Online personalized feedback intervention to reduce risky cannabis use. Randomized controlled trial[☆]

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ABSTRACT

Background and aims: Given the widespread use of cannabis, and the concomitant risks associated with the drug, there is a need to increase the availability of interventions designed to reduce risky cannabis use. One promising intervention in the addictions employs personalized normative feedback to motivate change.
Methods: A two-arm randomized controlled trial (RCT) was conducted in which participants who used cannabis in a risky fashion were randomly assigned to one of two groups – those who received an online personalized feedback report in addition to educational materials about risky cannabis use and those who just received the online educational materials. Follow-up assessment occurred at three- and six-months post-randomization. Outcome variables included: number of days cannabis was used in the past 30, risky cannabis use (ASSIST score of four or more), and participant estimates of the proportion of cannabis users among those of the same age and gender.
Results: A total of 744 participants with risky cannabis use were recruited for the trial using online advertisements. There were no significant differences between intervention and educational materials only groups at three- and six-month follow-ups for the outcome variables, number of days used cannabis in the last 30 ($p = 0.927$) and proportion of participants engaging in risky cannabis use ($p = 0.557$). At three and six month follow-ups, participants who received the feedback intervention were more likely than those in the educational materials group to estimate that a larger proportion of people their age and gender did not use cannabis in the last year ($p = 0.028$).
Discussion and conclusion: While there was some evidence that the personalized feedback intervention modified normative perceptions about cannabis use, there did not appear to be support for the prediction that the intervention reduced cannabis consumption.

1. Introduction

In recent years, several countries have modified their policies regarding use of cannabis, with changes including allowing cannabis use for medical purposes, decriminalization, or legalization for recreational use (Hammond et al., 2020). Canada is one of the countries that has now legalized cannabis for recreational use, which has led to increased availability and prevalence of use (Rotermann, 2021). While policies have been made more liberal, it is still important to recognize that cannabis use has health and psychosocial risks (Bedrouni, 2018; Committee on the Health Effects of Marijuana, 2017; Cunningham et al., 2000; Institute of Medicine, 1990). Further, the majority of risky cannabis users, including those meeting criteria for cannabis dependence, will never seek treatment if they become concerned about their use (Cunningham, 1999, 2000), often because of stigma or embarrassment – and this is unlikely to change with legalization (Cunningham

et al., 1993). However, many cannabis users are interested in receiving self-help materials to help them evaluate their own cannabis use without formal treatment (Cunningham, 2005). It is possible then, that this emerging health issue could be partially addressed through the development, evaluation and dissemination of scalable interventions that can be self-administered by people who engage in risky cannabis use.

Several researchers have successfully evaluated face-to-face interventions for cannabis users, including brief interventions targeting risky use (Lang et al., 2000; McRae et al., 2003; Stephens et al., 2000). Further, there are a limited number of single and multi-session Internet-based interventions that have demonstrated small but significant impacts on cannabis use (Boumparis et al., 2019; Hoch et al., 2016; Olmos et al., 2018; Sinadinovic et al., 2020; Tait et al., 2013). One type of brief online intervention incorporates personalized normative feedback, having as its central component the comparison of participant's consumption to others of the same age and gender, and has largely been studied within college settings. Additionally, such interventions can also include feedback about the personal risks and consequences of using cannabis as well as other educational information (i.e. general health statistics, information about comorbid use with tobacco and alcohol). Four trials employed versions of the same intervention and found promising corrections of normative misperceptions (Elliott and Carey, 2012; Elliott et al., 2014) and an impact of the intervention on the amount of time spent 'high' (Riggs et al., 2018) or the experience of negative consequences related to cannabis use (Palfai et al., 2014). Employing a different personalized normative feedback intervention, but again in college students, Lee and colleagues found no impact of the intervention on cannabis use (Lee et al., 2010). Finally, one trial did employ a non-college adult population and compared a brief versus an extended personalized feedback intervention for cannabis use, finding no evidence of a differential impact of the two interventions (Copeland et al., 2017).

Given this limited research base, particularly in non-college samples, more research is needed to determine the efficacy of personalized normative feedback interventions for risky cannabis use. Further, it is possible that the deregulation of cannabis as an illegal substance might impact on people's normative perceptions, making it important to examine the effects of normative feedback interventions in regions where use of cannabis is legal. The current trial addressed this gap and had the following hypotheses:

1.1. Primary hypothesis

Participants who receive the full personalized feedback intervention will report greater reductions in frequency of cannabis use (past 30-days) at three- and six-month follow-up compared to participants who receive educational materials only.

