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TITLE
THC-influenced drivers in the new Danish three-level offence system

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ABSTRACT

Objective

The objectives of the study were to describe the distribution of tetrahydrocannabinol (THC)-influenced drivers in a new Danish three-level offence system and discuss the consequences of the changed legislation.

Methods

By request of the police, blood of individuals suspected for driving under the influence of drugs (DUID) in Funen and Southern Jutland was sampled by medical staff and shipped to the Section of Forensic Toxicology of the University of Southern Denmark in Odense. Samples from individuals suspected for driving under the influence of cannabis (DUIC) were stored at 5 °C prior to immediate analysis, and THC content in whole blood samples was established by gas chromatography-mass spectrometry analysis (GC-MS). Quantitative results for blood THC levels were available from 2017 and 2018, resulting in 2206 eligible cases. Data before and after the legal change on the 15th of December 2017 were extracted from the department’s laboratory information management system.

Results

With the new graduated sanctions introduced in December 2017, 70% of the DUIC suspects faced milder sanctions. The number of DUIC cases has been increasing and has almost doubled in the last four years from 648 cases in 2015 to 1206 in 2018. Correspondingly, the total number of DUID cases increased by 80% from 898 cases in 2015 to 1614 cases in 2018. The concentration of THC in blood was above the legal limit of 0.001 mg/kg in 73% of the cases; 18% had concentrations categorized as low, 32% as medium and 22% as high.

Conclusion

We found that more than two-thirds of the THC offenders faced milder sanctions compared to before, suggesting that the new graduated legislation has had a significant impact. The current trend is a steadily increasing number of DUID cases. We believe that the continual increase is caused by a combination of factors including increased police awareness and skill training of police personnel along with improved roadside screening abilities.

KEY WORDS:

DUI, DUID, drugs, new regulations, graduated sanctions, tetrahydrocannabinol
INTRODUCTION

In July 2007, Danish drivers were subjected to a per se policy regarding drugs and medication regulated under the Danish Traffic Act (Retsinformation 2017). Practically, the per se law gave a set of fixed concentration limits for drugs with the potential to put road safety at risk. After the introduction of per se laws, blood concentrations above the limit of any of the listed drugs sufficed for convicting drivers under the influence of drugs (DUID). It was a paradigm shift as DUID convictions before July 2007 required clinical assessment of driving impairment by a physician. For tetrahydrocannabinol (THC), the fixed concentration limit in blood was defined as 0.001 mg/kg, and the penalty for exceeding the limit was a fine of one month’s salary and a three-year revocation of the driver’s license for first-time offenders. The THC legislation was effectively changed as per the 15th of December 2017 with a new three-level offence system parallel to the progressive system used for drivers under the influence of alcohol (Table 1) (Retsinformation 2017). The design and thresholds themselves were inspired by the Norwegian sanctioning model, where legislation for driving under the influence of drugs was harmonized to the current practice regulating alcohol (Retsinformation 2017, Vindenes et al. 2012). The Norwegian fixed concentration limit for alcohol is currently a blood alcohol concentration (BAC) of 0.02%, and the graded sanctions for higher BACs are 0.05% and 0.12%. According to the study by Vindenes et al., equivalent concentration limits for THC in blood were found to be 1.3 ng/mL, 3 ng/mL and 9 ng/mL, respectively (Vindenes et al. 2012). When implementing the three-level offence system in Denmark, the fixed concentration limit of 0.001 mg/kg was maintained while the graded sanctions were directly adopted (Table 1). In Norway, the graduated sanctioning system was implemented on the 1st of February 2012 for 13 out of the 20 most common drugs. Later revisions have included graduated sanctioning for more drugs (Samferdselsdepartementet 2015). Regarding the Danish legal change, the main purpose was to soften sanctions for driving under the influence of cannabis (DUIC) as revoking the driver’s license for all cases with a blood THC level above 0.001 mg/kg was thought to be disproportionate to the committed crime (Retsinformation 2017). DUIC is associated with a slightly increased risk of being seriously injured or killed in road traffic crashes (RTCs) and the risk is generally considered lower than for many other drugs, alcohol and alcohol in combination with drugs (European Monitoring Centre for Drugs and Drug Addiction, 2012). Although cannabis and driving impairment has been thoroughly investigated, there still exists some disagreement about the relative risk (Gjerde et al. 2019). Furthermore, evidence shows that passive exposure to cannabis can result in whole blood concentrations above the legal limit (Berthet et al. 2016), and revoking one’s license could entail far-reaching and unintended consequences not in public interest. As of now, ungraded per se laws remain for the rest of the illicit drugs and medication regulated under the Danish Traffic Act.

