Correlates of Perceived Harmfulness of Regular Cannabis Use among Canadian University Students Before and After Legalization

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ABSTRACT

Objective: Among a prospective sample of Canadian university students, this study aimed to: 1) document changes in cannabis use and perceived harmfulness of use before and after the legalization of recreational cannabis; 2) examine correlates of perceived harmfulness; and 3) explore changes in perceived harmfulness as a function of cannabis use patterns. **Method:** A random sample of 871 students at one western Canadian university were assessed pre- and post-legalization of recreational cannabis. Descriptive and inferential statistics were used to explore changes in cannabis use and perceived harmfulness. A random effects model was developed to assess whether cannabis legalization was associated with perceptions of harmfulness of regular cannabis use. **Results:** Twenty-six percent of the sample used cannabis during the past three months at both timepoints. The majority of the sample perceived regular cannabis use as a high-risk behaviour at each timepoint (57.3% and 60.9%, respectively). Results from the random effects model showed that after controlling for covariates, cannabis legalization was not associated with changes in perceived harmfulness. Perceptions of harm remained relatively stable regardless of cannabis use pattern. Respondents who endorsed cannabis use at both timepoints reported a significant increase in their frequency of cannabis use post-legalization. **Conclusions:** Legalization of cannabis for recreational use was not associated with substantive changes in perceptions of harm among post-secondary students, yet it might lead to increases in cannabis use among those who already use the substance. Ongoing monitoring of policies is needed, as are targeted public health initiatives to identify post-secondary students who are at risk for cannabis-related consequences.

Key words: = cannabis use; young adults; cannabis legalization; perceived risk; post-secondary students

In 2018, Canada passed Bill C-46, becoming the second country to legalize recreational cannabis use for adults. Of significant interest from a public health standpoint is whether the legalization of cannabis for recreational use promotes permissive norms or is associated with changes in the incidence, prevalence, or patterns of cannabis use among youth. In a study of cannabis use among post-secondary students at Washington State University, Miller et al. (2017) found an increase in the frequency of use following legalization of recreational cannabis. In a similar study, Kerr et al. (2017) compared students attending studies in Oregon, a state where cannabis was legalized for non-medicinal use in 2015, to students attending universities in states

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where recreational cannabis use remained illegal (n = 12, 963) via repeated cross-sectional surveys. The authors found that a significant trend existed from 2012 – 2016, with students reporting increases in cannabis use at six of the seven universities included in the study. Students attending studies in Oregon demonstrated the largest increase in use, although this only occurred among those who had endorsed recent heavy use of alcohol.

In a subsequent study of a large sample from US states that had recently legalized marijuana, Cerdá and colleagues (2020) found a significant increase in the prevalence of cannabis use disorder (CUD)[1] among adolescents ages 12 to 17 from pre- to post-legalization. The authors also found a significant increase in the frequency of past month cannabis use as well as an increase in CUD among adults aged 26 and older. There was, however, no increase in frequency of cannabis use among adolescents, nor was there any significant changes in frequency of use or CUD among 18- to 25-year-olds. In another study in Washington State completed by Kilmer et al. (2022), the authors found an increase in cannabis use and CUD symptomology following the legalization of non-medicinal cannabis among a sample of 12,963 young adults, ages 18 – 25.

Whether or not legalization of cannabis for personal use results in an increase in consumption is not a trivial concern. Research has shown that up to 30% of those who use cannabis develop CUD (Hasin et al., 2015), with the risk being even higher among those who initiate cannabis use early in adolescence (Volkow et al., 2021), and among those who use cannabis more frequently (Curran et al., 2019; Simpson et al., 2021; Steeger et al., 2021). Thus, if cannabis use increases, it is expected that the prevalence of CUD will increase as well. Further, there have been substantial increases in THC potency in recent years (Chandra et al., 2019), prompting concerns about the possible adverse impacts of high-potency THC products on risk for CUD, neurocognitive functioning, and mental health (e.g., Stuyt, 2018). Frequent cannabis use has also been associated with negative outcomes including increased risk of psychosis, poorer academic achievement, and increased risk of respiratory issues such as chronic cough (National Academies of Sciences, Engineering and Medicine, 2017).