1.2. Secondary hypotheses

(1) Participants who receive the full personalized feedback intervention will be less likely to report risky cannabis use at three- and six-month follow-up compared to participants who receive educational materials only.

(2) Participants who receive the full personalized feedback intervention will report greater reductions in their perceptions of how much others use cannabis at a three-month follow-up compared to participants who receive educational materials only.

(3) Reductions in perceptions of how much others use cannabis at three-month follow-up will be positively associated with reduction in the participant's risky cannabis use at six-month follow-up, and will partially mediate the effect of the intervention on risky cannabis use at six-month follow-up.

2. Methods

The study was a two-arm, double-blinded parallel group randomized controlled trial with three- and six-month follow-ups. See Fig. 1 for a CONSORT diagram of the trial.

2.1. Recruitment

Current cannabis users from across Canada were recruited using Facebook and Kijiji advertisements asking for people who were concerned about their cannabis use and who were interested in participating in a study to find ways to help people who were worried about their cannabis use. Potential participants who responded to the advertisement by clicking on the link to the study website were first provided a brief description of the study. Those who were interested clicked on a link which took them to an eligibility screener. Eligible participants were 18 years or older. Eligibility criterion for risky cannabis use was defined as a Involvement Screening Test (ASSIST), developed by the World Health Organization (Humeniuk et al., 2008). A score of four or more on the ASSIST (sum of items 2 through 7) is indicative of moderate risk associated with cannabis use and is the level at which a brief intervention is recommended when encountered in a primary care setting. Indeed, sensitivity analyses recommend that a criterion of four be used to identify individuals "at-risk" in clinical settings (Davis et al., 2009). Failure to meet inclusion criteria comprised the exclusion criteria for this trial. Those found eligible were asked to provide informed consent after the eligibility screener had been completed. They were further asked to provide an email address as well as telephone number and mailing address as additional contact information. All participants were asked to provide permission for study staff to contact them via phone or mail for follow-up surveys if correspondence by email was unsuccessful. Participants who were found not eligible for the study were thanked for their interest.

Participants who completed the consent form and provided a real postal address were emailed a link to complete a baseline survey. A real postal address ensured that participants were not recruited in duplicate, and that the survey was completed by a person and not an Internet bot. An automated set of checks was programmed into the baseline survey to confirm the consistency in participants' responses between the eligibility screener and the baseline survey (Schell et al., under review). Briefly, participants were screened out if, on the baseline survey: 1) they reported no cannabis use; 2) their cannabis subscale ASSIST score totaled less than four; 3) ASSIST total score changed by more than 10 points from the eligibility screener; or 4) ASSIST item responses changed to "never" (when the item was not scored as never on the eligibility screener). Those who were not consistent in their responses were thanked for their participation but were excluded from the randomized trial. It is important to note that the time between the two surveys was on average less than 3 days ($M = 2.5$ days, $SD = 2.75$). Those who completed the baseline survey were provided with a gift certificate of $10 from Amazon.ca in order to promote retention at this point in the trial.

