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Co-use of cannabis and alcohol before and after Canada legalized nonmedical cannabis: A repeat cross-sectional study

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Abstract

Background: This study examined changes in population-level co-use of cannabis and alcohol before and 12 months after nonmedical cannabis legalization in Canada, relative to the United States that had previously legalized and not legalized (US legal and illegal states, respectively).

Methods: Data are from waves 1 and 2 of the International Cannabis Policy Study, collected in 2018 (before) and 2019 (12 months after legalization in Canada). Respondents aged 16–65 years from Canada ($n = 25{,}313$) and US legal ($n = 25{,}189$) and US illegal ($n = 19{,}626$) states completed an online survey. Changes in co-use between 2018 and 2019 in US legal and illegal states compared to those in Canada were assessed using multinomial logistic regression.

Results: Descriptive analyses show increases in cannabis use and monthly or more frequent (MMF) co-use between 2018 and 2019 in all jurisdictions. Compared to no MMF use of cannabis or alcohol, there was no evidence suggesting differences in changes in MMF co-use in US legal or illegal states relative to Canada. However, respondents in US legal states had 33% higher odds of MMF alcohol-only use (OR = 1.33, 99% CI: 1.12, 1.57) compared to no MMF use relative to Canada.

Conclusions: Increases in co-use were observed between 2018 and 2019 in all jurisdictions regardless of the legal status of cannabis. These shifts were largely due to increases in cannabis use across the population, including those that use alcohol, and may indicate changing societal norms toward cannabis generally. As the cannabis legalization transition in Canada matures, evaluation over the longer term will improve understanding of the influence of cannabis liberalization on co-use.

Keywords

Cannabis, alcohol, co-use, cannabis legalization, quasi-experiment

Introduction

Cannabis and alcohol are two of the most prevalent psychoactive substances consumed in Canada and the United States (SAMHSA, 2021; Statistics Canada, 2021). Cannabis is also one of the most widely used substances among those who drink alcohol (SAMHSA, 2021; Weinberger et al., 2019). In Canada, data from the Canadian Tobacco Alcohol and Drugs Survey indicate the prevalence of cannabis use has increased over the previous decade, while alcohol use has remained stable (Lowry et al., 2020; Rotermann, 2019; Statistics Canada, 2020). In both Canada and the United States, alcohol is legalized at the federal level, yet a combination of federal, state/provincial, and local laws regulate the sale, distribution, and possession of alcohol as well as the penalties or responses to alcohol-related problems (Health Canada, 2019; NIAAA, 2022). Canada legalized nonmedical (recreational) cannabis through the Cannabis Act, which came into effect on October 17, 2018, making Canada the second country after Uruguay to legalize and regulate the possession and sale of nonmedical cannabis at the federal level (Parliament of Canada, 2018). In the year prior to legalization, approximately 15% of Canadians aged 15+ years reported consuming cannabis in the past 12 months and 78% reported using alcohol (Rotermann 2019; Statistics Canada, 2021). In the United States, cannabis is not legalized at the federal level and remains a schedule I substance. However, 18 states and the District of Columbia (DC) have legalized nonmedical cannabis since 2012 (National Conference of State Legislatures, 2022). Data from the US National Survey on Drug Use and Health suggest that in 2018, 16% of individuals aged 12+ years reported using cannabis in the past 12 months, and these estimates were higher than estimates from 2002 to 2017 (SAMHSA, 2019). In 2018, 66% reported any alcohol use in the past 12 months, a prevalence similar to 2015 through 2017 (SAMHSA, 2019).

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Systematic reviews and a meta-analysis assessing the effects of legalizing nonmedical cannabis for those under age 25 found that, overall, liberalization of cannabis policy in the United States appeared to have little effect on actual patterns of cannabis use among young people when use was assessed at either the past 30-day or 12-month marks (Melchior et al., 2019; Pacula et al., 2022; Sarvet et al., 2018; Smart, et al., 2019). Among middle-aged and older adults, the findings are mixed: the liberalization of cannabis policy has been followed by increases in the prevalence of any cannabis use, heavy use, and disorders, as well as small changes in related health and social consequences in some jurisdictions but not others (Cerdá et al., 2020; Chu, 2014; Carliner et al., 2017; Fischer et al., 2021; Hall et al., 2016; Lira et al., 2021; Pacula et al., 2022; Subbaraman et al., 2020).

While national data routinely report on the consumption of single substances in the population, less is known about the co-use of cannabis and alcohol. Co-use refers to the general use of both substances by the same person, but not necessarily at the same time. Examining patterns of co-use is critical because of its additive or interactive effects found to start at mid-levels of co-use such as once or twice per month (Gunn et al., 2022). Existing studies indicate that co-use of cannabis and alcohol is associated with higher volume and more frequent use of both substances, and negative behavioral and social consequences including injuries, driving under the influence, and high-risk sexual behavior (Gunn et al., 2022; Subbaraman et al., 2015; Yurasek et al., 2017). Additionally, co-use of cannabis and alcohol during early adolescence is associated with negative outcomes in later adolescence and adulthood including substance dependence, involvement in crime, and lower rates of educational attainment compared to using either substance alone (Brière et al., 2011; Moss et al., 2014; Trenz et al., 2012; Yurasek et al., 2017). Examining population-level patterns of co-use of cannabis and alcohol is timely given the recent and ongoing policy changes surrounding the legalization of nonmedical cannabis.

