Cannabis, driving and traffic crashes: where are we now?

F. Javier Álvarez

Catedrático de Farmacología
Facultad de Medicina, Universidad de Valladolid
alvarez@uva.es

ALCOHOL Y DROGAS

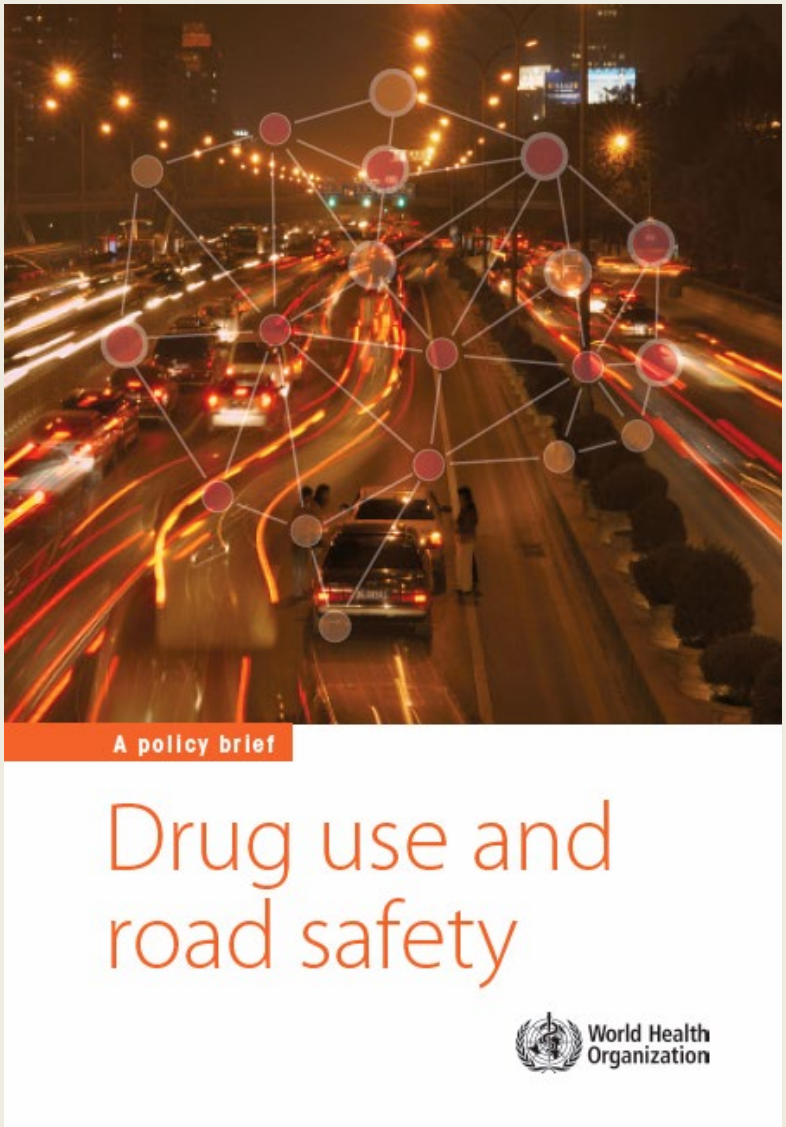
Grupo de sustancia	Sustancias
Alcohol	Alcohol
Cannabis	Cannabis
Opioides	6-Acetil morfina, Codeína, Morfina, Metadona
Cocaína	Cocaína, benzoilecgonina
Anfetamina y análogos	Anfetamina, Metanfetamina, MDA, MDMA, MDEA
Benzodiacepinas	7-Aminoclonazepam, Alprazolam, Clonazepam, Diazepam, Flunitrazepam, Lorazepam, Nordiazepam, Oxazepam, 7-Aminoflunitrazepam
Zolpidem	Zolpidem
Alucinógenos	Ketamina, LSD.

DOS ENEMIGOS AL VOLANTE

MUY DIFERENTES ENTRE SI

SU MEZCLA ES EXPLOSIVA AL VOLANTE

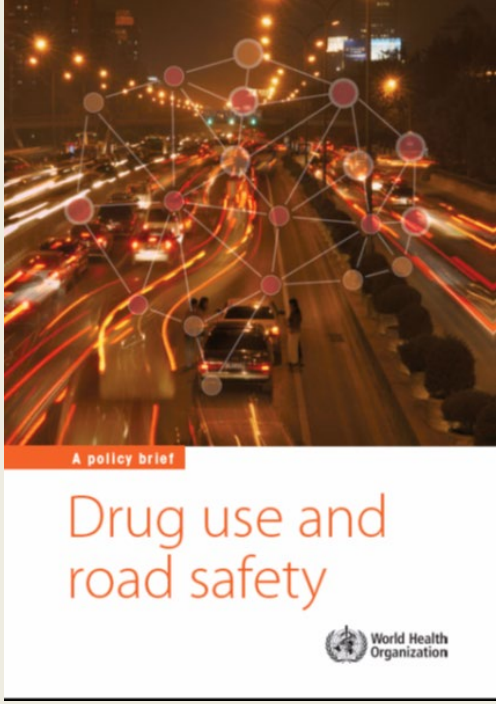
ALCOHOL, DROGAS Y LEGISLACION
Lo que sabemos y podemos hacer



https://www.who.int/publications/i/item/drug-use-and-road-safety
WHO/MSD&NVI/2016.01, Geneva, 2016

• **Zero tolerance laws** make it unlawful to drive with any amount of specified drugs in the body.

• tolerancia cero: cualquier nivel de droga en el organismo es sancionable
(en ocasiones estos niveles son coincidentes con los limites analíticos o próximos a estos, y no necesariamente está establecido un mayor riesgo de implicación en colisiones de tráfico con estos niveles).



• **Impairment laws** make it unlawful to drive when the ability to drive has become impaired following drug use, often described as being "under the influence" or in similar terms.

• La legislación se basa en el criterio de deterioro (impairment), cuando lo que no está permitido, y por tanto es sancionable, es el hecho de que el conductor muestre indicios de deterioro o "influencia" (conducción bajo la influencia o bajo los efectos), lo que se suele evidenciar mediante la utilización de diversas pruebas de campo (pruebas de coordinación… etc).

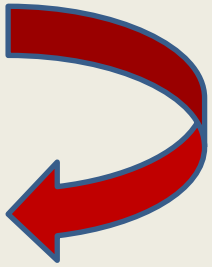
• **Per se laws** make it unlawful to drive with amounts of specified drugs that exceed the maximum set concentration.

•Leyes especificas: se establecen para cada sustancia un punto de corte (concentración), por encima del cual es sancionable conducir.

