Occupational Medicine 2020;**70:**570–577
Advance Access publication on 27 October 2020 doi:10.1093/occmed/kqaa175

Cannabis use and work-related injuries: a cross-sectional analysis

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Background	Although the association of cannabis use with automobile accidents has been well-studied, the impact of cannabis on workplace safety and injuries is less clear.
Aims	The purpose of this study was to examine the relationship between work-related injury and cannabis use in the past year.
Methods	We performed a cross-sectional analysis of the Canadian Community Health Survey (2013–16) of working individuals. We used multiple logistic regression modelling to calculate the odds of experiencing a work-related injury (defined as non-repetitive strain injury) among workers who reported using cannabis more than once during the prior 12 months as compared to non-users. We repeated the analysis among participants working in high injury risk occupational groups only.
Results	Among the 136 536 working participants, 2577 (2%) had a work-related injury in the last 12 months. Of these 2577 who had a work-related injury, 4% also reported being a cannabis user in the same period. We found no association between past-year cannabis use and work-related injury (odds ratio for work injury among users 0.81, 95% confidence interval 0.66–0.99). The association was unchanged in the subgroup analysis limited to high injury risk occupational groups.
Conclusions	We found no evidence that cannabis users experienced higher rates of work-related injuries. While awaiting prospective studies, occupational medicine practitioners should take a risk-based approach to drafting workplace cannabis policies.
Key words	Accident; cannabis; injury; marijuana; occupational; substance use.

Introduction

Cannabis is the most commonly used psychoactive recreational substance worldwide and second only to alcohol in Canada [1,2]. 9-tetrahydrocannabinol (THC), the main psychoactive agent in cannabis, produces effects of euphoria, altered mood or perception, slowed reaction time and impaired attention, concentration and memory [3,4]. A national Canadian survey in 2018 reported that 22% of participants over the age of 16 had used cannabis for non-medical purposes in the last 12 months, and of those, 23% reported using cannabis before or at work [5]. These statistics were especially concerning for workers with safety-critical jobs, defined as 'one that, if not performed in a safe manner, can cause direct and significant damage to property, and/or injury to the employee, others around them, the public and/or the immediate environment' [6]. Cannabis policies in the workplace differed depending on the industry, province and employer in Canada [7,8]. For instance, although most provinces prohibited non-medical use of cannabis at work, permissibility of medicinal cannabis use may be granted at the workplace based at the discretion of employers [9]. Similarly, in the USA, legality of recreational or medicinal cannabis use varied across state lines [10]. With an increasing wave of legalization and decriminalization of cannabis worldwide, understanding its use in relation to the workplace has become a pressing issue internationally.

Key learning points

What is already known about this subject:

- The effects of cannabis-related impairments on automobile safety were well-studied, with many studies providing evidence for a positive association.
- However, there is limited research examining the association between cannabis use and workplace injuries. Most previous studies were limited in either using small cohorts, older data or the number of possible confounders adjusted.

What this study adds:

- We conducted a large cross-sectional analysis of working individuals in Canada using contemporary data to examine the relationship of reporting work-related injury among cannabis users while adjusting for many potential confounders that previous studies have not included.
- We found that among a large group of workers, workers who reported using cannabis more than once in the last year did not report increased work-related injuries. These results were consistent in subgroup analyses that focused on workers in high injury risk occupation groups (industry (primary industry or production) and trades (trades, transport and equipment operators)).

What impact this may have on practice or policy:

- Despite a small number of studies on the subject, there is a lack of definitive evidence on cannabis users and workplace outcomes such as accidents and injuries.
- Given these limitations, occupational medicine physicians and employers should consider taking a risk-based yet balanced approach in drafting cannabis-related workplace policies.

Most of the literature studying the impact of cannabis use on injury risk was derived from either experimental studies or epidemiologic studies of road accidents [11–16]. For instance, studies on cannabis use and road vehicle accidents in Australia, France, USA and Canada showed that cannabis use was associated with increased risk of both non-fatal and fatal crashes [11–15]. A 2012 meta-analysis that included nine epidemiological studies found that driving under the influence of cannabis was associated with a significantly increased risk of motor vehicle collisions, with the risk being higher in fatal collisions [16].