The Section of Forensic Toxicology of the University of Southern Denmark in Odense analyzes blood samples from suspected DUID drivers obtained from the police districts of Funen and Southern Jutland. In total, the two districts cover approximately 1 million inhabitants, resulting in approximately one thousand cases of suspected DUIC per year. The purpose of the current study was to map the distribution of Southern Danish THC-drugged drivers in the new three-level offence system implemented on the 15th of December 2017 and to discuss the implications of the new sanctions.

MATERIALS AND METHODS

The forensic traffic data presented in this paper originate from the Section of Forensic Toxicology, Department of Forensic Medicine, Faculty of Health Sciences at the University of Southern Denmark in Odense. In total, 5133 cases were analyzed for illicit drugs between 2015 and 2018. Quantitative results for blood THC levels were available for 2206 cases in the period from 2017 to 2018. National data for alcohol and drug-related traffic charges originated from the National Police registry (Rigs-politiet 2019). THC blood concentration data before and after the changed legislation was extracted from the department’s laboratory information management system (LIMS) (LabWare 7, LabWare Inc., Wilmington, DE, USA) and comprised data from all cases analyzed for THC in 2017 (n =1000) and 2018 (n = 1206). To describe the distribution of THC-influenced drivers in the new three-level offence system, minimum values were computed (using the national consensus where results are subtracted by a 33% safety
margin to account for analytical uncertainty), rounded to two significant digits and compared to the Danish legal limit of 0.001 mg/kg. Cases above the legal limit were stratified into sanction groups denoted as “low”, “medium” and “high” based on the intervals presented in Table 1. Cases below the legal limit comprise both negative cases and cases ≤ 0.001 mg/kg.

The Danish police routinely use the roadside drug screening apparatus Dräger DrugTest® 5000 (Drägerwerk AG & Co. KGaA, Lübeck, Germany) that qualitatively detects the presence of five drugs/drug classes and their related compounds (cannabis, opiates, benzodiazepines, THC and amphetamines) in human oral fluid samples (saliva). The drug test is an important tool for helping police to investigate recent drug intake, but the police officers may also consider clinical signs of drug use and impairment before subjecting DUID suspects to blood sampling and forensic analysis. A positive drug test also aids the police in determining whether to request forensic analysis for “THC”, “other drugs” or both based on the results. By request of the police, blood of possible offenders were sampled by medical staff (i.e., physician or laboratory technicians) into Vacuette® tubes containing sodium fluoride and potassium oxalate preservatives and then shipped to the Section of Forensic Toxicology. Samples for THC detection were stored at 5 °C prior to immediate analysis. These storage conditions have shown acceptable stability for at least 8 weeks (Størensen and Hasselstrøm 2018). After analysis, the samples were stored at -20 °C. THC content in whole blood samples was established by gas chromatography-mass spectrometry (GC-MS) (Agilent Technologies, Santa Clara, CA, USA). Sample preparation included protein precipitation with acetonitrile followed by a unique solid phase extraction (SPE) procedure using disposable pipette extraction reverse-phase tips (DPX-RP) (DPX Technologies, GERSTEL GmbH & Co. KG, Mülheim an der Ruhr, Germany) and N-methyl-N-(trimethylsilyl)trifluoroacetamide (MSTFA) (Sigma-Aldrich, St. Louis, MO, USA) derivatization. The final quantitative results were based on two independent analytical runs where one served as a screening and one as a quantification run, thus adhering to Forensic Toxicology best practices. The laboratory is accredited under DS/EN ISO/IEC 17025:2017 and participates in the LGC proficiency scheme (QUARTZ) for forensic blood toxicology laboratories.