Among all age groups, youth and young adults (those between the ages of 18 and 25) are the most likely to use cannabis. Recent findings from a national Canadian survey showed that the prevalence of using cannabis during the past three months was twice as high among adolescents ages 15 to 24 as it was for adults 25 and older (i.e., 30% versus 16%, respectively; Government of Canada, 2019). Cannabis use during these developmental periods might have particularly deleterious effects given that adolescence and young adulthood are stages marked by ongoing neuromaturation (Lubman et al., 2015).

Beyond age and legal status, factors that have been shown to increase the odds of using cannabis are complex and include environmental factors such as parental permissiveness and experiences of childhood adversity (Bogdan et al. 2016), and individual traits such as higher impulsivity, antisociality, and sensation seeking (Scheier & Griffin 2021). Perceptions of cannabis risk also appear to influence choices regarding use. For example, Franelić and colleagues (2011) found that perceived availability of cannabis and perceived use among peers were among the largest correlates of cannabis use in an international sample of adolescents ages 15 to 16. At a population level, declining perceptions of harmfulness have been associated with increased prevalence of cannabis use (Compton et al., 2016; Keyes et al., 2016; Terry-McElrath et al., 2017). This association was shown to be most robust among male cannabis users, who rated harms associated with cannabis use as being less risky, while endorsing higher levels of cannabis use than females (Hellemans et al., 2019).

There has been a gradual decline over the last two decades in perceived harmfulness with a growing majority of youth and adults reporting that cannabis use possesses minimal to no risk. For example, Compton and colleagues (2016) reported that among US high school students, there was a significant decline from 50.4% in 2004 to 33.3% in 2014 in perceived cannabis risk, a finding consistent with Cerdá and colleagues who found a decline in perceived harmfulness among an adolescent sample following legalization (Cerdá et al., 2017). Yet, the results are mixed on the issue of legalization and its subsequent effect on perceptions of harmfulness, and it is unclear

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[1]CUD is a condition marked by a loss of control of use, engagement of use in risky situations/contexts, physiological dependence (e.g., tolerance, cravings and withdrawal) and social impairment (American Psychiatric Association, 2022).

what effect the declining perception of harmfulness is having on rates of cannabis use. For example, in a US sample of youth ages 16 to 19, Wadsworth and Hammond (2018) found no significant difference in perceptions of harm between those who resided in states where cannabis was legal for recreational use versus those who resided in states where it was illegal. Sarvet and colleagues (2018) found that while perceived risk declined substantially among a nationally representative sample of twelfth graders in the US, there has not been an appreciable change in cannabis use in recent years. Despite some divergence in findings from studies, changes in estimated harm related to cannabis consumption has been suggested to be a key indicator to monitor for jurisdictions and countries who have legalized the substance for retail sale (Wallingford et al., 2019).

Continuous monitoring of perceived harmfulness is needed as findings might provide important insights regarding public perceptions towards cannabis, perceptions which in turn could impact consumer choices or patterns of use. Furthermore, much of the research on legalization policies has focused on US states where cannabis has been legalized for medicinal or recreational use, while little research has been completed regarding the effect of Canada's national legalization policy on cannabis use and perceived harmfulness (Turna et al., 2021). To build on the existent literature, this study surveyed a sample of Canadian university students before and after the country's legalization of recreational cannabis to: 1) document changes in cannabis use and perceived harmfulness of cannabis use before and after legalization; 2) examine correlates of perceived harmfulness; and 3) understand subgroup variation in changes of perceived harmfulness.

METHODS

Study Design

In March 2018, 4,000 University of Calgary students were randomly selected by the university Registrar's Office and invited via email to complete an online survey before the legalization of recreational cannabis. The legalization of cannabis had been announced by the Government of Canada well before students were invited to participate in the survey. This change in national drug policy was widely covered in the news and media, and it was common knowledge that non-medicinal cannabis would be legal in October 2018. The email inviting to students to participate directly referenced the upcoming legalization, and it was assumed all students were aware of the change in the legal status of cannabis while completing the survey.

