Mental Disorders Associated with Driving under the Influence of Alcohol and/or Drugs: A Register-Based Study

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Key Words

Driving under the influence • Mental disorders • Register-based study

Abstract

Background/Aims: Mental disorders are associated with driving under the influence (DUI), but the evidence is scarce and mostly focused on a limited group of repeat drunken drivers. Thus, the aim of this study was to examine which mental disorders were risk factors for DUI of alcohol only (DUIA), of illicit drugs (DUID) or of alcohol and psychoactive prescription drugs (DUIAP), and whether and how the risk differs over time. **Methods:** A register-based case-control study was conducted. Cases (n = 44,188) suspected by the police of DUI during 1997–2007 and controls (n = 45,148) were drawn from the general Finnish population. The official national register of hospital treatments was the data source for mental disorders. The effects of mental disorders on DUI were estimated using logistic regression analysis. **Results:** Substance use disorders increased the risk of DUI overall. Childhood- and adolescence-onset disorders were a strong predictor of DUID, and bipolar and depressive disorders predicted DUIAP. The risk was highest soon after hospital admission with a psychiatric diagnosis, but it de-

creased over time. **Conclusions:** Actions to prevent DUI should be developed and implemented during the treatment of mental disorders.

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Introduction

Driving under the influence (DUI) of alcohol and/or drugs may indicate problematic substance use or substance misuse. Also, other mental disorders, such as depression, bipolar disorder and posttraumatic stress disorder, have been associated with DUI [1–5]. Women seem to be more vulnerable, since female DUI offenders are more likely to be diagnosed with mental problems [3], more commonly report lifetime psychiatric diagnoses [6] and experience more problems [7] than men. While comorbid psychiatric disorders are common, still there is evidence that mental disorders other than substance use disorders are underdiagnosed among DUI offenders [8]. The few population studies have found that DUI at a young age is strongly associated with mental disorders and violent criminality [9] and that among young men any psychiatric diagnosis is associated with drunk driving [10].

The majority of previous studies have focused on a rather limited group of repeat DUI offenders who have been convicted for drunk driving. To the authors' knowledge, only a few prospective studies with somewhat inconsistent results have dealt with mental disorders and DUI [11–13]. Thus, more information is needed about other DUI subgroups, especially those driving under the influence of drugs (DUID). In addition, more information is needed about whether it is primarily diagnosed psychiatric disorders (especially other than substance use disorders) that increase the risk of DUI.

The authors had the possibility to analyze at the population level the association of earlier diagnosed mental disorders with DUI of alcohol and/or drugs by using official Finnish registers. The aims of this study were, first, to examine which mental disorders are risk factors for driving under the influence of alcohol only (DUIA), illicit drugs (DUID) or alcohol and psychoactive prescription drugs (DUIAP) and, second, whether and how the risk for DUI differs over time after a primary psychiatric diagnosis.

Material and Methods

This case-control study was based on extensive register material, which was compiled by linking the register of Finnish DUI suspects with the Finnish Hospital In-Patient Register. Different health and social welfare registers have been maintained in Finland since the 1950s, and several of them have been shown to have good coverage and validity [14]. Since all Finnish registers are based on an individual identification number, different registers can be linked together, which provides an exceptional opportunity to use these registers for research purposes.

The main reasons for detecting drunken or drugged drivers in Finland are impaired or dangerous driving, traffic accidents, information from a bystander and random stop-checks. Finnish police are authorized by law to submit drivers to a preliminary breath alcohol screening test or oral fluid on-site drug test (launched in 2003). In Finnish drink driving legislation [15], the punishable thresholds of blood alcohol concentration (BAC) are 0.5‰ (g/kg) for drunken driving and 1.2‰ for aggravated drunken driving. Since February 2003, there has been a zero tolerance law for illicit drugs and driving, which also includes medicinal substances (e.g. benzodiazepines) listed in the Decree on substances, preparations and plants (548/2008) and used illicitly, i.e. without prescription. However, if the use of these medicinal substances is licit (driver has a prescription), DUI of psychoactive prescription drugs is then controlled under the impairment law; the driver will be convicted for driving while intoxicated by the use of any substance if impairment can be proven in court.