1. Efecto sobre el rendimiento psicomotor

A partir años 60
Sedación/Somnolencia
No evalúan
-la percepción del riesgo y
-adopción de conductas de riesgo

+ Policonsumo
+ Fatiga
+ Depreciación del sueño



Deterioro:

USA/Australia
Pruebas de sobriedad de campo

http://www.who.int/substance_abuse/drug_use_road_safety/en/

OMS... Drogas y conducción

La Organización Mundial de la Salud acaba de publicar el infome Drug Use and Road Safety. Es un breve informe (preliminar) sobre un tema de especial relevancia como es el del uso de alcohol y otras drogas y la conducción

Este informe es fruto del trabajo de diversos expertos a nivel internacional, y con especial participación de España. Se han llevado a cabo dos reuniones presenciales en diciembre de 2014 y diciembre de 2015.

Este informe se centra en las sustancias distintas del alcohol: se han diferenciado dos grandes grupos, las drogas ilegales o ilícitas, y los medicamentos. En la Tabla siguiente se presentan los efectos de los distintos tipos de sustancia sobre una serie de parámetros: no todas las drogas y medicamentos interfieren de la misma forma. En dicha Tabla se han incluido nuevas sustancias psicoactivas, que no se utilizan con fines médicos, y que se consumen con el fin de obtener efectos parecidos a las drogas originales (por ejemplo catinonas y cannabinoides sintéticos): sin embargo no siempre el perfil de efectos es el mismo.

Tabla. Formas en que diferentes drogas afectan el funcionamiento del cerebro.

Clases de drogas	Drogas	Discapacidad						
		Somnolencia	Funciones Cognitivas	Funciones Motoras	Estado Anímico	Control Lateral del Vehículo	Tiempo estimado	Balance
Drogas ilícitas	Cannabis	●	●	●	●	●	●	●
	Cocaína	-	●	●	●	-	-	-
	Anfetaminas	-	●	●	●	-	●	●
	MDMA[a]	-	●	-	●	-	-	●
	Alucinógenos	-	●	●	●	-	●	●
Medicamentos prescritos	Benzodiacepinas	●	●	●	-	●	-	●
	Opioides	●	●	●	●	●	-	●
	Otros depresores	●	●	●	●	●	-	●
Nuevas sustancias psicoactivas	Cannabinoides sintéticos	●	●	●	●	●	●	●
	Catinonas sintéticas	-	●	●	●	-	-	-

• La sustancia tiene efecto o provoca deterioro sobre esas actividades
- La sustancia no tiene efecto o no deteriora esas actividades
[a] Metilendioximetanfetamina.

Fundación mapfre

ETSC
European Transport Safety Council

Accident Analysis and Prevention 232 (2026) 108535

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

The influence of cannabis on real time higher-order driving skills: a scoping review

Sander Thomas van der Kint *, Ragnhild Johanna Davidse, Maura van Strijp

SWOV Institute for Road Safety Research, P.O. Box 93113, The Hague 2509 AC, the Netherlands

ARTICLE INFO

Keywords:
THC
Higher-order driving skills
Driver behaviour
Driving performance
Driving under the influence
Scoping review

ABSTRACT

Cannabis use is frequently detected in motor vehicle crashes. While research has found an increased crash risk of driving under the influence of cannabis, research on the effects of cannabis, or THC, on driving behaviour seems to be somewhat limited to vehicle control. Our objectives were to map available research into the effects of THC on higher-order driving skills during actual driving. A scoping review was conducted by systematically searching Scopus, PubMed and TRID between 2003 and 2024. After applying inclusion criteria to 2326 studies, 40 studies underwent full-text review, after which three studies met the inclusion criteria. These studies examined higher-order driving skills using driving simulators or real-world driving and measured executive function, attention, time perception, decision making, visual search and vigilance. The results of this study revealed a scarcity of research investigating the effects of THC on higher-order driving skills. While the results of the included studies show no or only small effects of THC on higher-order driving skills, there is so little research available that no conclusions can be made. There seems to be limited evidence addressing the impact of THC on critical higher-order cognitive abilities which are essential for safe driving. This highlights a significant gap in the body of research underlining the need for future research to explore these skills in a driving environment. Research using simulators combined with eye-tracking might provide these important insights.

scientific reports

OPEN

Potency-related effects of smoked cannabis on simulated driving performance: a randomized, controlled crossover trial

Bruna Brands[1,2,3], Adam Zaweel[2,3,4], Madison Wright[2,3], Patricia Di Ciano[2,3,5,6], Christine M. Wickens[2,3,5,6,7], Justin Matheson[2,3,4], Andrew Fares[2,3], Omer S. M. Hasan[2,8], Marcos Sanches[9], Beth Sproule[10,11,12], Marilyn A. Huestis[13], Timothy L. Brown[14] & Bernard Le Foll[2,3,4,6,11,15,16]

Given the increasing availability of high-potency Δ9-tetrahydrocannabinol (Δ9-THC) products, understanding potency-related effects of Δ9-THC on driving performance is an important public safety issue. This randomized, double-blind, placebo-controlled, within-subjects trial examined the effects of smoked cannabis with varying Δ9-THC concentrations on simulated driving. Adults aged 19–45 who regularly used cannabis and held valid driver's licenses completed simulated driving tasks after smoking placebo, or cannabis containing low (6.25%/47 mg Δ9-THC), medium (12.5%/94 mg Δ9-THC), or high (22%/165 mg Δ9-THC) Δ9-THC levels. The primary outcome was mean speed (km/h); secondary measures included maximum speed, standard deviation of lateral position (SDLP), reaction time (RT), and subjective ratings of driving ability and intoxication. Mean speed did not differ across conditions. Maximum speed increased under medium ($p = 0.006$) and high ($p = 0.02$) potencies versus placebo. SDLP was higher across all Δ9-THC potencies ($p < 0.001$), and RT was longer under medium and high potencies ($p < 0.001$). Both SDLP ($p < 0.001$) and RT ($p = 0.023$) positively correlated with blood Δ9-THC concentrations. Participants reported poorer driving performance and reduced willingness to drive at higher potencies. Findings demonstrate potency-dependent impairments in simulated driving linked to Δ9-THC concentration, underscoring implications for road safety.

Trial registration: clinicaltrials.gov, ID NCT03656029; First posted date: 04/09/2018; URL: https://clinicaltrials.gov/study/NCT03656029.

