Prevalence of alcohol and drugs among motorcycle riders killed in road crashes in Norway during 2001–2010

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A B S T R A C T

The aim of the study was to examine the prevalence of alcohol and drugs in blood samples from motorcycle riders who died in road crashes in Norway from 2001 to 2010. An additional aim was to compare the prevalence of alcohol and drugs in blood samples from fatally injured motorcycle riders and car drivers who died during the same time period.

Blood samples from motorcycle riders who died within 24 h after the accident (n = 207, 63% of all killed riders), were analysed for alcohol, psychoactive drugs (medicinal and illicit drugs). The cut-off concentrations for alcohol and drugs findings in blood samples (i.e., the drug concentrations above which a finding was regarded as positive) were set according to the legislative limits under the Norwegian Road Traffic Act. Results were assessed in relation to age, sex, time of the day and week, and single versus multiple-vehicle accidents.

Alcohol or drugs were found in 27.1 percent of all investigated riders. For riders killed in single or multiple-vehicle accidents, alcohol or drugs were found in 44.6 and 15.3 percent, respectively. Alcohol was the most frequently found substance for all age groups and most prevalent in samples from riders below 25 years who died in single-vehicle accidents (45.8 percent). Drugs were most often found among riders between 25 and 34 years (19.6 percent in total and 25.9% for those killed in single-vehicle crashes). The prevalence of alcohol or drugs was highest among riders killed in single-vehicle accidents during weekend days and nights (60.9 and 65.2 percent).

Alcohol and drugs were less often found in samples from killed motorcycles riders than in samples from car and van drivers (40.2 percent). For single-vehicle accidents, the total prevalence of alcohol or drugs among killed motorcycles riders and car drivers was 44.6 percent and 638 percent, respectively. The same pattern of alcohol and drugs was found among the two groups, except that the prevalence among motorcycle riders was lower compared to car drivers in all age groups and time periods, which may be related to the fact that they are more vulnerable for fatal injury compared to car drivers in similar accidents.

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1. Introduction

Motorcycle riders represent a group of road users with high accident risks (Clarke et al., 2004; Elliot et al., 2009; Jama et al., 2011; Bjørnskau et al., 2012; Breitenbach et al., 2012). The number of motorcycles is growing, both in low/middle and high income countries, resulting in an increase of road traffic accidents (Clarke et al., 2004; Kasantikul et al., 2005; Jama et al., 2011; Breitenbach et al., 2012). This development should lead to an increased focus on the road safety for motorcycle riders from those who are responsible for the traffic rules, traffic control, training, as well as from motorcycle riders themselves, other motor vehicle drivers and road users, particularly in regions with high density of motorcycles in road traffic.

Despite preventive precautions, such as requirements for helmet and other protective equipment, motorcycle riders are more vulnerable when involved in an accident than other motor vehicle drivers (Servadei et al., 2003; Elliot et al., 2009). Therefore, the number of serious accidents is high relative to the number of motorcycles on the road and driving distance (Haworth et al., 2009; Jama et al., 2011; Bjørnskau et al., 2012; Rifat et al., 2012). Motorcycle riders have from twenty to more than thirty times higher risk of death in road accidents and are six to eight times more likely to be seriously injured compared to other groups of drivers (Clarke et al., 2004; Huang and Preston, 2004; Elliot et al.,...
2009; Bjørnskau et al., 2012). The severity of a crash is highly related to non-use of protective accessories (Clarke et al., 2004; Kasantikul et al., 2005; Haworth, 2009; Lin and Kraus, 2009; Jama et al., 2011; Bjørnskau et al., 2012). Young men with minor traffic experience who believe they can easily handle complicated traffic challenges, sensation seekers, high speed riders, and drunken motorcycle riders constitute groups with particularly high crash risk (Clarke et al., 2004).

The effect of alcohol on motorcycle riding has been studied using motorcycle simulator, showing increased reaction time and more errors compared to car drivers (Colburn et al., 1993). Other studies of alcohol’s effects on motorcycle riding have documented inconsistent driving, excessive and inappropriate speed, curve ignoring, with increased risk to run off the road (Kasantikul et al., 2005; Creaser et al., 2009). Thus, alcohol has been documented to be one of the most frequent causes of motorcycle injury and fatal accidents (Kasantikul et al., 2005; Subramanian, 2005; Zambron and Hasselberg, 2006; Moskal et al., 2012; Papadimitriou et al., 2014). It has therefore been proposed that the legislative blood alcohol concentration (BAC) limit for motorcycle riders should be lower than for car drivers (Colburn et al., 1993; Sun et al., 1998; Creaser et al., 2009).