Cannabis legislation is an important environmental factor influencing cannabis supply, availability, risk perceptions, and use (Levy et al., 2021; Kim et al., 2021), making evaluations of the impact of cannabis liberalization policies on co-use a priority. Few studies in the United States (Kim et al., 2021; Pacula et al., 2022; Subbaraman et al., 2020) and none in Canada have investigated the effects of nonmedical cannabis legalization policy on the co-use of cannabis and alcohol. Using data from the US 2004–2017 National Survey on Drug Use, a study by Kim et al. (2021) found increases in past 30-day co-use in US states that have legalized nonmedical cannabis versus states that have not legalized, and these increases were detected among adults overall and were seen across age, race/ethnicity, income, and education subgroups. However, the impacts of legalization were greatest among respondents aged 35–49 years, and greater among women relative to men, with no differences by income, race/ethnicity, or education. Another US study examining the impact of legal cannabis retail stores opening in Washington state observed small increases in any co-use, including both concurrent (i.e., on separate occasions) and simultaneous (i.e., co-ingestion of alcohol and cannabis), in a sample of 5492 adults (Subbaraman et al., 2020). Additionally, stratified results showed a greater prevalence of any alcohol use and heavy use (5+ drinks on one occasion) in past 30-day alcohol drinking measures among cannabis users compared to non-users. Results of a recently published review examining the effects of nonmedical cannabis legalization policy on cannabis use, alcohol use, and co-use observed an association between cannabis legalization and cannabis use among adults and insufficient evidence to conclude that cannabis policy liberalization is associated with increases or decreases in alcohol use or the co-use of cannabis and alcohol (Pacula et al., 2022).

The primary aim of the current study was to examine whether the transition to legal nonmedical cannabis in Canada in 2018 was associated with changes in regular co-use defined as monthly or more frequent (MMF) co-use of cannabis and alcohol in 2019, relative to US states that have previously legalized ("US legal") and have not ("US illegal") legalized nonmedical cannabis. To better understand the population-level patterns of co-use during this time period, we first described the prevalence of a number of past year co-use, cannabis use, and alcohol use indicators separately, in Canada, and US legal and illegal states in 2018 and 2019 and examined the socio-demographic characteristics associated with MMF co-use.

Methods

Study design and sample

The International Cannabis Policy Study (ICPS) aims to examine associations between cannabis legalization in Canada and specific US states using a repeated cross-sectional quasi-experimental study design (Hammond et al., 2020).

Data were collected via self-completed web-based surveys conducted in August–October 2018 and September–October 2019 from respondents aged 16–65. A nonprobability sample of respondents was recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. The Nielsen panels were recruited using a variety of probability and nonprobability sampling methods. For the ICPS surveys, Nielsen drew stratified random samples from the online panels, with quotas based on age and state/province of residence. Nielsen emailed panelists an invitation to access the ICPS survey via a hyperlink; respondents were unaware of the survey topic prior to accessing the link. Respondents confirmed their eligibility and provided consent before completing the survey. Upon completion, respondents were transferred back to the Nielsen platform and received remuneration in accordance with their panel's usual incentive structure. Monetary incentives have been shown to increase response rates and decrease response bias in subgroups under-represented in surveys, including disadvantaged subgroups (Groves et al., 2009).

Surveys were conducted in English in the United States and English or French in Canada. Median survey time was 20 min in 2018 and 25 min in 2019. Data integrity measures included checks for "speeders" based on completion times, the quality of open-ended responses, patterns of "Don't Know/Refusal" responses, and inconsistent responses across items (AAPOR, 2018). As an additional data integrity check, respondents were asked to identify the current month from a list toward the end of the survey to verify survey engagement (Goodman and Hammond, 2019, 2020). In 2018, 44,364 respondents accessed the survey link, of which 28,471 completed the entire survey for a cooperation rate of 64.2%. In 2019, 81,263 respondents accessed the survey link, of which 51,087 completed the entire survey for a cooperation rate of 62.9%.

The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee

(ORE#22392/31330). A full description of the study methods can be found in the ICPS Technical Reports—wave 1 (2018) and wave 2 (2019) (Goodman and Hammond, 2019; Goodman et al., 2020).

Measures

Cannabis use. Cannabis use was categorized into (1) No use (Never, Used more than 12 months ago), (2) Past 12-month use, but less than monthly use, (3) Monthly or weekly use, or (4) Daily or almost daily use. Among those who reported any cannabis use in the past 12 months, MMF cannabis use was categorized into: "Monthly or more frequent cannabis use" versus "Past year use, but less than monthly use."

Alcohol use. Alcohol use was categorized into: "No alcohol use in the past year" (Never in last 12 months) and "Any alcohol use in the past year" (Every day or nearly every day; 3–4 times a week; Once or twice a week; 1–3 times a month; 7–11 times in the last 12 months; 3–6 times in the last 12 months; Twice in the last 12 months; and, Once in the last 12 months).

Among those who reported any alcohol use in the past 12 months, alcohol use was further categorized into: "No monthly alcohol use in the past year" versus "At least monthly alcohol use in the past year."