Keywords Cannabis, THC, Simulated driving, Cannabis potency, *Ad libitum*

[1]Controlled Substances and Cannabis Branch, Health Canada, Ottawa, ON, Canada. [2]Institute for Mental Health Policy Research, Centre for Addiction and Mental Health, 33 Ursula Franklin Street, Toronto, ON M5S 2S1, Canada. [3]Department of Pharmacology and Toxicology, University of Toronto, 27 King's College Circle, Toronto, ON M5S 3H7, Canada. [4]Translational Addiction Research Laboratory, Centre for Addiction and Mental Health, 33 Ursula Franklin Street, Toronto, ON M5S 2S1, Canada. [5]Dalla Lana School of Public Health, University of Toronto, 155 College Street, Toronto, ON M5T 3M6, Canada. [6]Campbell Family Mental Health Research Institute Centre for Addiction and Mental Health, Ursula Franklin Street, Toronto, ON M5S 2S1, Canada. [7]Institute of Health Policy, Management and Evaluation, University of Toronto, 155 College Street, Suite 425, Toronto, ON M5T 3M6, Canada. [8]Institute of Medical Sciences, University of Toronto, 1 King's College Circle, Toronto, ON M5S 1A8, Canada. [9]Biostatistician, Biostatistics Core, Centre for Addiction and Mental Health, 60 White Squirrel Way, Toronto, ON M6J 1H4, Canada. [10]Leslie Dan Faculty of Pharmacy, University of Toronto, 144 College Street, Toronto, ON M5S 3M2, Canada. [11]Department of Psychiatry, University of Toronto, 250 College Street, Toronto, ON M5T 1R8, Canada. [12]Pharmacy, Centre for Addiction and Mental Health, 1001 Queen Street, Toronto, ON M6J 1H4, Canada. [13]Institute of Emerging Health Professions, Thomas Jefferson University, 1020 Walnut Street, Philadelphia, PA 19107, USA. [14]Driving Safety Research Institute, University of Iowa, 2401 Oakdale Blvd, Iowa City, IA 52242, USA. [15]Department of Family and Community Medicine, University of Toronto, 500 University Avenue, 5th Floor, Toronto, ON M5G 1V7, Canada. [16]Waypoint Research Institute, Waypoint Centre for Mental Health Care, 500 Church St, Penetanguishene, ON L9M 1G3, Canada. email: bernard.lefoll@camh.ca

JAMA Psychiatry | Original Investigation

Evaluation of Field Sobriety Tests for Identifying Drivers Under the Influence of Cannabis
A Randomized Clinical Trial

Thomas D. Marcotte, PhD; Anya Umlauf, MS; David J. Grelotti, MD; Emily G. Sones, BA; Kyle F. Mastropietro, BS; Raymond T. Suhandynata, PhD; Marilyn A. Huestis, PhD; Igor Grant, MD; Robert L. Fitzgerald, PhD

IMPORTANCE With increasing medicinal and recreational cannabis legalization, there is a public health need for effective and unbiased evaluations for determining whether a driver is impaired due to Δ^9-tetrahydrocannabinol (THC) exposure. Field sobriety tests (FSTs) are a key component of the gold standard law enforcement officer–based evaluations, yet controlled studies are inconclusive regarding their efficacy in detecting whether a person is under the influence of THC.

OBJECTIVE To examine the classification accuracy of FSTs with respect to cannabis exposure and driving impairment (as determined via a driving simulation).

DESIGN, SETTING, AND PARTICIPANTS This double-blind, placebo-controlled parallel randomized clinical trial was conducted from February 2017 to June 2019 at the Center for Medicinal Cannabis Research, University of California, San Diego. Participants were aged 21 to 55 years and had used cannabis in the past month. Data were analyzed from August 2021 to April 2023.

INTERVENTION Participants were randomized 1:1:1 to placebo (0.02% THC), 5.9% THC cannabis, or 13.4% THC cannabis smoked ad libitum.

MAIN OUTCOME AND MEASURES The primary end point was law enforcement officer determination of FST impairment at 4 time points after smoking. Additional measures included officer estimation as to whether participants were in the THC or placebo group as well as driving simulator data. Officers did not observe driving performance.

RESULTS The study included 184 participants (117 [63.6%] male; mean [SD] age, 30 [8.3] years) who had used cannabis a mean (SD) of 16.7 (9.8) days in the past 30 days; 121 received THC and 63, placebo. Officers classified 98 participants (81.0%) in the THC group and 31 (49.2%) in the placebo group as FST impaired (difference, 31.8 percentage points; 95% CI, 16.4-47.2 percentage points; $P < .001$) at 70 minutes after smoking. The THC group performed significantly worse than the placebo group on 8 of 27 individual FST components (29.6%) and all FST summary scores. However, the placebo group did not complete a median of 8 (IQR, 5-11) FST components as instructed. Of 128 participants classified as FST impaired, officers suspected 127 (99.2%) as having received THC. Driving simulator performance was significantly associated with results of select FSTs (eg, ≥2 clues on One Leg Stand was associated with impairment on the simulator: odds ratio, 3.09; 95% CI, 1.63-5.88; $P < .001$).

CONCLUSIONS AND RELEVANCE This randomized clinical trial found that when administered by highly trained officers, FSTs differentiated between individuals receiving THC vs placebo and driving abilities were associated with results of some FSTs. However, the high rate at which the participants receiving placebo failed to adequately perform FSTs and the high frequency that poor FST performance was suspected to be due to THC-related impairment suggest that FSTs, absent other indicators, may be insufficient to denote THC-specific impairment in drivers.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT02849587

Visual Abstract
Editorial page 871
Supplemental content

Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Thomas D. Marcotte, PhD, Center for Medicinal Cannabis Research, Department of Psychiatry, University of California, San Diego, 220 Dickinson St, Ste B, San Diego, CA 92103 (tmarcotte@health.ucsd.edu).

JAMA Psychiatry. 2023;80(9):914-923. doi:10.1001/jamapsychiatry.2023.2345
Published online August 2, 2023.

Received: 12 June 2023 | Accepted: 3 October 2023
DOI: 10.1111/add.16372

EDITORIAL

ADDICTION SSA

How research and policy can shape driving under the influence of cannabis

In the wake of widespread cannabis legalization in the United States (US) and internationally, law enforcement and policy makers are at a standstill on solutions to deter people from driving under the influence of cannabis (DUIC). As the prevalence of cannabis use increases, the public perception of DUIC as safe and devoid of consequence is growing. Shifting this perception and preventing DUIC will require clear messaging about risk, development of a consistent DUIC impairment standard and DUIC-specific statutes and law enforcement efforts.

There has been an increase in prevalence of driving under the influence of cannabis (DUIC) and in fatal motor vehicle collisions in US states [1] and other countries following recreational cannabis legalization (e.g. Uruguay [2]; Canada [3]). Studies have found that acute cannabis intoxication is associated with a statistically significant increase in motor vehicle collision risk [4]. Cannabis impairs psychomotor skills critical to driving in both occasional and heavy users [5]. This is particularly concerning because of the increasing potency of Δ9-tetrahydrocannabinol (THC) concentration linked with more severe withdrawal and motor impairment [6].

