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Associations between substance use among car and van drivers in Norway and fatal injury in road traffic accidents: A case-control study

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ABSTRACT

The aim of this study was to determine the association between alcohol or drug use with fatal injury in road traffic accidents by calculating odds ratios (ORs) using a case-control design. The 'cases' were 508 drivers killed in road traffic accidents in the period 2003–2010 from whom blood samples were sent to the Norwegian Institute of Public Health for alcohol and drug testing, and the 'controls' were 9261 random drivers in normal traffic. Blood samples from 'cases' and oral fluid samples from 'controls' were analysed for alcohol, 15 drugs which have legislational concentration limits in Norway, in addition to two other commonly detected psychoactive drugs. The ORs for being killed in a traffic crash with blood alcohol concentration above the legal limit of 0.02 g/dL was 199.5 (95% CI 112.6–353.2). For the use of amphetamines without other substances the OR was 41.6 (95% CI 12.6–137.1), and for use of two or more substances 85.0 (95% CI 46.3–156.1). The OR for general use of only one medicinal drug was 6.0, and no significant ORs were found for the specific use of only zopiclone or THC. The ORs were generally higher for involvement in single-vehicle accidents. It is likely that the observed ORs, particularly for alcohol, are not only related to the risk posed by the substance alone, but a combination with behavioural factors, such as sensation seeking or risk taking behaviour.

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1. Introduction

It is well-known that driving under the influence of alcohol or drugs increases the risk of involvement in road traffic accidents. Several methods are being used to investigate the accident risk posed by different substances: case-control studies, culpability studies, pharmaco-epidemiological studies, and testing of psychomotor performance after using potentially impairing substances (Raes et al., 2008; Verster, Pandi-Perumal, Ramaekers, & de Gier, 2009).

Case-control studies have been used to estimate the odds ratios (ORs) for involvement in road traffic accidents; the 'cases' were drivers injured or killed in road traffic accidents, and 'controls' were random drivers (Houwing, Mathijssen, & Brookhuis, 2009; Raes et al., 2008). Ideally, case-control studies should be performed by collecting blood samples from both 'cases' and 'controls', the refusal rate should be negligible, 'cases' and 'controls' should be selected from the same population driving at the same roads at the same time of day, and the samples should be analysed for a broad range of psychoactive substances.

The refusal rate is often high when collecting blood from volunteers. When collecting blood samples in recent roadside surveys of alcohol, drugs and driving, the refusal rate was 24% in Lithuania; it was 52% when collecting blood or oral fluid in

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Belgium, and 25% refused to give a blood sample but 20% were willing to give a sample of oral fluid instead of blood in the Netherlands (Houwing et al., 2011). In American roadside surveys, 50–60% refused to give blood samples (Lacey, Kelley-Baker, Furr-Holden, Brainard, & Moore, 2007; Lacey et al., 2009). When collecting oral fluid the refusal rate was less than 10% in roadside surveys in Denmark, Norway, Poland, Portugal and Spain; however, it was higher in Sweden, Finland, the Czech Republic and Hungary (Houwing et al., 2011). It has thus been possible to obtain high participation rates if collecting oral fluid. However, other factors, such as the study design and cultural issues may also have affected the participation rate.

It can be difficult to compare the prevalence and concentration of drugs in samples of blood and oral fluid. However, the prevalence of a drug in paired samples of oral fluid and blood from the same cohort are equal if using equivalent (not equal) cutoff concentrations (Gjerde & Verstraete, 2011), and the mean drug detection time in oral fluid will be the same as in blood. Equivalent cutoff concentrations for oral fluid and blood have been used in a few previous studies (Gjerde, Normann, Christophersen, Samuelsen, & Mørland, 2011; Houwing et al., 2011).

Some other studies have compared results for blood samples from 'cases' with urine samples from 'controls' or used a mixture of blood and urine samples (Dussault, Lemire, Bouchard, & Brault, 2000; Movig et al., 2004; Woratanarat et al., 2009). That type of case-control design makes interpretation of results very difficult, because urine samples may be positive for a drug and/or metabolites for a number of days longer than a blood sample with very large variation between individuals, and it is therefore impossible to define equivalent cutoff concentrations in blood and urine.

Other difficulties are covariates related to behaviour after using alcohol or drugs (Houwing et al., 2009). If 'cases' and 'controls' have different attitudes regarding risk-taking behaviour, the calculated odds ratios from a case-control study will not reflect the risk posed by alcohol or drug use alone, but a combination of substance use with risk-taking behaviour, which again might be influenced by use of alcohol or drugs.

Finally, multi-drug use is common among drug using drivers, especially among those being arrested for drug driving. Therefore, omitting the analysis of some commonly used drugs might erroneously associate single substance use with high ORs.

We have previously performed a case-control study of alcohol, drugs and fatal traffic accidents in Norway (Gjerde, Normann, et al., 2011) where 204 killed drivers from south-eastern Norway were included. The aim of this new study was to include a larger number of 'cases' selected from all parts of the country. The 'cases' were drivers killed in road traffic accidents in the period 2003–2010 where the police requested analysis of alcohol or drugs. To obtain the highest possible participation rate among 'controls', samples of oral fluid were collected from random drivers during 2008–2009, and equivalent cutoff concentrations in blood and oral fluid were used. The new legislational limits for drugs introduced in Norway in February 2012 (Vindenes et al., 2012) were used as cutoff concentrations in blood. The legislational limits corresponded about to a blood alcohol concentration (BAC) of 0.02 g/dL with respect to traffic relevant impairment. In our study, we have included the 15 most commonly found drugs that routinely have been analysed during 2003–2010 for which legislational limits were introduced, excluding the rarely detected drugs LSD, GHB, ketamine, buprenorphine and phenazepam. We have also included two more drugs: codeine, because it is one of the most frequently used medicinal drugs in Norway which might impair driving ability, and nordiazepam, which is an active metabolite of diazepam.

2. Methods

2.1. Study design and setting

In this case-control study, 'cases' were car and van drivers killed in road traffic accidents in Norway and 'controls' were random car and van drivers from selected areas in south-eastern, south-western, middle and northern Norway. The areas included both some of the largest cities in Norway and representative rural areas. The study was approved by the Regional Committee for Medical and Health Research Ethics, the Higher Prosecution Authority and the Council for Confidentiality and Research of the Norwegian Ministry of Justice.

2.2. Selection of 'cases'

Data on persons injured or killed in road traffic accidents in Norway are submitted by the police to Statistics Norway on a regular basis. These data are entered into the Norwegian Road Accident Registry. The recorded data include the national identification number of the subject, type of road user (e.g. car driver, car passenger, bicyclist or pedestrian) in addition to information about the accident (e.g. date, time, geographical site, single vehicle or multiple vehicle accident).

In most fatal road traffic accidents, the police requests sampling of blood from the drivers for analysis of alcohol and drugs. All samples of that type that are taken after the accident and before legal autopsy are analysed by the Norwegian Institute of Public Health (NIPH), and results are recorded in the Forensic Toxicology Database at NIPH. This database contains the national identification number together with analytical results for each blood sample taken in police investigations from the whole country. In addition, all samples taken from legal autopsies from all regions of the country except Trøndelag in central Norway (which comprises two counties and 8.7% of the Norwegian population) are also analysed at NIPH and results are included in this database.

A new dataset was generated by Statistics Norway by coupling those two databases, selecting drivers of cars and vans who had been killed in road traffic accidents in Norway from January 2003 to December 2010. As only the date and not

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