2.2. Randomization, experimental groups

Participants who completed the baseline survey with responses consistent with the eligibility screener were randomized (block randomized using random numbers list entered into survey portal – generated using randomizer.org) to immediately receive either the personalized feedback final report (and educational materials; Intervention group) or to just receive the educational materials (Control group). Those completing the three- and six-month follow-up surveys were provided with gift certificates from Amazon.ca ($20 for three-month and $30 for six-month). Participants were sent an email (and up to three reminder emails) containing a link to complete the follow-up survey online.
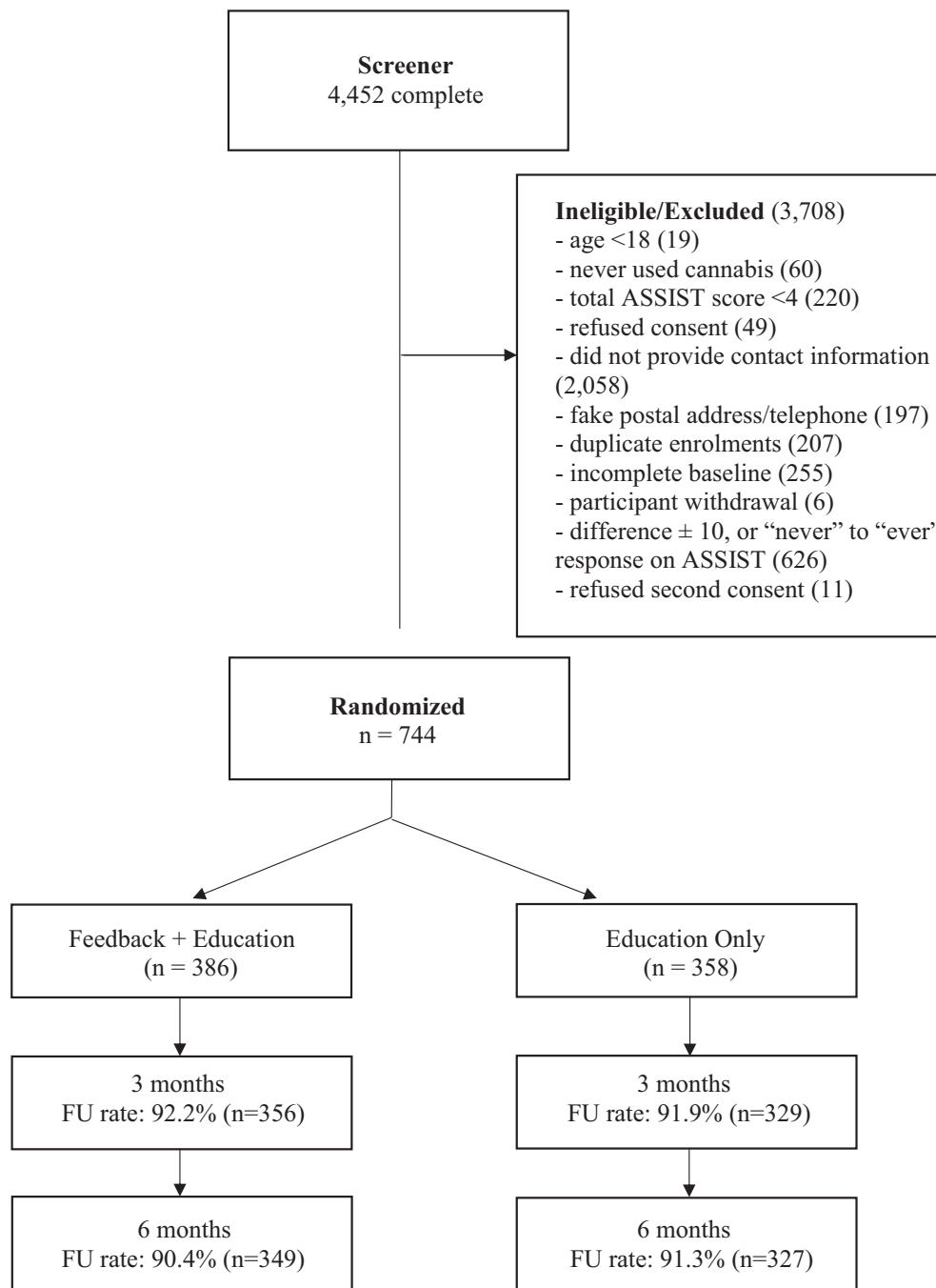
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                              ┌─────────────────────────┐
                              │        Screener         │
                              │     4,452 complete      │
                              └─────────────────────────┘
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Ineligible/Excluded (3,708)
- age <18 (19)
- never used cannabis (60)
- total ASSIST score <4 (220)
- refused consent (49)
- did not provide contact information (2,058)
- fake postal address/telephone (197)
- duplicate enrolments (207)
- incomplete baseline (255)
- participant withdrawal (6)
- difference ± 10, or "never" to "ever" response on ASSIST (626)
- refused second consent (11)

Randomized
n = 744

Feedback + Education
(n = 386)

Education Only
(n = 358)

3 months
FU rate: 92.2% (n=356)

3 months
FU rate: 91.9% (n=329)

6 months
FU rate: 90.4% (n=349)

6 months
FU rate: 91.3% (n=327)

Fig. 1. CONSORT diagram.

2.2.1. Intervention groups

2.2.1.1. Intervention group. In the current trial, an updated version of an existing personalized feedback intervention for risky cannabis use was employed (Cunningham and van Mierlo, 2009). Briefly, the personalized feedback final report allows participants to compare their own risky cannabis use to other people in the general population of Canada. For this version, the general population norms were derived from the most recently available Canadian Tobacco, Alcohol and Drugs Survey (CTADS) (Health Canada, 2015). In the final report, norms regarding frequency of cannabis use were provided that compared the participant to others of the same gender and age group. If participants did not identify as male or female, then feedback was generated based on the population norms of age (but not sex). It should be noted that the norms

generated were derived from population data collected prior to the legalization of cannabis in Canada and it was anticipated that they would report lower levels of cannabis use than was observed in the general population after legalization. However, we believed that this was not necessarily a weakness for the proposed intervention as norms that show lower use of cannabis in the general population would accentuate the difference between the participant's own use and that of other Canadians their age and gender, thus potentially making the intervention more impactful. As new population data is collected, the population norms could be updated. See Fig. 2 for an example of the personalized normative feedback component from the final report.

