lower limits of 0.2 or 0.3 per mille (Blomberg et al., 2009; Desapriya et al., 2007; Desapriya et al., 2003).

Finland has traditionally been considered a 'dry' drinking culture where alcohol use is infrequent in everyday life, while episodes of heavy drinking take place during certain times. Drunken driving follows this same pattern. Almost two thirds of all drunken driving occurs between Friday and Sunday. It tells us that alcohol consumption during the weekends is still heavy, and may lead to bad decisions regarding driving after drinking. More effective methods of preventing drunken driving are needed to support the police who control the legal BAC limits.

7.6.2 Alcohol-ignition interlocks

Although recidivism is a major problem among drunken drivers, a considerable proportion of drunken driving is still done by single-offenders. A single offence may often be the consequence of a misjudgment, a bad decision. This suggests that concentrating mainly on preventing the drunken driving of convicted drunk drivers, so-called hard-core drunk drivers, does not solve the whole problem of DUI. In the optimal scenario, drunken driving would be prevented already before it takes place for the first time.

Alcohol ignition interlocks have been tested in Finland since 2005, and utilized regularly since 2008 ([Act on alcohol-ignition interlock controlled driving license 26.6.2008/439], ; [Act on testing the alcohol-ignition interlock controlled driving license 27.5.2005/360]). By using an interlock, the offender has a possibility to avoid license revoke. Use of interlocks was made mandatory for vehicles used for school and kindergarten transportations at the end of 2010 ([Act on alcohol-ignition interlock use in school and kindergarten transportation 10.12.2010/1110]), but in addition to this specific use, they are not yet used widely. While the technology is novel in Finland, good experiences from utilizing alcohol-ignition interlocks have been gained in other countries. Swedish drivers with interlocks have had positive health effects resulting from their reduced drinking, compared to control subjects with no interlocks (Bjerre et al., 2007a; Bjerre et al., 2007b; Bjerre and Thorsson,

2008). Interlocks have also achieved a reduction of 64–80% in drunken driving episodes (Raub et al., 2003; Willis et al., 2004). However, removing the interlock from the vehicle has been reported to restore the previous drunken driving behavior (Raub et al., 2003). In a zero-vision of drunken driving, where all drunken driving could be prevented, one possible step would be to equip all new vehicles with alcohol-ignition interlocks. Transition to a wider usage of alcohol-ignition interlocks should nevertheless be strongly advocated.

7.6.3 Treatment for substance abuse

The European Union directive prohibits issuing a driver's licence to a person with an addiction to alcohol or drugs (Council Directive on driving licences 91/439/EEC). This has compelled Finland to evaluate the substance abuse problem and driving capability of convicted drunken drivers, and to establish treatment programs. Experience has shown that treatment is a very challenging task, as the patients are often seriously addicted (Viitasalo, 2002). In 2004 physicians were obligated to report to licensing authorities if their patient had weakened driving abilities; this presented a new challenge (Seppä, 2005). Despite the fact that treatment has been found to be beneficial in preventing DUI recidivism (DeYoung, 1997; Wells-Parker et al., 1995; Wells-Parker and Williams, 2002), it has also been expressed in Finland that the efforts put in the treatments and evaluations have in some cases been seen as inefficient and a waste of resources (Mettovaara et al., 2006). A current guideline of the Ministry of the Interior is attempting to clarify the various practices. It directs the police to demand a physician's professional opinion when a driver has committed two DUI offences in three years (SMDno/2008/1133).