Despite the unequivocal evidence that cannabis acutely impairs driving-related skills and increases risk, public attitudes toward DUIC are highly permissive in the United States and in Australia, particularly among medical cannabis users [7]. DUIC is perceived as safe, normative and associated with fewer consequences than alcohol-impaired driving [8]. However, this may not extend to other countries with high prevalence of cannabis use [9–11]. As the prevalence of cannabis use and DUIC increases, challenging and correcting these perceptions is imperative for the new generations of drivers who also use cannabis. To this end, we need universal objective standards for DUIC, combined with consistent DUIC-specific offenses and sanctions, to ensure highway safety [5].

Many countries have achieved significant reductions in alcohol-impaired driving and fatalities through a combination of policy, law enforcement and public awareness campaigns [12]. Of these, perhaps the most successful has been *per se* blood alcohol concentration (BAC) legal limits, currently 0.08 in 49 US states and 0.05 in many industrialized nations [13]. *Per se* laws provide a clear, consistent standard for defining prohibited levels of alcohol-based impairment for driving and are thought to reduce alcohol-impaired driving by increasing the perceived risk of arrest [14], particularly when combined with visible enforcement.

Unfortunately, replicating this effective policy/enforcement combination for DUIC is complicated by differences in pharmacology and impairment indicators between the two drugs. Currently, there are no reliable and practical biochemical or behavioral on-the-road methods to establish cannabis-induced impairment. In contrast to alcohol, there is poor correspondence between levels of THC in biological specimens (e.g. blood, saliva) and psychomotor impairment [15]. THC-induced impairment continues well after the decline of THC in blood and oral fluid. Maximal impairment is typically observed during the first hour after inhalation, with subsequent declines over 3 to 4 h [15, 16] and recovery of most driving-related skills within 5 h [17]. However, there is a substantial delay in the time course for impairment following oral ingestion, with at least 8 h of driving-related cognitive impairment [17] and substantial individual variability in THC's pharmacokinetic profile. Such poor correspondence produces significant challenges for DUIC policy and prevention efforts.

These challenges underscore the complexities in developing clear, consistent and enforceable policies to limit DUIC. The most promising approach would be behavioral assessment of impairment combined with a positive biomarker test [18]. Ideally, this combination would use a "successive hurdles" approach, where an initial step with high sensitivity to detect recent cannabis use would be followed by a more thorough assessment with high specificity to detect impairment. Although there are promising methods for such an approach, there are several problems that would need to be resolved prior to implementation.

Oral fluid (OF) tests are likely the best candidates for detecting recent use. OF screening is non-invasive, carries minimal risk of adulteration, can be conducted in proximity to the time of driving and has reduced interindividual variability and reduced variability between THC doses compared to blood [19]. At very low thresholds (e.g. ≤1 ng/mL), OF testing detects recent (past 3 h) use of smoked THC with very high sensitivity, but has modest specificity and longer detection windows, which may lead to positive tests outside of the typical time course of impairment [19]. A higher cut-off of 10 ng/mL has better specificity for detecting recent use, although THC remains detectable in a small proportion of users long term [20]. Higher cut-offs also risk missing occasional users who may be impaired. Further complicating the issue is the difference in impairment time course

Fundación mapfre

ETSC European Transport Safety Council

Published in final edited form as:
JAMA Psychiatry. 2023 September 01; 80(9): 871–872. doi:10.1001/jamapsychiatry.2023.2309.

High Traffic—The Quest for a Reliable Test of Cannabis Impairment

Johannes G. Ramaekers, PhD,
Faculty of Psychology and Neuroscience, Maastricht University, the Netherlands

Frederick Vinckenbosch, PhD,
Faculty of Psychology and Neuroscience, Maastricht University, the Netherlands

Jodi M. Gilman, PhD
Center for Addiction Medicine, Department of Psychiatry, Massachusetts General Hospital (MGH), Boston

Harvard Medical School, Boston, Massachusetts

In this issue of *JAMA Psychiatry*, Marcotte et al[1] report that field sobriety tests (FSTs) as administered by highly trained police officers are insufficient to detect cannabis-induced impairment in a double-blind, placebo-controlled, parallel randomized clinical trial involving a large sample of 184 cannabis users. Although the group receiving active doses of Δ-9-tetrahydrocannabinol (THC), the active ingredient in cannabis, performed worse on the FSTs as compared with the placebo group; about half of the participants in the placebo group were classified as impaired. These findings are in line with previous placebo-controlled studies that also reported high false-positive FST rates under placebo.[2,3] The legal implication of these findings can be major given that FSTs are currently part of the evaluation protocol in North America to detect drivers who are cannabis impaired. Yet, the lack of sensitivity of FSTs to detect THC-impaired individuals does not come as a big surprise, as FSTs have primarily been validated to detect gross alcohol impairment at high (more than 0.10%) blood alcohol concentrations.[4] To add to this problem, there is no cannabis equivalent of a breathalyzer to verify exposure induced impairment, as trace amounts of THC in biomarkers correlate poorly with cannabis-induced behavioral impairment.[5]

2. Riesgo

Fundación mapfre

ETSC
European Transport Safety Council

Desde año 2000

- **Tolerancia Cero**
- **Leyes especificas (con niveles)**

Europa

Pruebas de cribado y confirmación

Table 3 Odds ratios of driver responsibility associated with blood concentration of Δ^9 tetrahydrocannabinol and alcohol

	No of drivers	Odds ratio (95% confidence interval)		
		Unadjusted	Adjusted for alcohol or Δ^9 tetrahydrocannabinol	Multivariate model*
Concentration of Δ^9 tetrahydrocannabinol (ng/ml):				
Negative	9013	1.00	1.00	1.00
<1	78	2.18 (1.22 to 3.89)	1.89 (1.03 to 3.47)	1.57 (0.84 to 2.95)
1 to 2	298	2.54 (1.86 to 3.48)	2.04 (1.47 to 2.84)	1.54 (1.09 to 2.18)
3 to 4	143	3.78 (2.24 to 6.37)	2.78 (1.61 to 4.78)	2.13 (1.22 to 3.73)
≥5	240	4.72 (3.04 to 7.33)	3.06 (1.93 to 4.84)	2.12 (1.32 to 3.38)
Present at any dose	759	3.17 (2.56 to 3.94)	2.37 (1.89 to 2.97)	1.78 (1.40 to 2.25)
Blood concentration of alcohol (g/l):				
Negative	7181	1.00	1.00	1.00
<0.5	495	3.41 (2.67 to 4.35)	3.30 (2.59 to 4.22)	2.70 (2.10 to 3.48)
0.5 to 0.8	211	8.00 (4.80 to 13.4)	7.74 (4.64 to 12.9)	6.29 (3.74 to 10.6)
0.8 to 1.2	304	9.32 (5.91 to 14.7)	8.73 (5.53 to 13.8)	7.56 (4.75 to 12.0)
1.2 to 2.0	739	15.0 (10.4 to 21.6)	14.1 (9.79 to 20.2)	13.2 (9.11 to 19.1)
≥2.0	842	41.8 (24.1 to 72.4)	40.0 (23.1 to 69.4)	39.6 (22.7 to 68.9)
Present at any dose	2591	9.97 (8.44 to 11.8)	9.50 (8.04 to 11.2)	8.51 (7.15 to 10.1)

*Included variables: blood concentration of Δ^9 tetrahydrocannabinol, blood concentration of alcohol, age, vehicle type, time of crash.