Data

The National Institute for Health and Welfare of Finland maintains a register of DUI suspects, which includes all persons apprehended and suspected by the police of DUI of alcohol, illicit and/or medicinal drugs potentially harmful for traffic safety in Finland.

At the request of the police, blood (and urine) samples are taken and a clinical sobriety test is conducted by a physician [16]. During 1977–2007, all drug/alcohol analyses of DUI suspects were carried out in the National Institute for Health and Welfare and registered in a database. This register of DUI suspects includes information about age and gender, details of the case and some clinical data.

The Finnish Hospital In-Patient Register [17] provides information, e.g. diagnoses, about all hospital treatment periods in Finland, thus covering all mental and general hospitals, in-patient wards of local health centers, military wards, prison hospitals and private hospitals. For every patient, at least one primary diagnosis is registered, and in addition there might be subsidiary diagnoses. Since 1996, the International Classification of Diseases version 10 (ICD-10) has been used to classify the diagnoses. The diagnoses are based on clinical interviews conducted by physicians.

For the purposes of a larger study project concerning the life course of DUI offenders, a random sample of 40% ($n = 92,270$) of all DUI suspects was drawn from the register of DUI suspects (includes years 1977–2007). For these DUI suspects, a control group ($n = 86,510$) was drawn from the general Finnish population not suspected of DUI and were matched for age (± 1 year) and gender with DUI suspects. Thus, the entire study population was 178,780 persons. Because of some incomplete or incorrect identification numbers of DUI suspects, the control group was slightly smaller than the group of DUI suspects. The linkage of the registers was performed by Statistics Finland, and all identification information was then removed.

Cases and Controls

Cases were DUI suspects, suspected by the police of DUIA and/or DUID and/or driving under the influence of psychoactive prescription drugs (affecting the nervous system and possibly impairing driving abilities, e.g. anxiolytics, hypnotics, sedatives, opioids). The entire database covered the years 1977–2007 (92,270 DUI suspects, 86,510 controls), but cases suspected of DUI for the first time during 1997–2007 were included in the study. Cases were traced back until 1977 to ensure that they had no DUI offences prior to 1997. Thus, the total number of cases included in the study was 44,118. Controls ($n = 45,148$ during 1997–2007) were matched for age and gender with cases at the time of the corresponding case's first offence ('DUI year' used later in the text refers to that time point).

Measurement

The outcome measure was the apprehension of suspected DUI, and the explanatory factor was the ICD-10 diagnosis (either as a primary or subsidiary diagnosis) from class F: Mental and behavioral disorders (diagnosis codes F00–F99). The hospital treatment period with a class F diagnosis had to precede the year of first DUI among cases or the corresponding year of first DUI among controls. Of the cases, 10.7% ($n = 4,720$) and of the controls 2.9% ($n = 1,326$) had a class F diagnosis preceding the first DUI. The diagnoses were categorized into the following groups: alcohol use disorders (ICD-10 group F10), psychopharmaca use disorders (F13), illicit drug use disorders (F11–F12, F14–F16, F18–F19), schizophrenia group disorders (F20–F29), bipolar disorders (F30–F31), depressive disorders (F32–F39), anxiety etc. disorders (F40–F48), personality disorders (F60–F69), childhood and adolescence disorders (F90–F98) and 'other' disorders (F00–F09, F50–F59, F70–F79, F80–F89, F99).

These groups are not mutually exclusive. An individual with multiple F diagnoses previous to the first DUI year is included in each group for which the individual has a diagnosis; i.e. the same person can be included in more than one group of psychiatric disorders.

DUI Groups

DUI suspects were divided into three different groups based on what substances were detected in their blood samples at apprehension. The first group consisted of people DUIA ($n = 41,069$), and alcohol was the only finding in all their apprehensions (if they were recidivists). Mean BAC among this group was 1.4‰. The second group included persons who were caught DUID ($n = 1,907$) at least once. If they were recidivists, there might have been apprehensions where no illicit drugs were found. The most prevalent illicit drugs were amphetamine-type stimulants and cannabinoids, which were found in 46 and 26%, respectively, of all apprehensions among this group. DUI suspects who were caught DUIAP at least once ($n = 676$) comprised the third group. If recidivists, it was possible that the individuals might have had a finding for alcohol only in some cases. The mean BAC in this group was 1.4‰, and the most common prescription drug found among this group was benzodiazepines, found in 44% of cases. Medicinal opioids (e.g. buprenorphine, codeine and tramadol) were found in 4.4% of cases and other prescription drugs (e.g. antidepressants) in 13% of the cases.