New to this version of the intervention, participants were provided feedback from the Marijuana Problems Scale (Steinberg et al., 2005), a self-report questionnaire with 19 items asking how frequently the

My Final Report

About 55% of 45-54 year old Canadian men have used cannabis, marijuana or hashish at least once in their lifetime.

You use cannabis more often than 95% of 45-54 year olds.

The white segment in the pie graph is where your cannabis use fits compared to how often other Canadian men your age use cannabis, marijuana or hashish.
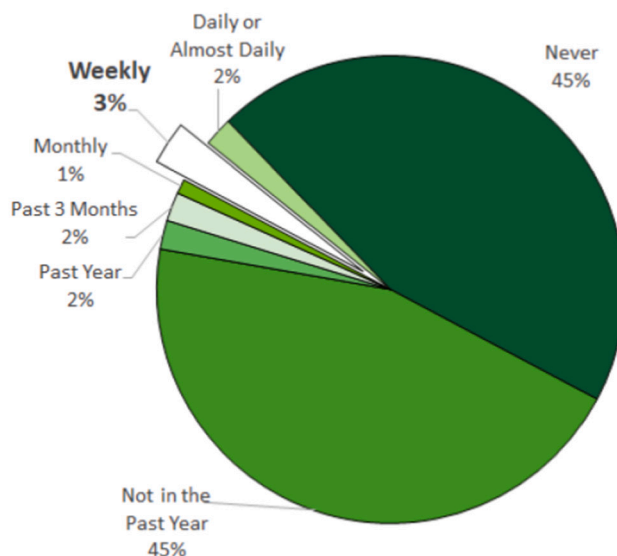

Fig. 2. Sample of personalized feedback.

participant experienced a number of consequences related to their cannabis use. Following the feedback framework developed by Bertholet et al. (2015) in their personalized feedback intervention for alcohol, relevant items from this scale were divided into three categories – Me & my body (9 items), Me and my relationships (4 items), and Me and my professional activities (6 items). A thermometer-type figure was provided in the feedback for each of these categories with the level on the thermometer marked based on the number of consequences experienced in the past three-months (e.g., the thermometer was shaded two-thirds of the way up if four out of six consequences were endorsed). The actual consequences endorsed were also listed after each thermometer (please see Appendix 1 for an example copy of the complete feedback). Next, if participants stated that they used cannabis with tobacco, with alcohol, or drove while under the influence of cannabis, they were provided with an explanation of why each of these activities increased their risk of harm. The feedback then continued with a summary of their ASSIST cannabis subscale score that included a graphical depiction of their score (note: this ASSIST feedback was also included in the original version of this feedback). Finally, the personalized feedback was accompanied by educational material that had already been developed and pilot tested at the Centre for Addiction and Mental Health. Specifically, participants were provided with content from, "Canada's Lower-Risk Cannabis Use Guidelines" (Fischer et al., 2017).

2.2.1.2. Control group. Participants randomly assigned to the control group did not receive the personalized feedback final report but instead just received the online educational material (i.e., content of the Canada's Lower-Risk Cannabis Use Guidelines).

2.3. Content of surveys

The Primary Outcome measure was the number of days that the participant used cannabis in the past 30 days (Hoch et al., 2016; Olmos

et al., 2018; Tait et al., 2013). The Secondary Outcome measures were: 1) a score of four or more on the cannabis subscale of the ASSIST which indicated risky cannabis use (Humeniuk et al., 2008); and 2) normative perceptions about the proportion of others who do not use cannabis (of Canadians the same age and gender). Normative perceptions were asked using the item "What percent of Canadian 'gender' your age do you think have not used cannabis, marijuana or hashish at all in the past 3 months?", and response options 0 to 100%.

2.3.1. Content of baseline survey

The baseline survey included questions on demographic characteristics (gender, marital status, education, gross family income, and employment status), frequency of cannabis use in the past 30 days, the ASSIST cannabis use subscale and the Marijuana Problems Scale. Next, using measures developed in our other trials, but modified for cannabis use, we assessed the participant's perceptions of the proportion of others of the same age and gender who did not use cannabis (Cunningham et al., 2012). Finally, use of treatment services for cannabis concerns was assessed.

2.3.2. Content of three- and six-month follow-up survey

The same series of questions were asked on the follow-up surveys (demographic items were not repeated). Finally, at the end of the six-month follow-up survey, participants were asked questions regarding their impressions of the materials they were provided.