The contribution of psychoactive drug use (psychoactive medicines and illicit drugs) in motorcycle accidents has received less attention than alcohol; studies documenting risk caused by use of illicit drugs or psychoactive medicines are sparse. Our current knowledge on traffic accident risk related to drug use is primarily based on experimental studies using psychomotor tests and epidemiological studies of car drivers involved in traffic accidents including case-control and culpability studies (Longo et al., 2000; Ramaekers et al., 2006; Berghaus et al., 2007; Verster and Mets, 2009; Phillips and Brewer, 2011; Gjerde et al., 2011; Ravera et al., 2011; Merland et al., 2011; Bernhoft et al., 2012; Poulsen et al., 2014). It might be expected that medicines and illicit drugs with impairing effect on car driving would affect the crash risk even more for motorcycle riders.

Published data on alcohol and drug use by motorcycle riders involved in crashes show large variations with regards to the prevalence of alcohol and drug use, for alcohol ranging from about 5% to more than 40%. The prevalence of other drugs has also varied from less than 5% to more than 30% (Soderstrom et al., 1995; Drummer et al., 2003; Elliot et al., 2009; Lin and Kraus, 2009; Jama et al., 2011; Poulsen et al., 2014). However, the results are difficult to compare due to use of different study protocols, e.g. regarding the selection of drugs that are analysed and the cut-off concentration limits that are used for blood samples. Most studies have analysed for alcohol only.

Norway has a strict Road Traffic Act with regards to the legislative limits for alcohol and drugs. A legislative BAC limit of 0.05 g/dl was established in 1936. The limit was reduced to 0.02 g/dl in 2001. An impairment-based law for psychoactive drugs was implemented in 1959, whereas legislative blood concentration limits for illicit drugs and some psychoactive medicines (in total 20 drugs) were implemented in 2012 (Vindenes et al., 2012). Psychoactive drugs without legislative limits are still handled in accordance with the impairment-based law. The sanctions for driving under the influence of alcohol or drugs are related to the BAC levels or drug concentrations.

The aim of this study was to investigate the prevalence of alcohol and drugs among motorcycle riders (i.e., operators) killed in traffic accidents on Norwegian roads during 2001–2010 and to study the differences between age groups, gender and time of the week for the accidents. An additional aim was to compare the prevalence of alcohol and drugs among fatally injured motorcycle riders with car and van drivers during the same time period, using the same protocol including analysis of alcohol and the same drugs (Christophersen and Gjerde, 2014).

2. Materials and methods

2.1. Selection of cases

The study included motorcycle riders who were fatally injured on Norwegian roads and who died within 24 h after the accident during 2001–2010. Information on gender, age, day and time of the crash was obtained from the Norwegian Road Traffic Accident Registry operated by Statistics Norway. The registry is based upon information submitted by the police. Blood samples from the killed riders were identified in the forensic toxicology database operated by the Norwegian Institute of Public Health (NIPH) using the

