Crude estimates of cannabis-attributable mortality and morbidity in Canada–implications for public health focused intervention priorities

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ABSTRACT

Background Cannabis is the most commonly used drug in Canada; while its use is currently controlled by criminal prohibition, debates about potential control reforms are intensifying. There is substantive evidence about cannabis-related risks to health in various key outcome domains; however, little is known about the actual extent of these harms specifically in Canada.

Methods Based on epidemiological data (e.g. prevalence of relevant cannabis use rates and relevant risk behaviors; risk ratios; and annual numbers of morbidity/mortality cases in relevant domains), and applying the methodology of comparative risk assessment, we estimated attributable fractions for cannabis-related morbidity and mortality, specifically for: (i) motor-vehicle accidents (MVAs); (ii) use disorders; (iii) mental health (psychosis) and (iv) lung cancer.

Results MVAs and lung cancer are the only domains where cannabis-attributable mortality is estimated to occur. While cannabis use results in morbidity in all domains, MVAs and use disorders by far outweigh the other domains in the number of cases; the popularly debated mental health consequences (e.g., psychosis) translate into relatively small case numbers.

Conclusions The present crude estimates should guide and help prioritize public health-oriented interventions for the cannabis-related health burden in the population in Canada; formal burden of disease calculations should be conducted.

Keywords attributable fractions, Canada, cannabis use, health risks, morbidity, mortality, public health

Introduction

Cannabis is the most commonly used illegal drug in Canada. Some 10–13% of the general adult population are current cannabis users (i.e. past year-use), translating into an estimated total user population of 2.5–3.0 million cannabis users; use rates are considerably elevated (20–30%) in adolescent and young adult age groups (i.e. 16–25 years).[1,2] While cannabis use is criminalized in Canada, there are ongoing debates about potential control or policy reforms, including proposals for 'decriminalization' or 'legalization'; these debates are amplified by recent policy developments throughout the Americas, where, for example, select US states as well as the country of Uruguay have moved towards implementation of legalization regimes for cannabis.[3–5]

Alcohol, tobacco and illicit drug use are among the top 10 risk factors for disease burden in North America.[6] While it is well documented in seminal reviews that cannabis is

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associated with elevated risks for detrimental health outcomes in various domains,[5,7−9] there have been few attempts to actually quantify or compare cannabis-related harm (e.g. morbidity, mortality) outcomes on a population level for Canada [for exceptions see refs (10,11)]; such efforts would not only be useful to assess the public health burden of cannabis vis-à-vis other drugs, yet also to inform and guide policy and intervention priorities on the basis of actual harms.[12−14]

Based on the above reviews, there are four main substantive areas of health risks identified for cannabis use: (i) accidents/injury (e.g. motor-vehicle accidents, MVAs); (ii) use disorders (including dependence); (iii) mental health (e.g. psychosis); (iv) cancer (e.g. lung cancer); while most of these problems occur predominantly among frequent (e.g. daily or near-daily users, e.g. 25−30% of total users) and/or long-term/chronic cannabis users, accidents/injuries can occur acutely, i.e. following single episode-use.[7,8,12−16] Given these elevated cannabis-related risk profiles, what do we actually know about the extent of tangible health—i.e. morbidity or mortality—outcomes on a population level in Canada? The simple answer is: Not much, especially since the last attempt for quantification as part of the Canadian 'Cost of Substance Abuse' study in 2002.[10,11,17]

Facing this major gap, we conducted a small and simple projection exercise to estimate cannabis-attributable morbidity and mortality in the above key domains in Canada, with the principal objective to suggest basic relative quantification in these different areas of potential cannabis-related harms which can then be used to inform and prioritize interventions.

Methods

We applied the assumptions of a comparative risk assessment (CRA), with a counterfactual scenario of 'no cannabis use at all'.[18] In other words, we estimated the proportion of mortality and morbidity which could be avoided in the absence of cannabis use in Canada.[19] The estimates were based on cannabis-attributable population impact fractions (PIFs), a generalized form of attributable fractions,[20,21] with the basic formula of:

$$\text{PIF} = \frac{\sum_{i=1}^{n} P_i \text{RR}_i - \sum_{i=1}^{n} P_i' \text{RR}_i}{\sum_{i=1}^{n} P_i \text{RR}_i}$$

where i is the exposure-level category; RR_i is the relative risk at exposure level i; P_i is the prevalence of the ith category of exposure under the current situation in Canada; and P_i' is the prevalence of the ith category under the counterfactual scenario, i.e. 100% of Canadians with a relative risk of 1 for no cannabis use.

