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Brief mindfulness intervention for adults with cannabis use disorder: A randomised clinical trial

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ABSTRACT

Background: Cannabis use disorder (CUD) is characterised by strong cravings and an inability to reduce cannabis use despite experiencing adverse psychosocial outcomes. Brief, accessible, scalable, and low-cost interventions are needed to support people with a CUD. We investigated if a brief mindfulness-based intervention (MBI) reduces cannabis frequency, quantity and craving, compared to both an active and passive control conditions.
Methods: A pre-registered, double-blind randomised control trial was run in in 66 adults (19 female) aged 18–56 with CUD reporting attempts to cut down or quit in the past 2 years, recruited from the general community (October 2019-July 2022). Participants were 1:1:1 allocated, to one of 3 interventions; MBI (n = 23), Relaxation (n = 21) or Control (n = 22) with a mean duration of 16 days, stratified by age and sex. All conditions included daily monitoring of usage. Baseline and follow-up in person testing occurred in Melbourne, Australia. The intervention occurred online. The primary outcome was change in cannabis use days (Δ follow-up *minus* baseline). Secondary outcomes were changes (Δ follow-up *minus* baseline) in: cannabis grams and craving (visual analogue scale; VAS), mindfulness (Five-Facet Mindfulness Questionnaire) and relaxation (VAS). We carried out intention-to-treat analysis.
Results: There were no significant intervention-by-time effects on the primary outcome — cannabis frequency ($F = 0.26$, FDR$p = .86$)—nor on secondary outcomes: quantity, cravings, relaxation or mindfulness.
Conclusion: Based on these findings a brief MBI does not appear to help people with CUD reduce their cannabis use.
Trial registration: ISRCTN Registry Identifier: ISRCTN76056942 (Mapping short-term brain changes in cannabis users). Submission date: 28/04/2020. Registration date: 12/05/2020. The interventions are described below and here: ISRCTN76056942 https://www.isrctn.com/ISRCTN76056942 (DOI: https://doi.org/10.1186/ISRCTN76056942). The pre-registered hypotheses and analysis plan can be found here: https://osf.io/sfjwk.

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1. Introduction

Cannabis use disorder (CUD) is endorsed by approximately 36-to-56 million people globally and by 18–26 % of people who consume cannabis (Leung et al., 2020). CUD has been characterized by an increased prevalence by 32.3 % from 1990 to 2019, and by a 38.6 % increase in disability-adjusted life years (Shao et al., 2023). Recent evidence suggests that U.S. communities with increased access to cannabis may experience increased healthcare usage and costs due to cannabis harms, including CUD (Jayawardhana et al., 2025). Concerningly, only 15 % of people with CUD seek treatment during their lifetime (Khan et al., 2013). Overall, these statistics underscore an urgent need to develop novel, accessible, low-cost approaches that help reduce cannabis use frequency, quantity, and craving.

The last decade has seen an increase of psychological therapies that incorporate mindfulness - the 'awareness that arises through paying attention, on purpose, in the present moment, non-judgmentally' (Kabat-Zinn, 2013). Evidence in substance use disorders (SUD; e.g., nicotine, alcohol), shows that mindfulness-based interventions (MBIs) can be effective at: increasing cognitive control over habitual substance use and the saliency of natural rewards (Garland et al., 2014; Rosenthal et al., 2021); increasing mindfulness (Li et al., 2017); and at reducing craving, stress (Demina et al., 2023; Grant et al., 2017; Korecki et al., 2020; Li et al., 2017; Rosenthal et al., 2021), withdrawal (Grant et al., 2017; Li et al., 2017), and depression symptoms (Grant et al., 2017). A 2021 Cochrane review of MBIs effects on SUD outcomes concluded that the evidence is uncertain (Goldberg et al., 2021). MBIs were associated with modest reductions on frequency of substance use post-treatment and at 4-to-10 months follow-up (Goldberg et al., 2021). The evidence was inconclusive about the effect of MBI on abstinence, quantity of substance use and craving (relative to other treatments), with few adverse events being reported (Goldberg et al., 2021). In this review (Goldberg et al., 2021), the only study that examined people who use cannabis was one examining young women and reported significantly greater reductions in cannabis using days after MBI (combined with brief motivational interviewing), relative to assessment only (de Dios et al., 2012).

MBIs for SUDs are often delivered in clinician-guided, in-person, structured weekly group sessions run across a 8–12 week period (Li et al., 2017). MBIs can include, Mindfulness-Based Relapse Prevention (MBRP) (Bowen et al., 2009; Grant et al., 2017), Mindfulness-Orientated Recovery Enhancement (MORE) (Parisi et al., 2022), and Mindfulness Training for Smoking (Brewer et al., 2011). Although the minimum effective dose of MBIs for SUDs is not yet known, existing MBIs that involve intensive and sustained practice are associated with high rates of attrition (Lam et al., 2022). Thus, there is value in developing brief, online, self-administered MBIs that overcome barriers to engagement (e.g., work and household commitments). For example, in a study conducted by De Dios and colleagues (2012) MBI-related effects on cannabis use were observed with a clinician-guided MBI comprising just two 45-minute sessions 2-weeks apart (de Dios et al., 2012). Others have shown that ultra-brief (10-minute) mindfulness audio instructions, compared to active-control relaxation produces a behavioural signal (e.g., lower weekly alcohol consumption in at-risk drinkers) (Kamboj et al., 2017). Indeed, in one study, a single session of MBI was associated with reduced nicotine use (Westbrook et al., 2011). Overall, early evidence suggests brief MBIs could be engaging and help reduce substance use and related problems, though a recent digital ecological momentary assessment (EMA) micro-randomised trial of a mindfulness coping strategy did not reduce craving relative to a control condition among people who use cannabis (Stanger et al., 2024).

Whilst studies to date (de Dios et al., 2012; Schneegans et al., 2022; Stanger et al., 2024) have investigated MBIs in people who use cannabis, the presence of CUD was not measured or reported, or they have lacked suitable control interventions as they focused on treatment as usual [TAU] or assessment only (Li et al., 2017). To our knowledge, no study to date has compared MBI to an adequately matched active control intervention and a passive control condition. It remains unclear if MBIs can reduce cannabis use and related problems in individuals who experience a CUD. This evidence gap echoes recent calls for targeted research efforts, including large, controlled trials of MBI for people who use cannabis (Barré et al., 2024). Effective brief MBIs are highly scalable and so could reduce cannabis-related harms among the larger number of non-treatment seekers in the community.

In this double-blind RCT we sought to address these identified knowledge gaps and methodological limitations by using a brief, low-cost, accessible, self-administered online MBI in people with moderate-to-severe forms of CUD, compared to active and passive control conditions. The primary aim was to examine if a brief MBI could reduce cannabis use frequency (primary outcome), cannabis quantity and subjective craving (secondary outcomes); and if the brief MBI could increase mindfulness and relaxation (exploratory outcomes). The MBI aimed to emphasise ongoing attention to internal experiences without attempting to change these (Kamboj et al., 2017). The MBI was compared to both a passive control (i.e., monitoring of usage) and an active control Relaxation condition used in previous experimental work (Kamboj et al., 2017) which was designed to downregulate craving by reducing arousal, a prototypical emotion regulation strategy, commonly employed in psychosocial AUD treatments to reduce craving-related physiological arousal (Spada, 2012). We describe the MBI and Relaxation instructions as 'brief' given their brevity relative to instructions typically used in MBIs (e.g. typically >10 hours) (Bowen and Marlatt, 2009); and in line with previous meta-analytic work (e.g., brief MBIs being delivered over an individual day, sessions delivered every few days and daily sessions over up to 5 weeks) (Kamboj et al., 2017; Li et al., 2017). Based on emerging evidence, we hypothesised that the MBI relative to the other interventions, would be associated with significantly greater reductions in cannabis use frequency, quantity and craving as well as significantly increased mindfulness and relaxation scores.