Data were processed in accordance with the European Union General Data Protection Regulations (EU GDPR) and approved by the Research and Innovation Organization of the University of Southern Denmark (SDU-RIO) (10.340).

RESULTS

The sum of criminal charges regarding driving under the influence has been steady at approximately 12000 since 2007, from which records were first publicly available (Figure 1a) (Rigspolitiet 2019). However, the proportion of DUID cases has been increasing nationwide, and in 2016, there were more drug-related charges than those related to alcohol for the first time. The national number of criminal charges regarding RTCs related to DUID has also been increasing since 2007 (Figure 1b) (Rigspolitiet 2019). At the Section of Forensic Toxicology, the number of DUID cases increased by 80% from 898 cases in 2015 to 1614 cases in 2018 (Figure 2). The number of DUIC cases has correspondingly increased and has almost doubled in the last four years from 648 in 2015 to 1206 in 2018. Analysis of THC in blood samples was the most requested analysis, with 1206 cases in 2018 compared to 961 for that of other drugs.

The proportion of cases in the new three-level legislation before and after the legal change is presented in Figure 3. Proportions were similar on both sides of the change, with 26-27% categorized below the legal limit and with the most dominant group being medium level offenders (33 and 32% before and after the legislative change, respectively). After the legal change, 899 suspects were over the legal limit, and 627 of these, corresponding to 70%, belonged to the low and medium sanction groups. In the high sanction group, THC blood concentrations (minimum values) up to 0.092 mg/kg (92 times the legal limit) were found, and the group had a median THC blood concentration of 0.014 mg/kg [95% CI of median: 0.013 – 0.015 mg/kg].
As illustrated in Figure 4, age profiles were similar across offender categories. The median age for all DUIC offenders above the legal limit was 25 (age range 14–65 years). Equally, the median age was 25 (age range 15–64 years) for suspects with THC blood concentrations below the legal limit. DUID suspects were predominantly male, constituting 93-96% of the cases for each of the sanction categories.

Of the individuals accused of DUIC, 82% were charged one time for this crime in the investigated period (2017 - 2018), 11% were accused two times, and 6% were accused three times or more (Table 2). In total, 1705 individuals accounted for 2206 DUIC charges.

**DISCUSSION**

A major question regarding the more lenient DUIC sanctions is whether they work as intended or not. Dividing the offenders into three groups (low, medium and high blood THC levels) could potentially have little or no effect if they all belonged to the high category where penal sanctions are the same as before. However, 627 cases out of 899 corresponding to more than two-thirds of the suspected individuals belong to the low and medium categories, where the sanction is milder than before. With more than two-thirds of the offenders facing milder sanctions than before, a significant impact by the legal change would be expected. The single most prevalent category was the medium category (0.003 mg/kg < THC ≤ 0.009 mg/kg), where reduced sanctions for first-time offenders comprise a one-year suspension of their driving license contrary to the former three-year revocation.

Current Danish thresholds were based on the Norwegian sanctioning model, where per se limits corresponding to impairment level at 0.02% BAC were used (Retsinformation 2017, Vindenes et al. 2012). This means that driving impairment at 0.02% BAC should theoretically correspond to approximately 0.001 mg/kg THC. In Denmark, however, the per se limit for BAC is 0.05%, theoretically corresponding to 0.003 mg/kg THC. Effectively, this means that in Denmark, impairment due to THC is sanctioned more severely than that caused by alcohol. Alignment of these limits should be considered.