Although cannabis was legalized nationally in Canada in October 2018, each province was responsible for the oversight and regulation of the retail sales of the substance. In Alberta, where the University of Calgary is located, the legal minimum age for purchasing recreational cannabis is 18 years old. Cannabis can only be purchased legally in Alberta via licensed retailers or by ordering online from *Alberta Cannabis*, a website operated and owned by the Alberta Gambling, Liquor and Cannabis Agency. In addition to variation in policies, important differences exist provincially with respect to cannabis use and consumption. For instance, a national survey completed pre-legalization found Albertans were among the highest consumers of cannabis, with residents of British Columbia and Nova Scotia holding the second highest and highest rates of consumption, respectively (Government of Canada, 2017).

To be eligible for participation in the study, students had to be 18 years or older and enrolled in at least one university class on campus. The response rate for the Time 1 (pre-legalization) survey was 55%, with 2,212 individuals choosing to participate. All Time 1 respondents were given the option of completing a future survey, and 1,202 respondents (54%) agreed to be contacted. All respondents who completed the Time 1 survey and consented to be contacted were eligible to participate regardless of student status at Time 2 (post-legalization). In March 2019 (approximately six months post-legalization), an email was sent to these 1,202 individuals, and 890 (74%, or 40% of the original Time 1 sample) chose to participate in the second survey. Of these respondents, 19 cases were dropped due to missing values on key variables (i.e., frequency of cannabis use at Time 2), resulting in an analytic sample of 871.

The study was approved by the University of Calgary Conjoint Health Research Ethics Boards (REB18-0184). The recruitment methods employed in this study followed the protocols described by Dillman et al. (2014). For both surveys, four

reminders were sent via email over a period of six weeks. Informed consent was obtained prior to each survey, and respondents were provided with a gift card as an honorarium for their time ($10 for the pre-legalization survey and $15 for the post-legalization survey). The incentive for the post-legalization survey was increased to maximize participation and reduce attrition.

Transparency and Openness

The data for this study represent a portion of a larger dataset that was collected as part of the University of Calgary's Campus Experience with Cannabis Study. Two papers have been published from this study, both of which described cross-sectional data collected via the pre-legalization survey in March 2018 (Mader et al., 2019 & Smith et al., 2019). No findings from the post-legalization survey were presented in those studies, as the follow-up survey had not been sent yet to participants. All de-identified data, analysis code, and research materials are available upon request. This study's design and its analysis were not pre-registered, and sample size was not calculated in advance to data collection or analysis.

Measures

Frequency of cannabis use. At both Time 1 and Time 2, frequency of cannabis use in the past three months was measured using the second item of the World Health Organization's Alcohol, Smoking and Substance Involvement Screening Test (WHO ASSIST Working Group, 2002). Specifically, respondents were asked "In the past three months, how often have you used cannabis products (marijuana, pot, grass, hash, etc.)"? Possible responses to this item were *Never, Once or Twice, Monthly, Weekly,* or *Daily or Almost Daily.* To explore changes in perceptions of harmfulness based on patterns of cannabis use, we later created a composite variable where respondents were grouped based on their endorsement of past three month use at Time 1 and Time 2. The four groups were: "Abstinence" (respondents who did not report use at either time point); "Initiation/re-initiation" (respondents who only endorsed past three-month use at Time 2); "Persistent" (respondents who endorse past three-month use at both time points); and "Cessation" (respondents who endorsed past three-month use at Time 1 but not Time 2).

Perceived Harmfulness of Regular Cannabis Use. Respondents' estimation of the harm associated with regular cannabis use was measured using an item from the Monitoring the Future survey (Inter-University Consortium for Political and Social Research, 2018). This item asked respondents to indicate how much people risk harming themselves (physically or in other ways) if they smoke marijuana regularly. The ordinal response options for this item were *No risk, Slight risk, Moderate risk, Great risk,* or *Can't say.* Later, we dichotomized respondents' responses to perceived harmfulness by collapsing "no risk" and "slight risk" into one category representing lower perceived risk, and "moderate" and "great risk" into another representing higher perceived risk. Recoding was done to simplify the statistical analyses, as this allowed for the use of logistic model versus multinomial. Respondents who selected "can't say" were treated as missing in the analyses.