Statistical Analysis

A logistic regression model was used, with results presented as odds ratios (ORs) with 95% confidence intervals (CIs). The modeling was executed in two phases. First, models were constructed with DUI apprehension as a dependent variable, and different groups of F class diagnoses were considered as explanatory variables. In addition to univariate models (model 1), models were adjusted for age (classified into 10-year age groups) and gender (model 2), and for age, gender and other mental disorders previous to first DUI (model 3).

Second, psychiatric diagnoses with statistically significant ORs (>1) indicating an increased risk of DUI were classified into two groups, i.e. substance use disorders (alcohol use disorders and illicit drug use disorders) and other mental disorders (bipolar disorders, depressive disorders, anxiety etc. disorders, personality disorders and childhood and adolescence disorders). In this second modeling, the time between the first hospital admission with a psychiatric diagnosis and first DUI was taken into consideration, and the ORs were calculated in 3-year periods. Models were adjusted for age and gender and by the other group of psychiatric disorders previous to first DUI. All models in both phases were conducted separately for different DUI groups, namely alcohol only, illicit drugs only and alcohol and psychoactive prescription drugs.

One-way analysis of variance was used to test the differences in mean age among different DUI groups.

A p value <0.05 was considered statistically significant. PASW Statistics 18 was used to analyze the data.

Research Ethics

The study protocol was approved by the Institutional Review Board of the National Institute for Health and Welfare. Informed consent was not required since the data were anonymous register

data, and individuals were not contacted. In addition, to ensure privacy, only a 40% sample of the entire DUI suspects database was drawn.

Results

Eighty-six percent of both cases and controls were men. Among the DUIA and DUID groups the proportion of men was also approximately 86%, but among the DUIAP group the proportion of men was lower, being 81%. Mean age at first DUI was 35.4 years (median 34 years) in cases and 36.1 years (median 35 years) in controls. DUID suspects were significantly younger (mean 25.1 years, median 22 years) than DUIA suspects (mean 36.0 years, median 35 years) and DUIAP suspects (mean 34.9 years, median 34 years; $F = 478.76$, $p < 0.001$).

The Overall Association of Psychiatric Diagnoses and DUI

Mental disorders were more common among DUI suspects overall, as well as in the different DUI groups, compared to the general Finnish population (tables 1–3). F class diagnoses involving substance use (alcohol use disorders, psychopharmaca use disorders and illicit drug use disorders) were significantly associated with DUI. For example, as shown in table 1 in model 1, people diagnosed with alcohol use disorders had a higher risk (OR 7.1, CI 6.4–8.0) for DUIA when compared to those without alcohol use disorders. However, some of this association was explained by other psychiatric disorders, since the OR attenuated after adjusting for other F class diagnoses (OR 6.1, CI 5.4–6.9; table 1, model 3). Similarly, illicit drug use disorders were highly predictive of DUI (ORs 3.9–115.6; model 1 in tables 1–3), and the risk remained high after adjusting for other variables (model 3 in tables 1–3), the independent effect being especially high for DUID (table 2, model 3).

Other mental disorders were also associated with DUI. Bipolar disorders, depressive disorders and anxiety etc. disorders were risk factors for DUIA, DUID and DUIAP (model 1 in tables 1–3), and although the ORs attenuated when other variables were held constant, they retained their independent effect (model 3 in tables 1–3). The exception to this was bipolar disorders, which did not have an independent effect for DUID after adjusting for other variables (table 2, model 3). The association of bipolar disorders, depressive disorders and anxiety etc. disorders with DUIAP (table 3, model 3) was considerably stronger than the association with DUIA (table 1, model 3) or