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Comments</th>
<th>Legislative limitsa (ng/mL)</th>
<th>Prevalence (n) above legislative limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>All accidents</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Changed from 0.05 g/dL in 2001</td>
<td>0.02 g/dL</td>
<td>17.4 (36)</td>
</tr>
<tr>
<td>Amphetamine</td>
<td>ADHD treatment. Mostly illicit use</td>
<td>41</td>
<td>5.3 (11)</td>
</tr>
<tr>
<td>Clonazepam</td>
<td>Anxiolytic, hypnotic, anticonvulsant</td>
<td>1.3</td>
<td>1.0 (2)</td>
</tr>
<tr>
<td>Cocaine</td>
<td>Stimulant. Illicit</td>
<td>24</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Diazepam</td>
<td>Anxiolytic, sedative</td>
<td>57</td>
<td>3.4 (7)</td>
</tr>
<tr>
<td>Flunitrazepam</td>
<td>Hypnotic</td>
<td>1.6</td>
<td>1.0 (2)</td>
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<tr>
<td>Methadone</td>
<td>Opioid replacement therapy</td>
<td>25</td>
<td>0.5 (1)</td>
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<tr>
<td>Methamphetamine</td>
<td>Stimulant. Illicit</td>
<td>45</td>
<td>3.9 (8)</td>
</tr>
<tr>
<td>Morphine</td>
<td>Strong pain killer</td>
<td>9</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Nitrazepam</td>
<td>Hypnotic</td>
<td>17</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Oxazepam</td>
<td>Anxiolytic, sedative</td>
<td>172</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Zopiclone</td>
<td>Hypnotic</td>
<td>12</td>
<td>1.0 (2)</td>
</tr>
<tr>
<td>THC</td>
<td>Cannabis. Illicit</td>
<td>1.3</td>
<td>4.3 (9)</td>
</tr>
<tr>
<td>Medicinal drugs tot.</td>
<td></td>
<td></td>
<td>7.2 (15)</td>
</tr>
<tr>
<td>Benzo diazepines tot.</td>
<td></td>
<td></td>
<td>5.8 (12)</td>
</tr>
<tr>
<td>Illicit drugs</td>
<td></td>
<td></td>
<td>9.2 (19)</td>
</tr>
<tr>
<td>Total alcohol or drugs</td>
<td></td>
<td></td>
<td>27.1 (56)</td>
</tr>
</tbody>
</table>

Compounds (and cut-off limits) included in the program without positive results from MC riders: Alprazolam (31 ng/ml), MDMA (48 ng/ml), zolpidem (31 ng/ml).

a A higher cut-off than the legal limit was used for clonazepam during a part the study period.

b The limits for drugs were introduced in 2012.
national identification number of the riders. The blood samples had either been collected on police request shortly after the crashes when the riders were still alive, immediately after death or at legal autopsy. Equipment used for sample collection, storage condition before analyses and methods used for alcohol and drug analyses have previously been described (Gjerde et al., 2011).

The final generated research database contained data on age, gender, time of accident, type of crash (single or multiple-vehicle crash) and results from alcohol and drug testing of blood samples. Information on the use of helmet of other protective gear by the killed motorcycle riders was not available.

2.2. Analysis of alcohol and drugs

Blood samples from motorcycle riders were analysed for alcohol, illicit drugs and psychoactive medicines listed in Table 1. Drugs detected as a result of reported treatment or likely treatment after the accident were omitted from further evaluation; this including low concentrations of morphine and diazepam.

The individual compounds and their analytical cut-off concentration limits were according to the list of drugs that have legal limits according to the Norwegian Road Traffic Act (Vindenes et al., 2012). The drug concentration limits are equivalent to BAC of 0.02 g/dL. Driving with drug concentrations in blood above those limits will lead to fines, suspension of driving licence and possibly imprisonment, depending on the drug concentration, except for medication that is used as prescribed by a physician. The drug concentration limits are fairly low; therefore, concentrations slightly above the limits may not always lead to significant impairment of driving skills. All reported positive results were based on analyses from two different methods (screening and quantification/confirmation) using two different aliquots. The results from positive screening were not reported if sufficient blood was not available for confirmation analyses. Details of sample handling and analytical methods including references have earlier been described (Gjerde et al., 2013b). The laboratory is accredited by Norwegian Accreditation (www.akkrediter.no/en) according to ISO17025. The accident cases were disaggregated into two groups: multiple- and single-vehicle accidents, and further divided by gender, age groups, day- and night-time, week days and week nights crashes.

2.3. Statistical analyses

Person’s chi-squared test for categorical data was applied.

3. Results

Motorcycle riders represented 22% (n = 328) of the 1517 drivers and riders killed in road crashes during the investigated time period in spite of the fact that motorcycles represented only 11% of the 3.05 million motor vehicles registered in Norway in 2010 and 2% of the driving and riding distance (Statistics Norway, 2011). The vast majority was males (94.5%; n = 310). Car drivers who died during the same time period represented 71% (n = 1077) of all fatally injured drivers and riders.