Socio-demographic characteristics. Demographic information was collected at both Time 1 and Time 2. Respondents were asked their age at Time 1 and a composite variable was created for Time 2 where 1 year was added to each case. Respondents were asked to indicate their gender at Time 1 by selecting from one of three categories (female, male, and other). Only five respondents in the analytic sample selected "other" for gender and because there were so few cases for this category, these values were treated as missing for the analyses. Maternal education served as a proxy measure for socioeconomic status. Respondents were asked to indicate their mother's highest level of completed education via an ordinal item at Time 1, with possible responses ranging from no schooling to a professional/doctoral degree. Student status was measured at Time 2. Part-time and full-time statuses at Time 2 were later collapsed into one larger category, with enrolled in academic studies serving as the reference. Student status was not measured at Time 1 as the sample was drawn from a student population enrolled in classes at the University of Calgary. Respondents were asked to indicate their race/ethnicity at Time 2 by selecting from a comprehensive list of racial/ethnic categories. Due to the preponderance of respondents identifying as White or Asian, race/ethnicity was collapsed into three categories (White, Asian, and

Other race/ethnicity groups). Data on employment status was collected at Time 2, where respondents were asked if they were unemployed, employed part time, or employed full time.

Analytical Plan

To evaluate if changes occurred pre- and post-legalization, the analytic sample was limited to respondents who participated in both the Time 1 and Time 2 surveys ($n = 871$). The first step in the analysis was to assess the degree of attrition bias by comparing the sample of individuals who participated in both surveys to the sample who only completed the initial survey. Second, respondents were classified into one of four patterns based on their reported cannabis use at Time 1 and Time 2: abstinence, initiation/re-initiation, persistence, and cessation. Third, descriptive statistics were used to understand changes in cannabis use and perceived harmfulness of regular cannabis use. Fourth, to explore if intergroup differences existed based on pattern of cannabis use and changes in perceived harmfulness between Time 1 and Time 2, four McNemar Tests were completed, one for each of the four patterns.

Finally, we developed a random effects (RE) model (Laird & Ware, 1982) to evaluate the association between student status, age, gender, race/ethnicity, frequency of cannabis use, time (pre- versus post-legalization), and perceived harmfulness of regular cannabis use. We did not control for employment status, as this information was only collected at Time 2. When repeated measurements are collected for each subject, the observations at different time points tend to be correlated. RE modeling was chosen as it accounts for this correlation and produces statistically efficient estimates with correct standard errors (Laird & Ware, 1982). The structure of RE model is selected based on Bayesian Information Criterion (BIC; Schwarz, 1978). The BIC statistic balances model parsimony with model fit, with lower BIC statistics suggesting a better model.

For the RE model, observations for repeated measures collected at Time 1 and Time 2 were combined into composite variables. This was done for both perceived harmfulness and frequency of use. This allowed for intra-subject correlation to be estimated (e.g., correlations within subject at Time 1 and Time 2) and adjusted for when producing estimates. Time was added as a variable and was entered into the model to explore if there were changes in perceptions of harmfulness pre and post legalization. The dependent variable entered into the RE model was perceived harmfulness of regular cannabis use at Time 1 and Time 2. Forty-five cases were dropped from the analysis as they endorsed "can't say" when asked to evaluate risk at either Time 1 or Time 2. An additional 8 respondents were excluded due to missing values for gender (4), race/ethnicity (3), and age (1). This left a total of 818 complete cases to be included in the model. Given the exploratory nature of the study, we also investigated if there were any significant interaction effects using time (pre- and post-legalization), frequency of cannabis use, gender, ethnicity, and student status. Analyses were conducted using IBM SPSS Statistics 25 and STATA SE 15.1. Given the number of inferential tests and comparisons being made, alpha was set to .01.

RESULTS

Attrition Analysis

Compared to the students who only participated in the Time 1 survey ($n = 1322$), the analytic sample had a significantly greater proportion of females (53.6% versus 62.3%, respectively; $X^2 = 15.4$, $p < .001$). Respondents in the analytic sample were also, on average, one year younger than those who only participated in the Time 1 survey (22.7 versus 23.5, respectively; $t = 3.32$, $p = .001$). The prevalence of lifetime cannabis use at Time 1 was significantly higher among respondents who completed both surveys (55.3%) compared to those who only completed the Time 1 survey (49.2%; $X^2 = 5.3$, $p = .02$). These respondents also demonstrated greater frequency of past three-month cannabis use at Time 1 when compared to respondents who did not complete the Time 2 survey ($U = 4.2$, $p < .001$). The groups did not differ with respect to maternal education.