Table 1. Effects of mental disorders (F class diagnoses in ICD-10) on DUIA

F class diagnosis	DUIA cases, % (n = 41,069)	Controls, % (n = 45,148)	Model 1		Model 2		Model 3	
			OR	95% CI	OR	95% CI	OR	95% CI
Alcohol use disorders	5.36	0.79	7.13	6.37–7.98	7.31	6.52–8.18	6.12	5.44–6.87
Psychopharmaca use disorders	0.21	0.06	3.64	2.35–5.65	3.70	2.38–5.74	0.98	0.60–1.61
Illicit drug use disorders	0.52	0.14	3.85	2.90–5.12	4.08	3.07–5.43	2.38	1.74–3.25
Schizophrenia group disorders	0.69	0.71	0.97	0.82–1.13	0.99	0.84–1.16	0.62	0.52–0.75
Bipolar disorders	0.31	0.08	3.89	2.68–5.63	3.98	2.75–5.76	1.86	1.24–2.78
Depressive disorders	2.70	0.77	3.56	3.15–4.01	3.62	3.20–4.08	1.95	1.71–2.24
Anxiety etc. disorders	1.80	0.73	2.50	2.20–2.85	2.69	2.36–3.07	1.79	1.56–2.07
Personality disorders	0.96	0.29	3.40	2.78–4.15	3.52	2.88–4.29	1.21	0.96–1.52
Childhood and adolescence disorders	0.75	0.21	3.50	2.78–4.40	3.20	2.54–4.03	2.67	2.11–3.38
Other disorders	0.44	0.37	1.20	0.97–1.48	1.18	0.96–1.46	0.71	0.56–0.89

Model 1: univariate model; model 2: adjusted for gender and age; model 3: adjusted for gender, age and all the other F class diagnoses. $p < 0.05$ for ORs shown in bold type.

Table 2. Effects of mental disorders (F class diagnoses in ICD-10) on DUID

F class diagnosis	DUID cases, % (n = 1,907)	Controls, % (n = 45,148)	Model 1		Model 2		Model 3	
			OR	95% CI	OR	95% CI	OR	95% CI
Alcohol use disorders	4.20	0.79	5.51	4.30–7.05	13.84	10.44–18.35	4.28	2.89–6.33
Psychopharmaca use disorders	2.88	0.06	51.54	32.25–82.36	55.59	33.04–93.53	1.49	0.73–3.05
Illicit drug use disorders	13.53	0.14	115.64	87.11–153.52	109.68	81.03–148.44	61.18	43.95–85.17
Schizophrenia group disorders	2.99	0.71	4.29	3.22–5.71	5.81	4.29–7.85	1.40	0.88–2.20
Bipolar disorders	0.63	0.08	7.94	4.12–15.28	10.47	5.12–21.41	1.25	0.46–3.39
Depressive disorders	4.51	0.77	6.06	4.77–7.71	7.55	5.82–9.79	1.82	1.24–2.65
Anxiety etc. disorders	4.56	0.73	6.53	5.13–8.31	5.39	4.20–6.92	1.94	1.38–2.73
Personality disorders	3.46	0.29	12.51	9.27–16.89	16.52	11.84–23.03	1.56	0.95–2.56
Childhood and adolescence disorders	3.41	0.21	16.39	11.93–22.52	9.16	6.65–12.63	5.40	3.69–7.91
Other disorders	0.89	0.37	2.45	1.49–4.05	2.19	1.31–3.67	0.59	0.29–1.18

Model 1: univariate model; model 2: adjusted for gender and age; model 3: adjusted for gender, age and all the other F class diagnoses. $p < 0.05$ for ORs shown in bold type.

DUID (table 1, model 3). Childhood and adolescence disorders, too, were a significant predictor of DUI. The ORs remained quite high after adjusting for other variables (model 3 in tables 1–3), but the independent effect of childhood and adolescence disorders was especially high for DUID (table 2, model 3).

Although personality disorders seemed to be associated with DUI in the univariate model (model 1 in tables 1–3), the effect was explained by other variables (model 3 in tables 1–3). Contrary to the other F class diagnoses, the risk for DUIA among people with schizophrenia group disorders or ‘other’ disorders was lower (model 3 in table 1) when compared to those without these disorders.