Average alcohol volume consumed in the past year was derived using the quantity/frequency method. Quantity of alcoholic drinks was assessed by asking, "On those days when you had any kind of beverage containing alcohol, how many drinks did you usually have?" (Enter number of drinks per day) and a definition of "a drink" was provided, and consistent with the Canadian definition of a drink (13.6 g of pure ethanol) (Goodman and Hammond, 2019). The quantity of alcoholic drinks reported was multiplied by the frequency of alcohol use (described above) to calculate the mean number of drinks per week and categorized using Canada's Low-Risk Drinking Guidelines: low volume ($\leqslant$10 for females/$\leqslant$15 for males per week), risky volume (11–19 for females/16–29 for males per week), high risk volume ($\geqslant$20 for females/$\geqslant$30 for males per week), unstated (includes responses Don't know or Refuse to answer) (Goodman and Hammond, 2019).

MMF co-use categorizations. MMF co-use of cannabis and alcohol was defined as respondents who reported at least monthly cannabis use in the past 12 months; and at least monthly alcohol use in the past 12 months. Responses for MMF co-use in past 12 months were categorized into four groups: non-cannabis user/drinker (MMF alcohol-only use); cannabis user/non-drinker (MMF cannabis-only use); cannabis user/drinker (MMF co-use of cannabis and alcohol); and non-cannabis user/non-drinker (no MMF use of cannabis or alcohol). Similar measures and methods of categorizing regular co-use of cannabis and alcohol have been used in previous research (Subbaraman et al., 2020).

All measures and response options used to assess cannabis use, alcohol use, and co-use are summarized in Supplemental Table 1.

Socio-demographics. Socio-demographics included age, gender, race/ethnicity, perceived income adequacy, and highest level of education (see Table 1 for full coding response options).

Respondents with "Unstated," "Don't know," and "Refuse to answer" response options for socio-demographics and "Other" responses for gender were excluded. "Don't Know," "Refuse to answer," "Missing," and invalid responses were removed from all outcome measures.

Statistical analysis

A total of 28,471 respondents completed the survey in wave 1 and 51,087 in wave 2. After removing 1302 respondents in wave 1 and 3340 in wave 2 with invalid responses to data integrity questions, missing data, ineligible country of residence, or residence in DC (due to inadequate sample size for weighting in 2018), 27,169 respondents in wave 1 and 47,747 in wave 2 were retained. Of these, 2012 respondents from 2018 were re-interviewed in 2019 for a separate, longitudinal element of the ICPS and were excluded, and the remaining 45,735 comprised the 2019 cross-sectional sample. Post-stratification sample weights were constructed based on the Canadian and US Census estimates. Separately for Canada and US legal and US illegal states, a raking algorithm was applied to the cross-sectional analytic samples to compute weights that were calibrated to these groupings. Weights were rescaled to the sample size for each jurisdiction. Estimates are weighted unless otherwise specified. Respondents in DC and Michigan were excluded in both waves due to inadequate sample size in 2018 (DC), and a change in nonmedical cannabis legalization from 2018 to 2019 (Michigan). This resulted in 363 respondents being excluded from wave 1 (all from Michigan) and 2413 respondents being excluded from wave 2 (148 respondents from DC, 2265 from Michigan). The final analytic sample included 26,806 respondents in wave 1 and 43,322 in wave 2. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA, 2008).

First, descriptive analyses using logistic (dichotomous outcomes: cannabis use, alcohol use, risky/high risk drinkers) and multinomial (categorical outcome: MMF co-use of cannabis and alcohol) regression models adjusted for gender, age, race/ethnicity, income adequacy, and education were undertaken to explore prevalence trends between years within each jurisdiction. Relative percent differences were calculated by dividing the 2019 prevalence estimates by the 2018 prevalence estimates and *p*-values were reported.

Next, multinomial logistic regression was used to test for associations across jurisdictions, year, the interaction between Jurisdiction $\times$ Year, socio-demographics, and MMF co-use of cannabis and alcohol in the past year. Canada is the reference jurisdiction because of the change in the legal status of cannabis in the study period versus US legal and US illegal states with no change in legal status. To examine the extent to which cannabis use frequency changed among risky and high-risk alcohol drinkers relative to low-risk drinkers between 2018 and 2019, multinomial logistic regression was used to test for associations across year, risky/high risk drinker, the interaction between Year $\times$ Risky/High Risk Drinker, jurisdictions, socio-demographics, and cannabis use frequency groups. Adjusted odds ratios (ORs) using rescaled weights and corresponding 99% confidence intervals (CI) were estimated to quantify associations in multinomial logistic regressions.

Table 1. ICPS sample demographics from Canada, US legal, and US illegal states by year (weighted %, unweighted sample size) (n=70,128[a]).