Sample Characteristics

Table 1 presents the characteristics of the total sample as well as respondents stratified by pattern of cannabis use. The majority of the sample

Table 1. *Sample Characteristics*

Variable	Total sample (*n* = 871)	Abstinence (*n* = 488)	Initiation/ re-initiation (*n* = 100)	Persistent (*n* = 231)	Cessation (*n* = 52)
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Gender (n, % female)	543 (62.3)	318 (65.2)	62 (62)	128 (55.4)	35 (67.3)
Ethnicity					
White	469 (53.8)	228 (46.7)	58 (58)	153 (66.2)	30 (57.7)
Asian (South and East Asian)	308 (35.4)	211 (43.2)	32 (32)	50 (21.6)	15 (28.8)
Other	91 (10.4)	47 (9.6)	10 (10)	27 (11.7)	7 (13.5)
Maternal education					
<High school	68 (7.8)	45 (9.2)	6 (6)	13 (5.6)	13 (25)
High school	119 (13.7)	60 (12.3)	12 (12)	38 (16.5)	9 (17.3)
Some technical school, college, or university	129 (14.8)	63 (12.9)	24 (24)	36 (15.6)	6 (11.5)
Completed technical school	67 (7.7)	43 (8.8)	5 (5)	13 (5.6)	6 (11.5)
Completed college or university	360 (41.3)	204 (41.8)	36 (36)	99 (42.9)	21 (40.4)
Professional or graduate degree	127 (14.6)	73 (15.0)	16 (16)	32 (13.9)	6 (11.5)
Time 2 Employment status					
Full-time employment	170 (19.5)	79 (16.2)	17 (17)	61 (26.4)	13 (25)
Part-time employment	330 (37.9)	180 (36.9)	47 (47)	81 (35.1)	22 (42.3)
Time 2 Student status					
Full-time academic studies	615 (70.6)	366 (75)	70 (70)	149 (64.5)	30 (57.7)
Part-time academic studies	36 (4.1)	19 (3.9)	3 (3)	13 (5.6)	1 (1.9)
Not employed, nor enrolled in academic studies at Time 2	43 (4.9)	29 (5.9)	2 (2)	8 (3.5)	4 (7.7)
Past three-month cannabis use at Time 1 (pre-legalization)					
Never	588 (67.5)	488 (100)	100 (100)	-	-
Once or twice	124 (14.2)	-	-	90 (39)	34 (65.4)
Monthly	65 (7.5)	-	-	52 (22.5)	13 (25)
Weekly	52 (6.0)	-	-	49 (21.2)	3 (5.8)
Daily or almost daily	42 (4.8)	-	-	40 (17.3)	2 (3.8)
Past three-month cannabis use at Time 2 (post-legalization)					
Never	540 (62.0)	488 (100)	-	-	52 (100)
Once or twice	147 (16.9)	-	67 (67)	80 (34.6)	-
Monthly	46 (5.3)	-	12 (12)	34 (14.7)	-
Weekly	71 (8.2)	-	15 (15)	56 (24.4)	-
Daily or almost daily	67 (7.7)	-	6 (6)	61 (26.4)	-
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Time 2 Age	23.7 (4.7)	24.0 (5.4)	22.8 (3.5)	23.7 (3.9)	22.9 (2.8)

was female (62.3%), and slightly more than half of the respondents were White. Most respondents indicated at Time 2 that they were enrolled in full-time studies (70.6%), while a minority endorsed taking classes part-time (4.1%).

Cannabis Use

The largest pattern of use was abstinence, with 56.0% of the sample reporting no cannabis use at either time point. The second most common pattern was persistent, with 26.5% of cases having endorsed cannabis use in the three months preceding the pre- and post-legalization surveys. Eleven percent were classified under the

initiation/re-initiation pattern[2], while 6.0% reported use at Time 1 but not at Time 2.

With respect to changes in frequency of cannabis consumption, we compared frequency among respondents those who endorsed a persistent pattern of use (i.e., endorsed cannabis use in the past three months at both time points; *n* = 231). A significant increase was observed at Time 2 when compared to Time 1 (*W* = 3.5. *p* = .001), indicating there was an increase in frequency of use post-legalization among this group. As seen in Table 1, the proportion of those with a persistent pattern of use showed an increase in cannabis *daily or near daily* from 17.3% at Time 1 to 26.4% at Time 2.