Blood samples were received from 63% of the motorcycle riders (n = 207), the same proportion as for killed car and van drivers (Christophersen and Gjerde, 2014). Some samples from riders killed in three counties in central Norway were analysed at another laboratory. Fatally injured riders in those counties represented 11.9% (n = 39) of the killed riders; we included data for 10 of them. Thus, we can assume that the missing samples represented about 5% of the total number of blood samples taken from killed motorcycle riders.

3.1. Alcohol and drug findings – all fatal motorcycle accidents

The analytical findings presented below are based on blood samples from the 207 motorcycle riders who were killed in road traffic crashes and who were subject to toxicological investigations for alcohol and drug use. In total, 27.1% (n = 56) of investigated fatally injured motorcycle riders had one or more substances detected at blood concentrations above the legislative limits presented in Table 1. Two or more drugs were found in 5.3% of the cases (n = 11). Alcohol was the most frequently detected compound; 17.4% (n = 36) had BAC concentrations above 0.02 g/dL. In 19.4% (n = 7) of these cases, other drugs were also detected. Psychoactive medicines were found in 7.2% (n = 15) of the cases; benzodiazepines (BZD) represented the most frequently detected group of psychoactive medicines (5.8%, n = 12), and diazepam the most frequently detected BZD (3.8%, n = 8). The prevalence of illicit drugs was 9.2% (n = 19). Amphetamine/methamphetamine (6.3%, n = 13) and tetrahydrocannabinol (THC) (4.3%, n = 9) were the most frequently detected illicit substances (Table 1).

3.2. Single and multiple-vehicle motorcycle accidents

Of the 328 fatally injured motorcycle riders, 43.6% (n = 143) riders were killed in single-vehicle crashes and 56.4% (n = 185) in multiple-vehicle accidents. Of those, 67.0% (n = 124) and 58.0% (n = 83), respectively, were subject to toxicological investigations. The prevalence of alcohol or drugs among motorcycle riders killed in single-vehicle crashes was higher (44.6%; n = 7) than among those killed in multiple-vehicle crashes (15.3%; n = 19); p < 0.001 (Table 1).

3.3. Gender

Only 5.5% (n = 18) of the fatally injured motorcycle riders were female, and half of those (n = 9) were investigated for alcohol and drugs. Alcohol above the legislative limit was found in only one sample, whereas medicines or illicit drugs were not found in any sample from the females.

3.4. Age distribution

Many of the killed motorcycle riders were young: 31.5% were below 25 years of age, 25.9% were 25–34 years, 35.4% were 35–54 years and 7.3% were above 54 years. The alcohol and drug investigation rate was not significantly different between age groups, except for those older than 55 years, where blood samples for alcohol and drug analyses were collected from only 45.2% of this age group. Fig. 1 shows the prevalence of alcohol and drugs in the different age groups of killed motorcycle riders. Alcohol and drug findings in samples from riders killed in multiple-vehicle accidents showed the same patterns by age as for those killed in single-vehicle crashes, except that the prevalence of all compounds was lower. As shown in Fig. 1, alcohol was the dominant single compound in all age groups. For riders below 25 years, 45.8% of those killed in single-vehicle accidents had used alcohol before the accident resulting in BAC levels above the legislative limit; 12.5% had combined alcohol with other drugs. The highest prevalence of drugs was found among those between 25 and 34 years. In single-vehicle accidents more than one out of four of the investigated motorcycle riders between 25 and 34 years had used drugs before the accidents.
3.5. **Time of accident**

Data from Statistics Norway showed that most of the accidents occurred during daytime (between 4:00 am and 9:59 pm) at weekdays (45.7%) and weekends (33.8%), and the number of accidents was lower during weeknights (8.5%) and weekend nights (11.9%). However, the number of accidents per hour was much higher on weekends compared to the rest of the week.

The highest prevalence of alcohol or drugs was recorded among riders killed in single-vehicle accident during weekends, both at daytime (60.9%) and night time (65.2%) (Fig. 2).

In total, 56.3% of riders killed during weekend nights (between 10:00 pm and 3:59 am) and 33.3% of riders killed at daytime during weekends (between 4:00 am and 9:59 pm) were positive for alcohol or drugs. If only including blood samples from riders killed between 6:00 am and 9:59 pm, the prevalence of alcohol or drugs was 28.0%. Among riders killed in single-vehicle crashes between 4:00 am and 9:59 pm in weekends, 60.9% were positive for alcohol or drugs; for those killed between 6:00 am and 9:59 pm the prevalence was 52.6%, which is still a high proportion.

