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Estimating the harms and costs of cannabis-attributable collisions in the Canadian provinces

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ABSTRACT

Introduction: In 2012, 10% of Canadians used cannabis and just under half of those who use cannabis were estimated to have driven under the influence of cannabis. Substantial evidence has accumulated to indicate that driving after cannabis use increases collision risk significantly; however, little is known about the extent and costs associated with cannabis-related traffic collisions. This study quantifies the costs of cannabis-related traffic collisions in the Canadian provinces.
Methods: Province and age specific cannabis-attributable fractions (CAFs) were calculated for traffic collisions of varying severity. The CAFs were applied to traffic collision data in order to estimate the total number of persons involved in cannabis-attributable fatal, injury and property damage only collisions. Social cost values, based on willingness-to-pay and direct costs, were applied to estimate the costs associated with cannabis-related traffic collisions. The 95% confidence intervals were calculated using Monte Carlo methodology.
Results: Cannabis-attributable traffic collisions were estimated to have caused 75 deaths (95% CI: 0–213), 4407 injuries (95% CI: 20–11,549) and 7794 people (95% CI: 3107–13,086) were involved in property damage only collisions in Canada in 2012, totalling $1,094,972,062 (95% CI: 37,069,392–2,934,108,175) with costs being highest among younger people.
Discussion: The cannabis-attributable driving harms and costs are substantial. The harm and cost of cannabis-related collisions is an important factor to consider as Canada looks to legalize and regulate the sale of cannabis. This analysis provides evidence to help inform Canadian policy to reduce the human and economic costs of drug-impaired driving.

1. Introduction

Globally, cannabis is the most commonly used illicit drug and the prevalence of use in North America is higher than the global average (United Nations Office on Drugs and Crime, 2015). In 2012, the prevalence of past year cannabis use in Canada was 10% (Health Canada, 2012), with highest rates among youth aged 15–19 (22.4%) and young adults aged 20–24 (26.2%) (Statistics Canada, 2012). Youth often initiate use of cannabis at a young age, aligning the age of initiation of cannabis use with the driving age in many provinces (Statistics Canada, 2013).

Recent roadside and self-report survey data indicate that between 2.5% and 5.5% of licensed drivers in Canada have driven under the influence of cannabis (Beasley et al., 2013; Health Canada, 2012), again with higher rates among younger drivers (Health Canada, 2012; Pashley et al., 2014; Solomon et al., 2015; Walsh and Mann, 1999; Young et al., 2011). To coincide with this, substantial evidence points to the role of cannabis use in elevating crash involvement (e.g., (Asbridge, 2014; Asbridge et al., 2012, 2014,

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2005; Beasley et al., 2013; Bédard et al., 2007; Beirness and Porath-Waller, 2015; Hall and Degenhardt, 2009; Mann et al., 2007, 2010; Mura et al., 2003; Poulin et al., 2007)). Four recent meta-analyses have concluded that cannabis use increases collision risk, with odds ratio estimates ranging from 1.10 to 2.79 (Asbridge et al., 2012; Elvik, 2013; Li et al., 2012; Rogeberg and Elvik, 2016). Although more research on how the drug affects collision risk is needed — for example, evidence on how collision risk varies with dose or blood THC levels (Asbridge et al., 2012).

While there is growing evidence that cannabis impairs the skills necessary for safe driving and increases collision risk (Burston et al., 2015), less is known about the larger social and economic impact of driving under the influence of cannabis (DUIC). Studies have demonstrated the health and economic burden of motor vehicle collisions (Vodden et al., 2007) and, more specifically, the impact of alcohol-involved collisions (Rehm et al., 2006). To date, the health, social and economic costs linked to DUIC-related collisions have yet to be estimated. Two recent studies, using different methodologies, estimated the numbers of traffic collision fatalities and injuries caused by cannabis in Canada (Fischer et al., 2015; Imtiaz et al., 2015). This study extends those methods and seeks to estimate the prevalence of DUIC by age and province in order to calculate the numbers of people involved in fatal, injury and property damage only (PDO) collisions.

Additionally, this information will be used to estimate the social costs of cannabis-attributable traffic collisions across the Canadian provinces.