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[2]71% of students categorized as initiators/re-initiators endorsed having used cannabis in their lifetime at Time 1 but did not report having used cannabis in the three months preceding the pre-legalization survey.

Table 2. *Perceived Harmfulness Based on Pattern of Cannabis Use Pre- to Post-Legalization*

	Total Sample (n = 871)				Abstinence (n = 488)				Initiation/re-initiation (n = 100)				Persistent (n = 231)				Cessation (n = 52)			
	Time 1		Time 2		Time 1		Time 2		Time 1		Time 2		Time 1		Time 2		Time 1		Time 2	
Perceived Harm	N	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
No risk	93	10.7	73	8.4	18	3.6	10	2.0	12	12.0	8	8.0	56	24.2	49	21.2	7	13.2	6	11.3
Slight risk	249	28.6	250	28.7	93	19.0	100	20.5	35	35.0	38	38.0	103	44.6	96	41.5	18	34.0	16	30.2
No or slight risk, combined		39.3		37.1		22.7		22.5		47.0		46.0		68.8		62.8		48.1		42.3
Moderate risk	297	34.1	346	39.7	183	37.5	212	43.4	35	35.0	41	41.0	57	24.7	72	31.2	22	41.5	21	39.6
Great risk	202	23.2	185	21.2	173	35.5	153	31.4	13	13.0	12	12.0	12	5.2	12	5.2	4	7.5	8	15.1
Moderate or great risk, combined		57.3		60.9		73.0		74.8		48.0		53.0		29.9		36.4		50.0		55.8
Can't say*	30	3.4	17	2.0	21	4.3	13	2.7	5	5.0	1	1.0	3	1.3	2	0.9	1	1.9	1	1.9

*Participants were categorized into the patterns of use based on their reported cannabis use: "Abstinence" (those who endorsed no past three-month use at Time 1 or Time 2); "Initiation/re-initiation" (those who only endorsed past three-month use at Time 2); "Persistent" (those who endorsed past three-month use at both Time 1 and Time 2); Cessation" (those who endorsed past three-month use at Time 1 but not Time 2)

Participants who selected "can't say" for perceived harm at either time point were excluded from the McNemar's Tests and the RE model.

Perceived Harmfulness Pre- and Post-Legalization

Table 2 presents respondents' perceptions of harm pre- and post-legalization. At both Time 1 and Time 2, the majority of the sample perceived regular cannabis use as being high risk (57.3% and 60.9%, respectively). Without controlling for covariates, there was no significant difference between Time 1 and Time 2 regarding perceived harmfulness of regular cannabis use ($W = .72$, $p = .47$). The Persistent group demonstrated the largest change in perceptions of harmfulness, with 6.5% more individuals endorsing that regular cannabis carried moderate or great risk at Time 2. However, McNemar tests revealed no significant within-group changes existed in perceptions of harmfulness based on pattern of use (Abstinence, $p = 0.919$; Initiation/re-initiation, $p = 1.000$; Persistent $p = 0.104$; Cessation $p = 0.791$).

Random Effects Model

The best fitting model was selected using the BIC statistic and is presented in Table 3. A significant intraclass correlation coefficient (ICC) was found 0.57 (95% CI: 0.48-0.65, p < .001), indicating that a moderate correlation existed among observations from each student.

Of the variables included in the model, cannabis use frequency and ethnicity were significantly associated with perceptions of harm. Specifically, frequency of cannabis use was inversely related to perceived harmfulness, such that more frequent consumers were less likely to endorse higher perceived risk. Similarly, White respondents demonstrated significantly lower perceptions of risk when compared to Asian students. Although Time 2 had the third largest effect size (Odds Ratio = 1.41), it was not found to be a significant predictor of perceived harmfulness (p = 0.03). No significant interaction effects were observed.

