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Review

# International approaches to driving under the influence of cannabis: A review of evidence on impact

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ABSTRACT

*Background:* There are knowledge gaps regarding the effectiveness of different approaches designed to prevent and deter driving under the influence of cannabis (DUIC). Policymakers are increasingly interested in evidence-based responses to DUIC as numerous jurisdictions worldwide have legally regulated cannabis or are debating such regulation. We contribute a comprehensive review of international literature on countermeasures that address DUIC, and identify where and how such measures have been evaluated.
*Methods:* The following databases were systematically searched from 1995 to present: Medline, Embase, PsycINFO, CINAHL, Sociological Abstracts, and Criminal Justice Abstracts. Hand searching of relevant documents, internet searches for grey literature, and review of ongoing email alerts were conducted to capture any emerging literature and relevant trends.
*Results:* Numerous international jurisdictions have introduced a variety of measures designed to deter DUIC. Much interest has been generated regarding non-zero per se laws that set fixed legal limits for tetrahydrocannabinol and/or its metabolites detected in drivers. Other approaches include behavioural impairment laws, zero-tolerance per se laws, roadside drug testing, graduated licensing system restrictions, and remedial programs. However, very few evaluations have appeared in the literature.
*Conclusions:* Although some promising results have been reported (e.g., roadside testing), it is premature to draw firm conclusions regarding the broader impacts of general deterrent approaches to DUIC. This review points to the need for a long-term commitment to rigorously evaluate, using multiple methods, the impact of general and specific deterrent DUIC countermeasures.


## 1. Introduction

For decades, alcohol has been recognized as the psychoactive drug that is most associated with impaired driving. In recent years, increasing attention is being paid to other drugs and impaired driving, and accompanying legal and public health implications. Among illicit drugs, cannabis is the most commonly consumed in the world, although the prevalence of cannabis use is not evenly distributed as some regions, such as North America, report much higher usage rates than others (Degenhardt et al., 2008; UNODC, 2015; WHO, 2016). Furthermore, the legality of cannabis is shifting, as varied jurisdictions have legalized cannabis or are debating how to implement regulated cannabis markets, despite international drug treaties (Bewley-Taylor et al., 2016; Hall and Lynskey, in press). In the United States, for example, four states have legalized cannabis for recreational use, while 23 states have approved cannabis for medical use (Huestis, 2015). Given these shifts, legal and policy responses to driving under the influence of cannabis (DUIC) are also evolving and generating increasing public interest. Thus it is presently an important time to review literature on such responses, especially as there are gaps in our knowledge regarding the effectiveness of different approaches designed to prevent, deter, and reduce any potential harms associated with DUIC.

General deterrent approaches to impaired driving aim to dissuade the public or subgroups of people who may not have performed the behaviour, while specific deterrent approaches target those who have performed the behaviour or have been apprehended (Krismann et al., 2011). Efforts to prevent DUIC can reasonably be guided by and compared to approaches to prevent

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driving under the influence of alcohol (DUIA). Initial understanding of the effects of alcohol on basic driving skills and collision risk (e.g., Bjerver and Goldberg, 1950; Holcomb, 1938; Smith and Popham, 1951) led to the development of methods to assess the level of alcohol in the body, legal frameworks designed to achieve general deterrence, and educational and specific deterrent measures designed to reinforce the general deterrent impact of drinking-driving laws. Behavioural impairment laws, requiring assessment of behavioural symptoms of impairment, were implemented in many jurisdictions. However, it was not until the development and introduction of per se laws in the Scandinavian countries and subsequently in most other parts of the world – implemented through criminal or administrative law with the ability to make the probability of detection, apprehension, and sanctioning relatively swift and certain – that substantial reductions in rates of drinking-driving deaths (i.e., general deterrence) were observed (e.g., Byrne et al., 2016; Homel, 1994; Mann et al., 2001; Ross, 1973; Tippetts et al., 2005; Voas and Lacey, 1990). Per se laws that address DUIA set fixed limits for alcohol detected in the driver's system (e.g., blood alcohol concentration [BAC] of 0.05%). Over the past few decades, per se laws, combined with public education and high-visibility enforcement, have been considered the cornerstones of effective general deterrence of DUIA, while behavioural impairment laws by themselves have been considered largely ineffective in achieving general deterrence (Mann et al., 2001; Voas and Lacey, 1990). Additionally, effective rehabilitative programs and incapacitative measures such as ignition interlock programs have added to the ability to reduce driver recidivism (i.e., specific deterrence) and thus to the overall impact of DUIA laws (Elder et al., 2011; Ma et al., 2015).