Few deceased riders had BACs above the legal limit during weekdays (both at daytime and night time), whereas a large proportion of the investigated killed riders had BACs above the legal limit in weekends (daytime or night time; see Fig. 2).

3.6. **Comparison with killed car drivers**

Alcohol or drugs were more often found in blood samples from killed car and van drivers (40.2% of 676 drivers; Christophersen and Gjerde, 2014) than in samples from killed motorcycle riders (27.1% of 151 riders); \( p < 0.001 \). For single-vehicle accidents, alcohol or drugs were found in 63.8% of the killed car drivers (173 out of 271 drivers) and 44.6% of the killed motorcycle riders (37 out of 83 riders), \( p < 0.0001 \).

4. **Discussion**

The number of fatally injured motorcycle riders in Norway is low compared to the number of killed car and van drivers. We included 207 motorcycle riders killed during 2001–2010 in this...
study, compared to 676 killed car and van drivers who were included in a previously published study covering the same time period (Christophersen and Gjerde, 2014). However, the number of killed motorcycle riders is very high compared to killed car and van drivers when taking the number of vehicles or the driving distance into consideration (Statistics Norway, 2011).

Our investigation of alcohol and drug related motorcycle fatal accidents showed that more than one out of four motorcycle riders killed in road crashes had alcohol or drugs above the legislative limits that were implemented in 2012. Nearly half of the riders killed in single-vehicle crashes and nearly one sixth of those killed in multiple-vehicle crashes had used one or more impairing substances. Drivers and riders killed in single-vehicle accidents are in most cases culpable for the accident, as no other vehicles are involved (Longo et al., 2000; Poulsen et al., 2014). For multiple-vehicle crashes, which also included non-culpable drivers or riders, the killed riders or drivers might not have the main responsibility for the crash (Gjerde et al., 1993; Drummer et al., 2003; Mørland et al., 2011). Therefore, it is expected that the prevalence of alcohol and drugs is higher among drivers and riders killed in single-vehicle crashes than those killed in multiple-vehicle accidents.

The prevalence of alcohol and other impairing substances found in a study on injured motorcycle riders treated at an emergency department in a Norwegian hospital showed similar proportion (24%) as the present study. The substances analysed in that study were essentially the same as in the present study (Bogstrand et al., 2011).

The studies from other countries that were available for comparison had different selections of substances analysed as well as different cut-off concentration limits. Investigations of motorcycle riders killed in road accidents in Australia and New Zealand found higher prevalence of alcohol and drugs (36–53%) than in our study (Drummer et al., 2003; Jama et al., 2011). In studies of injured or killed motorcycle riders in the USA, alcohol or drugs were found in 47–53% of the cases (Soderstrom et al., 1995; Villavecchi et al., 2003; Lin and Kraus, 2009; Rossheim et al., 2014). The prevalence of cannabis and cocaine were higher than in our study, whereas the prevalence of amphetamines and BZDs was...
lower. A study from UK also reported higher prevalence of alcohol, cannabis, opiates and cocaine in motorcycle fatalities (48%; Elliot et al., 2009). A study from Brazil on injured motorcycle riders found alcohol in 7% of the blood samples, but 26% reported alcohol use within the last 24 h (Breitenbach et al., 2012). A study of fatal motorcycle crashes in the same country found that 42.3% of the killed riders had positive blood sample for alcohol (Carrasco et al., 2012).

We can conclude that alcohol and drug use among fatally killed motorcycle riders may represent a larger problem in many other countries than in Norway. This may primarily be related to the fact that the incidence of driving under the influence of alcohol is very low in Norway; only about 0.2% of random drivers have BAC above the legal limit of 0.02 g/dL (Gjerde et al., 2013a).

4.1. Age groups and gender

The highest prevalence of alcohol or drugs was found in blood samples from riders below 25 years of age. The most striking result was that half of those below 25 years who died in single-vehicle accidents had used alcohol or drugs before the accidents. No substance was detected among riders above 55 years killed in single-vehicle accidents; however, this age group had low investigated rate (45.2%) and the number of cases was low.