Fundación mapfre

ETSC
European Transport Safety Council

Cite this article as: BMJ, doi:10.1136/bmj.38648.617986.1F (published 2 December 2005)

Papers

Cannabis intoxication and fatal road crashes in France: population based case-control study

Bernard Laumon, Blandine Gadegbeku, Jean-Louis Martin, Marie-Berthe Biecheler, the SAM Group

Abstract

Objectives To evaluate the relative risk of being responsible for a fatal crash while driving under the influence of cannabis, the prevalence of such drivers within the driving population, and the corresponding share of fatal crashes.
Design Population based case-control study.
Participants 10 748 drivers, with known drug and alcohol concentrations, who were involved in fatal crashes in France from October 2001 to September 2003.
Main outcome measures The cases were the 6766 drivers considered at fault in their crash; the controls were 3006 drivers selected from the 3982 other drivers. Positive detection of cannabis was defined as a blood concentration of Δ^9tetrahydrocannabinol of over 1 ng/ml. The prevalence of positive drivers in the driving population was estimated by standardising controls on drivers not at fault who were involved in crashes resulting in slight injuries.
Results 681 drivers were positive for cannabis (cases 8.8%, controls 2.8%), including 285 with an illegal blood alcohol concentration (≥0.5 g/l). Positive cannabis detection was associated with increased risk of responsibility (odds ratio 3.32, 95% confidence interval 2.63 to 4.18). A significant dose effect was identified; the odds ratio increased from 2.18 (1.22 to 3.89) if 0<Δ^9tetrahydrocannabinol <1 ng/ml to 4.72 (3.04 to 7.33) if Δ^9tetrahydrocannabinol ≥5 ng/ml. The effect of cannabis remains significant after adjustment for different cofactors, including alcohol, with which no statistical interaction was observed. The prevalence of cannabis (2.9%) estimated for the driving population is similar to that for alcohol (2.7%). At least 2.5% (1.5% to 3.5%) of fatal crashes were estimated as being attributable to cannabis, compared with 28.6% for alcohol (26.8% to 30.5%).
Conclusions Driving under the influence of cannabis increases the risk of involvement in a crash. However, in France its share in fatal crashes is significantly lower than that associated with positive blood alcohol concentration.

Introduction

Experimental studies have shown that consumption of cannabis diminishes the faculties needed for vehicle driving.[1 2] These effects are sometimes perceptible on driving simulators[3–5] or in real situations.[6 7] Epidemiological studies have often focused on responsibility for a crash; results have varied with respect to the increase in responsibility attributable to cannabis consumption.[8 9] The underlying difficulty is in the absence of a synchronous relation between a change in behaviour and the presence of cannabinoids in the blood or urine.[10] Recent studies have highlighted the importance of focusing analyses on the detection of Δ^9 tetrahydrocannabinol in the blood.[11 12] However, the low number of drivers positive for Δ^9 tetrahydrocannabinol and the common association of cannabis and alcohol hamper the detection of effects entirely attributable to cannabis.[13]

In 1999, before considering changes in drug legislation, the French government wished to obtain reliable epidemiological data, especially on the role of cannabis in the occurrence of crashes. Systematic research was organised in France, from October 2001 to September 2003, into drug consumption in drivers involved in fatal road crashes.

Methods

Study population and drug detection process

We included all fatal crashes resulting in immediate death (including pedestrian fatalities) in the study. All the drivers involved were taken as soon as possible to the hospital, under the control of the police, for compulsory urine testing to detect four major drug families (cannabis, amphetamines, opiates, and cocaine). If the test was positive or impossible a blood sample was taken. This information was associated with the blood alcohol concentration in the police reports.

These reports provided 10 748 drivers who had had full tests for drugs and alcohol. We considered urinary screening for drugs as positive above a concentration of 1000 ng/ml of urine for amphetamines, 300 ng/ml for cocaine and opiates, and 50 ng/ml of acid tetrahydrocannabinol for cannabis. We considered blood tests for drugs (using gas chromatography-mass spectrometry) positive above a concentration of 50 ng/ml for amphetamines and cocaine, 20 ng/ml for opiates, and 1 ng/ml of Δ^9 tetrahydrocannabinol for cannabis. We considered drivers negative if their urine tests were negative or their blood concentrations below these thresholds. However, during the analyses of dose and effect, we no longer considered non-null below threshold concentrations as "negative."

Objectives and study design

We estimated the relative risk of responsibility for fatal crashes while driving under the influence of cannabis and evaluated the corresponding share of fatal crashes. This also implied estimating the prevalence of cannabis in the driving population (drivers not involved in a crash). Under certain conditions, these variables can be estimated from a case-control study.[14]

Cannabis intoxication may favour fatal crash occurrence in two ways: either by increasing the risk of causing a crash (resulting in death), or by increasing the risk of being killed (in a crash caused by another driver) because of greater vulnerability. Our analysis only dealt with the first hypothesis. We considered the

Cannabis y accidentes de tráfico

Fundación mapfre

ETSC
European Transport Safety Council

World Health Organization (WHO). The health and social effects of nonmedical cannabis use. Geneva: WHO, 2016. ISBN 978 92 4 151024 0
http://www.who.int/substance_abuse/publications/msbcannabis.pdf

La Organización Mundial de la Salud acaba de publicar un informe sobre las consecuencias del uso no médico de cannabis sobre la salud y los aspectos sociales. Esta publicación está en abierto en su versión inglesa.

Uno de los apartados al que prestan especial interés es la relación entre el cannabis y las colisiones de tráfico. Nuestro conocimiento ha avanzado enormemente desde que es posible determinar la sustancia activa, Δ^9 -tetrahidrocanabinol, en sangre y fluido oral, y no sólo su metabolito carboxilado.

En la sección 5.1.6 se revisan los distintos estudios de caso-control y estudios de culpabilidad, así como los metanálisis publicados. En la tabla siguiente se reproduce la tabla 5.1 del texto original, en la cual se muestran los riesgos de accidente asociados al consumo de cannabis, tanto sin ajustar como tras ajustar por el sesgo de publicación.

