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Authors

Bonar, Erin E
Goldstick, Jason E
Chapman, Lyndsay
[et al.](#)

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A Social Media Intervention for Cannabis Use among Emerging Adults: Randomized Controlled Trial

Erin E. Bonar^{a,b,c}, Jason E. Goldstick^{b,d,e}, Lyndsay Chapman^a, José A. Bauermeister^f, Sean D. Young^{g,h}, Jenna McAfeeⁱ, Maureen A. Walton^{a,b}

^aAddiction Center, Department of Psychiatry, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 16, Ann Arbor, MI 48109, USA

^bInjury Prevention Center, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 10, Ann Arbor, MI 48109, USA

^cCenter for Sexuality and Health Disparities, University of Michigan, 400 North Ingalls Street, Ann Arbor, MI 48109, USA

^dDepartment of Emergency Medicine, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 10, Ann Arbor, MI 48109, USA

^eDepartment of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109, USA

^fDepartment of Family and Community Health, School of Nursing, University of Pennsylvania, Philadelphia, PA 19104

^gDepartment of Informatics, Donald Bren School of Information and Computer Sciences, University of California Irvine, Irvine, CA 92697

^hDepartment of Emergency Medicine, School of Medicine, University of California Irvine, Irvine, CA 92697

ⁱDepartment of Anesthesiology, University of Michigan, Ann Arbor, MI 48109

Abstract

Purpose: Cannabis use is increasing among emerging adults (ages 18–25), necessitating the need for prevention interventions. Using a novel platform – social media – we developed an 8-week motivational interviewing and cognitive-behavioral intervention targeting cannabis use among emerging adults. Herein, we report on the feasibility and acceptability of the intervention in a pilot trial.

Procedures: For [NCT 04187989](#) we recruited N = 149 emerging adults who used cannabis (at least 3 times/week for the past month) using social media advertising. Their mean age was 21.0 years (SD = 2.2); 55.7% were female. Most were White (70.5%; 20.1% Black/African American,

Corresponding Author: Erin E. Bonar, Ph.D., University of Michigan Addiction Center, 2800 Plymouth Road, North Campus Research Complex, Building 16, 764-734-7936, erinbona@med.umich.edu.

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9.4% Other races), with 20.1% identifying as Hispanic/Latinx. Participants were randomized to the 8-week intervention or an 8-week attention-placebo control condition, both delivered in secret Facebook groups by electronic health coaches (e-coaches). Follow-up assessments occurred at 3- and 6-months.

Results: The intervention was well-received and follow-up rates were high; fidelity was good. Intervention participants rated e-coaches significantly higher in terms of helpfulness, warmth, etc., compared to control participants. Intervention participants were more likely to engage with and recommend the group. In terms of percentage reductions in cannabis outcomes, the intervention group evidenced absolute reductions over time in several measures of cannabis consumption across modalities. In an adjusted model, reductions in vaping days in the intervention group, relative to attention-control, reached statistical significance ($p=.020$, $D = .40$).

Conclusions: This social media intervention for emerging adults' cannabis use was feasible and acceptable in the target population warranting future testing in a fully powered trial.

Keywords

emerging adults; cannabis; social media; motivational interviewing

1. Introduction

Cannabis use is increasing among emerging adults (EAs; ~18–25 years-old), the age group with the highest prevalence in the United States (Substance Abuse and Mental Health Service Administration, 2021). Cannabis prevalence peaks at ages 21–22 and past-year use rates are similar regardless of college enrollment status (Schulenberg et al., 2020). Current cannabis products have higher potency than ever before (ElSohly et al., 2021; ElSohly et al., 2016; Freeman et al., 2021), including extracts with 70% THC (Hall and Lynskey, 2020; Jones et al., 2016; Matheson and Le Foll, 2020) and flower at 20–45% THC (Cash et al., 2020; Mahamad et al., 2020; Smart et al., 2017). Increases in EAs' vaping (13% 30-day prevalence) from 2017–2019 are particularly alarming (Schulenberg et al., 2020).