Furthermore, these two groups of disorders were not independently associated with DUID or DUIAP (model 3, tables 2–3).

Gender

In general, women with an F class diagnosis had a higher risk for DUI compared to men (age-adjusted OR 1.5, CI 1.3–1.8). When different DUI groups were examined with men as the reference group, the age-adjusted OR among women was 1.4 (CI 1.1–1.6) for DUIA and 1.6 (CI 1.2–2.1) for DUID. Women had the highest risk for DUIAP, the age-adjusted OR being 1.8 (CI 1.3–2.7).

Table 3. Effects of mental disorders (F class diagnoses in ICD-10) on DUIAP

F class diagnosis	DUIAP cases, % (n = 676)	Controls, % (n = 45,148)	Model 1		Model 2		Model 3	
			OR	95% CI	OR	95% CI	OR	95% CI
Alcohol use disorders	13.61	0.79	19.8	15.5–25.3	22.7	17.6–29.2	7.75	5.62–10.69
Psychopharmaca use disorders	3.11	0.06	55.6	31.1–99.4	51.7	28.8–92.8	3.13	1.46–6.69
Illicit drug use disorders	4.88	0.14	37.9	24.7–58.4	37.7	24.4–58.3	7.49	4.32–12.98
Schizophrenia group disorders	3.85	0.71	5.6	3.7–8.4	5.5	3.6–8.3	1.65	1.00–2.70
Bipolar disorders	3.25	0.08	42.2	24.7–72.0	41.8	24.3–71.8	10.05	4.97–20.34
Depressive disorders	11.98	0.77	17.5	13.5–22.5	17.5	13.5–22.7	4.49	3.13–6.43
Anxiety etc. disorders	6.80	0.73	10.0	7.3–13.7	9.9	7.2–13.7	2.19	1.43–3.36
Personality disorders	5.92	0.29	21.9	15.3–31.6	21.3	14.8–30.7	1.37	0.81–2.30
Childhood and adolescence disorders	1.78	0.21	8.4	4.6–15.4	8.4	4.6–15.6	2.72	1.28–5.77
Other disorders	1.48	0.37	4.1	2.2–7.8	4.2	2.2–7.9	0.84	0.37–1.92

Model 1: univariate model; model 2: adjusted for gender and age; model 3: adjusted for gender, age and all the other F class diagnoses. $p < 0.05$ for ORs shown in bold type.

Fig. 1. The effects (adjusted ORs and their 95% CIs) of substance use disorders on DUI in 3-year periods after the first hospital admission with a diagnosed substance use disorder during 1996–2007. **Fig. 2.** The effects (adjusted ORs and their 95% CIs) of mental disorders (substance use disorders excluded) on DUI in 3-year periods after the first hospital admission with a diagnosed mental disorder during 1996–2007.

The Association of Psychiatric Diagnoses and DUI in Three-Year Periods

As seen in figures 1 and 2, among both groups of disorders (substance use disorders and other mental disorders), the risk for DUI was highest soon after the first hospital admission with psychiatric diagnosis. The risk decreased over time so that 9 years after first diagnosis

the risk of DUI among those with some psychiatric diagnosis did not differ from those with no psychiatric diagnosis.

Among people with substance use disorders (fig. 1), the risk for DUID was highest during the entire follow-up period. The risk for DUIAP was higher than the risk for DUIA during the first 3 years following the hospital ad-

mission with diagnosed substance use disorder, but after that the risk for DUIA and DUIAP was very similar.

Among people with other mental disorders (fig. 2; substance use disorders excluded), the risk for DUIAP was considerably higher during the first 3 years compared to DUID and DUIA. However, it also attenuated the most during the follow-up, whereas the risk for DUIA and DUID remained steadier.