Currently, there is limited research examining the association between cannabis use and workplace injuries. A small number of prospective cohort studies involving specific populations, such as youth or postal workers, found no associations between cannabis use and workplace injuries [17,18]. Cross-sectional analyses produced conflicting results on the association between cannabis use and workplace injuries [19–21]. Most of these studies were limited in either using small cohorts, the number of possible confounders adjusted, or using older data set, last of which was an important consideration given the evidence of increasing THC concentration in commercial cannabis product overtime [22].

In this study, we explored the relationship between cannabis use and work-related injuries in the hope to help guide occupational safety policies. We evaluated the relationship between past-year cannabis use and work-related injuries using a large population-based sample from Canada. We hypothesized that cannabis users would experience more work-related injuries.

Methods

We used data from the Canadian Community Health Survey (CCHS) from 2013 to 2016. The CCHS had wide generalizability as it was a nationally administered large sample cross-sectional survey with the aim to capture a wide range of population-level health information [23]. It captured over 1000 variables relating to 'health status, health care utilization and health determinants' in Canadians aged 12 years and older [23]. The survey used a multistage sampling strategy, whereby each health region had a fair allocation of participants proportional to the population of the region or province. Since 2007, the survey has been conducted annually with approximately 65 000 participants per year. The survey was voluntary, offered in multiple languages, and included quality evaluation and validation processes to minimize sampling errors. Details of the sampling strategy are found on the Statistics Canada website [23].

We included all participants who completed a survey from 2013 to 2016 (four survey cycles) and worked either full- or part-time as an employee or self-employed person at any point in the 12 months prior to survey completion. We did not impose an age limit on our study population, as legal working age varied across the country (Figure 1).

The primary outcome was self-reporting of a work-related injury in the last 12 months (yes/no), defined specifically as non-repetitive strain injuries. We excluded participants with missing values (responded as 'don't know', 'refusal' or 'not stated') for this outcome from the analysis (Figure 1). The primary exposure variable of interest was self-reported cannabis use more than once

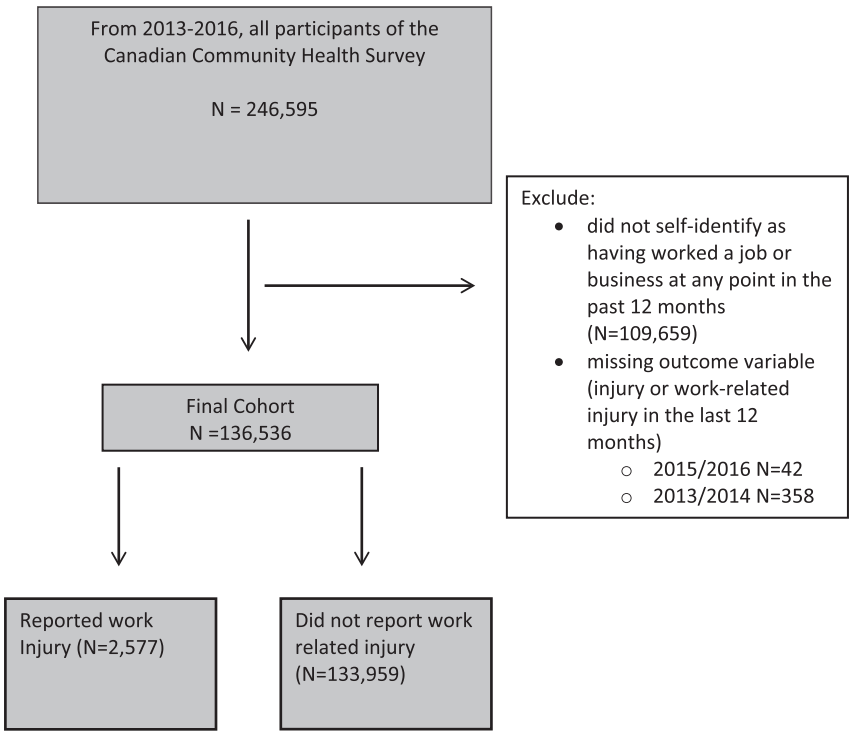

Figure 1. Data generation.

in the last 12 months (yes/no) to exclude infrequent cannabis users (those who reported only having used cannabis once in the last 12 months).