	Canada (n=25,313)				US legal states (n=25,189)				US illegal states (n=19,626)			
	2018 (10,057)		2019 (15,256)		2018 (7,398)		2019 (17,791)		2018 (9,351)		2019 (10,275)	
	Weighted %	Unweighted n=	Weighted %	Unweighted n=	Weighted %	Unweighted n=	Weighted %	Unweighted n=	Weighted %	Unweighted n=	Weighted %	Unweighted n=
Gender												
Women	49.1	5781	49.2	9250	49.0	4836	49.5	13,015	49.7	5673	50.6	7423
Men	49.7	4178	49.1	5804	49.4	2488	49.2	4564	49.3	3598	48.7	2778
Other	0.7	53	0.4	60	1.1	52	0.3	79	0.6	60	0.1	16
Unstated	0.6	45	1.3	142	0.5	22	1.0	133	0.3	20	0.6	58
Age group												
16–25	18.9	1325	18.8	2251	19.6	762	19.6	2651	19.9	2126	19.9	2043
26–35	20.7	1424	20.9	2863	23.0	1270	23.0	4096	21.5	1270	21.5	2260
36–45	19.6	1538	19.8	3102	17.3	1268	19.4	3506	19.1	1445	19.1	1985
46–55	20.8	2185	19.9	3165	21.7	1570	19.4	3184	20.0	1805	19.8	1763
56–65	20.0	3585	20.6	3875	18.4	2528	18.5	4354	19.5	2705	19.7	2224
Race/ethnicity												
White	77.3	8195	73.2	11,617	76.3	6304	76.0	13,739	76.3	7990	75.9	8122
Mixed/Other	21.4	1735	24.1	3269	21.9	1000	21.5	3612	22.6	1276	23.1	2038
Don't Know	0.3	26	1.1	139	0.7	30	1.2	184	0.3	21	0.5	48
Refuse to Answer	1.0	101	1.6	231	1.1	64	1.3	256	0.8	64	0.5	67
Income adequacy												
Very difficult	8.2	806	9.6	1382	8.9	554	10.2	1966	9.3	817	10.7	1148
Difficult	19.9	2000	22.1	3332	19.5	1423	22.5	4185	22.0	2015	23.2	2,547
Neither easy/difficult	35.9	3593	34.9	5333	32.1	2443	33.1	5828	31.6	2903	33.0	3364
Easy	21.3	2197	19.7	3161	22.8	1715	19.8	3416	22.1	2149	19.0	1901
Very easy	11.2	1183	9.5	1540	13.6	1118	11.0	1876	13.0	1286	11.5	1044
Unstated	3.5	278	4.1	508	3.1	145	3.5	520	2.1	181	2.7	271
Education												
Less than high school	15.4	873	15.4	1241	11.8	358	4.6	646	15.3	1588	12.1	1168
High school	26.6	1548	26.5	2516	15.9	1003	20.1	3,218	19.3	1503	22.5	2271
Some college, associate degree	32.5	4268	32.4	6382	42.0	2567	41.9	7,101	38.0	2793	36.3	3687
Bachelor's or higher	24.7	3309	24.6	4968	29.9	3456	32.9	6740	27.1	3442	28.7	3109
Unstated	0.8	59	1.2	149	0.5	14	0.5	86	0.3	25	0.4	40

ICPS: International Cannabis Policy Study.
[a]Excludes Michigan and the District of Columbia.

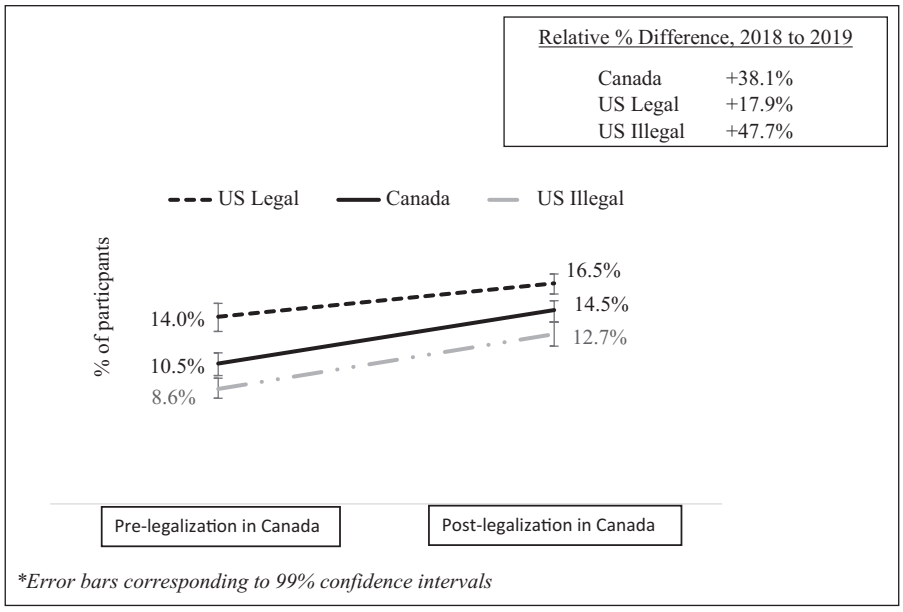

Figure 1. Prevalence of monthly or more frequent co-use in 2018 (pre-legalization in Canada) and 2019 (post-legalization in Canada) in Canada, US legal states, and US illegal states.
*Error bars corresponding to 99% confidence intervals.

Results

The unweighted sample size and weighted percentage for sample characteristics by jurisdiction and year are presented in Table 1.