2. Methods

First, information on the prevalence of cannabis use in Canada's ten provinces was obtained and the prevalence of DUIC was calculated. Next, information on the number of traffic collision fatalities, injuries and PDO victims for each province was collected. Then, the relative risk of collision involvement associated with DUIC was obtained. This information permitted the estimation of population-attributable fractions which were used to determine the number of people involved in traffic collisions resulting in death, injury and PDO caused by cannabis in each province. Finally, estimates of the direct costs and human consequences associated with a collision fatality, injury and PDO collision were applied to estimate costs of DUIC-attributable traffic collisions in Canada. These figures were estimated for 2012, which was the most recent year in which data were available. Estimates were not calculated for the territories due to a lack of available data.

2.1. Exposure data

The 2012 Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) was used to obtain provincially representative estimates of past-year cannabis use by age group (Health Canada, 2012). To address the issue of small cell sizes, the marginal distributions were used to estimate the provincial prevalence rates by age group. The prevalence of DUIC was obtained from a roadside survey of randomly selected drivers in British Columbia (B.C.). This survey tested oral fluids collected by the Quantisal® (Immunalysis Corporation, Pomona, CA) oral fluid collection kit to measure cannabis use. Laboratory testing of the samples used a cut off value of 5 ng/mL in oral fluid (personal communication, Beirness, 2015), which corresponds with the limit of detection for THC in whole blood (0.2 ng/mL) (Brubacher et al., 2016; Karschner et al., 2009). Due to the lack of provincial level data, the prevalence rates of DUIC from B.C. were used as a basis to derive comparable estimates for the other provinces. These estimates were derived by incorporating variations in age specific self-reported prevalence rates of cannabis use based on survey data to the BC roadside DUIC data in order to estimate the prevalence of DUIC among the other nine Canadian provinces.

2.2. Traffic collision outcome data

Provincial data on the number of persons involved in a traffic collision according to severity (fatality, injury, and property damage only), age group (16–19; 20–24; 25–34; 35–44; 45–54; 55–64; 65–74 and 75+) and road user type (motor vehicle driver, motorcyclist or moped rider, bicyclist, motor vehicle passenger and pedestrian) were provided by Transport Canada from the National Collision Database. Saskatchewan does not record age or road user information for all PDO collisions, and as such Saskatchewan PDO information was derived based on that observed in adjoining provinces (Alberta and Manitoba).

2.3. Relative risk: the relationship between cannabis use and traffic collision outcomes

Risk relation (RR) functions for fatal (RR = 2.17, 95% CI: 1.00–4.70) and injury (RR = 1.80, 95% CI: 1.00–3.23) traffic collisions for THC positive drivers were obtained from Imtiaz et al. (2015). These RRs were derived based on pooled relative risk estimates from four North American studies as RTIs are co-determined by other regionally varying factors that likely interact with cannabis use (see, Imtiaz et al., 2015). Risk estimates for property damage only (RR = 1.26, 95% CI: 1.10–1.44) traffic collision outcomes were obtained from Elvik (2013).

2.4. Population attributable fractions

To estimate the costs associated with DUIC, the number of persons involved in cannabis- attributable traffic collisions was estimated using the population attributable fraction methodology. Province and age-specific cannabis-attributable fractions (CAFs) were calculated by traffic collision severity. The following formula was used to calculate the CAF:

$$\mathrm{CAF} = \mathrm{Pe(RRe\text{-}1)}/(1 + \mathrm{Pe(RRe\text{-}1)})$$

where Pe = Prevalence of exposure; RRe = Relative risk of outcome due to exposure group.

The CAFs were then applied to traffic collision data from Transport Canada in order to estimate the total number of persons involved in cannabis-attributable traffic collisions. Age- and province-specific estimates were generated for cannabis-attributable traffic collisions by varying severity. A sensitivity analysis was conducted to estimate the number of PDO victims and the associated costs at different cannabis exposure parameters as the relative risk estimate from Elvik (2013) was based on both acute and past-year cannabis exposure. The 95% confidence intervals (CI) around the point estimates were computed using Monte Carlo simulations. Each parameter of the CAF was sampled 1 million times based on their error distribution giving 1 million CAF samples. The CIs were taken as 2.5% and 97.5% percentiles of the CAF samples.

2.5. Cost estimation

Traffic collision cost estimates for 2012 were provided by the Ministry of Transportation of Ontario (Haya, personal communication, 2016), and these Ontario cost values were applied to all provinces to estimate costs of cannabis-attributable traffic collisions. The 2012 Ontario cost estimates were based on Vodden et al. (2007), who utilized a willingness-to-pay (WTP) methodology. Updated cost values taking into account recent modifications to the