2. Methods

This trial was nested within a larger pre-registered MRI study examining how brain, cognitive performance, and mental health differs between individuals with a CUD compared to control participants who do not consume cannabis and the impact of MBI in neurobehavioral outcomes in the CUD group (ISRCTN76056942, see Appendices), with pre-registered analyses for the outcomes of interest reported herein (https://osf.io/sfjwk). Participants' allocation to the intervention and flow are described as per *Consolidated Standards of Reporting Trials* guidelines (CONSORT; Figure A.1, Appendices). Ethics approval was obtained by the Human Research Ethics Committee of the Australian Catholic University, Melbourne (HREC:2019-71H). Participants gave written informed consent prior to participation, were debriefed at the end of face-to-face testing and reimbursed at the end of the follow-up (A $150 vouchers).

2.1. Sample recruitment and eligibility

Participants were recruited from the Melbourne metropolitan area, Australia via public platforms (e.g., Google Ads, Gumtree, Facebook, university websites, community flyers, and others). Advertisements mentioned the words "cannabis" and "willing to follow brief instructions for 2 weeks" in between two "testing sessions" with no "mindfulness" or "intervention" keywords. Advertisements included a link that directed community members to an online screening survey followed by a phone screening interview to determine study eligibility. The target sample was community members who endorse a moderate-to-severe CUD with a history of attempts to cut down or quit in the past 2 years without a history of mindfulness practice. Intervention participants completed a baseline intervention and follow-up sessions; and controls a baseline

testing session only. Interim analysis was performed on 40 participants between approximately the 27 of June 2022 – 18 August 2022 for a PhD thesis, prior to completion of data collection. Recruitment procedures and participants' screening are detailed in Appendices and pre-registration protocol.

2.2. Power analysis

For sample size calculation we estimated effect sizes from previous similar work (η_p^2=0.13, f=0.39) (Beadman et al., 2015) using G*Power3 (Faul et al., 2007). To consider any further uncertainties, a conservative small-medium sized effect (f=0.21) was assumed. As such, a sample of $n \geq 60$ was deemed sufficient to detect significant (α=0.05, 1-β=0.80) conditions-by-time effects.

2.3. Selection criteria

Inclusion criteria were: i) age between 18 and 55 years; ii) proficiency in English; iii) normal or corrected-to-normal vision due requirements outside of the scope of this study; iv) endorsed DSM-5 criteria for a moderate-to-severe Cannabis Use Disorder (CUD) based on the Structured Clinical Interview for DSM-5 Research Version (SCID-5-RV) (First et al., 2015); v) consumed cannabis daily/almost daily for at least the past 12-months; and vi) reported at least one attempt to quit or to reduce their use in the past 24 months. Exclusion criteria are outlined in Appendices.

2.4. Randomisation and double blinding

The randomisation system for the CUD participants was developed by a Senior Research Team member (LG) with extensive expertise in double-blind trials. Following online and telephone screening, a study co-ordinator not involved in blinded data collection or analysis at the time of data collection, allocated participants to one of three intervention conditions. Eligible participants were randomised in a 1:1:1 ratio between groups using a separate password-protected file, managed by study coordinators in password-protected folders in Cloudstor to help maintain blinding. Participants were stratified by sex (i.e., males, females), and age (i.e., 18–24, 25–35, 36–55), to achieve the same number of participants of similar sex and age per intervention condition. Participants were kept blinded from the fact the study was testing a MBI designed to change cannabis use and craving. Additional details on blinding are given in Appendices. Testing was conducted by students/researchers blinded to participant's intervention with a different researcher delivering the intervention component. All testers had psychology backgrounds, had received training from the lead author on test/survey administration, attended a Good Clinical Practice (GCP) course and as required underwent Applied Suicide Intervention Skills Training (ASIST) certification and training in their specific components of the intervention.

2.5. Intervention condition instructions

Full intervention scripts are provided verbatim in Table C.1.

2.5.1. MBI condition

The MBI instructions emphasised ongoing attention to internal experiences without attempting to change these (Kamboj et al., 2017). They did not mention reduced craving or of controlling, transforming, or regulating internal experience; and clarified that the aim was not to simply relax, but to be alert and attentive. The instructions emphasised "open monitoring" of experiences and particularly on "aware[ness] of feelings and bodily sensations" and to "experience craving in a different way." Participants were told that by noticing bodily sensations they could "experience them as temporary events in the body," helping the participant to "tolerate [bodily sensations] without acting on them."

2.5.2. Relaxation condition

The instructions for the Relaxation condition were specifically designed to downregulate craving by reducing arousal (Kamboj et al., 2017). By contrast, during the explanation of the strategy, the group in the relaxation condition was told, for example, that craving intensity can be reduced by "softening the muscles…and calming and unwinding the mind…releasing tension in your body". It was also emphasized that this is a way of gaining control over craving. Participants were also instructed that relaxation enables transformation of sensations into more calming, less unpleasant experiences.

2.5.3. Passive placebo

Participants allocated to the no intervention condition were asked to complete a daily questionnaire to mask discernment of allocation to the control group.

2.6. Study design

A double-blind, three-arm RCT was conducted. The testing protocol comprised three distinct phases outlined below, including baseline, intervention and follow-up assessment two weeks later, conducted in person, at the Monash Biomedical Imaging facility in Clayton, Victoria, Australia. Between baseline and follow-up, the ~2-week intervention conditions were carried out online by participants (Fig. 1).

2.6.1. Baseline

The in-person baseline testing lasted ~4-to-6 hours and included components beyond the scope of this report. Participants completed a battery of validated questionnaires and semi-structured interviews to profile substance use, mindfulness, mental health and IQ; as well as intervention-related tasks and questionnaires (Appendices). At the end of *baseline assessment*, the assigned intervention was delivered for the first time, which included a few questionnaires (Appendices). Interventions were not personally tailored. That is, all participants within the same intervention arm received identical instructions.

At the end of baseline testing, the researcher instructed participants on self-administering the intervention in order to optimise intervention adherence (e.g., set daily phone reminders) after which participants received SMS and emails with weblink access to the interventions delivered online via Qualtrics XM. All participants were provided with a USB stick with the intervention instructions in audio form, and additionally with the questionnaire files if they did not have access to mobile/Wi-Fi data. Participants were debriefed at the end of baseline testing.

2.6.2. 2-week interventions

The intervention conditions entailed self-administered daily ~10–15-minute practice using online links delivering either: a MBI with daily monitoring (of cannabis use/mood), active control relaxation with daily monitoring, and passive control daily monitoring only (for more details see Fig. 2 and pre-registration: https://osf.io/sfjwk).

2.6.3. Follow-up

An in-person ~4-hour *follow-up assessment*, was conducted regardless of intervention adherence level. This was identical to baseline testing with some exceptions (see Appendices), with the assigned MBI and active placebo relaxation intervention delivered for the last time at the start of testing session, immediately after consent.