DISCUSSION

In this Canadian university sample, no changes in the perceived harmfulness of regular cannabis use were observed pre- to post-legalization of recreational cannabis. Approximately one-quarter of the sample endorsed having used cannabis in the prior three months at both time points; these participants also reported a significant increase in self-reported frequency of cannabis use from pre- to post-legalization. In terms of perceptions of harmfulness, those who had abstained at both

Table 3. *Factors Associated with Higher Perceived Harmfulness of Cannabis Pre- and Post-Legalization*

Variables	Odds Ratio	95% CI	SE	*p*-value
Legal status				
Time 1 (Pre-legalization)	Ref	-	-	-
Time 2 (Post-legalization)	1.41	[1.03, 1.92]	0.22	.03
Cannabis use frequency	0.44	[0.37, 0.52]	0.04	**<.001**
Ethnicity				
Asian	Ref	-	-	-
Other	0.53	[0.24, 1.17]	0.21	0.11
White	0.41	[026, 0.65]	0.10	**<.001**
Age	1.03	[0.99, 1.07]	0.02	.20
Gender				
Male	Ref	-	-	-
Female	1.04	[0.68, 1.60]	0.23	.89
Student status at Time 2				
No	Ref	-	-	-
Yes	1.19	[0.70, 2.05]	0.33	.51

Note. Ref = reference category.

time points viewed smoking cannabis regularly as being a riskier activity compared to their counterparts who reported a persistent pattern of use. Perceptions of risk remained relatively stable over time based on pattern of cannabis use. Among the total sample, no significant changes were observed with respect to perceived harmfulness of regular cannabis use pre- to post-legalization after controlling for demographic variables and frequency of cannabis use. However, White ethnicity and frequency of cannabis use were found to be significantly associated with lower perceptions of harmfulness.

Although a causal relationship cannot be drawn, the increases in frequency of use pre- to post-legalization among individuals who reported cannabis use at both Time 1 and Time 2 is concerning. Increases in frequency of cannabis use, especially daily use, among post-secondary students is likely to translate into more cannabis-related harms downstream, which could include poorer psychosocial outcomes (Meier, 2021), lower academic achievement (Arria, et al., 2015), and higher incidence of CUD (Kroon et al., 2020). Ongoing monitoring of these possible negative outcomes, as well as interventions and initiatives that seek to reduce risk of harm among this population are needed. This could include the development and evaluation of campus policies that discourage cannabis use among students (e.g., prohibiting sales, advertisement and consumption of cannabis on campus) as well as the promotion of brief interventions and substance use counselling services which target cannabis use among students (Winters et al., 2021).

While the present study asked about perceived harm related to *smoking* marijuana, more varied cannabis products are becoming available on the legal market (e.g., vaping, edibles, drinks, etc.). These other methods of administration also warrant consideration (Wallingford et al., 2019), as consumers might evaluate these products differently when considering risk. Similarly, the current study explored generalized perceptions of harm (e.g., harm to others) versus personalized perceptions of harm (e.g., harm to self). Exploring changes in the evaluation of risk as it relates to self and others within a legal context are important areas that warrant further monitoring. Nonetheless, our finding that legalization of recreational cannabis use was not associated with

significant changes in the perceptions of harmfulness of regular cannabis use is consistent with Wadsworth and Hammond's (2018) findings. As in their study, perceptions of harm in our sample remained stable despite changes in legal status of cannabis. It is worth noting that past research has shown that lower perceptions of harmfulness are associated with greater support for legalization of non-medicinal cannabis (Campbell et al., 2017). It is plausible that fluctuating perceptions of harm may have preceded changes in attitudes towards legalization and that legal status may not result in substantive changes regarding perceptions of harm, at least in the short-term.

Further longitudinal research is needed to better understand the long-term impacts legalization might have on attitudes and evaluations of risk regarding the use of cannabis. Phenomenon such as confirmation bias could be explored within this context, as this bias would predict that an individual's perception of harm would influence their views on legalization in a confirmatory manner. Moreover, notable differences existed with respects to perceptions of harmfulness when comparing students who abstained versus those who were consumers of cannabis. This difference was most notable between the "persistent" and "abstinent" groups. Further research is needed as legalization becomes more standard to determine if, and how, consumption patterns may change in concert with perception of harmfulness, and whether subgroup variations may exist based on patterns of use.

Further investigation is also needed to better understand what may have contributed to White students demonstrating lower perceptions of harmfulness when compared to their Asian counterparts, and whether this same finding exists among other college aged or university samples. It should be noted that the University of Calgary has a large representation of international students from Asian countries. Given that so few countries have legalized the substance, the majority, if not all, international students would have been from countries where cannabis remains an illegal substance. It is plausible that norms regarding cannabis use in these countries may be less permissive when compared to Canada, and this may have informed international students' perceptions of harmfulness regarding the substance.