2.4. Sample size estimate

Based on the systematic reviews of computerized brief interventions for cannabis use (Hoch et al., 2016; Olmos et al., 2018; Tait et al., 2013), the power analysis for this trial was conducted with the assumption that the intervention would have a small effect on the primary outcome variable, number of days used cannabis in the past 30 days. Assuming a

correlation of 0.5 between baseline and follow-up values, power = 0.80 and an $\alpha = 0.05$, it was estimated that a sample of 296 participants per group was needed to conduct the trial. This sample size should have sufficient power to detect a small difference of 10 percentage points on the secondary outcome measure, proportion using cannabis in a risky fashion at 6-months. While a 10% reduction might seem minimal, given the scalability of the intervention, such a reduction would be of significant public health value if the intervention was used widely. That is, within a study sample a small change of 10% may not be clinically relevant, but a reduction of 10% at a community or national level would be significant. We allowed for a 20% loss to follow-up at three- and six-months, resulting in a total of 740 participants to be recruited at baseline.

2.5. Data analysis

The primary analysis employed a generalized linear mixed modelling framework (Fox, 2008), using an intent-to-treat approach. Missing data was handled using maximum likelihood estimation. Analyses of the primary hypothesis evaluated the effect of the personalized feedback intervention (intervention group) versus the educational material only (control group) on reductions in the variable, number of days consumed cannabis in the past 30, between baseline and three and six months. Time point (baseline versus three and six months) was entered as a within-subjects predictor and a dummy-coded contrast represented intervention versus control group conditions. The interaction between time point and condition was examined to determine if changes in cannabis consumption differed between the two conditions. Demographic or cannabis use characteristics that were significantly different across condition at baseline were included as covariates to address any potential differences between intervention and control groups. In addition, because the COVID pandemic was ongoing during the follow-up period for some participants of this study, we included a variable that recorded whether the pandemic was ongoing (according to the WHO) as a covariate. As part of this analysis, a chi-square analysis was conducted to determine whether there was differential loss to follow-up between experimental groups.

The analysis for secondary hypothesis 1 employed a manual stepwise logistic regression, with risky use of cannabis at the three- or six-month follow-ups as the dependent variable. In this analysis, participants lost to follow-up were assumed to still be engaging in risky cannabis use. In Step 1 of the logistic regression, any demographic or cannabis use characteristics that were significantly different at baseline were entered into the logistic regression. In step 2, experimental group was entered as a dummy coded variable (0 = control group; 1 = intervention group). This step tested the hypothesis regarding the impact of personalized feedback intervention.

Secondary hypothesis 2, reductions in perceptions regarding how much others used cannabis, was measured using a continuous scale. As such, the analytic procedure was the same as was employed for the primary hypothesis. Secondary hypothesis 3 was tested using the using the PROCESS macro (Hayes, 2018) to examine whether reductions in perceptions of how much others use cannabis at three months (difference score from baseline; mediator variable) was positively associated with reductions in the participant's risky cannabis use at six-month follow-up (as measured by the difference score between the total cannabis ASSIST at baseline vs. six-month follow-up; outcome variable). Intervention condition was specified as the independent variable in the model to examine whether reductions in normative perceptions mediated the effect of the intervention on reductions in risky cannabis use at six-month follow-up. Bootstrapping was used (with 5000 replications) to calculate a bias-corrected confidence interval for the indirect effect.

2.6. Ethics approval

The research was approval by the standing research ethics board of

the Centre for Addiction and Mental Health.

3. Results

A total of 744 participants were recruited for the trial from September 2019 to March 2020. Table 1 compares the demographic and cannabis use characteristics of participants between those randomly assigned to the intervention condition (n = 386) and to the educational materials condition (n = 358). While most participant characteristics were not significantly different between condition ($p > 0.05$), the mean number of days used cannabis in the past 30 days was lower in the intervention condition compared to in the educational materials condition at baseline (Mean [SD] = 23.9 [8.8] versus 25.1 [8.1]; t (1, 742) = −1.97, $p = 0.049$). As such, number of days used cannabis in the last 30 at baseline was entered as a covariate in all analyses.

Follow-up rates at the three- and six-month follow-ups were excellent (92% and 91% respectively). There was no significant difference in follow-up rates between experimental condition (Fischer's exact tests: three-months $p = 0.87$; six-months $p = 0.66$; please see Table 1). To test hypothesis 1 and secondary hypothesis 1 (time points three months and six months respectively), a mixed effects model was conducted to compare changes in number of days used cannabis in past 30 days between participants in the two conditions (personalized feedback versus education materials) from baseline to three- and six-month follow-ups.