2.7. Primary and secondary outcomes

2.7.1. Changes in cannabis use frequency and quantity

The *primary outcome* — change in *cannabis use frequency* — was computed from the TLFB (Sobell and Sobell, 1992): i.e., number of cannabis use days over the intervention period taken from the number of cannabis use days over the period of equivalent duration prior to

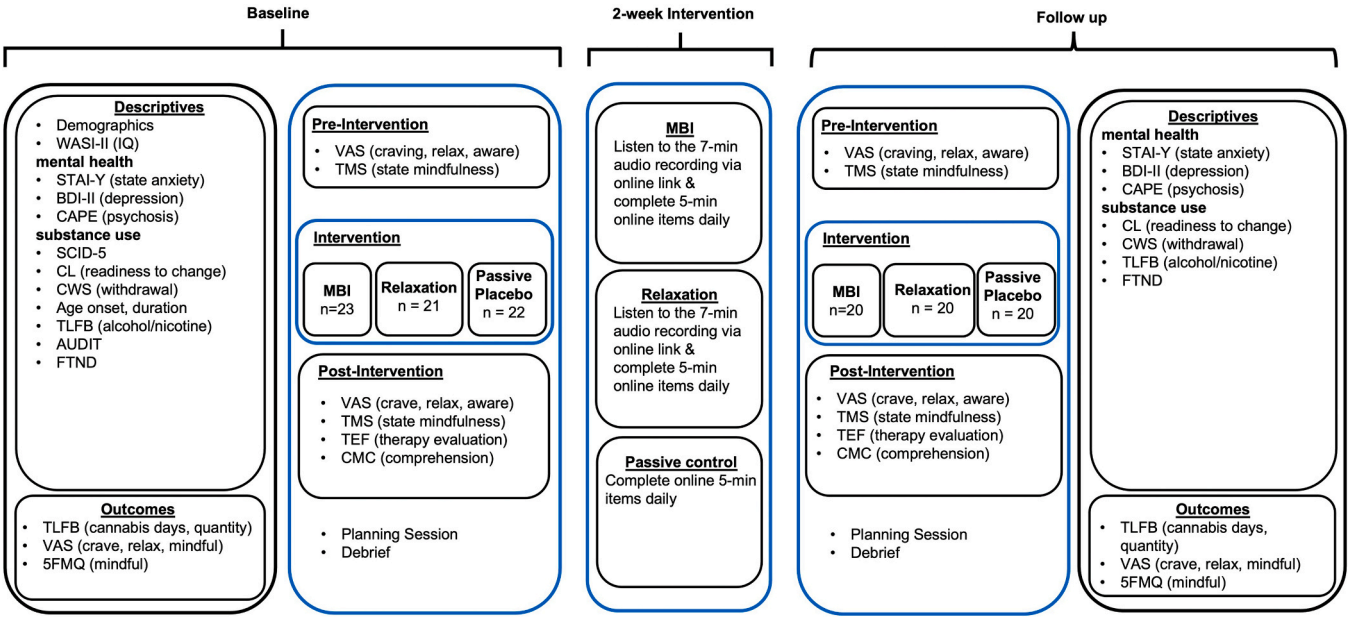

Fig. 1. Overview of the RCT testing protocol. *Abbreviations.* WASI-II = Weschler Abbreviated Standardised Intelligence – II; IQ = Intelligence Quotient; STAI-Y = State Anxiety; BDI-II = Beck Depression Inventory second edition; CAPE = Community Assessment of Psychic Experiences; SCID-5 = Structured Clinical Interview for the Diagnostic and Statistical Manual for Mental Health Disorders – fifth edition research version; CUDIT-R = Cannabis Use Disorder Identification Test – Revised; CL, Contemplation Ladder (BDF) (Government, 2013; Slavet et al., 2006); CWS = Cannabis Withdrawal Scale; TLFB = Timeline Follow-Back; AUDIT = Alcohol Use Disorder Identification Test; FTND = Fagerström Test for Nicotine Dependence; VAS = Visual Analogue Scale; 5FMQ = Five Facet Mindfulness Questionnaire; TMS = Toronto Mindfulness Scale; MBI = Mindfulness-Based Intervention; TEF = Therapy Evaluation Form; CMC = Credibility and Manipulation Check.

baseline. The *secondary outcome* - changes in *cannabis quantity* was computed as: the number of cannabis grams consumed over the intervention period, *minus* the number of cannabis grams used over the period of equivalent duration prior to baseline.

2.7.2. Changes in craving, state relaxation and mindfulness

Additional secondary outcomes measured at baseline and follow-up were: changes in cannabis craving, state mindfulness and state relaxation measures. Subjective *cannabis craving* was assessed using a VAS 1-to-10 ratings, with '1' indicating *"not at all"* to '10' *extremely"*) post a cue-reactivity fMRI task (Cousijn et al., 2012; Thomson et al., 2025), with the item: *"how much do you feel like smoking cannabis right now"*. State *relaxation* (added as an additional secondary outcome variable via update to pre-registration 27/11/24; https://osf.io/sfjwk) was assessed using a VAS (1-to-10 ratings): *"What is your level of relaxation-tension"*. State *mindfulness* was assessed using a VAS (1-to-10 ratings): "How aware are you of whatever arises in your moment-to-moment awareness?". *Trait mindfulness* was measured using five related dimensions from the 5FMQ: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience (Baer et al., 2022). Changes in craving and mindfulness were computed by subtracting follow-up MINUS baseline.

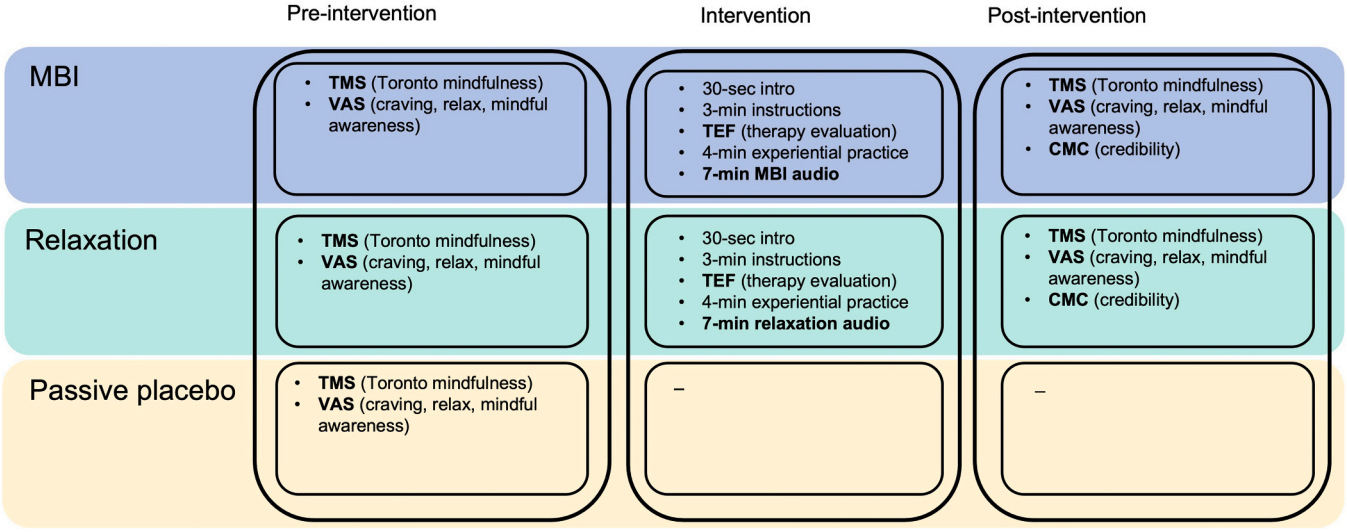

Fig. 2. Overview of intervention session at the end of the face-to-face baseline testing. *Abbreviations:* MBI = mindfulness-based intervention; TMS = Toronto mindfulness scale; VAS = visual analogue scale; TEF = therapy evaluation form; CMC = credibility and manipulation check.