Prevalence trends in cannabis use, alcohol use, and MMF co-use

Cannabis use. Between 2018 and 2019 in all three jurisdictions, the past year prevalence of *any cannabis use* increased (Canada: 24.2 vs 33.5%; US legal: 31.8 vs 38.8%; US illegal: 20.6 vs 30.4%; $p < 0.0001$ for all), *monthly or weekly cannabis use* increased (Canada: 15.7 vs 21.6%; US legal: 21.6 vs 27.9%; US illegal: 13.9% vs. 21.7%; $p < 0.0001$ for all), and *daily or almost daily cannabis use* increased (Canada: 7.5 vs 9.9%; US legal: 10.5 vs 15.7%; US illegal: 6.0 vs 11.4%; $p < 0.0001$ for all).

Alcohol use. Between 2018 and 2019, the past year prevalence of *any alcohol use* increased in US illegal states (66.6 vs 70.2%; $p < 0.0001$) and Canada (83.1 vs 84.0%; $p = 0.008$), but there was no change in US legal states (77.0 vs 76.9%; $p = 0.50$). Between 2018 and 2019, *at least monthly alcohol use* increased in US illegal states (41.2 vs 43.7%; $p < 0.0001$) and Canada (56.7 vs 57.2%; $p = 0.006$), and decreased in US legal states (52.4 vs 50.4%; $p = 0.88$) but the difference was not statistically significant. Between 2018 and 2019, *risky and high-risk alcohol use* increased in US illegal states (8.8 vs 10.2%; $p = 0.002$), and decreased in US legal states (10.1 vs 9.9%; $p = 0.97$) and Canada (8.8 vs 7.5%; $p = 0.01$) yet the differences were not statistically significant.

MMF co-use categorizations. Between 2018 and 2019, the past 12-month prevalence of *MMF co-use* increased in all jurisdictions (Canada: 10.5 vs 14.5%; US legal: 14.0 vs 16.5%; US illegal: 8.6 vs 12.7%; $p < 0.0001$ for all—Figure 1); *MMF cannabis-only use* increased in all jurisdictions (Canada: 5.1 vs 7.0%; US legal: 7.7 vs 11.2%; US illegal: 5.3 vs 9.0%; $p < 0.0001$ for all); and *MMF alcohol-only use* decreased in US illegal states (32.6 vs 31.0%; $p < 0.0001$), and in US legal states (38.4 vs 33.9%; $p = 0.94$) and Canada (46.2 vs 42.6%; $p = 0.07$), but the difference was not statistically significant, compared to the prevalence of no MMF use of either cannabis or alcohol in each jurisdiction.

Trends in the prevalence of cannabis use, alcohol use, and MMF co-use by jurisdiction and year are presented in Table 2.

Changes in MMF co-use categorizations in US legal and US illegal states compared to Canada. Relative to no regular use, the odds of MMF co-use increased to a similar extent in Canada and US legal (OR = 1.03, 99% CI: 0.81–1.29) and illegal (OR = 1.07, 99% CI: 0.86–1.34) states (Table 3). In 2019, respondents in US illegal states had a 25% greater increase (OR = 1.25, 99% CI: 0.94–1.65) and US legal states had a 2% greater increase (OR = 1.02, 99% CI: 0.76–1.37) in the odds of reporting MMF cannabis-only use versus no MMF use relative to respondents in Canada, although both crossed 1. In 2019, respondents in US illegal states had a 15% greater increase (OR = 1.15, 99% CI: 0.99–1.33) and US legal states had a 33% greater increase (OR = 1.33, 99% CI: 1.12–1.57) in the odds of reporting MMF alcohol-only use compared to no MMF use relative to respondents in Canada, yet the estimate for US illegal states crossed 1. Age, gender, perceived income adequacy, education, and race/ethnicity were associated with MMF co-use overall across jurisdictions and time. Middle aged adults (aged 30–49) had higher odds of MMF co-use (OR = 1.54, 99% CI: 1.38–1.72), MMF cannabis-only use (OR = 1.26, 99% CI: 1.10–1.44), and MMF alcohol-only use (OR = 1.95, 99% CI: 1.78–2.12) relative to no MMF use compared to younger participants aged 16–29. Older aged adult

Table 2. Prevalence in cannabis use, alcohol use, and MMF co-use in past year by jurisdiction and year (n = 67,072[a]).

	Canada (n = 24,035)			US legal states (n = 24,084)			US illegal states (n = 18,953)		
	2018 (n = 9615)	2019 (n = 14,420)	Trend p[b]	2018 (n = 7150)	2019 (n = 16,934)	Trend p[b]	2018 (n = 9046)	2019 (n = 9907)	Trend p[b]
Cannabis use, past year (%)									
Any use	24.2	33.5	<0.0001	31.8	38.8	<0.0001	20.6	30.4	<0.0001
Monthly or weekly use	15.7	21.6	<0.0001	21.6	27.9	<0.0001	13.9	21.7	<0.0001
Daily or almost daily use	7.5	9.9	<0.0001	10.5	15.7	<0.0001	6.0	11.4	<0.0001
Alcohol use, past year (%)									
Any use[c]	83.1	84.0	0.008	77.0	76.9	0.50	66.6	70.2	<0.0001
At least monthly use[c]	56.7	57.2	0.006	52.4	50.4	0.88	41.2	43.7	<0.0001
Risky/high-risk drinkers, past year (%)[d,e]	8.8	7.5	0.01	10.1	9.9	0.97	8.8	10.2	0.002
MMF co-use categorization, past year (%)[c]									
No MMF use of alcohol or cannabis	38.2	35.8	(ref)	39.8	38.4	(ref)	53.5	47.2	(ref)
MMF co-use	10.5	14.5	<0.0001	14.0	16.5	<0.0001	8.6	12.7	<0.0001
MMF cannabis-only use	5.1	7.0	<0.0001	7.7	11.2	<0.0001	5.3	9.0	<0.0001
MMF alcohol-only use	46.2	42.6	0.07	38.4	33.9	0.94	32.6	31.0	<0.0001