Prevalence is increasing in a context of more permissive laws (e.g., over a dozen states allow legal recreational cannabis; most allow medical cannabis), increased access (i.e., ~90% of EAs say cannabis is easy to get), and historical lows in cannabis disapproval and risk perceptions (Azofeifa et al., 2016; Carliner et al., 2017; Salas-Wright et al., 2016; Somerville, 2016). Early cannabis use increases risk for short- and long-term negative physical, psychiatric, and social outcomes, and cannabis use disorder (CUD) (Behrendt et al., 2009; Castellanos-Ryan et al., 2016; Hall and Degenhardt, 2009; Scott et al., 2018; Sun et al., 2020; Volkow et al., 2014). Preventive interventions to address cannabis use among EAs are necessary, as few seek treatment (Arterberry et al., 2020; Standeven et al., 2020).

Emerging adulthood is a unique developmental period involving role transitions and independence that can facilitate risky cannabis use (Arnett, 2000, 2005). This period is distinct from younger adolescence and full adulthood, necessitating developmentally-tailored interventions. A recent review (O'Connor et al., 2020) of drug use prevention found only 2 interventions focused on EAs: 1) a trial with 19 year-old males in Switzerland (Gmel

et al., 2013) involving a brief intervention and booster randomization, and 2) another trial with American college students (Lee et al., 2010) using personalized feedback. Both studies found no significant intervention effects on cannabis use.

In contrast, a recent meta-analysis of brief interventions (~1–2 sessions, in-person; ages 15–30 inclusion criteria) supported small reductions in CUD symptoms and increases in abstinence at short-term follow-ups (1–3 months) compared to control conditions (Halladay et al., 2019). The meta-analysis, which largely included non-treatment seekers, found that consumption, consequences, and long-term outcomes (6–12 months) were no different when pooling across intervention studies versus passive control conditions. Another meta-analysis across adult ages suggested no pooled impact of healthcare-based brief interventions on cannabis use severity scores and days of cannabis use, with recommendations including: extended interventions, addressing peer networks, and consideration of how the acceptability of cannabis use and legal status could affect efficacy (Imtiaz et al., 2020). Importantly, most studies occurred prior to shifts in cannabis availability and proliferation of newer consumption modalities and higher THC products.

In summary, current gaps pertaining to cannabis interventions for EAs could be addressed by new approaches. First, interventions likely need to be longer than 1–2 sessions, and could be enhanced by modalities that allow for intervening during daily life when cannabis consumption occurs (as opposed to during a healthcare visit, school-based interaction, or one-time web program). Such lengthening and ongoing engagement could result in stronger effects on cannabis-related behaviors when also rooted in evidence-based approaches from substance use trials (e.g., Motivational Interviewing [MI], cognitive-behavioral approaches; (Bernstein et al., 2009; Magill et al., 2009; Walker et al., 2016; Woolard et al., 2013; Yurasek et al., 2015). Given increased cannabis acceptability, intervention content must consider harm reduction approaches across consumption modalities, with updated psychoeducation about potency and risks. Finally, intervention studies have targeted a range of cannabis inclusion criteria (e.g., monthly use to CUD), and focusing on more frequent consumers (e.g., several times/week or more) may have a wider public health benefit than focusing on individuals who use infrequently.

We developed and piloted a new 8-week MI-based intervention using a novel, constantly accessible platform: social media. EAs are avid users of social media (84%, $M=46$ hours/month) (Gutierrez and Cooper, 2016). Others have used social media for health behavior interventions (Bonar et al., 2020; Bull et al., 2012; Maier et al., 2020; Pagoto et al., 2016; Ramo et al., 2015; Young et al., 2015), moving the intervention out of the clinician's office or school and into daily life where behavior change occurs, but none have targeted cannabis. Further, 70% of EAs use Facebook (71% Instagram, which is owned by Facebook and allows cross-posting; 65% Snapchat; 48% TikTok) (Auxier and Anderson, 2021), which provides optimal features for private group-based discussions on threads, consistent with key considerations for social media interventions (Moreno and D'Angelo, 2019). Herein we describe the intervention development and approach, trial feasibility, acceptability and engagement, and preliminary outcomes.