2.8. Two-week daily intervention

Participants were asked to engage with daily tasks including items reporting on cannabis use in all three interventions; and for the MBI and active control conditions to additionally listen to the ~7-minute audio with the intervention (see Table C.1). We measured the following intervention-related variables: duration (i.e., number of days of the intervention including baseline and follow-up); adherence to the daily questionnaire in all 3 conditions (i.e., *number of days, % days*); and to the audio for MBI/active control conditions (i.e., *number of days*, *% days*). An unblinded researcher monitored participants' completion of the daily tasks based on Qualtrics' completion. If the intervention was not completed, participants received an SMS reminder after 1-to-2 days; and a phone call after 3+ days, and up to two SMS reminders.

2.9. Statistical analyses

2.9.1. Descriptives

Summary statistics were conducted to characterise the sample at baseline and for intervention relevant parameters, via outlining mean, standard deviation, median, and range.

2.10. Statistical analysis

2.10.1. Primary aim

To examine the primary aims, we ran linear mixed effects models, using intervention condition (MBI, active control, passive control), time (baseline, follow-up), and a condition-by-time interaction as fixed factors, and participant ID as a random intercept. The outcome variable was cannabis use days/~2 weeks, over the duration of the intervention period.

2.10.2. Secondary aims

To address the secondary aim, we also ran linear mixed effects models. Fixed factors were intervention condition (MBI, active control, passive control), time (baseline, follow-up), and condition-by-time, participant ID as a random intercept. Secondary outcome variables were: cannabis use grams/~2 weeks, over the duration of the intervention period; cannabis craving (VAS), state relaxation (VAS), state mindfulness (VAS, and 5FMQ subscales of observing, describing, acting-aware, non-judgment, non-reactivity).

We used the same statistical model parameters to measures changes in state mindfulness (i.e., Toronto Mindfulness Scale [TMS], VAS) and state relaxation (i.e., VAS), immediately pre-to-post the first in-person intervention session at baseline and the final in-person intervention session at follow-up (i.e., Δ immediately post-session *minus* pre-session).

2.10.3. Primary and secondary aims

In all omnibus models supporting the primary and secondary aims, we used a standard alpha level (0.05), followed by Benjamini–Hochberg False Discovery Rate (FDR) correction to adjust p-values for multiple comparisons (Benjamini and Yekutieli, 2001). To interpret any significant omnibus effects, we conducted post-hoc pairwise analyses using estimated marginal means (EMMs) tests. Spearman's correlations were run post-hoc to explore the associations between scalar variables.

Analyses employed a standard intention to treat approach (McCoy, 2017). All participants who were randomised to the interventions were included in the analyses, regardless of missing data or loss to follow-up. Details are outlined in the CONSORT flowchart in Figure A.1. We excluded ineligible participants or participants who did not complete testing at baseline, and a participant who withdrew their data from the study at the start of baseline testing. Figure D.1 and Figure D.2 show the pattern of missing data across variables. Sensitivity analyses were run to interpret the study results, without multivariate outliers (Figure D.3), defined as Cook's distance (>4*population mean), and with imputation (Figure D.4).

3. Results

Participants were recruited and followed up from October 2019 to August 2022, until sample size requirements were deemed to be met. Participants' flow is described in the CONSORT flowchart Figure A.1 and is detailed in Appendices.

3.1. Baseline characteristics

The 66 participants with moderate-to-severe CUD (19 female) were aged around 27 years, mostly with secondary-to-tertiary education and above-average IQ (Table 1). Participants exhibited minimal levels of depression and state anxiety, and levels of positive and negative psychotic symptoms slightly higher than normative samples (Konings et al., 2006). Alcohol use levels varied from 0 to 207 drinks in the past month, and on average participants had low risk AUDIT scores. Nicotine use occurred in a minority of the sample.

Cannabis use characteristics are outlined in Table 1. At baseline, most participants were contemplating changing their cannabis consumption, but had not made specific plans and showed moderate-to-high levels of subjective relaxation and mindfulness (Slavet et al., 2006). No participants reported any adverse events or intervention-related harms during their debrief with the researcher at the end of the last face-to-face assessment session.

3.2. Results on primary outcomes

There were no significant main effects of time or intervention, or intervention-by-time effects on cannabis *frequency* following FDR correction (Table 2). However, a main effect of time was observed, prior to FDR correction. See Table 3 for tests of estimated marginal means and effect sizes with confidence intervals.

3.3. Results on secondary outcomes

There were no significant time, intervention, or time-by-intervention effects on cannabis *grams*, *craving*, *relaxation* or *mindfulness*) following FDR correction (Table 2).

3.4. Exploratory correlations

Due to the lack of any statistically significant condition-by-time effects from baseline to follow-up, correlations were not performed.

3.5. Interventions' adherence, credibility/expectancy and comprehension

The interventions lasted just over two weeks and participants' completion of the daily tasks ranged from ~50–75 % meaning the intervention was adhered to every second day or more over the 2-week period, with lower adherence in the MBI versus relaxation group, which were both lower than the passive placebo group. See Appendices for specific information on the interventions' adherence, credibility/expectancy (Table E.1) and participant comprehension (Table E.2).

3.6. Exploratory analyses: acute effects of the first, in-lab and last, in-lab intervention sessions

3.6.1. Time

The first time the single intervention session was delivered, there was a significant effect of time (F=18.41, FDRp = .003) on VAS-Relaxation, which was driven by increased relaxation immediately pre-to-post- a single session (M difference=1.23, p < .001, D=0.55 (0.10–1.00); see Fig. 3, Table F.1). There were no significant time effects for the other outcome variables (VAS-Mindfulness, TMS DeCentering/Curiosity; FDRp's = .84–.88).

At the beginning of the second face-to-face session, a single

Table 1
Pairwise baseline demographic, substance use, trait and state mindfulness, and state relaxation data.