Table 1

Differences between personalized feedback and education interventions on baseline demographic and cannabis use characteristics.

Variable	Intervention		p
	Personalized feedback (n = 386)	Education (n = 358)	
Age, mean years (SD)	35.3 (13.0)	36.3 (12.6)	0.270
% gender[a]			0.398
Males	38.3	34.2	
Females	54.7	58.0	
Trans	1.0	2.2	
Non-binary	6.0	5.6	
% Some post-secondary or greater	59.8	60.6	0.830
% married/common law	43.5	44.4	0.807
% full/part-time employed	52.8	57.0	0.258
% household income ≤$20,000	54.1	52.0	0.550
# days used cannabis in last 30, mean (SD)	23.9 (8.8)	25.1 (8.1)	0.049
ASSIST score, mean (SD)	23.6 (10.3)	23.0 (10.3)	0.431
% ever attended formal treatment	18.1	16.2	0.485
% ever attended any treatment	30.6	28.5	0.535
% After pandemic[a,b]			0.988
All before	2.8	3.1	
Baseline & 3-month fu before	46.4	45.3	
Baseline before	48.2	48.9	
All after	2.6	2.8	
% 3-month follow up complete	92.2	91.9	0.868
% 6-month follow up complete	90.4	91.3	0.661

ASSIST: Cannabis subscale from the Alcohol, Smoking and Substance Involvement Screening Test.

Formal treatment defined as attending detox, outpatient, inpatient, emergency, professional counseling.

Any treatment included formal treatment plus use of … self-help materials for cannabis concerns, online websites, Narcotics Anonymous (or other similar self-help group).

[a] Crosstabs have at least one cell with an expected count less than 5.

[b] After pandemic –surveys completed after the WHO declared the global pandemic on Mar 11, 2020 (reference group interviews completed before this date).

There were significant reductions in the number of days participants used cannabis over time across the sample as a whole ($p < 0.001$). However, there were no significant intervention by time interaction ($p = 0.927$). See Table 2 for details of this mixed model analysis.

Binomial logistic regressions were conducted to test secondary hypothesis 2 and compared the proportion of participants with risky cannabis use (ASSIST score > 3) between experimental condition at three- and six-months follow-ups. There were no significant differences between experimental conditions in the proportion of risky cannabis users at either time point ($p = 0.557$ and $p = 0.116$; see Table 3 for details).

Table 4 presents the results of a mixed effects model to test secondary hypothesis 2, comparing participants' estimates of the proportion of participants of the same age and gender who have not used cannabis in the last year at the three- and six-month follow-ups (please note that secondary hypothesis 2 was specific to the 3 months' time point but both time points were included in this analysis). There was a significant effect of time ($p < 0.001$) and a time by intervention interaction ($p = 0.028$). See Fig. 3 for a depiction of the pattern of results with those receiving the intervention materials appearing to temporarily increase their estimates of the proportion of Canadians of the same age and gender who did not smoke cannabis in the past year and those in the educational materials reducing their estimates.

The results of the mediation analysis did not support the hypothesis that changes in perceptions of the proportion of people who used cannabis between baseline and three-months were positively associated with reduction in the participant's risky cannabis use at six-month follow-up (see Table 5). The analyses also did not demonstrate any evidence that these changes in perceptions mediated the effect of the intervention on risky cannabis use at six-month follow-up, *indirect effect estimate* = 0.06, 95% CI [−0.08, 0.22].

4. Discussion

In the current era of rapidly shifting cannabis policies, there is a need for accessible and scalable interventions for individuals who are engaging in risky cannabis use. This study examined the efficacy of a brief, online personalized normative feedback intervention in a large, non-college sample of adults in Canada following national legalization of recreational cannabis use. Participants who received the personalized normative feedback intervention did not reduce their cannabis use between baseline and three- and six-month follow-ups to a greater extent than those who received the educational materials only. Further, while receiving the normative feedback information did have an impact of participants' perceptions of how common cannabis use was among adults of the same age and gender, this change did not mediate the impact of the intervention on their own cannabis risk level. As such, it appears that the trial failed to find a significant impact of the

Table 2

Mixed-effect model results of time, intervention, and time by intervention on past 30-day cannabis use.

Effect	Estimate	t	p
Intercept	3.34	4.76	<0.001
BL # of days used cannabis in last 30	0.88	45.47	<0.001
After pandemic[a]	−0.15	−0.56	0.575
Time (reference: Baseline)			
3-months	−1.93	−4.59	<0.001
6-months	−2.48	−5.89	<0.001
Intervention (reference: Education)			
Feedback	−0.15	−0.33	0.744

Interactions	F		p
Time by intervention	0.08		0.927

[a] After pandemic - surveys completed before/after the WHO declared the global pandemic on Mar 11, 2020.