To account for potential confounding, we included the following variables in the analysis: basic demographic variables (age, sex, ethnicity, immigrant status), socio-economic variables (highest education achieved, personal income), clinical variables (arthritis, back problem, migraine headaches, cancer, poor sleep, mood disorder, anxiety disorder), substance-related variables (current smoking, frequent alcohol use) and work-related variables (occupational group, work-related stress). In the analysis, we defined poor sleep as having trouble going to sleep or staying asleep most of the time or all the time. We also defined frequent alcohol use as using alcohol 4–6 times a week or every day. Occupational groups included the following categories: industry (primary industry or production); trades (trades, transport or equipment operators); sales and services; and other (management, art, education, business, finance, administration, health occupations, social science, government, religion). We considered industry (primary industry or production) and trades (trades, transport or equipment operators) occupational groups as high injury risk in the subgroup analysis as these groups have had high fatalities as reported by the Ontario Workplace Safety Insurance Board (WSIB) [24].

We compared the demographic, socio-economic, clinical, substance-related and work-related factors among those who did and did not experience a work-related injury, descriptively and using two-sample *t*-tests and Pearson's chi-square tests, where appropriate.

We assessed the association between past-year cannabis use and work-related injuries using multivariable logistic regression. We also performed a subgroup analysis including only workers in high injury risk occupation groups (industry or trades) to exclude those working in settings with low injury risk which may bias the results. For both models, we considered all the variables as mentioned above as covariables and computed odds ratios (ORs) and 95% confidence intervals (CIs). We calculated variance inflation factors to assess for multicollinearity—a scenario where multiple independent variables in a regression model are highly linear and predicative of each other, with a cut-off of four indicative of high multicollinearity [25]. We performed model reduction for variables showing evidence of multicollinearity to arrive at the final model. We collapsed age categories 20–39 and 40–59 to a single category (age 20–59 years). We imputed for missing data using multiple imputation with additive regression, bootstrapping and predictive mean matching method to avoid excluding participants with missing values in the following covariables: immigrant status, education, personal income, arthritis, back problem, migraine headache, cancer, poor sleep, mood disorder, anxiety, current smoking, frequent alcohol use, cannabis use, occupational group and work-related stress. We performed a sensitivity analyses for the primary model by constructing it with exclusion of

all participants with missing covariables. We considered $P < 0.05$ as statistically significant.

We completed all analyses in the study using R (version 3.5.1) [26]. This research received exemption from ethics review at the University of Toronto as per Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2018 Article 2.2 as the data were legally and publicly accessible [27].

Results

There were 136 536 survey participants between 2013 and 2016 (Figure 1), of whom 2577 (2%) reported having experienced a work-related injury in the last 12 months and 133 959 did not (Table 1). Response rates were 66% and 59% for 2013–14 and 2015–16 survey cycles, respectively [28,29]. For the full cohort 49% of respondents were male and the most frequent age group was 40–59 years (41% of respondents). In total, 4% of all participants reported using cannabis more than once in the last 12 months. Among all participants, 8%, 14% and 24% were working in industry, trades, and sales and services occupational groups, respectively.

Compared to participants who did not report a workplace injury, those who did report an injury were significantly younger (40% versus 35% in age category 20–39, $P < 0.001$), more likely to be male (66% versus 49%, $P < 0.001$), less likely to be immigrants (9% versus 14%, $P < 0.001$), less likely to have completed education beyond high school (62% versus 66%, $P < 0.001$), less likely to be in the highest income category of >$80 000 (14% versus 19%, $p < 0.001$) and more likely to be working in high injury risk occupation groups, including trades (29% versus 14%, $P < 0.001$) and industry (16% versus 8%, $P < 0.001$). With regard to chronic diseases, participants who reported work-related injuries were also more likely to have back problems (29% versus 18%, $P < 0.001$), migraine headaches (13% versus 11%, $P < 0.001$), mood disorder (12% versus 8%, $P < 0.001$) or anxiety (10% versus 7%, $P < 0.001$). We denoted variables with missing baseline values, which were later imputed in the analytical models, in Table 1.