Variables			MBI				Relaxation				Passive placebo			
			Mean	SD	Median	Range	Mean	SD	Median	Range	Mean	SD	Median	Range
Total *N* [female]			*23* [6]	_	_	_	*21* [7]	_	_	_	*22* [6]	_	_	_
Age, yrs			26.87	7.36	25	19–44	28.14	8	26	18–51	26.73	8.34	24	18–56
Education, yrs			14.49	2.56	13.58	11–21	15.13	2.08	15.42	10.17–19.25	16.69	3.39	16.25	12–23
IQ (WASI-II)			109.77	9.81	108	90–129	104.33	8.79	107	90–121	106.10	9.67	104	90–123
BDI			11.87	7.01	11	0–27	12.67	11.06	8	2–46	9.95	7.21	8	2–25
STAI-Y			34.30	8.27	34	21–53	32.48	10.76	29	20–69	29.71	8.22	27	20–44
CAPE	Positive		41.68	13.43	41	23–76	38.14	10.94	36	20–59	36.57	12.05	33	20–73
	Negative		39.05	13.80	37.5	14–62	40.57	16.97	36	21–82	40.57	12.67	41	24–80
	Depressive		23.32	9.83	22	8–45	24.52	7.70	25	12–44	21.43	8.72	17	12–43
Alcohol	AUDIT		7.26	5.68	6	0–22	5.29	3.54	5	1–12	8	4.51	7	1–17
	drinks/past mo		38.43	57.37	16	0–206.80	17.66	30.85	4.5	0–111.40	36.81	50.52	16.30	0–201
	days/past mo		6.61	6.83	4	0–22	3.14	2.95	3	0–11	8.18	8.65	5	0–30
Nicotine	FTND		1	1.95	0	0–6	1.29	1.71	0	0–5	0.9	1.34	0	0–5
	cigarettes/past mo		35.03	77.67	0	0–262	75.40	99.66	15	0–294	86.12	183.10	0.5	0–600
	cigarette days/past mo		7.29	11.95	0	0–30	14.57	13.75	8.5	0–30	14.94	14.70	13.5	0–30
Cannabis	CUDIT-R		15.61	4.92	14	8–26	16.33	4.67	15	11–30	16.24	5.71	14	7–27
	days/past mo		26.48	4.94	29	13–30	25.95	5.06	29	14–30	24.72	5.66	26	14–30
	grams/past month		28.31	21.96	23.08	3.88–78.50	30.90	22.53	26.65	4.88–84.00	20.71	15.43	16.85	0.90–60.43
	craving (VAS)		4.30	2.36	4	1–9	4.48	2.77	4	1–10	4.82	3.05	5	1–10
	Withdrawal (CWS)		32.39	29.04	26	0–118	37.86	27.35	26	8–91	28.33	26.00	23	0–98
	age first try		17.44	3.79	16.83	12.83–32.08	16.19	1.99	15.50	50–100	16.57	2.07	16.25	13.50–21.25
	age regular use		19.97	4.30	18.58	15–33.83	19.63	3.18	18.67	15.25–28.83	20.60	3.04	20	16.50–26.50
	duration, years		7.18	7.28	4.00	0.5–25.58	7.71	6.40	7	0.99–23.94	6.01	7.53	4.00	0.88–34.75
TMS	Curiosity		14	5.84	15	3–24	14.33	4.85	14	5–24	14.55	5.06	14.5	6–24
	De-Centering		12.43	4.91	13	2–23	14.43	4.51	14	4–24	13.68	4.90	13.5	6–25
VAS	State relaxation		6.26	2.44	6	2–10	6.67	2.33	7	2–10	7.82	2.02	8.5	4–10
	State mindfulness		7.17	1.59	7	4–10	7.05	2.44	7	2–10	7.72	1.64	8	4–10
5FMQ	Observing		27.96	6.50	27	11–40	27.76	5.54	28	18–39	26.29	6.39	25	16–40
	Describing		31.17	5.91	32	22–40	28.43	6.24	29	14–40	26.81	7.33	29	13–36
	Acting-Aware		26.78	5.65	28	15–40	26.24	6.96	26	13–37	26.90	7.46	29	11–38
	Non-Judgement		26.43	8.27	27	13–39	25.81	7.83	27	11–37	27.38	7.57	27	11–39
	Non-Reactivity		21.96	4.68	21	16–33	21.43	4.59	21	11–34	23.67	5.26	24	10–33
Readiness to change (CL)			5.26	2.16	5	1–9	5.33	2.44	5	1–9	5.19	1.89	5	1–8
Intervention	length, N days		17.30	4.69	15	11–33	16.5	3.47	15	14–29	15.65	4.34	15	10–32
	daily task completed	N days	9.24	3.24	9	5–19	9.62	3.41	10	2–15	10.91	3.22	10.50	5–20
		% days	54.77	16.83	59.41	22.73–82.61	60.95	24.80	60.27	12.50–100	70.30	19.93	71.28	28.13–100
	audio task completed	N days	8.24	3.52	8	1–18	8.48	3.46	9	2–14	_	_	_	_
		% days	48.43	19.28	51.67	6.67–80	53.51	24.98	55.63	12.50–93.33	_	_	_	_

Abbreviations: MBI, mindfulness-based intervention; F, Female; N, number of participants; WASI-II, Wechsler Abbreviated Scale of Intelligence, 2nd Edition; BDI, Beck Depression Inventory; STAI-Y, state subscale of the State-Trait Anxiety Inventory-Form Y; CAPE, Community Assessment of Psychic Experiences; AUDIT, Alcohol Use Disorder Identification test; FTND, Fagerström Test for Nicotine Dependence; CUDIT-R, Cannabis Use Disorder Identification Test – Revised; CWS, Cannabis Withdrawal Scale; CB, cannabis; regular use, $\geq$ 3 days/week; TMS, Toronto Mindfulness Scale; VAS, Visual Analogue Scale; 5FMQ, Five Facet Mindfulness Questionnaire; CL, Contemplation Ladder.

Table 2
Imputed pre-to-post intervention changes across interventions in substance use and related problems, state and trait mindfulness, and state relaxation.

Variable			MBI	Relaxation	Passive placebo	Condition			Time			Condition-by-Time			ICC
						F	Unc. *p*	FDR*p*	F	Unc. *p*	FDR*p*	F	Unc. *p*	FDR*p*	
Cannabis	days/~2 weeks	*BL*	14.74 (4.34)	14.39 (2.64)	12.23 (4.01)	2.25	.11	.44	2.52	.12	.44	0.26	.77	.86	.66
		FU	13.67 (4.91)	12.80 (4.82)	11.25 (3.89)										
	grams/~2 weeks	*BL*	14.92 (14.09)	18.80 (15.26)	11.22 (6.14)	1.75	.18	.54	6.12[a]	.02*	.39	1.16[b]	.32	.68	.77
		FU	14.28 (14.74)	15.94 (18.05)	8.44 (6.59)										
	craving, VAS	*BL*	4.05 (2.42)	4.60 (2.78)	4.82 (3.05)	0.47	.63	.80	2.60	.11	.44	0.52	.60	.80	.52
		FU	3.05 (2.04)	4.34 (2.74)	3.98 (2.60)										
State relaxation, VAS		*BL*	6.15 (2.52)	6.65 (2.39)	7.82 (2.02)	3.21	.04*	.39	0.00	.99	.99	0.82	.45	.68	.48
		FU	6.99 (2.05)	6.72 (2.45)	7.83 (1.73)										
State mindfulness, VAS		*BL*	7.10 (1.68)	7.00 (2.49)	7.73 (1.64)	0.82	.44	.68	3.54	.06	.39	0.44	.65	.80	.56
		FU	6.60 (1.87)	6.80 (2.28)	7.02 (1.94)										
5FMQ	Observing	*BL*	28.70 (5.67)	27.20 (5.03)	26.35 (6.23)	0.93	.40	.68	0.75	.39	.68	0.37	.69	.80	.68
		FU	27.94 (5.01)	27.32 (4.48)	25.69 (6.78)										
	Describing	*BL*	31.65 (5.95)	28.25 (6.35)	26.96 (7.18)	2.84	.07	.39	2.23	.14	.47	3.44[c]	.04*	.39	.70
		FU	29.89 (6.77)	28.72 (6.24)	28.16 (6.57)										
	Acting-Aware	*BL*	26.60 (6.05)	25.75 (6.76)	26.92 (7.28)	0.20	.82	.88	0.57	.45	.68	0.15	.86	.89	.60
		FU	25.29 (4.34)	24.34 (6.47)	26.20 (5.86)										
	Non-Judgment	*BL*	26.05 (8.14)	25.25 (7.59)	27.38 (7.38)	0.45	.64	.80	0.86	.36	.68	1.50	.23	.63	.68
		FU	29.05 (7.29)	26.22 (7.42)	28.25 (6.68)										
	Non-Reactivity	*BL*	22.40 (4.84)	21.30 (4.67)	23.65 (5.13)	1.30	.28	.68	0.18	.67	.80	0.81	.44	.68	.64
		FU	22.14 (5.26)	22.51 (3.76)	23.98 (4.52)										

Abbreviations: *, statistically significant effect ($p < .05$); Unc. *p*, uncorrected p-value; FDR*p*, Benjamini-Hochberg FDR corrected p-value; MBI, mindfulness-based intervention; ICC, intraclass coefficient; BL, baseline; FU, follow-up; VAS, visual analogue scale; 5FMQ, five facet mindfulness questionnaire.

[a] For the non-significant main effect of time on cannabis grams/~2 weeks (F = 6.12, Unc.*p* = .02, FDR*p* = .39); FU < BL (M difference = 2.09, *p* = .003, d = 0.16 (95 % CI = −0.19 – 0.51)).