MMF: monthly or more frequent.
[a]Excludes Michigan and DC and respondents with *Unstated/Other* response options for gender, *Unstated* for income adequacy, *Unstated* for education and *Don't Know/Refuse to Answer* for Race/Ethnicity.
[b]From regression models adjusted for gender, age group, race/ethnicity, income adequacy, and education.
[c]Excludes Don't know (n = 1448; 2.2%) and Refuse to answer (n = 260; 0.4%) responses.
[d]Excludes respondents that "Did not drink in the past 12 months" (n = 15,073; 22.5%).
[e]Excludes Missing(n = 533; 1.0%) responses (Includes "Unstated" responses; n = 6825, 13.1%).

participants (aged 50–65) had lower odds of MMF co-use (OR = 0.74, 99% CI: 0.66–0.84) and MMF cannabis-only use (OR = 0.82, 99% CI: 0.71–0.93), yet higher odds of MMF alcohol-only use (OR = 1.61, 99% CI: 1.48–1.76) relative to no MMF use compared to younger participants aged 16–29. Compared to men, women had lower odds of MMF co-use (OR = 0.49, 99% CI: 0.45–0.53), MMF cannabis-only use (OR = 0.79, 99% CI: 0.71–0.88), and MMF alcohol-only use (OR = 0.70, 99% CI: 0.66–0.75). Participants with very easy/easy income adequacy had higher odds of MMF co-use (OR = 1.17, 99% CI: 1.05–1.30) and MMF alcohol-only use (OR = 1.30, 99% CI: 1.21–1.40), and lower odds of MMF cannabis-only use (OR = 0.85, 99% CI: 0.74–0.98) compared to those with neither easy nor difficult income adequacy. Those with higher education levels reported higher odds of MMF co-use (OR = 1.34, 99% CI: 1.21–1.48) and MMF alcohol-only use (OR = 1.95, 99% CI: 1.81–2.10), and lower odds of MMF cannabis-only use (OR = 0.81, 99% CI: 0.72–0.90) compared to those with lower education levels. Participants who identified as "other than White" or "mixed" race/ethnicity had lower odds of MMF co-use (OR = 0.78, 99% CI: 0.70–0.87), cannabis-only use (OR = 0.82, 99% CI: 0.72–0.94), and alcohol-only use (OR = 0.67, 99% CI: 0.62–0.73) compared to those who identified as White.

Changes in cannabis use among risky/high-risk consumers compared to low-risk alcohol consumers. In the fully adjusted model, we found that the interaction between year and alcohol use was not statistically significant for the three cannabis use outcomes (OR = 1.37, 99% CI: 0.94–2.01 for any cannabis use, OR = 1.32, 99% CI: 0.83–2.10 for monthly or weekly cannabis use, OR = 1.26, 99% CI: 0.79–2.01 for daily or almost daily cannabis use). However, the results of the main effects suggest considerably higher odds of any cannabis use (OR = 2.47, 99% CI: 1.82–3.35), monthly or weekly cannabis use (OR = 3.23, 99% CI: 2.20–4.74), and daily or almost daily cannabis use (OR = 4.89, 99% CI: 3.29–7.23) relative to no cannabis use among risky and high-risk alcohol consumers compared to low risk consumers across jurisdictions and years.

Discussion

Results of this study found no evidence that the contemporaneous changes in MMF co-use of cannabis and alcohol in US legal or US illegal states differed relative to Canada between 2018 and 2019. In 2018 and 2019, the year prior to and immediately following the legalization of nonmedical cannabis in Canada, the prevalence of MMF co-use of cannabis and alcohol increased in Canada and US legal and illegal states regardless of legal status or legislative change. Increases in co-use across all three jurisdictions between 2018 and 2019 appear to be largely driven by increases in the prevalence of cannabis use. As shown in the descriptive analyses in Table 2, increases were observed in cannabis use indicators across the three jurisdictions between 2018 and 2019, while alcohol indicators remained high with only small changes in both directions in the prevalence of any, at least monthly, and risky and high-risk alcohol use. These observations align with national reports and studies by cannabis legalization status (Cerdá et al., 2020; Rotermann, 2021; SAMHSA, 2021). Increases in cannabis use are potentially driven by changes in public acceptability or risk perceptions of cannabis. For example,

Table 3. Results of multinomial regression assessing changes in MMF co-use between 2018 and 2019 in US legal and US illegal states compared to Canada.