Obviously, it is of primary importance to prevent drunk drivers from repeating their offence. In the long run, this has succeeded only partially in Finland, as a large proportion of drunk drivers have still continued to drive while under the influence of alcohol. The second objective of the authorities should be to intervene with the possibly harmful use of alcohol. The high alcohol-related mortality figures indicate that this objective has not been achieved. A high mortality rate among a certain sub-population is indeed a public health problem. During a 20-year period, the police have confronted around 250,000 drunk drivers. This is almost 6% of the current population aged 15–84 years. It is unlikely that premature mortality is the only problem within this population. It is much more likely that this population has a greater number of health problems, more work disability, substance abuse, and mental health disorders, all of which are costly to the society. Treatment for persons with substance abuse would benefit a certain part of this population, but experience has shown that carrying out these treatments successfully is a challenging task.

7.7 Strengths and limitations of the study

The data on drunken driving used in this study is unique. It covers all blood tests and evidential breath tests of suspected drunken driving in Finland during a 20-year period, and covers almost half a million cases known to the police. While a 50% random sample was drawn from the original data for the purpose of combining it with other register data, this new unbiased sample still includes a sufficiently large number of observations for statistically reliable inference. We combined it with data on mortality and social variables, and were thus able to get a very comprehensive picture of how drunken driving is connected to social position and health effects. Data of this magnitude have not been used earlier to estimate social factors, recidivism or mortality associated with drunken driving.

The data on drunken driving and other register data can be considered reliable. The number of missing data was small, and the quality of the police information and laboratory tests is considered good. Finnish register data have been assessed to be of high quality in general (Gissler and Haukka, 2004), and the data on mortality are regulated by law. In addition, the percentage of medico-legal autopsies performed is very high (Lunetta et al., 2007).

Even if the data on arrested drunken driving is comprehensive, it does not give a complete picture of drunken driving. The data are affected by selection, resulting from the activity of the police. The arrested drivers are more likely to represent heavily impaired, risk-taking and inexperienced drivers who stand out of the average traffic. When different substances are compared in terms of rearrests, it is likely that certain stimulants, such as amphetamines or other drugs causing serious impairment, are spotted more easily. The data have been gathered during a 20-year period. Regarding to drunken driving, there have been little changes in legislation and testing methods. In the area of drugged driving, however, a zero-tolerance law was introduced in 2003, methods of analysis have developed, and the capability of the police to recognize drug use has improved. A long study period also presents a challenge regarding the reliability and comparability of all data. For some cases, not all information was available annually, but the proportion of missing data was nevertheless rather small.

Many traditional studies are based on limited populations obtained from surveys, groups of substance abuse patients, or mortality of drunk drivers in limited sample. In this study, we were able to analyze nationwide data on 440,000 cases in Study I, 80,000 drunk drivers with their controls in Study II, and 190,000 drivers in Study III. Study IV included 110,000 drunk drivers and their referents, providing data on 15,000 and 5000 deaths, respectively. DUI data of this extent has not been previously analyzed in epidemiologic studies.

8 Conclusions

This study investigated drunken driving known to the police in Finland in 1988–2007. The changes that took place in drunken driving happened simultaneously with economic developments and changes in alcohol consumption. Number of cases of drunken driving among youth was changed most alongside these societal changes. Young persons were also most prone to drunken driving; their incidence was twice as high as that of the general population aged 15–84 years. The proportion of female drunk drivers is increasing continuously. The proportion of women among the arrested drunk drivers has doubled during the 20-year period. In spite of this, still only every ninth drunk driver is a woman. A strong correlation was found between poor social background and increased drunken driving. These associations, however, were not always straightforward. Among young persons aged 15–24 years, for example, a better income meant more drunken driving. There were some factors indicating a high prevalence of alcohol-dependence and other alcohol-related problems among drunk drivers. First of all, at least every third drunk driver was rearrested during the study period, and the estimated rearrest rates are closer to one half of all drunk drivers. Secondly, the mortality of drunk drivers is very high compared to the general population, and the deaths are often related to alcohol. People driving under the influence of drugs had higher rearrest rates than drunk drivers, and they were rearrested sooner.