[b] For the non-significant condition-by-time interaction effect on cannabis grams/~2 weeks (F = 1.16, Unc.*p* = .32, FDR*p* = .68); *MBI* FU < BL (M difference = 0.64, d = 0.05 (95 % CI = −0.29 – 0.59); *Relaxation* FU < BL (M difference = 2.86, *p* = .02, d = 0.22 (95 % CI = −0.40 – 0.84); *Passive control* FU < BL (M difference = 2.78, *p* = .02, d = 0.21 (95 % CI = −0.38 – 0.81).

[c] For the non-significant condition-by-time interaction effect on the 'Describing' subscale of the 5FMQ (F = 3.44, Unc.*p* = .04, FDR*p* = .39); *MBI* FU < BL (M difference = 1.76, *p* = .04, d = 0.27 (95 % CI = −0.35 – 0.89); *Relaxation* BL < FU (M difference = 0.47, *p* = .58, d = 0.07 (95 % CI = −0.55 – 0.69); *Passive control* BL < FU (M difference = 1.20, *p* = .14, d = 0.18 (95 % CI = −0.41 – 0.78)).

Table 3
Post hoc tests of estimated marginal means: differences between conditions pre-to-post intervention in cannabis frequency, dosage and craving, state and trait mindfulness, and state relaxation.

Outcome variable		Tests of estimated marginal means						
		Contrast	**MD**	**SE**	**df**	***t***	***p***	***d* (95 % CI)**
Cannabis	**days/~2 weeks**	**Time** (*change over time, regardless of intervention condition*)						
		Follow-up – Baseline	−1.21	0.37	f	−3.28	.002**	0.29 (−0.06 – 0.65)
		Intervention condition (*difference between intervention conditions, regardless of time***)**						
		Passive placebo - Relaxation	−1.85	1.21	59	−1.53	.13	0.34 (−0.10 – 0.77)
		Passive placebo - MBI	−2.46	1.21	59	−2.04	.05*	0.45 (0.01 – 0.88)
		Relaxation - MBI	−0.61	1.23	59	−0.49	.62	0.11 (−0.33 – 0.55)
		Condition-by-time (*change over time, separately for each intervention condition***)**						
		Δ Passive placebo (Follow-up - Baseline)	−0.98	0.62	59	−1.59	.12	0.24 (−0.36 – 0.83)
		Δ Relaxation (Follow-up - Baseline)	−1.59	0.65	59	−2.44	.02*	0.38 (−0.24 – 1.01)
		Δ MBI (Follow-up - Baseline)	−1.07	0.65	59	−1.64	.11	0.26 (−0.37 – 0.88)
	grams/~2 weeks	**Time**						
		Follow-up - Baseline	−2.09	0.67	59	−3.12	.003**	0.16 (−0.19 – 0.51)
		Intervention condition						
		Passive placebo - Relaxation	−7.54	3.96	59	−1.90	.06	0.42 (−0.02 – 0.85)
		Passive placebo - MBI	−4.77	3.96	59	−1.20	.23	0.26 (−0.17 – 0.69)
		Relaxation - MBI	2.77	4.06	59	0.68	.50	−0.15 (−0.59 – 0.29)
		Condition-by-time						
		Δ Passive placebo (Follow-up – Baseline)	−2.78	1.12	59	−2.47	.02*	0.21 (−0.38 – 0.81)
		Δ Relaxation (Follow-up - Baseline)	−2.86	1.18	59	−2.42	.02*	0.22 (−0.40 – 0.84)
		Δ MBI (Follow-up - Baseline)	−0.64	1.18	59	−0.54	.59	0.05 (−0.57 – 0.69)
	craving, VAS	**Time**						
		Follow-up - Baseline	−0.70	0.31	59	−2.26	.03*	0.27 (−0.09 – 0.62)
		Intervention condition						
		Passive placebo - Relaxation	0.83	0.52	59	1.61	.11	0.02 (−0.41 – 0.45)
		Passive placebo - MBI	0.26	0.54	59	0.47	.64	−0.26 (−0.69 – 0.17)
		Relaxation - MBI	1.00	0.54	59	1.85	.07	−0.28 (−0.72 – 0.16)
		Condition-by-time						
		Δ Passive placebo (Follow-up - Baseline)	−0.83	0.52	59	−1.61	.11	0.32 (−0.28 – 0.91)
		Δ Relaxation (Follow-up - Baseline)	−0.26	0.54	59	−0.47	.64	0.10 (−0.52 – 0.72)
		Δ MBI Follow-up - Baseline	−1.00	0.54	59	−1.85	.07	0.38 (−0.25 – 1.01)
State relaxation, VAS		**Time**						
		Follow-up - Baseline	0.31	0.30	59	1.04	.30	−0.14 (−0.49 – 0.21)
		Intervention condition						
		Passive placebo - Relaxation	1.14	0.58	59	1.97	.05	−0.43 (−0.86 – 0.00)
		Passive placebo - MBI	1.25	0.58	59	2.17	.03*	−0.47 (−0.91 – −0.04)
		Relaxation - MBI	0.11	0.59	59	0.19	.85	−0.04 (−0.48 – 0.40)
		Condition-by-time						
		Δ Passive placebo (Follow-up – Baseline)	0.01	0.50	59	0.01	.99	0.00 (−0.59 – 0.59)
		Δ Relaxation (Follow-up – Baseline)	0.07	0.52	59	0.14	.89	−0.03 (−0.66 – 0.59)
		Δ MBI (Follow-up – Baseline)	0.84	0.52	59	1.62	.11	−0.38 (−1.01 – 0.24)
State mindfulness, VAS		**Time**						
		Follow-up - Baseline	−0.47	0.22	59	−2.09	.04*	0.23 (−0.12 – 0.59)
		Intervention condition						
		Passive placebo - Relaxation	0.47	0.56	59	0.85	.40	−0.19 (−0.62 – 0.24)
		Passive placebo - MBI	0.52	0.56	59	0.94	.35	−0.21 (−0.64 – 0.22)
		Relaxation - MBI	0.05	0.57	59	0.09	.93	−0.02 (−0.46 – 0.42)
		Condition-by-time						
		Δ Passive placebo (Follow-up – Baseline)	−0.70	0.37	59	−1.88	.06	0.35 (−0.24 – 0.95)
		Δ Relaxation (Follow-up – Baseline)	−0.20	0.39	59	−0.50	.62	0.10 (−0.52 – 0.72)
		Δ MBI (Follow-up – Baseline)	−0.50	0.39	59	−1.26	.21	0.25 (−0.37 – 0.87)
5FMQ	**Observing**	**Time**						
		Follow-up - Baseline	−0.43	0.45	59	−0.96	.34	0.08 (−0.28 – 0.43)
		Intervention condition						
		Passive placebo - Relaxation	1.24	1.65	59	0.75	.46	−0.16 (−0.59 – 0.27)
		Passive placebo - MBI	2.30	1.65	59	1.39	.17	−0.31 (−0.74 – 0.13)
		Relaxation - MBI	1.06	1.69	59	0.63	.53	−0.14 (−0.58–0.30)
		Condition-by-time						
		Δ Passive placebo (Follow-up – Baseline)	−0.65	0.75	59	−0.86	.39	0.12 (−0.48 – 0.71)
		Δ Relaxation (Follow-up – Baseline)	0.12	0.79	59	0.15	.88	−0.02–0.64 – 0.60)
		Δ MBI (Follow-up – Baseline)	−0.76	0.79	59	−0.97	.34	0.14 (−0.49 – 0.76)
	Describing	**Time**						
		Follow-up - Baseline	−0.03	0.48	59	−0.06	.95	0.01 (−0.35 – 0.36)
		Intervention condition						
		Passive placebo - Relaxation	−0.92	1.93	59	−0.48	.64	0.10 (−0.32 – 0.53)
		Passive placebo - MBI	2.30	1.65	59	1.39	.17	−0.31 (−0.74 – 0.13)
		Relaxation - MBI	1.06	1.69	59	0.63	.53	−0.14 (−0.58–0.30)
		Condition-by-time						
		Δ Passive placebo (Follow-up – Baseline)	1.20	0.80	59	1.49	.14	−0.18 (−0.78 – 0.41)
		Δ Relaxation (Follow-up – Baseline)	0.47	0.84	59	0.55	.58	−0.07 (−0.69 – 0.55)
		Δ MBI (Follow-up – Baseline)	−1.76	0.84	59	−2.09	.04*	0.27 (−0.35 – 0.89)
	Acting-Aware	**Time**						
		Follow-up - Baseline	1.15	0.57	59	2.01	.05*	−0.19 (−0.54 – 0.17)