2. Method

2.1 Design

This Stage 1 (Onken et al., 2014) pilot randomized controlled trial (RCT) recruited 18–25 year-olds for online screening, enrolling those using cannabis 3 times/week in the past-month (Bonar et al., 2021). This eligibility criterion was selected because prior work (Pearson et al., 2017) showed that EAs who used cannabis 2–3 times per week in the past-month experienced a $M=6$ consequences. Participants were randomized to groups (separated by age [18–20; 21–25] and residence in a state with legal recreational cannabis [yes/no]) consisting of an 8-week intervention or attention-control. Follow-ups occurred at 3- and 6-months. Our institutional review board provided approval and a Certificate of Confidentiality was issued.

2.2 Procedures

Because of limited pilot staffing, we conducted recruitment sequentially in two waves: Wave 1 (2/3/20–2/26/20) enrolled participants residing in states without legal recreational cannabis and Wave 2 (5/11/20 – 5/28/20) enrolled those in states with legal recreational cannabis. The ordering of non-recreational states followed by recreational states was chosen to allow more time for recent cannabis recreational laws (e.g., Michigan) to be in place before recruitment since these laws affect access and availability. Recruitment used online targeted advertisements (e.g., age, interested in cannabis-focused media) on Facebook and Instagram using a script (i.e., “Use weed? Participate in a research study; earn \$ \$ \$.”) and images of EAs (varied gender and racial/ethnic appearance). Ads *did not* request individuals want to reduce cannabis use.

Clicking the ad led to a screening consent followed by an eligibility survey. Those meeting inclusion criteria were redirected to a separate contact information page. Using procedures from prior work (Bauermeister et al., 2012; Teitcher et al., 2015), study staff verified participants and their Facebook profile then participants were selected (based on order of screening completion and racial, ethnic and sex distribution to meet targeted enrollment goals) and sent a link to a baseline/RCT consent form (fully available on [ClinicalTrials.gov](https://www.clinicaltrials.gov)) and baseline survey (\$35 compensation). Baseline consenting included reviewing a “User Safety Agreement” where participants signified agreement to follow group guidelines (e.g., no selling substances; no business advertising; respect and confidentiality). The consent form described the study’s purpose as “to develop and test social media interventions to help young people increase well-being and reduce risky behaviors.” The intervention group was described as a “secret Facebook page that will deliver health information focused on increasing well-being and reducing risky behaviors” where participants could interact. The control group was described as a “secret Facebook page that will share news and other information about things like entertainment, sports, weather and current events.”

Next, participants submitted a timestamped selfie for study staff to compare to their Facebook profile for identity verification. In Wave 1, to support self-report, consented participants were mailed a urine drug screen (UDS) to self-administer from home and instructions for taking photos of results to upload via a survey link at baseline. However,

given limited utility of biological verification in non-abstinence focused early interventions combined with COVID-19-related feasibility challenges, the UDS procedure was removed.

After individuals were randomly assigned to a condition, they received a Facebook friend invitation from a study staff member's work account to join a secret, private group. Groups included a cover photo with crisis text/phone lines for emergencies indicating that groups would not be monitored 24/7; after 56 days, groups were archived (i.e., content viewable, but no new posts or comments allowed). Participants completed follow-up surveys online at 3- and 6-months (\$35, \$40 gift card compensation, respectively) after group-start.

2.3 Study Conditions

2.3.1 Control Group.—Daily for 56 days, staff posted manual-based content (e.g., articles, memes, links) in the group (~6 posts/day). Content was unrelated to substance use or mental health and followed weekly themes (e.g., travel, sports, animals). Staff responded to participant comments (e.g., brief comment, clicking reaction button), but did not use therapeutic techniques.

2.3.2 Intervention Group.—Daily for 56 days, staff (referred to as “e-coaches”) posted content in the group (~6 posts/day) consistent with weekly themes (Table 1). Posts mentioned cannabis (e.g., influence on mental health), addressed the theme without directly mentioning cannabis (e.g., eliciting coping strategies for mental health), and/or focused on building rapport and participation (e.g., introductions, goals/accomplishments, pet pictures). Content on alcohol and other drugs was included as a secondary focus.