Discussion

Main Results

The main results of this study were as follows. Firstly, mental disorders (other than substance use disorders) diagnosed during hospital admission significantly increased the risk for DUI. As expected, substance use disorders were also a risk factor for DUI. The association of childhood and adolescence disorders and DUID was especially strong, whereas the risk for DUIAP was high among people diagnosed with bipolar or depressive disorders. Secondly, women with mental disorders had a higher risk for DUI compared to men. Thirdly, the risk for DUI was highest soon after the hospital admission with psychiatric diagnosis, but the risk decreased over time. Diagnosed substance use disorder especially increased the risk of DUID, whereas other mental disorders (substance use disorders excluded) were highly associated with DUIAP, particularly during the first 3 years after hospital admission. To the authors' knowledge, this is the first study where the association of mental disorders with separate DUI groups (alcohol/illicit drugs/alcohol and psychoactive prescription medicine) is examined, and thus the findings are more comprehensive compared to those concerning drink drivers only.

The finding that mental disorders are associated with DUI is consistent with the previous research conducted among DUI offenders [1–5], but some population-based cohort studies [10, 11] have reached contradictory results that indicated an association did not exist. In a Finnish cohort study [10], the association of psychiatric disorders and DUI disappeared after adjusting for parental education level in childhood. Furthermore, lower socioeconomic position is found to be a risk factor for both DUIA [18] and DUID [19]. Thus, some of the observed association in this study may be due to other confounding factors, such as socioeconomic background, which could not be taken into consideration.

DUID was strongly associated with childhood and adolescence disorders, even after adjusting for other vari-

ables. This group of disorders includes diagnoses such as hyperkinetic disorders and conduct disorders, which are shown to predict illicit drug use [20]. Hence, the association found in the present study reinforces the results of previous research concerning illicit drug use and childhood and adolescence disorders, but it also indicates that people with childhood and adolescence disorders are more prone to drive after using illicit drugs.

Previously diagnosed bipolar disorder in particular was found to increase the risk for DUIAP, and this finding is in accordance with previous studies concerning drunk driving [5]. It is likely that due to the symptoms of a manic episode individuals are more prone to drive under the influence, although they otherwise would go against it. However, in another group of psychotic disorders the effect was completely the opposite; among schizophrenia group disorders, the risk for DUI was lower when compared to the general population. This, too, might be explained by the disease itself. Commonly, individuals with schizophrenia group disorders are socially disabled [21], and due to their disease often unable to work. In consequence, they have a low income and thus might not have a car, which for its part prevents DUI.

The data used did not include information on whether the prescription drugs were used as a medication for the individual's condition, or if they had a physician's prescription for the drugs used, and if they had, whether the drugs were used as prescribed. Thus, we could not know if these drugs among the DUIAP group were used properly or possibly misused. However, on the other hand, the mean BAC among the DUIAP group was high, at 1.4‰, and in addition to alcohol they had used one or multiple different prescription drugs, possibly impairing their driving skills, which from the point of view of traffic safety might be even more dangerous than DUIA only.

Substantial gender differences seem to appear among DUI suspects in general. Most of the DUI offenders are men [22, 23], but there is evidence that female DUI offenders have a lower socioeconomic position [18, 19] and higher mortality [24, 25] compared to men. This study also gave the result that the effect of psychiatric disorders on DUI was stronger among women than men, as has also been found previously [6, 7]. This might indicate that DUI offending is a sign of even more serious problems among women, and that special attention should be focused on women when caught DUI, despite the fact that the number of female suspects is marginal compared to men.

When the time between the first hospital admission with psychiatric diagnosis and first DUI was taken into

consideration, it was found that the risk for DUI decreased over time. Several factors might influence this. First of all, as time passes, the treatment for the psychiatric disorder takes effect, the individual accommodates and the situation stabilizes. Second, it has been shown that overall criminality declines with age [26]. Third, the decrease in the risk of DUI might be due to mortality. High mortality rates have been shown both among people with psychiatric disorders [27] as well as among DUI suspects [24, 25, 28].

Methodological Considerations

The data concerning mental disorders was based on the Finnish Hospital In-Patient Register. While the strength of this register is that it covers all the hospitals in Finland, there are also some limitations that should be noted. The register includes only hospital treatment periods, and thus it does not provide information on psychiatric outpatients. The need for hospitalized treatment differs according to the disorder [29]; for example, depression, personality disorders and anxiety disorders are only rarely treated in hospital, whereas schizophrenia is almost always treated in hospital. Therefore, the results are not directly extrapolatable to the entire population of people with mental disorders. In addition, it should be noted that the diagnoses of mental disorders are not based on structured instruments such as the Composite International Diagnostic Interview but on clinical interviews conducted by physicians during the whole hospital treatment period.