(*continued on next page*)

Table 3 (*continued*)

Outcome variable	Tests of estimated marginal means						
	Contrast	**MD**	**SE**	**df**	***t***	***p***	***d* (95 % CI)**
	Intervention condition						
	Passive placebo - Relaxation	1.51	1.79	59	0.85	.40	−0.19 (−0.61 – 0.24)
	Passive placebo - MBI	0.61	1.79	59	0.34	.73	−0.08 (−0.50 – 0.35)
	Relaxation - MBI	−0.90	1.83	59	−0.49	.62	0.11 (−0.33 – 0.55)
	Condition-by-time						
	Δ Passive placebo (Follow-up – Baseline)	−0.72	0.96	59	−0.76	.45	0.12 (−0.48 – 0.71)
	Δ Relaxation (Follow-up – Baseline)	−1.41	1.00	59	−1.41	.16	0.23 (−0.40 – 0.85)
	Δ MBI (Follow-up – Baseline)	−1.31	1.00	59	−1.30	.20	0.21 (−0.41 – 0.83)
Non-Judgment	**Time**						
	Follow-up - Baseline	1.61	0.56	59	2.87	.006**	−0.22 (−0.57 – 0.14)
	Intervention condition						
	Passive placebo - Relaxation	2.09	0.94	59	0.95	.34	−0.21 (−0.64 – 0.22)
	Passive placebo - MBI	0.27	0.99	59	0.12	.90	−0.03 (−0.46 – 0.40)
	Relaxation - MBI	−1.81	0.99	59	−0.81	.42	0.18 (−0.26 – 0.62)
	Condition-by-time						
	Δ Passive placebo (Follow-up – Baseline)	0.87	0.94	59	0.92	.36	−0.12–0.71 – 0.47)
	Δ Relaxation (Follow-up – Baseline)	0.97	0.99	59	0.98	.33	−0.13 (−0.49 – 0.75)
	Δ MBI (Follow-up – Baseline)	3.00	0.99	59	3.03	.004**	−0.40 (−1.03 – 0.22)
Non-Reactivity	**Time**						
	Follow-up - Baseline	0.43	0.47	59	0.92	.36	−0.09 (−0.44 – 0.26)
	Intervention condition						
	Passive placebo - Relaxation	1.91	1.35	59	1.42	.16	−0.31 (−0.74 – 0.12)
	Passive placebo - MBI	1.54	1.35	59	1.15	.26	−0.25 (−0.68 – 0.18)
	Relaxation - MBI	−0.36	1.38	59	−0.26	.79	0.06 (−0.38 – 0.50)
	Condition-by-time						
	Δ Passive placebo (Follow-up – Baseline)	0.34	0.78	59	0.43	.67	−0.07 (−0.66 – 0.52)
	D Relaxation (Follow-up – Baseline)	1.21	0.82	59	1.48	.15	−0.26 (−0.88 – 0.37)
	D MBI (Follow-up – Baseline)	−0.26	0.82	59	−0.32	.75	0.06 (−0.57 – 0.68)

Abbreviations: *, statistically significant effect ($p < .05$); **, $p < .01$; ***, $p < .001$; MBI, mindfulness-based intervention; MD, mean difference; SE, standard error; df, degrees of freedom; t, t ratio; *p*, p-value; D, Cohen's D; CI, confidence interval; VAS, visual analogue scale; 5FMQ, five facet mindfulness questionnaire

intervention (i.e., MBI and active placebo relaxation) session was delivered one last time, and there were no significant time effects for VAS or any of the other outcome variables (FDR*p*'s = .05–.84). See Table F.2 for tests of estimated marginal means and effect sizes with confidence intervals.

N.B. There was a non-significant acute condition-by-time interaction effect on state relaxation (F = 3.76, Unc.$p = .06$, FDR$p = .36$); Relaxation condition pre-int < post-int (M difference = 1.80, $p < .001$, d = 0.81 (95 % CI = 0.16 – 1.45); MBI condition pre-int < post-int: M difference = 0.65, $p = .13$, d = 0.29 (95 % CI = −0.33 – 0.91).

3.6.2. *Intervention condition-by-time*

There were no significant condition-by-time effects for the any of the hypothesised outcome variables at baseline (FDR*p*'s = .36–.84) or follow-up (FDR*p*'s = .17–.84).

4. Discussion

In this world-first study of a brief MBI for non-treatment seekers with moderate-to-severe CUD, no significant intervention-by-time effects were found on cannabis frequency, quantity and cravings, nor on measures of relaxation and mindfulness, relative to active (relaxation intervention) and passive (assessment only) control conditions. This was contrary to our hypothesis. Since MBIs purportedly reduce substance use and craving (Garland and Howard, 2018), we anticipated reductions in cannabis and craving as a result of a brief MBI.

These null findings suggest a brief MBI does not benefit general community members with CUD who are not seeking or undergoing treatment. It may be that participants received an insufficient dose to change their cannabis use due to the brevity of the MBI, with a maximum of 3.5 hour practice. Indeed, in a review of MBI for SUDs, the durations of MBIs tested were mostly 13–16 hours, with no beneficial clinical effects beyond comparator interventions on return to substance use (Grant et al., 2017). Nonetheless, our findings are line with null findings from other cannabis studies of 4-week (Stanger et al., 2024) and 8-week (Schneegans et al., 2022) MBIs, but contrast with one on females with CUD (de Dios et al., 2012) reporting cannabis reduction effects with 2 × 45 min sessions, suggesting MBI dose may have little impact. However, the results also contrast with MBI RCTs on other substances, where an ultra-brief (11-minute) MBI *versus* relaxation reduced alcohol use in participants who report risky alcohol consumption, which formed the basis of the current trial's protocol (Kamboj et al., 2017).The present study's negative findings are at odds with prior research demonstrating that brief MBIs can reduce symptoms of anxiety, depression and distress and to a lesser extent substance craving and consumption (Howarth et al., 2019), Kamboj and colleagues (2017) (Howarth et al., 2019; Li et al., 2017; Schumer et al., 2018). Whilst these findings require replication, they suggest that a brief MBI may be insufficient as a stand-alone approach for people with CUD. Nonetheless, these findings should not discourage further examination of MBIs as a potential intervention for this population, given the emerging evidence for longer MBIs with other SUDs (Li et al., 2017).

It is worth highlighting that *prior* to FDR correction, there was a main effect of time on reduction in cannabis grams (mean reduction of 2.09 g, $p = .003$), albeit a modest reduction (d=0.16, (95 % CI=-0.19–0.51)) and one driven by changes in the relaxation ($p = .02$, d=0.22, (95 % CI=-.40–0.84)) and passive control groups ($p = .02$, d=0.21, (95 % CI=-.38–0.81)). Interestingly, the Kamboj et al. (2017) trial found that the relaxation intervention was more than twice as effective as the MBI, in reducing alcohol craving (without corrections for multiple comparisons). Furthermore, the passive control condition might also have been too active, in that it required participants to reflect on and report their cannabis use daily for 2 weeks. Indeed the effects of assessment reactivity, where mere exposure to substance use outcome measures increases self-awareness, is well documented in the literature for its potential to undermine true intervention effects (McCambridge, 2009). However, this does not explain the lack of change on the MBI group who were subjected to the same outcome assessment intensity.