In the primary adjusted analysis (Table 2), we found that participants who used cannabis did not report increased work-related injuries compared to those who did not (OR 0.81, 95% CI 0.66–0.99). In the subgroup analysis (Table 3) limited to participants working in high injury risk occupation groups (industry or trades) results were identical (OR 0.81, 95% CI 0.66–0.99). Factors associated with increased odds of injury included male sex (OR 1.55, 95% CI 1.41–1.71), non-white ethnicity (OR 1.34, 95% CI 1.17–1.53), history of back problems (OR 1.75, 95% CI 1.61–1.93), migraine headaches (OR 1.24, 95% CI 1.10–1.41), mood disorder (OR 1.46, 95% CI 1.27–11.67), smoking (OR 1.31, 95% CI 1.20–1.43) and workplace stress (OR 1.76, 95% CI 1.61–1.93). Participants working in industry (OR 3.16, 95% CI 2.75–3.62), trades (OR 2.98, 95% CI 2.65–3.36) or sales and services (OR 1.99, 95% CI 1.77–2.23) occupational groups were significantly more likely to report work-related injuries. Exclusion of participants with missing data in the sensitivity analyses did not change the overall results (Table S1, available as Supplementary data at *Occupational Medicine* Online).

Discussion

We found that among a large group of Canadian workers, cannabis users did not report increased work-related injuries. These results were consistent in subgroup analyses that focused on workers in high injury risk occupation groups (industry or trades).

Our study has several important strengths. To the best of our knowledge, this was the largest population-based cross-sectional study examining the association between past-year cannabis use and work-related injuries. The survey captured a wide range of health-related variables, which allowed us to construct robust statistical models accounting for several potential confounders. We also only included workers who reported using cannabis more than once in the analysis to exclude very occasional cannabis users. Lastly, as the data in our analysis were from pre-legalization of recreational cannabis in Canada, the results can be used as benchmarking to see if patterns of cannabis use and workplace injury change in a legalized landscape.

There were several limitations to the study. First, given the cross-sectional nature of the study, we cannot attribute causation. We also lacked information on the frequency of cannabis use or the type of products that were used. Second, our data were self-reported. Given the sensitive nature of cannabis use, we cannot exclude the possibility that some participants may not answer truthfully. Workers who had an injury at work may also be less inclined to disclose their cannabis use. However, the survey asked about a wide range of topics and this potential effect is likely minimized given that questions were not asked sequentially. Third, despite adjusting for several variables in our models, residual confounding likely remained. For example, the number of lost-time and non-lost-time injuries is highly occupation-dependent. The survey used occupation groups adapted from the National Occupational Classification Coding system. Due to lack of more granular information, we were limited by the extent of which this confounder was controlled in the analysis. Another source of confounding was co-use of other illicit substances. The survey inquired about any 'illicit substances use' in the last 12 months and lacked detail on what these other substances were (except for cannabis) or frequency of their use. Illicit drug use was