Our finding that individuals who reported greater frequency of cannabis use demonstrated lower ratings of perceived harmfulness is consistent with past research that has shown these two variables share an inverse relationship (Compton et al., 2016; Keyes et al., 2016). This consistency across studies is concerning, as those who might be at greatest risk of experiencing negative consequences seem to downplay the risk or may be less aware of the potential for harms associated with regular use. Although educational campaigns have been launched in Canada, a survey completed shortly after legalization showed that only 1/3 young adults in Ontario reported having been exposed to some form of public health messaging (Leos-Toro et al., 2020). Such findings underscore the need for more targeted public health initiatives in post-secondary settings. This could include the development and implementation of policies by university administrators to limit accessibility of cannabis campus and prohibiting advertisement. Educational programs targeting those who use cannabis the most about the possible adverse effects of cannabis use may also prove useful.

Limitations

The generalizability of the findings from this study is limited given the sample was from one geographic location (e.g., Calgary, Alberta), and as noted, there are significant differences in provincial and municipal policies and bylaws for the regulation of retail sales of cannabis. Self-reported changes in cannabis use post-legalization among the persistent group may reflect respondents being more willing to report their use in a legalized context versus representing changes in use. Several variables were only measured at Time 2 (e.g., part-time/full-time student status; employment) and because of this changes in these variables could not be included a covariates in the analysis. Similarly, measuring socioeconomic status via maternal education was not ideal, and more comprehensive information could have been collected (e.g., postal code of residence, paternal education etc.). The assessments of cannabis use, and perceptions of harm were also limited (e.g., two categorical variables), and a more in-depth assessment of these constructs could have yielded more nuanced findings. For example, future studies should

collect data on types of cannabis products used, average monies spent on cannabis, or the potency of products selected. However, given that the current study represented a subset of a larger dataset, which addressed a variety of topics, assessments of these constructs were restricted to ensure the survey was not excessively long or cumbersome to complete.

When compared to the group who completed only the pre-legalization survey, respondents who participated in both surveys were younger, and there was a greater representation of females. This is notable, as males have been consistently shown to demonstrate higher rates of cannabis use when compared to their female counterparts. The study results may have also been biased by an over-representation of students who had an interest in cannabis, given those who completed both surveys showed higher rates of lifetime use. Finally, less than 25% of the original sampling frame participated in both Time 1 and Time 2 surveys. Thus, different results might have been obtained if the full sample had been retained.

This study represents a brief snapshot given that the survey was completed by respondents approximately six months post-legalization. It is likely that as more time passes, further changes will occur with respect to public perceptions regarding cannabis, including the perceived harmfulness of the substance. Similarly, there were only two waves of data collection. This limited the statistical methods that could be employed, and, as a result, we were unable to complete more sophisticated analyses such as structural equation modelling, which could have provided greater insights with respect to the longitudinal relationships between variables (e.g., the direction of the relationship between perceived harmfulness and cannabis use). Despite these limitations, the study had a number of strengths, most notably the prospective design which allowed for changes in cannabis use pre- to post-legalization to be captured within a single sample. The potential effect of legalization on perception of harm was able to be explored while controlling for covariates.

Conclusions

In summary, cannabis use and perceptions of harm related to cannabis are important indicators to be monitored during and after the legalization,

especially among at-risk populations. Among this sample of post-secondary students in Canada, there did not appear to be a substantive change with respect to perceived harm of regular cannabis use pre- to post-legalization. However, perceptions of harm were associated with frequency of use and ethnicity, with White students and higher frequency cannabis users demonstrating lower perceptions of risk. Students who reported no use pre- and post-legalization demonstrated higher perceived harm, whereas those who endorsed cannabis use pre- and post-legalization generally viewed regular use as being less risky. Significant increases in the frequency of cannabis use were observed among these persistent users. This increase is cause for concern as this might translate into greater incidents of cannabis-related harm. Although these preliminary findings require replication, the results underscore the need for effective prevention and public health initiatives on college and university campuses. Moreover, ongoing monitoring and longitudinal research is required to better understand the long-term impact of legalization on post-secondary populations.

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