	MMF co-use vs no regular use Weighted AOR[a] (99% CI)	MMF cannabis-only use vs no regular use Weighted AOR[a] (99% CI)	MMF alcohol-only use vs no regular use Weighted AOR[a] (99% CI)
Year × Jurisdiction			
2019 × US (illegal)	1.07 (0.86, 1.34)	1.25 (0.94, 1.65)	1.15 (0.99, 1.33)
2019 × US (legal)	1.03 (0.81, 1.29)	1.02 (0.76, 1.37)	**1.33 (1.12, 1.57)**
Year			
2018	1.00 (ref)	1.00 (ref)	1.00 (ref)
2019	**1.33 (1.14, 1.55)**	**1.32 (1.07, 1.62)**	1.00 (0.90, 1.11)
Jurisdiction			
Canada	1.00 (ref)	1.00 (ref)	1.00 (ref)
US (illegal)	**0.61 (0.51, 0.73)**	**0.74 (0.59, 0.93)**	**0.53 (0.47, 0.60)**
US (legal)	1.01 (0.82, 1.23)	**1.39 (1.07, 1.80)**	**0.56 (0.48, 0.65)**
Age group			
16–29	1.00 (ref)	1.00 (ref)	1.00 (ref)
30–49	**1.54 (1.38, 1.72)**	**1.26 (1.10, 1.44)**	**1.95 (1.78, 2.12)**
50–65	**0.74 (0.66, 0.84)**	**0.82 (0.71, 0.93)**	**1.61 (1.48, 1.76)**
Gender			
Man	1.00 (ref)	1.00 (ref)	1.00 (ref)
Woman	**0.49 (0.45, 0.53)**	**0.79 (0.71, 0.88)**	**0.70 (0.66, 0.75)**
Income adequacy			
Neither easy nor difficult	1.00 (ref)	1.00 (ref)	1.00 (ref)
Very difficult/difficult	0.95 (0.86, 1.05)	1.10 (0.98, 1.24)	**0.85 (0.79, 0.92)**
Very easy/easy	**1.17 (1.05, 1.30)**	**0.85 (0.74, 0.98)**	**1.30 (1.21, 1.40)**
Education			
High school or lower	1.00 (ref)	1.00 (ref)	1.00 (ref)
Some college or higher	**1.34 (1.21, 1.48)**	**0.81 (0.72, 0.90)**	**1.95 (1.81, 2.10)**
Race/ethnicity			
White	1.00 (ref)	1.00 (ref)	1.00 (ref)
Other/mixed	**0.78 (0.70, 0.87)**	**0.82 (0.72, 0.94)**	**0.67 (0.62, 0.73)**

MMF: monthly or more frequent; AOR: adjusted odds ratio; CI: confidence interval.
[a]Adjusting for the covariates: gender, age group, race/ethnicity, income adequacy, and education.
Bold values are significant at $p < .01$.

as medical and nonmedical cannabis laws have liberalized over the past two decades in Canada and the US, perceived access to cannabis has increased, perceived harmfulness of cannabis has decreased, and public support for cannabis legalization has risen across age groups, while similar measures for alcohol have remained relatively stable (Levy et al., 2021; Rotermann, 2021; Waddell, 2022).

Prior work examining the effects of nonmedical cannabis legalization observed increases in population level co-use following legalization (Kim et al., 2021; Subbaraman et al., 2020). Findings from a recent study by Kim et al. (2021) using a representative population dataset showed respondents in US legal states had 25% higher odds of reporting past- 30-day co-use relative to US illegal states. This US study did not find evidence of an association between cannabis legalization and shifts in past 30-day cannabis-only use, yet observed a significant decrease in the prevalence of past 30-day alcohol-only use. Conversely, the current study observed only small differences in the change in MMF co-use or cannabis-only use relative to no MMF use across the three jurisdictions. Physical retail access to legal cannabis had not yet been established in most of Canada at the time of the post-legalization data collection in the current study in 2019; therefore, increases in access to legal cannabis were yet to be fully realized in Canada. This may in part explain the small differences in co-use and cannabis-only use in the United States compared to Canada. Instead, results suggest a 33% greater increase in MMF alcohol-only use relative to no MMF use in US legal states compared to Canada between 2018 and 2019. As shown in the descriptive analyses in Table 2, the prevalence of any alcohol use remained high in the three jurisdictions, with small changes in both directions in the prevalence of at least monthly alcohol use and risky/high-risk alcohol use. These results echo the complex picture regarding co-use and complementarity versus substitution of the two substances observed in two reviews examining the impacts of cannabis policy liberalization in the United States on alcohol-specific outcomes (Guttmannova, 2016; Risso et al., 2020). Future research is required to better understand the impacts of cannabis legalization in Canada on the prevalence of MMF co-use over the longer term, as well as the impacts on cannabis use, alcohol use, and health harms from both substances, which are not apparent one year after legalization given the lag in opening markets after laws have passed and time required for markets to mature.

Table 4. Results of multinomial regression assessing changes in cannabis use frequency among risky and high-risk alcohol consumers compared to low risk consumers.[a]

	Any cannabis use vs no cannabis use Weighted AOR[b] (99% CI)	Monthly or weekly cannabis use vs no cannabis use Weighted AOR[b] (99% CI)	Daily or almost daily cannabis use vs no cannabis use Weighted AOR[b] (99% CI)
Year × Alcohol Use			
2019 × Risky/High Risk Drinker	*1.37 (0.94, 2.01)*	*1.32 (0.83, 2.10)*	*1.26 (0.79, 2.01)*
Year			
2018	1.00 (ref)	1.00 (ref)	1.00 (ref)
2019	**1.18 (1.08, 1.28)**	**1.20 (1.05, 1.37)**	**1.46 (1.27, 1.68)**
Alcohol Use			
Low risk use	1.00 (ref)	1.00 (ref)	1.00 (ref)
Risky/high risk use	**2.47 (1.82, 3.35)**	**3.23 (2.20, 4.74)**	**4.88 (3.29, 7.23)**

AOR: adjusted odds ratio; CI: confidence interval.
[a]Excludes respondents that "Did not drink in the past 12 months" ($n = 15{,}073$; 22.5%).
[b]Adjusting for the covariates: jurisdiction, gender, age group, race/ethnicity, income adequacy, and education.
Bold values are significant at $p < .01$.