Content addressing cannabis use (i.e., smoking, vaping, dabbing, and edibles), was developed through an iterative participant-stakeholder approach (Figure 1). First, we asked M-Turk workers ages 18–25 to identify engaging online content for intervention topics (e.g., “Sometimes people want to cut back their [marijuana] use but have trouble resisting temptation in a difficult situation. Please attach one meme/picture, video and article highlighting ways to handle these tricky situations.”). After our team selected relevant content (e.g., articles, memes, images/infographics, links, gifs), the PI and study coordinator paired the items with MI-informed evocative questions/introductions to encourage discussion. We recruited 40 EAs (57.5% male sex; 60% White, 20% Black/African American, 12.5% Multi-Racial, 7.5% Other Race; 22.0% Hispanic/Latinx) reflecting RCT eligibility criteria and procedures to rate the content and suggest changes to make it more appealing or relevant, which we reviewed and refined iteratively.

The manualized content was reviewed prior to posting, with e-coaches making minor edits to improve relevance (e.g., reflecting participant comments, COVID-19). E-coaches posted in shifts throughout the day and responded to participants to elaborate discussion using MI skills.

2.4 E-coach training, supervision, and fidelity

E-coaches were master's-level staff with relevant backgrounds (e.g., social work). They completed online MI training modules, attended a two-day MI training from the PI (a member of the Motivational Interviewing Network of Trainers), and study-specific trainings

about cannabis, cognitive-behavioral skills for cannabis reduction, social media intervention delivery, and risk management. E-coaches practiced MI-based responses offline to mock participant posts created from public Reddit threads (e.g., cannabis use, mental health, other substance use), with feedback from the PI. Throughout the RCT, to monitor fidelity in near real-time, e-coaches received weekly group and individual supervision with review of the “live” groups and responding to posts together using MI.

To assess fidelity in group transcripts, we adapted codes from the MI Treatment Integrity (MI) and MI Skills Code (MISC). Staff coded a randomly selected 2 days per week from each intervention group and coded that day’s e-coach posts/responses ($n=562$; each could have multiple codes) for MI fidelity. Non-adherent confronting/persuading did not occur at all in selected posts (0.0%); adherent affirmations/support occurred frequently (61.4%). Complex reflections occurred in 47.9% of posts and simple reflections were coded in 17.1% of posts (i.e., 73.7% of reflections were complex). Questions were coded in 31.5%, resulting in a good reflection-to-question ratio (2.06:1). Given the nature of social media, e-coaches used a strategy we termed “personal share” wherein they briefly used personal experience (e.g., coping with a bad day, consequences of cannabis consumption among people they knew) to illustrate intervention concepts and encourage participants’ reactions. This was coded in 12.8% of comments. To assess reliability, staff double-coded 20% of posts and replies/comments with kappas as follows: simple reflection = .75, complex reflections = .86, affirmation/support = .94, questions = 1.00, and personal share = .88.

2.5 Measures

2.5.1 Eligibility and descriptive information.—We queried demographics to determine eligibility and describe the sample using items from prior studies (Kann et al., 2014; Stoddard et al., 2012). Participants completed two-item screeners for two-week depression and anxiety symptoms (cut-off scores of ≥ 3 ; (Kroenke et al., 2003; Plummer et al., 2016; Skapinakis, 2007). Participants chose their state residence to determine residence with/without legal recreational cannabis.

In the screening survey, we described varied forms of cannabis use, and to avoid reporting on products sold as “CBD only”, used this introduction : “*Next we will ask you about marijuana use. This includes any marijuana products that contain THC including flower in joints, blunts, bowls; dabs/wax/shatter/budder or other concentrates; oil or flower in vaporizers; edibles and tinctures; and skincare products such as lotions. Do not include products that contain only CBD.*” Cannabis eligibility was assessed with an item modified from prior work (Cutler and Spradlin, 2017): “Which of the following best captures the average frequency you used marijuana or marijuana products in the past month?” Response options were: never, once, 2–3 times, once a week, twice a week, 3–4 times a week, 5–6 times a week, once a day, and more than once a day. Participants selecting “3–4 times a week” or greater were eligible for enrollment.