We have found only one other study presenting alcohol and drug findings in relation to age. In the USA, the prevalence of alcohol in blood samples from fatally injured motorcycle riders was 50–60% in age groups between 20 and 49 years in 1983, but had declined significantly in 2003, particularly among young motorcycle riders; the highest prevalence of 40–44% was found in age groups between 35 and 44 years (CDC, 2004).

4.2. Critical accident time

The highest prevalence of alcohol and drugs was found among motorcycle riders who died during weekend days and nights, in particular for those who died in single-vehicle accidents.

The main reason is that people drink more on weekends and the use of recreational drugs is more common during weekends as well. The lack of public transportation, particularly in rural areas, makes private transport necessary to get home. The same tendency was also found for fatal car accidents during weekends and also documented in accident studies form other countries (Christophersen and Gjerde, 2014; Harrison, 1997; Kasantikul et al., 2005; Jama et al., 2011). The results should be taken in consideration by the police when planning traffic controls, and in particular focus on possible alcohol and drug impairment.

4.3. Comparison with fatally injured car drivers

We have previously studied alcohol and drug findings in blood samples from car drivers killed in road crashes during the same time period analysing for the same substances using the same cut-off concentrations in blood as used in the present study (Christophersen and Gjerde, 2014). When comparing the findings, the use of alcohol, medicines and illicit drugs was a contributing factor in a smaller proportion of fatal motorcycle crashes than car crashes. The types of drugs detected in blood samples from killed motorcycle riders and car drivers were mostly the same, except that alprazolam, MDMA, and zolpidem were only detected in samples from car drivers, probably because a lower number of motorcycle riders were studied. The distribution over age groups, genders and time periods were also similar for motorcycle riders and car drivers, except that the prevalence was lower among motorcycle riders.

A Vietnamese study found a similar difference between alcohol use among motorcycle riders and car drivers injured in traffic crashes; 27.8% of the hospitalized motorcycle riders had BAC above 0.05 g/dL, whereas 37.8% of car drivers had BACs above that limit (Nguyen et al., 2013). However, studies in the USA on alcohol use and studies in Australia and the UK on alcohol and drug use found similar or higher prevalence among killed or injured motorcycle riders when compared with car drivers (Drummer et al., 2003; Elliot et al., 2009; Christmas et al., 2011; NHTSA, 2014). This difference in results from Norway is unexpected and difficult to explain, but might be related to cultural issues, attitudes towards drinking or drug use before driving, and differences in the perceived risk for crash involvement or for being apprehended by the police and convicted for driving under the influence.

4.4. Strengths and limitations

The main strength of this study was the investigation of a comprehensive number of illicit drugs and psychoactive medicines in addition to alcohol.

The main weakness was that the police requested blood sampling and analyses for only 63% of the killed motorcycle riders, which is likely to have introduced a sampling bias. The proportion of alcohol or drug use was probably lower among riders who were not subject to toxicological testing. A higher proportion of investigated cases would increase the validity of the study. Our drug findings may represent a minimum number, mainly because some psychoactive drugs were not analysed.

5. Conclusion

In spite of relatively severe sentences for driving under the influence, which includes fines, imprisonment and suspension of driving licence depending of the degree of impairment, the prevalence of alcohol and drugs in blood samples from killed car drivers and motorcycle riders is high. Measures should be taken to reduce the use of alcohol or drugs before riding a motorcycle, in particular among young riders. Such measures could be the use of alcohol ignition interlock devices and drug intervention programme for repeat offenders. It is also important that traffic schools and teachers for motorcycle riders focus on increased risk by combining alcohol or drugs with riding. In addition, the police should focus on the most critical traffic accident times with more surveillance and random breath testing.

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Permission for the study was given by the Regional Committee for Medical and Health Research Ethics (approval no. S-08005d, 2010/2191 dated November 3, 2010) and by the Director of Public Prosecutions (approval Ra 07-211 dated March 3, 2010).

References


Phillips, D.P., Brewer, K.M., 2011. The relationship between serious injury and blood alcohol concentration (BAC) in fatal motor vehicle accidents: BAC = 0.01% is associated with significantly more dangerous accidents than BAC = 0.00%. Addiction 106, 1614–1622.