Table 3

Results of binomial logistic regression analyses assessing intervention group and associated with risky cannabis use (ASSIST>3) at 3- and 6-month follow up.

	Variables	Model 1–3 months		Model 2–6 months	
		Odds ratio (95% CI)	Likelihood ratio χ^2 (df), p	Odds ratio (95% CI)	Likelihood ratio χ^2 (df), p
Step 0	Constant	56.91	176.56 (1), <0.001	33.78	216.59 (1), <0.001
Step 1	Constant	3.67	5.61 (1), 0.018	0.93	0.01 (1), 0.932
	BL cannabis use[a]	1.16 (1.09–1.24)	19.32 (1), <0.001	1.13 (1.08–1.18)	26.00 (1), <0.001
	After pandemic[b]	1.40 (0.40–4.85)	0.28 (1), 0.596	4.16 (0.76–22.74)	2.70 (1), 0.101
Step 2	Constant	4.51	5.08 (1), 0.024	1.36	0.11 (1), 0.739
	BL cannabis use[a]	1.16 (1.09–1.24)	19.02 (1), 0.001	1.13 (1.08–1.18)	25.11 (1), <0.001
	After pandemic[b]	1.46 (0.42–5.09)	0.35 (1), 0.556	5.04 (0.95–28.88)	3.59 (1), 0.058
	Feedback	0.68 (0.19–2.47)	0.35 (1), 0.557	0.41 (0.14–1.24)	2.48 (1), 0.116

[a] Number of days used cannabis in the last 30 days at baseline, added to account for group differences.

[b] After pandemic –surveys completed after the WHO declared the global pandemic on Mar 11, 2020 (reference group interviews completed before this date).
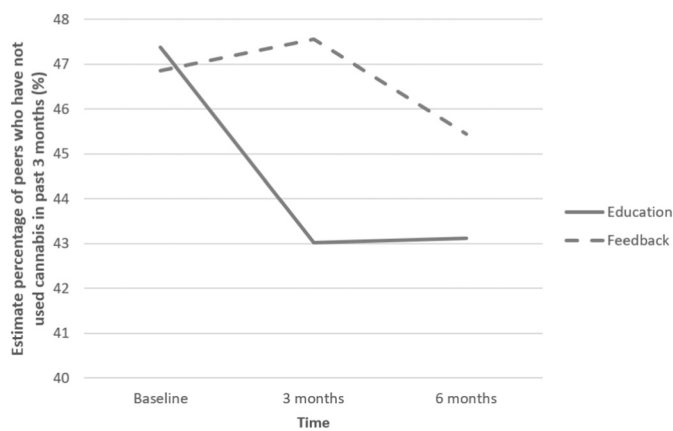
Table 4

Mixed-effect model results of time, intervention, and time by intervention on participant estimated percent of other Canadians who have **not** used cannabis in the past 3 months.

Effect	Estimate	t	p
Intercept	49.44	20.74	<0.001
BL # of days used cannabis in last 30	−0.05	−0.77	0.445
After pandemic[a]	−0.57	−0.64	0.521
Time (reference: Baseline)			
3-months	−4.37	−3.19	0.001
6-months	−4.26	−3.11	0.002
Intervention (reference: Education)			
Feedback	−0.53	−0.35	0.727

Interactions	F		p
Time by intervention	3.59		0.028

[a] After pandemic –surveys completed before/after the WHO declared the global pandemic on Mar 11, 2020.

intervention on cannabis use.

There are several possible reasons for these findings. One possibility is that the educational materials also motivated reductions in cannabis use and the intervention was unable to promote a larger reduction than the provision of these materials alone. However, the current trial was not designed to test for this possibility so it would be inappropriate to claim that both interventions worked. Another possibility is that the intervention was not an effective means of motivating reductions in cannabis use, particularly among our sample of somewhat heavier users of cannabis. As brief interventions are meant for those with ASSIST scores over 4, and not necessarily on the end of the scale, this may have contributed to the findings observed. Moreover, a recent meta-analysis uncovered that personalized normative feedback may not be effective at reducing drug use without the provision of additional interventions (Saxton et al., 2021). While the literature is still quite young on the use of personalized normative feedback for substances other than alcohol, we cannot assume the intervention was completely ineffective. The intervention was developed based on a sound theoretical foundation and

Fig. 3. Percent estimate of participant estimated percent of other Canadians who have not <u>used</u> cannabis in the past 3 months for education and feedback interventions.
Note: Graphed means represent estimated marginal means computed for the value of baseline cannabis use in the past 30 days = 24.42 and COVID = 1.51.