The exposure levels were based on theoretical considerations: for motor-vehicle accidents/injuries as acute effects, we used cannabis exposure immediately prior to traffic participation; for the other risks, we used regular cannabis use over time. As cannabis use is more prevalent at younger ages,[1,2] but some of the health problem outcomes (e.g. cancer) are more prevalent later in life, we used sex- and age-stratified analysis, i.e. the PIFs were calculated for each sex−age group and applied to the respective disease outcomes. Further disease-specific considerations are given below.

Results

The results of our estimations for the four main areas of cannabis-related harms are presented in the following.

Motor-vehicle accidents/injuries

Recent data from general population and roadside surveys suggest that some 2−4% of drivers have had recent driving episodes following cannabis use.[2,22,23] Seminal reviews concluded that, based on relevant cognitive, memory/reaction and psychomotor ability impairments, drivers under the influence of cannabis have a two to three times elevated risk of being involved in (fatal or non-fatal) MVA.[24−26] Recent Canadian studies based on blood samples collected from emergency room populations in several provinces found that 11−12% of drivers admitted for MVAs had used cannabis prior to driving and the derived relative risk was >4.[27,28] While concrete data for Canada are still limited, it can thus be estimated that 4−12% of MVA-related fatalities and/or injuries may involve driving under the influence of cannabis.[25,29,30] There were 2227 MVA-related fatalities and 170 629 injuries (all) in Canada in 2010.[31] On this basis, there may be 89−267 cannabis-related MVA fatalities, and 6825−20 475 cannabis-related MVA injuries in 2010. Beyond MVAs, cannabis may contribute to other kinds of injuries (i.e. falls, other traffic injuries involving bicyclists, pedestrians or boating), so that the reported data are likely underestimates.[32]

Use disorders

It has been estimated that some 5−10% of cannabis users develop dependence, but a much higher proportion develops cannabis use disorders, i.e. dependence or abuse as defined in DSM-IV; dependence, as the more severe outcome, interferes with social and economic functioning and, in many instances, requires treatment.[33−36] Importantly for problem outcomes, use disorders can be assumed to result in morbidity only, and do not lead to direct mortality outcomes. Based on most recent Canadian survey data (2012), 1.3% of the general adult population (15 years+) qualified for cannabis use disorders,[37] corresponding to 380 000 Canadians with cannabis use

disorders in a given year. About 20–25% of this population (33 000) were registered—on a prorated basis—in Ontario's publicly funded treatment system in 2012/13[38] which would translate into a Canada-wide treatment population of 76 000–95 000; however, an additional substantive number can be expected to receive private treatment care.

Mental health (Psychosis)

Psychoactive substance use and related disorders are associated with most mental disorders, and cannabis is no exception.[39,40] Some of these associations are causal, but there may also be reverse causality or third factors such a genetic predispositions underlying both the substance use and/or the mental disorders.[41] This complex causal web makes it virtually impossible to quantify the causal impact of cannabis use on mental health disorders; similar circumstances have led to a situation where, even though causality had been established, the impact of alcohol on mental health disorders (e.g. depression) could not be estimated within a CRA framework.[6,42] For cannabis, the only mental health condition for which a causal impact has been established within the most recent CRA is psychosis. Recent systematic reviews suggested that regular cannabis users have a 1.5–4 times elevated risk of psychosis.[43–45] The resulting attributable fractions would be overestimates, as many underlying studies were not adjusted for confounders, and as the respective formulae assumed that all causality is uni-directional.[46] Allowing for a correction factor of 50% of the effect as usual in CRA,[47] we estimate a cannabis-attributable fraction for psychosis between 2 and 3%. Based on the estimates by Dealberto[48] and on the assumption of at least weekly cannabis use, this would correspond to 106–186 estimated cannabis-attributable incident cases of schizophrenia in Canada. This number is conservative in the sense that all other possible cannabis-attributable mental health problem outcomes are neglected; for psychosis specifically, this number may over- or underestimate the actual cannabis-attributable incidence.