Existe un riesgo significativamente mayor en el caso de los accidentes con muertos y accidentes con heridos graves, si bien no se ha podido establecer una relación en los casos en los que se desconoce la severidad de las lesiones o solo existen daños materiales.

	Sin ajustar (95% IC)	Ajustados por el sesgo de publicación (95% IC)
Accidentes con muertos	1.37 (1.24; 1.52)	1.37 (1.24, 1.51)
Accidentes con heridos graves	1.96 (1.27; 3.02)	1.84 (1.19, 2.85)
Otros accidentes, sin conocerse el grado de severidad de las lesiones	1.41 (0.97; 2.05)	1.12 (0.78, 1.62)
Sólo existen daños materiales	1.43 (1.26; 1.63)	1.11 (0.93, 1.32)

Igualmente en este informe de la OMS se hace referencia a los datos obtenidos en el proyecto DRUID. Para una visión más global del riesgo asociado a conducir con presencia de drogas, reproducimos los riesgos observados en dicho proyecto.


ADDICTION

Letter to the Editor

The journal publishes both invited and unsolicited letters.

CORRECTION TO: 'THE EFFECTS OF CANNABIS INTOXICATION ON MOTOR VEHICLE COLLISION REVISITED AND REVISED' (2016)

As part of his own ongoing research into the epidemiological literature on the increased traffic crash risk associated with cannabis use, Michael White identified errors in the data used in our recent meta-analysis on this topic [1]. Examining the identified issues in collaboration with White, we have decided that the following corrections should be made to our original analysis:

Relevant control sample

Case–control and culpability studies infer raised risks by comparing the odds of substance use in accident-involved drivers relative to that of the driver population on the road. In one of the studies we included, the control population was a sample of patients visiting the emergency room for injuries and accidents not related to driving [2]. There is no inherent reason why this should give an accurate estimate of the on-the-road prevalence of drug use among drivers, and we have consequently excluded the study.

Controlling for alcohol

A number of studies were coded incorrectly as not controlling for alcohol. The coding was corrected and the assigned quality scores were adjusted.

- Seven of the 10 studies performed as part of the European Driving Under the Influence of Drugs, Alcohol and Medicines (DRUID) project [3–5] were analysed in our original paper. As alcohol was not listed as a confounder in the statistical analyses, we coded these as not controlling for alcohol. This was incorrect, as the studies control for alcohol by comparing 'THC-only' drivers with substance-free controls.
- Three of the 10 studies from DRUID (two from Finland and one from Sweden) were excluded from our original paper due to sampling issues. As the sampling issues concerned alcohol-impaired drivers, and as the studies control for alcohol (see last point), these studies have now been included in the sample.
- An earlier study that was included may also control for alcohol through the use of subsamples [6], although this is less certain: the paper is not explicit on the definitions used and we have been unable to get in touch with the original researchers. We left this as 'not controlling for alcohol'.

Overlapping studies

Our original study included Norwegian data from two studies [3,4] that used overlapping data. We traced this to a regrettable mistake in the supporting information of our original paper: when assessing study overlap, we confused two studies with the same first author. We now include

Figure 1 Forest plot


ADDICTION
REVIEW
doi:10.1111/add.13347

The effects of cannabis intoxication on motor vehicle collision revisited and revised

Ole Rogeberg[1] & Rune Elvik[2]

Ragnar Frisch Centre for Economic Research, Oslo, Norway[1] and Institute of Transport Economics, Norwegian Centre for Transport Research, Oslo, Norway[2]

ABSTRACT

Aims To determine whether and to what extent acute cannabis intoxication increases motor vehicle crash risk. **Design** Study 1 replicates two published meta-analyses, correcting for methodological shortcomings. Study 2 is an updated meta-analysis using 28 estimates from 21 observational studies. These included studies from three earlier reviews, supplemented by results from a structured search in Web of Science and Google Scholar, and by the personal libraries of the research team. Risk estimates were combined using random-effects models and meta-regression techniques. **Setting** Study 1 replicates the analysis of Asbridge *et al.*, based on nine studies from five countries, published 1982–2007; and Li *et al.*, based on nine studies from six countries, published 2001–10. Study 2 involves studies from 13 countries published in the period 1982–2015. **Participants** In study 1, total counts extracted totalled 50 877 (27 967 cases, 22 910 controls) for Asbridge *et al.* and 93 229 (4236 cases and 88 993 controls) for Li *et al.* Study 2 used confounder-adjusted estimates where available (combined sample size of 222 511) and crude counts from the remainder (17 228 total counts), giving a combined sample count of 239 739. **Measurements** Odds ratios (OR) were used from case–control studies and adjusted OR analogues from culpability studies. The impact of the substantial variation in confounder adjustment was explored in subsample analyses. **Findings** Study 1 substantially revises previous risk estimates downwards, with both the originally reported point estimates lying outside the revised confidence interval. Revised estimates were similar to those of study 2, which found cannabis-impaired driving associated with a statistically significant risk increase of low-to-moderate magnitude [random-effects model OR 1.36 (1.15–1.61), meta-regression OR 1.22 (1.1–1.36)]. Subsample analyses found higher OR estimates for case–control studies, low study quality, limited control of confounders, medium-quality use data and not controlling for alcohol intoxication. **Conclusions** Acute cannabis intoxication is associated with a statistically significant increase in motor vehicle crash risk. The increase is of low to medium magnitude. Remaining selection effects in the studies used may limit causal interpretation of the pooled estimates.

Keywords Cannabis, case-control, culpability, driving, DUI, driving under the influence, impairment, marijuana, meta-analysis.

Correspondence to: Ole Rogeberg, Ragnar Frisch Centre for Economic Research, Gaustadalléen 21, 0349 Oslo, Norway. E-mail: ole.rogeberg@frisch.uio.no
Submitted 28 October 2015; initial review completed 11 December 2015; final version accepted 5 February 2016

INTRODUCTION

The raised traffic crash risks of cannabis-impaired drivers has received increasing attention from researchers and policymakers following legislative changes for medical and recreational cannabis, particularly in US states. Researchers have highlighted cannabis-impaired driving as one of the three 'primary reasons for concern about legalized cannabis' [1], and the current consensus, as summarized in a recent narrative review of cannabis research, holds that the evidence 'suggests strongly' that cannabis-impaired driving increases the crash risk two to three times [2].