Table 5
Mediation model results of effect of reduced perceptions of the percentage of others' who do not use cannabis at 3-months on relationship between condition and change in risky cannabis use baseline to 6 months (change in total cannabis ASSIST score).

Antecedent	Consequent					
	Perceived percent change			Risky cannabis use		
	Coeff.	SE	p	Coeff.	SE	p
Constant	−7.04	3.12	0.025	4.46	0.82	<0.001
Condition	5.96	2.00	0.003	−0.71	0.52	0.176
Perceived percent change	–	–	–	0.01	0.01	0.348
Model summary	$R^2 = 0.01$, MSE = 652.17 $F(1, 653) = 8.90$, $p = 0.003$			$R^2 = 0.003$, MSE = 44.35 $F(2, 652) = 1.23$, $p = 0.294$		

Note: ASSIST - Alcohol, Smoking and Substance Involvement Screening Test.
Coeff. = coefficient.
SE: standard error.
Perceived Percent Change (in others who do not use): baseline – 3 months.
Risky cannabis use change: ASSIST baseline - 6 months.

employed content that has demonstrated efficacy in motivating change in trials targeting other addictive behaviors (particularly with hazardous alcohol consumption) (Neighbors et al., 2006). This does raise the interesting possibility that there is something different in the use of cannabis versus the consumption of alcohol that then makes social comparisons, and the correction of normative misperceptions, ineffective as a means to motivate change. Perhaps, while the recreational use of cannabis is now legal in Canada, there is still a counter-cultural mystique to its use. Also related, some participants provided feedback that cannabis use was healthy and queried why we were trying to say its use was bad. While these comments were not common, they might capture the general tone of a proportion of those people recruited for the trial – i.e., being unconcerned about their own cannabis use but instead participating because they were interested in issues relating to using cannabis (this is despite advertising for people who were concerned about their cannabis use).

Other relevant factors to consider when interpreting the results of this trial have to do with the time when it was conducted. First, cannabis use was legalized just a few years previously and the ready availability of cannabis from commercial sources was still continuing to expand (Rotermann, 2021). This relative newness of cannabis as a legal substance might be a situation where normative comparisons are less

meaningful to those receiving them. Further, with the prevalence of cannabis use increasing, it might be easier for participants to discount information about how much others smoke (e.g., by assuming the information is out of date). Finally, it is unknown what the impact of the pandemic had on peoples' need to find activities that were distracting (such as using cannabis) or on the efficacy of this intervention.

There were several limitations associated with the trial. First, while we incorporated extensive checks to prevent multiple registrations by one person, we relied on self-report regarding cannabis use both at the time of recruitment and at follow-up. Second, the outcome measures employed were fairly crude. Perhaps, in an environment where cannabis is legal, the variable number of days used cannabis in the past 30 might suffer from a ceiling effect if a substantial proportion of participants are using cannabis every day. Finally, while the trial was powered to detect a small effect, it is certainly possible that the intervention, if effective, would only ever have an impact that is very small; especially among heavy users of cannabis. Given that this is a low-cost intervention that can be distributed widely, having a very small impact is not necessarily a rule-out of the intervention's utility. It just implies that a much larger sample would be needed to establish efficacy, perhaps across a wider range of cannabis users.

5. Conclusion

While the current trial failed to demonstrate an impact of a normative feedback approach, there may still be value in finding out how social comparison interventions might be effective in the context of cannabis use. This approach, along with other interventions found to be effective in reducing cannabis use, could be a valuable component in efforts addressing the mitigation of risky cannabis use. As restrictions on the use of cannabis continue to be removed in many countries, it is imperative that research continue to develop effective means to motivate reductions in cannabis use among those whose use is risky. While the liberalization of cannabis use may lead to net benefits by removing unanticipated harms of classifying cannabis as an illegal substance, cannabis use continues to cause health-related consequences. The anticipated increase in the prevalence of cannabis use will no doubt lead to increases in some categories of costs to the individual and to society (Hall and Lynskey, 2016), and interventions must continue to evolve to address the harms of risky cannabis use.

CRediT authorship contribution statement

All authors have made an intellectual contribution to this research. JAC conceived the study and oversaw all aspects of the project. All authors developed the proposal and provided input on the design of the study. CS and AG conducted the trial and the analysis. JAC wrote the original draft of the manuscript. All authors have contributed to the manuscript drafting process, have read, and approved the final manuscript.

Declaration of competing interest

The authors have no conflicts of interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

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