Table 1. Baseline characteristics of participants in the cohort

Variable	Work injury in the past 12 months (N = 2577), n (%)	No work injury in the past 12 months (N = 133 959), n (%)	P-values
Demographic and socio-economic variables			
Age categories			<0.001
<20	158 (6)	79 683 (7)	
20–39	1039 (40)	47 218 (35)	
40–59	1084 (42)	55 039 (41)	
>60	296 (11)	22 099 (16)	
Male	1691 (66)	65 473 (49)	<0.001
Ethnicity[1]			<0.001
White	2111 (84)	108 041 (83)	
Non-white	365 (15)	18 596 (14)	
Other	30 (1)	3795 (3)	
Immigrant status (yes)[2]	219 (9)	18 531 (14)	<0.001
Education[3]			<0.001
Less than secondary school	333 (13)	16 165 (12)	
Completed secondary school	635 (25)	28 417 (21)	
Post-secondary diploma or University	1569 (62)	87 781 (66)	
Personal income, Canadian $[4]			<0.001
<20 000	427 (18)	25 687 (21)	
20–39K	670 (29)	30 572 (21)	
40–59K	557 (24)	26 097 (21)	
60–79K	331 (14)	16 883 (14)	
>80K	334 (14)	23 893 (19)	
Clinical variables (yes)			
Arthritis[5]	575 (22)	33 233 (25)	0.005
Back problem[6]	754 (29)	24 320 (18)	<0.001
Migraine headache[7]	338 (13)	14 472 (11)	<0.001
Cancer[8]	18 (1)	1452 (1)	0.06
Poor sleep[9]	54 (2)	5336 (4)	<0.001
Mood disorder[10]	306 (12)	10 336 (8)	<0.001
Anxiety[11]	245 (10)	9603 (7)	<0.001
Substance-related variables (yes)			
Current smoking[12]	832 (32)	28 477 (21)	<0.001
Frequent alcohol use[13]	341 (13)	16 507 (12)	0.135
Illicit drug use in last 12 months[14,a]	106 (4)	5525 (4)	0.971
Cannabis[15]	100 (4)	5359 (4)	0.752
Work-related variables			
Occupational group[16]			<0.001
Industry	360 (16)	9101 (8)	
Trades	671 (29)	16 111 (14)	
Sales and services	595 (26)	26 829 (24)	
Other	668 (29)	62 059 (54)	
Work-related stress (yes)[17]	746 (29)	25 640 (19)	<0.001

Variables superscript numbers represent variables with missing values—1: 3598; 2: 3898; 3: 1626; 4: 11 075; 5: 296; 6: 160; 7: 108; 8: 131; 9: 307; 10: 167; 11: 193; 12: 205; 13: 1327; 14: 681; 15: 618; 16: 20 132; 17: 1370.
[a]Exclude one-time cannabis in the last 12 months.

therefore not included in the model as a covariate as we were unable to disentangle if those who answered yes to illicit substance were using cannabis alone or with additional illicit substances.

Our finding was consistent with, but expanded upon, a number of smaller studies published previously [17,18,20,21]. In a study of 5466 job applicants with the US postal service, Normand *et al.* found that testing positive for illicit drugs (including cannabis) during pre-employment screening did not increase the risk of injury or accidents occurrence [17]. Similarly, an analysis of over 12 000 young people in the USA showed that the life-time use of cannabis did not increase the incidence of occupational injuries [18]. In contrast, a cross-sectional New

Table 2. Multivariable logistic regression modelling of work-related injuries with imputation

Variable	Adjusted OR (95% CI)
Demographic and socio-economic variables	
Age categories	
<20	0.82 (0.67–0.99)
20–59	Reference
>60	0.69 (0.60–0.78)
Male	1.55 (1.41–1.71)
Ethnicity	
White	Reference
Non-white	1.34 (1.17–1.53)
Other	0.37 (0.45–0.53)
Immigrant (yes)	0.53 (0.45–0.62)
Education	
Less than secondary school	0.84 (0.73–0.97)
Completed secondary school	Reference
Post-secondary diploma or University	1.05 (0.96–1.16)
Total personal income	
<20 000	0.89 (0.77–1.02)
20–39K	1.04 (0.92–1.16)
40–59K	Reference
60–79K	0.92 (0.80–1.06)
>80K	0.68 (0.59–0.78)
Clinical variables (yes)	
Arthritis	0.82 (0.74–0.90)
Back problem	1.75 (1.61–1.93)
Migraine headache	1.24 (1.10–1.41)
Cancer	0.71 (0.45–1.15)
Poor sleep	0.47 (0.36–0.62)
Mood disorder	1.46 (1.27–1.67)
Anxiety	1.08 (0.93–1.26)
Substance-related variables (yes)	
Current smoking	1.31 (1.20–1.43)
Frequent alcohol use	1.01 (0.90–1.14)
Cannabis use	0.81 (0.66–0.99)
Work-related variables	
Occupational group	
Industry	3.16 (2.75–3.62)
Trades	2.98 (2.65–3.36)
Sales and services	1.99 (1.77–2.23)
Other	Reference
Work-related stress	1.76 (1.61–1.93)

Table 3. Multivariable logistic regression modelling of work-related injuries with imputation for workers in industry or trades (N = 46 385)