The information about DUI was based on the register of DUI suspects, i.e. individuals who were suspected and apprehended by the police. Not all people DUI are caught by the police, and it should be noted that the first apprehension does not necessarily mean that the person was DUI for the first time. Furthermore, most DUI suspects are apprehended because of impaired driving or a traffic

accident, which indicates that the most impaired drivers are overrepresented.

In addition to age and gender, the data used did not include any information about the individual's background, such as socioeconomic status. Thus, some of the associations found in this study might be partly due to confounding factors that could not be taken into account. Furthermore, when time was taken into consideration, the longer the time between first psychiatric diagnosis and first DUI year, the smaller the number of study subjects there were. Thus, with longer time the effect estimates are less certain, as evidenced by the wide CIs.

The data studied were based on two registers that were linked by personal ID numbers. By linking different registers, a large sample size is relatively easy to gather, which aids in achieving sufficient power. This type of linked register data is internationally unique, and the reliability is increased by the good coverage and validity of the different Finnish registers [14].

Conclusions

Mental disorders – also those other than substance use disorders – increase the risk for DUIA and/or DUID. This finding highlights at least one circumstance in which an intervention may help prevent DUI. Based on the results of this study, preventive actions should be developed, and these actions should be implemented when diagnosing and treating mental disorders.

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References

- 1 Lapham SC, C'De Baca J, McMillan GP, Lapidus J: Psychiatric disorders in a sample of repeat impaired-driving offenders. *J Stud Alcohol* 2006;67:707–713.
- 2 Lapham SC, Smith E, C'De Baca J, Chang I, Skipper BJ, Baum G, Hunt WC: Prevalence of psychiatric disorders among persons convicted of driving while impaired. *Arch Gen Psychiatry* 2001;58:943–949.
- 3 Freeman J, Maxwell JC, Davey J: Unraveling the complexity of driving while intoxicated: a study into the prevalence of psychiatric and substance abuse comorbidity. *Accid Anal Prev* 2011;43:34–39.
- 4 Shaffer HJ, Nelson SE, LaPlante DA, LaBrie RA, Albanese M, Caro G: The epidemiology of psychiatric disorders among repeat DUI offenders accepting a treatment-sentencing option. *J Consult Clin Psychol* 2007;75:795–804.
- 5 Albanese MJ, Nelson SE, Peller AJ, Shaffer HJ: Bipolar disorder as a risk factor for repeat DUI behavior. *J Affect Disord* 2010;121:253–257.
- 6 LaPlante DA, Nelson SE, Odegaard SS, LaBrie RA, Shaffer HJ: Substance and psychiatric disorders among men and women repeat driving under the influence offenders who accept a treatment-sentencing option. *J Stud Alcohol Drugs* 2008;69:209–217.