The continual increase in DUID cases seen over the last four years is connected to an intensified police effort. Trends of increasing DUID prosecutions have been observed in the eastern part of Denmark (Steenoft et al. 2010), in Sweden (Jones 2005) and in Norway (Vindenes et al. 2014) after the introduction of per se laws. The increase in DUID prosecutions was proposed to be caused by a simplified and effective prosecution process stimulating the enforcement. However, our data show that the trend continues long after the introduction of per se laws with an 80% increase in DUID cases from 2015 to 2018. We believe the reasons for the continual increase to be a combination of several factors, including ever-increasing police awareness, continuous training of police personnel and better access to roadside tests. The total extent of DUID in the community is currently unknown. Police roadside screens using saliva have become more widespread and may become faster, smaller and less expensive to use. Furthermore, we find that RTCs related to DUID have been steadily increasing in Denmark since 2007, while traffic injuries involving alcohol-affected drivers have been decreasing since 2012 (Vejdirektoratet 2017). Considering the current development, the forensic area may expect more DUID cases in the following years.

The proportion of offenders in each THC category remains largely constant before and after the legal change. Assuming that the police have not changed the requisition pattern after the change, it could be proposed that the legal change has had little effect on the pattern of cannabis use. One could speculate that lessening the sanctions for low-level offences could entail an increase in this category due to the milder sanctioning, but that does not seem to be the case in the first year after effectuation.

Our data show that 73% of the blood samples analyzed for THC in 2017 and 2018 were above the legal limit. This observation is similar to data from the eastern part of Denmark, where 78% of the samples were above the limit in 2015 and 2016 (Simonsen et al. 2018). Equally, a recent Norwegian study comparing results of the Dräger DrugTest® 5000 with associated drug findings in blood showed that drivers found positive for THC in the drug test
were above the Norwegian limit approximately 84% of the time (percentage read from graph) (Gjerde et al. 2018). However, this study did not subtract safety margins before evaluating the true positive rate. Furthermore, the Norwegian fixed concentration limit is not completely identical to the Danish fixed concentration limit, thus limiting direct comparison to our results. The Dräger drug test itself is an antibody-based assay designed to supply a preliminary qualitative result that should be followed by confirmatory analysis. Antibody-based assays often struggle with specificity, and a THC-positive drug test could therefore be mediated by the presence of several THC-related compounds not regulated by the law including cannabidiol, cannabinol, delta8-THC, THC-COOH, THC-OH and others creating a risk of false positive results. Considering the limitations of the current pre-screening method in which oral fluid is used as a confirmation matrix instead of blood in combination with forensic analysis in which all doubts are in favor of the accused (reporting minimum values), an approximate 80% true positive rate seems reasonable. With 73% THC-positive cases, our data suggest a slightly lower true positive rate than expected. Some variation could be ascribed to limited access to the drug test in the field. Other factors could be population based, i.e., if more samples group around the legislative cut-off, more roadside false positives would be expected due to more impact of misaligned analytical cut-offs and the pharmacokinetic differences in the tested biological matrices (Langel et al. 2014). Additionally, the time elapsed between the field test and blood collection and degradation during storage could also affect the outcome (Gjerde et al. 2018, Hartman et al. 2016, Sørensen and Hasselstrøm 2018).

According to the latest report by the Danish Health Authority, the male-to-female ratio of THC users in the Danish community is approximately 2 (Sundhedsstyrelsen 2017). This proportion is very different in DUID cases where >90% of the convicted individuals are male, suggesting that male users are much more prone to drive while under the influence of drugs. Moreover, the median age being 25 for convicted drivers underlines that driving and getting arrested under the influence of THC is a male youth phenomenon. These findings are also supported by data from the eastern part of Denmark (Simonsen et al. 2018). Hence, the gender and age distribution seen in forensic THC traffic cases is markedly different compared to the abuse pattern of general society (Sundhedsstyrelsen 2017). According to our data, most individuals were only accused of DUIC once. Logically, this could be expected due to a certain preventive effect. It was, however, notable that 18% had two or more DUIC accusations in the limited two-year time span and that only 1705 individuals accounted for 2206 DUIC charges. It should be mentioned that some of the DUIC suspects theoretically could have DUIC charges in other parts of the country or elsewhere leading to some underreporting. In summary, the typical southern Danish THC-drugged driver is a young man with a median age of 25 and a medium blood THC concentration (0.003 mg/kg < THC ≤ 0.009 mg/kg) with only one DUIC offence in the last two years.