A central question for stakeholders and policymakers is the extent to which successful means to address DUIA are transferrable to DUIC. For example, can a per se or hybrid approach (e.g., behavioural impairment plus per se limits) similar to how many countries have addressed DUIA be effectively transferred to DUIC (e.g., Huestis, 2015; Solomon and Chamberlain, 2014)? Among many complicating factors is that cannabis has a very different pharmacological profile than alcohol. The main psychoactive component of cannabis is delta-9-tetrahydrocannabinol (THC) and, although it can have a shorter detection window, its metabolites (namely, carboxy THC or THC-COOH) can be detected in blood or urine for many days after cannabis use, long after any signs of impairment (Bergamaschi et al., 2013; Wolff et al., 2013).

As more jurisdictions consider legal initiatives to address DUIC, and also other drugs and driving, there is increasing interest in the relevant research and questions regarding the impact of cannabis use on collision risk, whether there should be a THC legal limit or per se level for drivers, and impact of DUIC laws on road safety. In this paper, we provide an overview of DUIC and international approaches to this issue, and contribute to the literature a comprehensive review of evaluations of the impact of varied countermeasures.

## 2. Methods

Systematic searches to identify literature on evaluations of DUIC countermeasures were performed using the following databases: Medline, Embase, PsycINFO, CINAHL, Sociological Abstracts, and Criminal Justice Abstracts. All databases were searched for literature published in English and from 1995 onward; no additional exclusion criteria were used. Various driving/driver-related terms were used and combined with cannabis/marijuana terms. (For complete search strategies, please contact the first author.) Hand searching of relevant articles, internet searches for grey literature, and review of ongoing email alerts from Medline, PsycINFO, and Web of Science were conducted to capture any new literature and emerging trends. All titles and abstract information were exported, de-duplicated, and organized using the reference manager program Refworks.

## 3. DUIC and road safety

### 3.1. Prevalence of DUIC

Providing a global picture of DUIC prevalence is challenging given numerous factors, including regional differences in cannabis use and in data collection methods across studies (Walsh et al., 2008). Data from general population surveys suggest that the proportion of the population that reports DUIC is relatively low, and is lower than the proportion that reports DUIA. For example, Walsh and Mann (1999) observed that 1.9% of the adult population in Ontario, Canada reported driving within one hour of smoking cannabis at least once in the past year. However, among some subgroups of the population the prevalence of self-reported DUIC is much higher. Not surprisingly, recreational and medical cannabis users are more likely to report DUIC (Alvarez et al., 2007; Johnson et al., 2012; Walsh and Mann, 1999). As well, younger drivers (e.g., adolescents in high school and young adults) in North America report levels of DUIC that equal or exceed the rates of DUIA (Adlaf et al., 2003; Cook et al., in press; O'Malley and Johnston, 2013). Recently, Cook et al. (submitted for publication) observed that among Ontario adolescents who are younger than the legal driver licensing age of 16, 2.5% reported DUIC and 1.7% reported DUIA. Research suggests that young drivers commonly perceive that DUIC is a relatively safe behaviour and that they are able to compensate for any impairing effects of cannabis (Fischer et al., 2006). Factors that appear to be associated with DUIC among young drivers include heavier or problematic use of cannabis and alcohol, and risk-taking propensities (Cook et al., in press, submitted for publication).

Roadside survey data from varied countries indicate that cannabis is often the most commonly detected illicit drug among drivers (e.g., Beirness and Beasley, 2010; EMCDDA, 2012; Wolff et al., 2013); however, it is notable that other drugs, particularly stimulants like amphetamines and cocaine, are more commonly found among drivers in some international jurisdictions (e.g., Gjerde et al., 2014; Jones, 2005). Roadside-test findings from the large, multi-year, multi-study DRUID project showed a THC prevalence of 1.32% in general driving populations (across 13 European countries, range of 0.0–5.99%), a lower average prevalence compared to alcohol (EMCDDA, 2012; Gjerde et al., 2013).

There is evidence of shifting trends in DUIC in jurisdictions that have introduced approval for medical cannabis and/or legal regulation of cannabis for recreational use (e.g., Couper and Peterson, 2014; Johnson et al., 2012; Salomonsen-Sautel et al., 2014). For example, an analysis of blood toxicology results provided by law enforcement in the state of Washington showed increases in THC and its main metabolite prevalence among suspected impaired drivers between pre- and post-legalization of cannabis (Couper and Peterson, 2014). However, it is important to be cautious about drawing conclusions regarding the impact of cannabis law reforms on rates of DUIC, as to date much existing data were collected at time points that are insufficient for showing long-term trends.

### 3.2. Cannabis use and collision risk

Assessments of the impact of cannabis use on road safety risk have considerably evolved over the past two decades. Toxicological analyses reveal that cannabis is one of the most commonly detected drugs in fatally injured drivers (Brady and Li, 2013, 2014).