- 7 Maxwell JC, Freeman J: Gender differences in DUI offenders in treatment in Texas. *Trafic Inj Prev* 2007;8:353–360.
- 8 McMillan GP, Timken DS, Lapidus J, C'De Baca J, Lapham SC, McNeal M: Underdiagnosis of comorbid mental illness in repeat DUI offenders mandated to treatment. *J Subst Abuse Treat* 2008;34:320–325.
- 9 Räsänen P, Hakko H, Järvelin MR: Early-onset drunk driving, violent criminality, and mental disorders. *Lancet* 1999;354:1788.
- 10 Elonheimo H, Niemelä S, Parkkola K, Multimäki P, Helenius H, Nuutila AM, Sourander A: Police-registered offenses and psychiatric disorders among young males: the Finnish 'From a boy to a man' birth cohort study. *Soc Psychiatry Psychiatr Epidemiol* 2007;42:477–484.
- 11 Karlsson G, Romelsjö A: A longitudinal study of social, psychological and behavioural factors associated with drunken driving and public drunkenness. *Addiction* 1997;92:447–457.
- 12 Sourander A, Jensen P, Davies M, Niemelä S, Elonheimo H, Ristkari T, Helenius H, Sillanmäki L, Piha J, Kumpulainen K, Tamminen T, Moilanen I, Almqvist F: Who is at greatest risk of adverse long-term outcomes? The Finnish From a Boy to a Man study. *J Am Acad Child Adolesc Psychiatry* 2007;46:1148–1161.
- 13 Peller AJ, Najavits LM, Nelson SE, LaBrie RA, Shaffer HJ: PTSD among a treatment sample of repeat DUI offenders. *J Trauma Stress* 2010;23:468–473.
- 14 Gissler M, Haukka J: Finnish health and social welfare registers in epidemiological research. *Nor Epidemiol* 2004;14:113–120.
- 15 Ministry of Justice Finland: Drunken driving and aggravated drunken driving. 23:3–4\$. Took effect 1.2.2003.
- 16 Lillsunde P, Gunnar T: Drugs and driving: the Finnish perspective. *Bull Narc* 2005;57:213–229.
- 17 National Institute for Health and Welfare: The Finnish hospital in-patient register. <http://www.stakes.fi/FI/tilastot/nettihilmo/hilmokayttajille.htm> (accessed 28 December 2011).
- 18 Impinen A, Mäkelä P, Karjalainen K, Haukka J, Lintonen T, Lillsunde P, Rahkonen O, Ostamo A: The association between social determinants and drunken driving: a 15-year register-based study of 81,125 suspects. *Alcohol Alcohol* 2011;46:721–728.
- 19 Karjalainen K, Lintonen T, Impinen A, Lillsunde P, Mäkelä P, Rahkonen O, Haukka J, Ostamo A: Socio-economic determinants of drugged driving – a register-based study. *Addiction* 2011;106:1448–1459.
- 20 Elkins IJ, McGue M, Iacono WG: Prospective effects of attention-deficit/hyperactivity disorder, conduct disorder, and sex on adolescent substance use and abuse. *Arch Gen Psychiatry* 2007;64:1145–1152.
- 21 Wiersma D, Wanderling J, Dragomirecka E, Ganey K, Harrison G, An Der Heiden W, Nienhuis FJ, Walsh D: Social disability in schizophrenia: its development and prediction over 15 years in incidence cohorts in six European centres. *Psychol Med* 2000;30:1155–1167.
- 22 Ojaniemi K, Lintonen T, Impinen A, Lillsunde P, Ostamo A: Trends in driving under the influence of drugs: a register-based study of DUID suspects during 1977–2007. *Accid Anal Prev* 2009;41:191–196.
- 23 Skurtveit S, Christophersen AS, Morland J: Female drivers suspected for drunken or drugged driving. *Forensic Sci Int* 1995;75:139–148.
- 24 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 Alcohol Depend* 2010;110:80–84.
- 25 Skurtveit S, Christophersen AS, Grung M, Morland J: Increased mortality among previously apprehended drunken and drugged drivers. *Drug Alcohol Depend* 2002;68:143–150.
- 26 Farrington DP: Key results from the first forty years of the Cambridge study in delinquent development; in Thornberry TP, Krohn MD (eds): *Taking Stock of Delinquency: An Overview of Findings from Contemporary Longitudinal Studies*. Secaucus, Kluwer Academic, 2002, pp 137–184.
- 27 Nordentoft M, Pedersen MG, Pedersen CB, Blinkenberg S, Mortensen PB: The new asylums in the community: severely ill psychiatric patients living in psychiatric supported housing facilities. A Danish register-based study of prognostic factors, use of psychiatric services, and mortality. *Soc Psychiatry Psychiatr Epidemiol* 2012;47:1251–1261.
- 28 Karjalainen K, Lintonen T, Impinen A, Mäkelä P, Rahkonen O, Lillsunde P, Ostamo A: Mortality and causes of death among drugged drivers. *J Epidemiol Community Health* 2010;64:506–512.
- 29 Kantojärvi L, Veijola J, Läksy K, Jokelainen J, Herva A, Karvonen JT, Kokkonen P, Järvelin MR, Joukamaa M: Comparison of hospital-treated personality disorders and personality disorders in a general population sample. *Nord J Psychiatry* 2004;58:357–362.