Cancer

While cannabis use may be associated with risk for other cancers, the main concern is lung cancer—the most common form of cancer in Canada. There are some 26 000 newly diagnosed cases of lung cancer in Canada per year, with a mortality rate of 80–85%.[49] While most studies find elevated risk for lung cancer, the quantification of the risk is difficult,[50–53] due to the following factors: (i) the high overlap with tobacco smoking—the primary risk factor for lung cancer, and the impossibility to fully adjust for confounding; (ii) most studies did not assess frequency and quantity of cannabis use; (iii) the

substantial lag-effect between risk and disease outcomes (∼20 years). We based our estimates on Callaghan et al.[53] who included a follow-up of 40 years and adjustment for tobacco smoking (RR slightly >2 based on at least 50 cannabis use occasions). This would result in cannabis-attributable fractions of 1–2%, corresponding to 130–280 lung cancer deaths in Canada. Based on biological pathways, we would expect more cases of cannabis-attributable cancer in Canada,[54,55] but we are lacking the necessary data to quantify these relationships.

Discussion

Main findings of this study

In the above, we offered simple and crude estimates of the extent of cannabis-attributable morbidity and mortality in key risk domains for Canada. Main findings are that the largest number of cases with cannabis-related harm consequences appears to occur through motor-vehicle accidents and use disorders, whereas the number of cases of lung cancer and psychosis occur at a markedly smaller scale. In addition, only two of the domains—motor-vehicle accidents and lung cancer—result in mortality outcomes. Based on these considerations, we conclude on the basis of our estimates that motor-vehicle accidents and use disorders form the majority of instances of cannabis-attributable disease burden in Canada, whereas lung cancer—despite a limited amount of mortality in this category—and psychosis lead to substantially less extensive burdens.

What is already known on this topic

Numerous previous studies have offered indicators of cannabis use-related relative risks for disease outcome in the main domains [e.g. refs (7,8)], although very few concrete and comprehensive estimates of actual disease burden exist which also allow for the comparison of actual outcome burden between the main domains. Previous studies from Canada and elsewhere have concluded that, when compared with other illicit drugs, the cannabis-related disease burden is comparably small despite relatively large population-level exposure.[8,10,11,56] For partial inter-domain comparisons, recent Global Burden of Disease (GBD) estimates focusing on cannabis use disorders have this burden estimated to be ∼100 times larger than that for cannabis-related psychosis outcomes on a global level.[57]

What this study adds

Our crude estimates at least point to a couple of key implications regarding the estimated extent of cannabis use-attributable disease outcomes in Canada. First, while cannabis use is not associated with direct acute mortality (e.g. from overdose/

poisoning), it may lead to fatalities from MVAs and cancer.[58] While these problems are rather different phenomena in terms of risk-behavioral characteristics—for example, cannabis use can be separated from the risk of impaired driving, while this is more difficult for cancer risks, at least in the predominant context of smoked cannabis—these should be key areas of attention for interventions given the (potentially extensive) mortality involved. Yet, while not involving attributable mortality outcomes, the extent of estimated cannabis use disorders is large, and therefore requires targeted and adequate interventions. In Canada's largest province of Ontario cannabis-related cases constitute a major proportion— 30%—of overall admissions for substance use treatment, and treatment options and resources are limited.[38] Compared with the other domains, the extent of cannabis-related instances of psychosis—while undoubtedly a serious disease outcome in individual cases—can safely be assumed to constitute the smallest amount of health problem burden of the four domains assessed on a general population level in Canada. This is very much contrary to trends in popular media reporting and social debates, also concerning the potential consequences of liberalizing cannabis control policies.[59–62]

The overall assessment of the actual burden of cannabis-attributable health problems on a population level should be further developed and refined. While our calculations are relatively simple and crude, priority-setting and resource allocation for interventions should be informed by the above public health-oriented estimations. For example, the effectiveness and practical application of interventions to detect and deter cannabis-impaired driving need to be improved, and treatment options for cannabis use disorder need to be expanded in variety and availability.[33,63–66] At the same time, recent public health-oriented intervention tools have offered evidence-based recommendations on how to reduce user-behavioral risks for key cannabis-attributable harm outcomes, and other recommendations for public health-oriented cannabis interventions and policy development are available.[12,14–16]

Limitations of this study

Our study was based on relatively crude and simple estimates, more detailed calculations for cannabis-attributable disease burden based on state-of-the-art methods in Canada need to be done.[56] These would include formal systematic reviews of the causality and level of the risk relations, focusing on evidence from Canada, and more detailed characterization of the relevant exposure dimensions. As many of the variables for estimating the actual extent of cannabis-attributable health harms are context specific, our estimate results are not generalizable to other settings or countries; however, similar exercises should be conducted elsewhere based on similar approaches.

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