The evidence for this claim includes both laboratory and epidemiological research. Experimental studies find evidence of dose-related impairment on a number of driving-relevant abilities, with a typical duration of 3–4 hours following intake through smoking [3,4], but also find that cannabis users tend to be aware of, and to some extent compensate for, these impairments when driving. Overall, the external validity of these studies remains unclear, necessitating the use of observational epidemiological studies to assess the net traffic risk of cannabis intoxication. This requires the use of meta-analytical techniques that

Nivel de riesgo	Riesgo	Grupos de sustancias
Ligero	1-3	Alcohol en sangre de 0.1g/L a 0.5 g/L Cannabis
Medio	2-10	Alcohol en sangre de 0.5 g/L a 0.8 g/L Benzoilecgonina Cocaína Opiáceos ilegales Benzodiacepinas y Z-Hipnóticos Opiáceos medicinas
Alto	5-30	Alcohol en sangre de 0.8 g/L a 1.2 g/L Anfetaminas Varias drogas
Extremadamente alto	20-200	Alcohol en sangre ≥ 1.2 g/L Alcohol en combinación con drogas

Niveles de riesgo relativo de resultar gravemente herido o fallecer en un accidente de tráfico, según el grupo de sustancias y las concentraciones de éstas encontradas en el conductor.

Driving Under the Influence of Drugs, Alcohol and Medicines in Europe findings from the DRUID project. Lisbon: EMCDDA, 2012. http://www.emcdda.europa.eu/attachements.cfm/att_192773_EN_TDXA12006ENN.pdf

Se acaba de publicar un estudio sobre los factores de riesgo asociados a conducir después y durante el consumo de cannabis. El estudio incluyo a 151 personas consumidores de cannabis, pero que no habían solicitado tratamiento por dicho consumo. Se analizó los factores asociados a conducir después de haber consumido cannabis y a conducir mientras se consume dicha droga. El que los amigos desaprueben dichas conductas se asocia a menor frecuencia de conducción durante y después del consumo de cannabis. Por otra parte, a mayor es la percepción del riesgo de conducir después de consumir cannabis, menor la frecuencia con que lo hacen.

J. Stud. Alcohol Drugs. 2016; 77: 309-316.
doi: 10.15288/jsad.2016.77.309

Fundación mapfre

ETSC
European Transport Safety Council

International Journal of Drug Policy 142 (2025) 104832

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Cannabis consumption and motor vehicle collision: A systematic review and meta-analysis of observational studies

Andrew Jin [a,†], Andrea J. Darzi [b,c,†], Amne Dargham [d], Navroop Liddar [e], Sepehr Bozorgi [f], Shamim Sohrevardi [g], Maurice Zhang [e], Kian Torabiardakani [b], Rachel J. Couban [b], Malahat Khalili [h], Jason W. Busse [b,c,i], Behnam Sadeghirad [b,c,h,*]

[a] Department of Neurology, McMaster University, Hamilton, Ontario, Canada
[b] Department of Anesthesia, McMaster University, Hamilton, Ontario, Canada
[c] Department of Health Research Methods, Evidence, and Impact (HEI), McMaster University, Hamilton, Ontario, Canada
[d] Department of Medicine, LAU Gilbert and Rose-Marie Chagoury School of Medicine, Byblos, Lebanon
[e] Schulich School of Medicine and Dentistry, Western University, London, Ontario, Canada
[f] School of Medicine, University of Western Australia, Western Australia, Australia
[g] Faculty of Health Sciences, Western University, London, Ontario, Canada
[h] Michael G. DeGroote Institute for Pain Research and Care, McMaster University, Hamilton, ON, Canada
[i] The Michael G. DeGroote Centre for Medicinal Cannabis Research, McMaster University, Hamilton, Ontario, Canada

ARTICLE INFO

Keywords:
Cannabis
THC
Motor vehicle injury
Motor vehicle fatality
Meta-analysis

ABSTRACT

Background: Increasing legalization of recreational cannabis and availability of cannabinoid products has resulted in expanded use, which is associated with adverse effects including concerns over increased risk of motor vehicle collision (MVC). We aimed to explore the association between cannabis consumption and MVC.
Methods: We searched MEDLINE, EMBASE, CINAHL, Cochrane library, SCOPUS, PsycInfo, Web of Science, TRID from inception to November 2024. We included studies assessing the association between cannabis consumption on MVC fatalities, any injuries, and culpability/unsafe driving actions. Pairs of reviewers independently screened search results, extracted data, and assessed risk of bias. We used a DerSimonian and Laird random-effects model for all meta-analyses and the GRADE approach to assess the certainty of evidence.
Results: We included 31 studies with 328,388 individuals. Low certainty evidence suggests that cannabis consumption may be associated with an increased risk of MVC fatality (8 studies, OR 1.55, 95% CI: 1.20 to 1.98) with an absolute risk increase (ARI) of 14 more deaths per 100,000 MVC's. Low certainty evidence from 9 case-control studies suggests cannabis consumption may be associated with an increased risk of injury due to MVC (OR 2.00, [95% CI: 1.31-3.07]; absolute risk increase of 6.8%). We are uncertain about the association of cannabis consumption with MVC culpability/unsafe driving action as the evidence was only very low certainty.
Conclusions: Low certainty evidence suggests that cannabis consumption may increase risk of MVC fatality and risk of injury from MVC. The association between cannabis use and risk of unsafe driving is uncertain.
Protocol registration: CRD42022357478

Background

Globally, cannabis is one of the most widely used illicit substances, and in Canada cannabis is the second most common recreational drug consumed after alcohol ("Canadian Cannabis Survey 2023: Summary," 2024). The legalization of cannabis for non-medical purposes in Canada and parts of United States, as well as other countries (e.g., South Africa, Thailand), and the expansion of available cannabinoid products, such as extracts, have increased the availability and potency of cannabis. (Matheson & Le Foll, 2020) The proportion of Canadians aged 16+

* Corresponding author at: Department of Anesthesia, McMaster University, 1280 Main Street West, MDCL-2112, Hamilton, Ontario, Canada L8S 4K1.
E-mail addresses: andrew.jin@medportal.ca (A. Jin), darzia@mcmaster.ca (A.J. Darzi), nliddar@uwo.ca (N. Liddar), ssohrev2@uwo.ca (S. Sohrevardi), torabiak@mcmaster.ca (K. Torabiardakani), rcouban@mcmaster.ca (R.J. Couban), khalim80@mcmaster.ca (M. Khalili), bussejw@mcmaster.ca (J.W. Busse), sadeghb@mcmaster.ca (B. Sadeghirad).
† Contributed equally.

https://doi.org/10.1016/j.drugpo.2025.104832

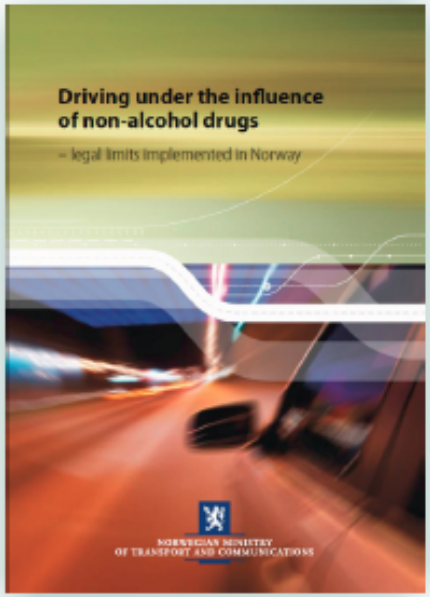
Available online 13 May 2025

3. Aprendiendo de otros países.

EL CASO NORUEGA.