Young people are overrepresented among arrested drunk drivers and among the victims of fatal as well as non-fatal traffic accidents. Young people are definitely not the group driving the most, when mileages are measured, and the prevalence of young people's drunken driving seen in roadside studies has not been very high. Previous studies have shown that young and inexperienced drivers are more seriously impaired by alcohol, and their high incidence in drunken driving arrests supports this view. Although young people probably do not drive under the influence of alcohol more frequently than the others, the consequences are more serious for them. The measures to prevent drunken driving and to reduce the consequences of drunken driving among youth could include lower BAC limits for them, and also early interventions focusing on substance abuse problems. If the first drunken driving arrest took place at a young age, this also predicted more rapid rearrests.

The proportion of female drunk drivers has doubled during the past 20 years and is likely to rise also in the future. The increased alcohol consumption and drunken driving of women can be seen as one of the consequences of advancing equality between men and women, but these are by no means positive consequences. When social factors were examined, it was seen that associations between drunken driving and negative social aspects, such as unemployment, divorce or living alone, were

sometimes stronger in women than in men. Also the mortality of women suspected of drunken driving was not only higher than that of other women, but it increased more than it did among men suspected of drunken driving. Women, on average, consume less alcohol than men, so the drunken driving of women might reflect more masculine-type behavior regarding the use of alcohol and risk taking. In other words, women with alcohol abuse differ from the norm more than do men with alcohol abuse.

In Finland, the association of poor social position with increased risk of drunken driving is similar to that seen with poor social position and health problems. It is well known that people with a higher socio-economic position are likely to live a healthier and longer life than people with a poorer socio-economic position. Policy programs aiming at narrowing these health differences also help to reduce drunken driving. The association between drunken driving and poor social position can be seen already among youth aged 15–24 years. The differences in health between people from different social backgrounds probably develop very early, because some of these factors are parental, e.g. parental education and income. Problems of substance abuse in youth are known to be difficult and long-lasting. This furthermore supports the importance of early interventions for substance abuse problems and drunken driving.

One out of ten drivers arrested for driving under the influence of amphetamine was rearrested within two months, and every third within a year. People arrested for drugged driving may be severely impaired, and in view of the high rearrest rates, severely dependent on the substances. Currently, the prevention of drugged driving is one of the weaknesses in the prevention of DUI. After the zero-tolerance law of 2003, cases of drugged driving increased dramatically. According to international experience, zero-tolerance of drugs in traffic has only a minor effect on solving the problem of drugged driving. It merely brings the problem to daylight by making it easier for the police to arrest drugged drivers. So far, there are no such technical solutions, e.g. ignition interlock devices that could efficiently prevent a person from driving under the influence of drugs. It is hoped that new narcotic legislation will alleviate the drug situation to some extent. Illicit drugs are currently determined in the narcotic legislation in such a way that it is possible to import, sell and use of some new design-drugs not covered in the legislation, with little fear of punishment before the substance can be classified as an illicit drug. The new narcotics law will be enforced during 2011, enabling the rapid classification of these new drugs.

The mortality of drunk drivers was high, not only due to directly alcohol-related causes, but other causes as well. Although other health outcomes were not studied, it is probable that drunk drivers suffer a number of other negative health effects, such as injuries, mental health problems, and work disability resulting from alcohol use and other poor health habits. Taken together, these may constitute a costly public health problem affecting this substantially large population.

Both drunken and drugged drivers are a sample of people using alcohol, and a sample of drug users. Impaired driving is one manifestation of problems arising from substance use and abuse. Using illicit drugs and driving under their influence can always be considered a serious problem, because according to the legislation, these substances should not be used at all. On the other hand, it is not so easy to determine just when the use of alcohol or prescribed medicines becomes abuse. In the case of alcohol, there are statutory limits for driving, but for medicines, such limits have not been determined. Excessive use of either one, or driving under their influence often are harmful. The results of this study show that suspected DUI is a possible indicator of numerous other alcohol-related harms. Well-defined guidelines and policies are needed for preventing such harms.

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