The findings must be interpreted in the context of the trial's methodological limitations, which include a male-predominant sample (i.e.,

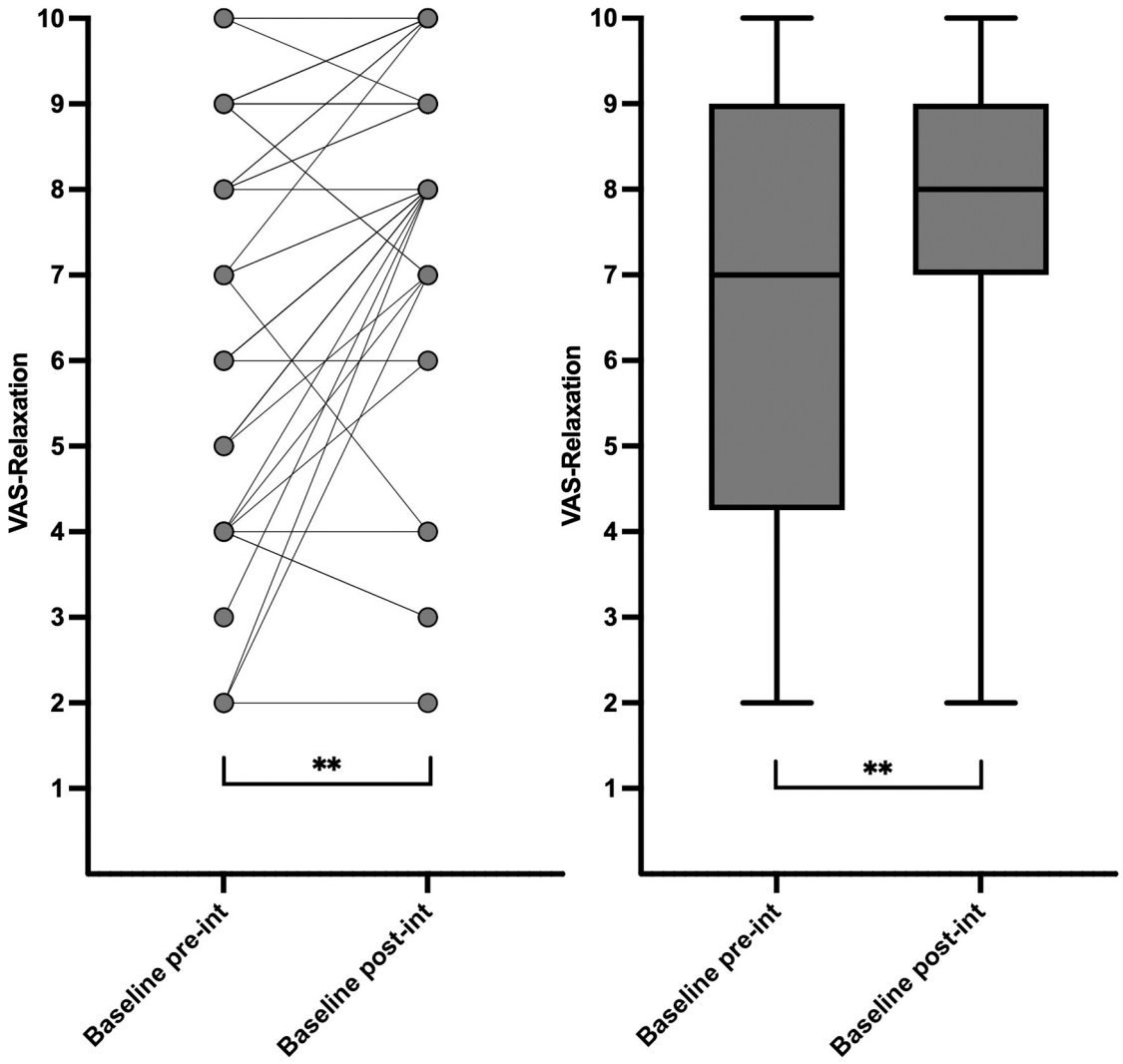

Fig. 3. Posthoc scatterplot (left) and box-and-whiskers plot (right) showing a significant main effect of the first session of the intervention (MBI *and* placebo relaxation), showing acute changes in VAS-state relaxation. *Abbreviations*: *** $p < .001$, VAS, visual analogue scale; pre-int, measurements taken immediately before a single intervention session at baseline or follow-up; post-int, measurements taken immediately following the first delivery of the intervention at baseline or follow-up.

19 of 66 participants are female), and sample restrictions in terms of size — which had to be reduced due the impact of extensive COVID-19 lockdowns in the Melbourne area during participants recruitment — and location (i.e., limited to metropolitan Melbourne). Adherence ranged from ~50–75 %, yet because the intervention required daily practice, the intervention's adherence was notable with practice occurring every second day or more often. Non-treatment seeking individuals may be less motivated and therefore less adherent, and so future studies may consider less frequent practice e.g., daily or almost daily and monitoring using electronic momentary assessment tools with automated SMS reminders and motivational messages. Future work testing MBIs may also benefit from implementation of more person-centred techniques, e.g., profiling dispositional mindfulness prior to MBIs, and from examining youth who report at-risk cannabis consumption who want to reduce or stop their use but do not have a CUD (Carlon et al., 2023), similar to previous work (de Dios et al., 2012; Kamboj et al., 2017). Further, we used VAS items implemented in previous studies from the relevant literature, the VAS might have been too limited to robustly capture changes in distinct dimensions of craving (e.g., compulsivity, emotionality, expectancy, purposefulness) (Li et al., 2017).

Strengths were that the first and final MBI sessions were supervised, and digital records verified MBI/relaxation practice at home – providing confidence that participants completed the active interventions. However, as participants had minimal mindfulness exposure prior to the intervention, they might have not fully engaged with the task when not supervised. Other major strengths were its double-blind RCT design with both an active and passive control group, the comprehensive metrics of cannabis use (including urine toxicology), trial pre-registration, and a rigorous statistical ITT approach which controlled for multiple comparisons (FDR and procedures to account for outliers using a multivariate approach).

Whilst it was encouraging that the supervised first session of MBI/relaxation resulted in a significant increase in relaxation, demonstrating successful intervention effects, these changes in relaxation did not translate into changes in cannabis use or craving, over the course of the intervention. In conclusion, based on these findings, a brief MBI does not appear to help people with CUD reduce their use. However, we encourage future research efforts to replicate the findings with a larger sample, longer/more intensive interventions, and a more passive control condition (e.g., treatment as usual), using apps for more accessible intervention delivery and more accurate measurement of cannabis/other substance consumption, before ruling out the potential of MBI to help people with CUD.

CRediT authorship contribution statement

Tom P Freeman: Writing – review & editing, Supervision, Methodology, Conceptualization. **Sunjeev K. Kamboj:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization. **Gill Terrett:** Writing – review & editing, Resources, Funding acquisition. **Lisa-Marie Greenwood:** Writing – review & editing, Supervision, Project administration, Investigation. **Adam Clemente:** Writing – review & editing, Supervision, Project administration, Investigation, Data curation. **Peter Rendell:** Writing – review & editing, Resources, Funding acquisition. **Eugene McTavish:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation. **Hannah Thomson:** Writing – review & editing, Project administration, Investigation, Data curation. **Valentina Lorenzetti:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Victoria Manning:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Conceptualization.

Declaration of Competing Interest

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2025.112909.

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