Noruega, legislación sobre drogas y conducción

Información adicional puede encontrase en:
https://www.regjeringen.no/globalassets/upload/sd/vedlegg/brosjyrer/sd_ruspavirket_kjoring_net.pdf



Noruega ha adoptado la estrategia "Vision Zero" muertes y lesiones graves en accidentes de tráfico. Es unos de los países con más baja accidentalidad de tráfico, fruto de las políticas viales implementadas en ese país. Se estima que alcohol/drogas/medicamentos son un factor contribuyente en el 24 % de los accidentes de tráfico con resultado de muerte en Noruega.

Desde el 1 Febrero de 2012, se han introducido niveles o concentraciones de drogas y medicamentos, a partir de los cuales es sancionado conducir un vehículo. Se ha armonizado el proceso en relación al alcohol y las drogas/medicamentos, estableciéndose concentraciones a partir de las cuales no está permitido conducir un vehículo. La regulación sobre alcohol y conducción en Noruega fue inicialmente establecida en 1936. El nivel actual a partir del cual no está permitido conducir es del 0,2% en sangre.

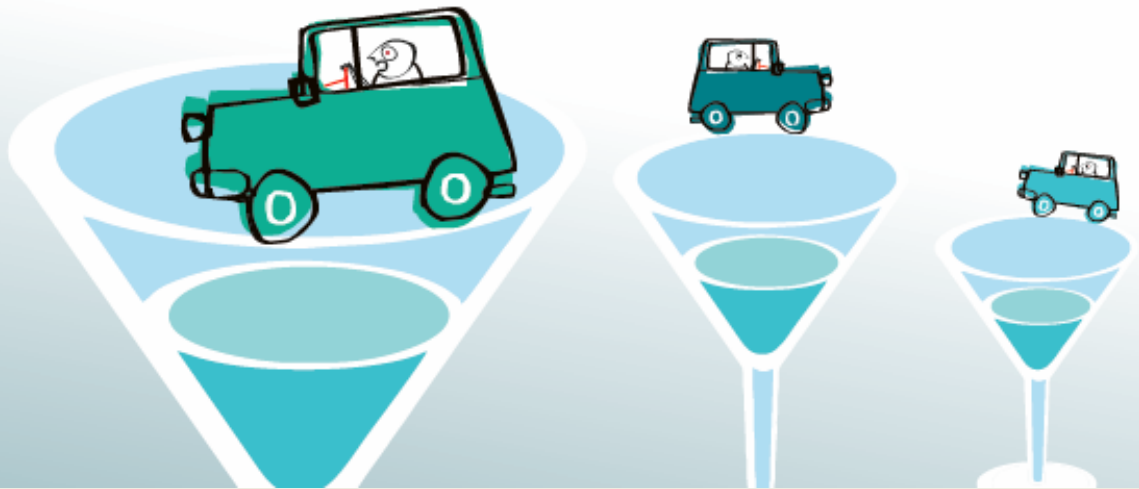
Las sanciones por conducir con presencia de sustancias son proporcionales al salario mensual del infractor y se incrementan en función de la concentración de la(s) droga(s) detectada(s), y van desde sanción económica hasta pérdida de la licencia de conducción y prisión.

Se han establecido límites en sangre total para 20 sustancias. Estas concentraciones se han determinado en base a que producirían un deterioro similar a una concentración de alcohol en sangre (BAC) de 0,2%. En algunos casos (13 de las 20 sustancias) se han establecido concentraciones de esas sustancias que producen deterioro similar a una BAC de 0,05% y 0,12%, y que justificarían sanciones mayores.

Droga/ Fármaco	Concentración que produce un deterioro comparable a alcohol 0,02% (ng /ml en sangre total)	Concentración que produce un deterioro comparable a alcohol 0,05% (ng /ml en sangre total)	Concentración que produce un deterioro comparable a alcohol 0,12% (ng /ml en sangre total)
Alprazolam	3	6	15
Clonazepam	1.3	3	8
Diazepam	57	143	342
Fenazepam	1.8	5	10
Flunitrazepam	1.6	3	8
Nitrazepam	17	42	98
Oxazepam	172	430	860
Zolpidem	31	77	184
Zopiclona	12	23	58
THC	1,3	3	9
Anfetamina	41	*	*
Cocaína	24	*	*
MDMA	48	*	*
Metanfetamina	45	*	*
GHB	10300	30900	123600
Ketamina	55	137	329
LSD	1	*	*
Buprenorfina	0.9	*	*
Metadona	25	*	*
Morfina	9	24	61

* Sustancias en las que no se ha podido establecer concentraciones para sanciones proporcionales a la concentración, ya que se desconoce esta información.

Excepción - medicinas prescritas: la legislación no se aplica en casos en los que el conductor está tomando la medicación bajo prescripción médica y siguiendo las instrucciones dadas por este.



Fundación mapfre

ETSC
European Transport Safety Council

4. Motivo de preocupación

¿CUAL ES EL NIVEL O CONCENTRACION O CUT-OFF DE TOLERANCIA CERO?

EL EJEMPLO DE CANNABIS

- **Aparato de screening o de cribado a pie de carretera:**
  25 ng/ml
  0,00000025 gr/ml

- **Pruebas cromatográficas en el laboratorio de toxicología:**
  Límite de detección: 1 ng/ml o incluso menor
  Límite de cuantificación: 2,4 ng/ml

¿Sancionados todos aquellos por encima de que Límite?: en la práctica del límite de cuantificación

- El punto de corte o cut-off debe de estar en relación con la concentración a la cual se produce un aumento estadísticamente significativo del riesgo

- En *tolerancia cero* el punto critico es que la relación de concentración – riesgo no es conocida con exactitud

- Cuestión adicional: la evidencia del riesgo se conoce a partir de la concentración de la sustancia en sangre, no el fluido oral

- Es compleja la relación entre concentración en sangre y fluido oral: no es lineal como en el caso del alcohol

Según diversos estudios, incluidos el proyecto DRUID 1ng/ml de THC en sangre = 27 o mas ng/ml de THC en fluido oral

- Conflicto de intereses: ninguno que declarar