There were associations between MMF co-use overall (not the impact of legalization on co-use) and socio-demographic indicators. Higher odds of MMF co-use were associated with being aged 30–49 compared to 16–29 years, reporting easy or very easy perceived income adequacy, and having a college education or higher, and lower odds of MMF co-use were associated with being a woman, aged 50–65 compared to 16–29, and reporting mixed/other ethnicity compared to White. These predictors of co-use are in line with prior research assessing co-use among adults in the United States (Subbaraman et al., 2015). Moreover, as shown in Table 4, increases in the past year prevalence of any, monthly or weekly, and daily or almost daily cannabis use among risky/high risk alcohol consumers relative to low-risk consumers were approaching significance. These findings are consistent with previous evidence suggesting the co-use of alcohol and cannabis is associated with more frequent and high-volume substance use (Gunn et al., 2022; Subbaraman et al., 2015; Yurasek et al., 2017). Other studies have consistently found simultaneous use of cannabis and alcohol to be more strongly associated with heavier alcohol use and more negative consequences and harms compared to concurrent use or alcohol use only (Gunn et al., 2022; Kerr et al., 2017, 2018; Metrik et al., 2018). Examining simultaneous separate from concurrent co-use was not possible in the current study, but should be a priority in future research.

Strengths and limitations

The International Cannabis Policy Study benefits from several strengths, including a large sample size, validated measures, and data in multiple jurisdictions in both the United States and Canada pre- and immediately following legalization in Canada. The data and timing permit the investigation of how changes in cannabis and alcohol co-use over time are associated with the rollout of cannabis legalization in Canada. The authors know of no other study or dataset in Canada, and few internationally, that include individual-level cannabis and alcohol use measures from both before and after legalization of nonmedical cannabis. Previous studies on co-use have largely investigated alcohol use among medical cannabis patients, or people in alcohol treatment (Gunn et al., 2022; Guttmannova et al., 2016; Karoly et al., 2021), whereas the current study examines co-use across the general population. Therefore, results of the current study are likely more relevant to public health and other jurisdictions considering legalizing nonmedical cannabis. Although this study included a large sample in Canada, US legal, and US illegal states, respondents were recruited using nonprobability-based sampling; therefore, it does not necessarily represent the entire population in these three jurisdictions. For example, the data collection did not include the three northern Canadian territories with the highest rates of cannabis use and alcohol use in Canada (Hammond et al., 2021). The Canadian territories are excluded from most national surveys in Canada due to the methodological challenges and costs of conducting population-based surveys in these small remote jurisdictions. In addition, the current study focused on nonmedical cannabis laws (US "legal" vs US "illegal"); however, cannabis policies vary by US legal state, and some "US illegal" states have medical cannabis laws. There is also variation in how the markets are regulated in the jurisdictions where cannabis is legal. This variation was not investigated in this study, and by grouping together jurisdictions with broadly similar policies, changes in co-use in some population subgroups or jurisdictions may have been overlooked. Future research should explore how the regulation of nonmedical cannabis markets is associated with levels of use, co-use, and harm to inform optimal regulatory approaches to protect public health. These should also draw on evidence of regulations (e.g., availability, marketing) for other substances such as alcohol and tobacco. For example, although alcohol is widely available and heavily marketed in both the United States and Canada, a notable limitation is that the current study did not account for concurrent changes in alcohol policies in individual jurisdictions that could also have influenced alcohol use. Lastly, similar to published co-use studies and government data standards for deriving regular alcohol use, the current study focused on MMF use and co-use of cannabis and alcohol as an indicator of regular mid-level co-use (Pacula et al., 2022; Statistics Canada, 2017). These measures may be considered infrequent by some and, on their own, are not an indicator of problematic use. Future studies focusing on higher risk patterns of co-use or problematic indicators are warranted.

Conclusion

The current study is the first in Canada to measure associations between the transition to legalized nonmedical cannabis and the co-use of cannabis and alcohol in the population; it may serve as a reference point for future studies examining changes in co-use. Increases in MMF co-use of cannabis and alcohol were seen 1-year following legalization of nonmedical cannabis in Canada, however similar trends were also seen in US legal and US illegal states, indicating these shifts may be the result of increasing cannabis use in the broader population as well as changing norms and attitudes to cannabis generally. There was no evidence of an increase in alcohol use overall over the study period, but there were small changes in alcohol indicators in both directions. This echoes the complex picture regarding complementarity versus substitution of the two substances identified in previous research. As the cannabis legalization transition in Canada matures, further evaluation over the longer term will allow for a better understanding of the effects of this policy change on co-use and should be subject of future studies.

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Supplemental material

Supplemental material for this article is available online.

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