Variable	Adjusted OR (95% CI)
Demographic and socio-economic variables	
Age categories	
<20	0.78 (0.64–0.96)
20–59	Reference
>60	0.64 (0.56–0.74)
Male	2.24 (2.06–2.45)
Ethnicity	
White	Reference
Non-white	1.29 (1.13–1.46)
Other	0.36 (0.25–0.52)
Immigrant (yes)	0.51 (0.44–0.60)
Education	
Less than secondary school	0.91 (0.79–1.04)
Completed secondary school	Reference
Post-secondary diploma or University	0.89 (0.81–0.98)
Total personal income	
<20 000	0.93 (0.80–1.08)
20–39K	1.10 (0.97–1.24)
40–59K	Reference
60–79K	0.88 (0.76–1.02)
>80K	0.63 (0.54–0.73)
Clinical variables (yes)	
Arthritis	0.84 (0.76–0.93)
Back problem	1.81 (1.65–1.98)
Migraine headache	1.23 (1.09–1.39)
Cancer	0.70 (0.44–1.12)
Poor Sleep	0.47 (0.35–0.61)
Mood disorder	1.44 (1.25–1.65)
Anxiety	1.05 (0.91–1.23)
Substance-related variables (yes)	
Current smoking	1.46 (1.34–1.59)
Frequent alcohol use	1.01 (0.89–1.13)
Cannabis use in the last 12 months	0.81 (0.66–0.99)
Work-related variables	
Work-related stress (yes/no)	1.69 (1.55–1.85)

Zealand study of 15 687 employed individuals in various sectors found that cannabis use in the last 12 months did slightly increase the risk of work injuries, but the authors did not adjust for other potential confounding variables in the model [20]. Wadsworth *et al.* conducted a community based survey of 7979 individuals in the UK and found that cannabis use in the past year was not associated with increased odds of work incidents, but increased the odds of overall incidents (e.g. accidents, road traffic accidents, minor injuries, cognitive failures) [21]. This is similar to the result of another cross-sectional analysis of 27 934 survey subjects in Spain which showed that cannabis use in the last 12 months was not associated with injuries at work but seemed to increase the frequency of overall non-traffic injuries [19].

Taken together, we did not find a relationship between past-year cannabis use and work-related injuries despite the known physiological effects cannabis has on cognitive and motor function. Although the reported absolute OR in our analysis was less than one, the upper limit of CI was sufficiently close to one such that we could not conclude with confidence that work-related injuries was reduced in cannabis users. However, it is important to note that the CCHS does not specifically differentiate between using cannabis at home, using at

work and whether a worker might come to the workplace while impaired. Some safety-sensitive employment settings have zero tolerance or drug testing policies that may deter workers from working under substance impairment or even using off-hours because urine testing can detect metabolites up to days to weeks after last use [30]. It is possible that such policies were effective in preventing workers from using cannabis prior to work sufficiently to prevent work-related injuries associated with cannabis use in our study population, accounting for the results seen. Lastly, it is worth noting that the reported percentage of cannabis use in the overall cohort of 4% is well below the national survey average of 22% [5]. This is likely because we only included individuals who were both employed and reported having used cannabis more than once in the last 12 months, whereas the national survey included all population regardless of their employment status and frequency of cannabis use.

We found that the strongest predictor of work-related injuries was occupational group with industry or trades having the highest odds of work-related injuries. This was consistent with reports published by the WSIB in Ontario where the transportation sector had the highest lost-time injuries rate of 1.9% in 2018 [24]. Unfortunately, injury rates by sector in our survey cannot be directly compared to published WSIB data as the latter only reports injuries that resulted in time away from work.

In conclusion, we found that workers reporting using cannabis more than once in the past year were no more likely to report having experienced a work-related injury over the same time period in a large cohort of the Canadian working population. However, further prospective studies are needed in this area to shed light on this issue. Occupational medicine physicians and organizations should consider taking a risk-based yet balanced approach in drafting cannabis-related workplace policies given the limited evidence informing on the issue of cannabis use and work-related injuries.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors. Dr Peter Cram received support from the US National Institute of Aging Grant (R01AG058878) and the University of Toronto Salary Award.

Competing interests

None declared.

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doi:10.1093/occmed/kqaa180