The present study describes the distribution of THC in drivers suspected of DUIC in Southern Denmark in the new graduated three-level offence system implemented nationwide on the 15th of December 2017. We find that more than two-thirds of the offenders now face milder sanctions than before, suggesting that the new legislation has had a significant impact. The current trend is a steadily increasing number of DUIC suspects, but nationwide, the total number of DUI cases (drugs and alcohol) remains constant at approximately 12000 cases per year. The cause of the continual increase is multifactorial and linked to ever-increasing police awareness, increased police training and better access to drug tests. The extent of DUID in the community is currently unknown.
FIGURES AND TABLES

Figure 1a: National number of criminal charges regarding driving under influence (criminal codes 80239, 80244, 80242 and 80201). Alcohol vs drugs (2007–2018) (Rigspolitiet 2019).

![Figure 1a](chart1a.png)

Figure 1b: National number of criminal charges regarding RTCs related to DUID (criminal codes 80119 and 80148), (2007–2018) (Rigspolitiet 2019).

![Figure 1b](chart1b.png)
Figure 2: Number of DUID cases in Southern Denmark where the police requested analysis of THC, other drugs or both (2015–2018).

Figure 3: The proportion of cases in the new Danish three-level legislation before and after the legal change effectuated on the 15th of December 2017 (normalized data). Numbers inside the columns denote the number of cases.
Figure 4: Age distribution of each of the THC categories, including cases below the legal limit (normalized data).
Table 1: Sanctions before and after the 15th of December 2017 (Retsinformation 2017, Retsinformation 2019).

<table>
<thead>
<tr>
<th>Period</th>
<th>THC blood concentration (mg/kg)</th>
<th>Category</th>
<th>Sanction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2007 – December 2017 (per se policy)</td>
<td>0.001 &lt; THC</td>
<td>-</td>
<td>Revocation of license for 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fine: One month’s salary</td>
</tr>
<tr>
<td>From December 2017 (three-level offence system)</td>
<td>0.001 &lt; THC ≤ 0.003</td>
<td>Low</td>
<td>One license penalty point**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fine: ½ a month’s salary</td>
</tr>
<tr>
<td></td>
<td>0.003 &lt; THC ≤ 0.009</td>
<td>Medium</td>
<td>Suspension of license for one year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fine: One month’s salary</td>
</tr>
<tr>
<td></td>
<td>0.009 &lt; THC</td>
<td>High</td>
<td>Revocation of license for 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fine: One month’s salary</td>
</tr>
</tbody>
</table>

*Sanctions listed are for first time offenders only. **In Denmark, license penalty points can be imposed in addition to fines. If three points accumulate within three years, the license is typically suspended.

Table 2: Number of DUIC charges per person (2017–2018).

<table>
<thead>
<tr>
<th>No. of DUIC charges</th>
<th>No. of persons (%)</th>
<th>No. above legal limit (%)</th>
<th>No. below legal limit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1406 (82)</td>
<td>981 (44)</td>
<td>425 (19)</td>
</tr>
<tr>
<td>2</td>
<td>196 (11)</td>
<td>300 (14)</td>
<td>92 (4)</td>
</tr>
<tr>
<td>3</td>
<td>54 (3)</td>
<td>139 (6)</td>
<td>23 (1)</td>
</tr>
<tr>
<td>4</td>
<td>25 (1)</td>
<td>85 (4)</td>
<td>15 (1)</td>
</tr>
<tr>
<td>5</td>
<td>11 (1)</td>
<td>42 (2)</td>
<td>13 (1)</td>
</tr>
<tr>
<td>≥6</td>
<td>13 (1)</td>
<td>68 (3)</td>
<td>23 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>1705 (100)</td>
<td>1615 (73)</td>
<td>591 (27)</td>
</tr>
</tbody>
</table>
REFERENCES


Samferdselsdepartementet. Revision of regulations regarding fixed limits for influence of other intoxicating or anesthetic drugs than alcohol etc. Assessment of existing limits and proposals for fixed limits of more drugs [in Norwegian]. Oslo, Norway. Ministry of Transport. 2015.