2.5.2 Cannabis consumption.—We used an online Timeline Follow Back (TLFB) (Martin-Willett et al., 2020; Martin-Willett et al., 2019) embedded in Qualtrics surveys to assess past 30-day use of cannabis across four modalities (i.e., smoking, vaping, dabbing,

eating). Participants first completed a calendar designating anchors (e.g., holidays, personal events), then entered their cannabis use separately for each modality consumed. They reported number of times used per day and, using pictorial aids for flower, dabs, and vapes, estimated quantity consumed per day (converted to grams for analysis). For analysis, we computed past 30-day totals (days, grams, times used) for each modality separately and combined.

2.5.3 Alcohol Consumption and Co-Use.—Our TLFB also prompted participants who reported past 30-day alcohol consumption to enter their estimated daily standard drinks (pictorial guide provided). We constructed summary variables for total alcohol use days and total estimated standard drinks among those reporting baseline consumption. We also calculated number of co-use days (alcohol+cannabis).

2.5.4 Intervention acceptability and engagement.—At 3-months, participants received questions assessing acceptability (e.g., e-coach helpfulness, helpfulness of peer interaction) rated on 5-point Likert scales (1=Not at all to 5=Extremely). A single item queried likelihood of recommending the group (1–10 scale) and 4 items queried satisfaction with different types of content (1=Not at all to 5=Extremely). To quantify engagement, we also separately tallied the number of comments/posts and reactions (e.g., likes, hearts) left by participants.

2.6 Statistical Analysis

We computed means, standard deviations, and proportions for descriptive analyses, including percent change from baseline for cannabis and alcohol consumption outcomes at 3- and 6-months. We used independent samples t-tests and chi-square analyses to compare the intervention and control groups on baseline demographics and cannabis consumption, acceptability and engagement (comments, reactions). Additionally, we used independent samples t-tests to compare individuals missing at 3- and 6-months follow-ups to those retained on baseline cannabis consumption. To examine preliminary effects of the intervention on consumption, we fixed linear mixed effects models adjusted for baseline measurement of the outcome and balancing factors (i.e., age group, sex, recreational cannabis legality), and included a random intercept for assigned group, to adjust for the fact that this an individually-randomized group treatment trial. We tested for treatment effects by conducting a two-sided test of the coefficient for the treatment/control indicator and estimated the Cohen's D (the mean difference between the two groups at follow-up divided by the total variation not captured by the fixed effects) and 95% confidence intervals. Separate treatment effects were estimated for 3- and 6-month follow-ups to inform future trial design; 14 participants who did not complete the 3-month follow-up, and 16 who did not complete the 6-month follow-up were excluded from those models, respectively.

3. Results

3.1 Trial Feasibility

Figure 2 shows the study flow chart; 2,229 individuals completed screening (eligibility rate=77.2%). Of those, 349 were invited to complete RCT consent and baseline survey.

Among the 212 who opened the email invitation and consented, 158 completed the baseline (74.5%) and 149 were fully-enrolled, randomized (N=76 intervention; N=73 control), and invited to join a group (N=1 per condition did not join). The 149 fully-enrolled did not significantly differ from the 63 who consented but did not complete enrollment on age, race, or cannabis use frequency; however, females were more likely to fully enroll (55.7% among enrolled, 31.8% among not fully-enrolled; $p=.001$).

Individuals were recruited from non-legal cannabis states and states with legal cannabis access, with per-wave advertising costs totaling \$2,484.12 and \$1,067.52, respectively. Advertising costs per-participant enrolled and randomized was \$23.83. Wave 1's baseline also involved mailing UDS kits in unmarked packages to participants (84% completed and submitted results; 93% were cannabis positive and consistent with self-report).

Follow-up rates were 92.1% in the intervention and 89.0% in the control group at 3-months (89.5% and 89.5%, respectively at 6-months). When examining differences in baseline cannabis consumption between those who completed follow-up and those who did not there were only three statistically significant differences which had to do with smoking (as opposed to times used, days used, and quantity of total consumption or across all other modalities at 3- and 6-months). Individuals who completed the 3-month follow-ups smoked a greater number of days ($M=17.25$, $SD=21.14$ vs. $M=9.39$, $SD=8.18$; $p=0.009$) and a greater number of times ($M=43.93$, $SD=55.12$ vs. $M=24.21$, $SD=24.10$; $p=0.019$) than individuals who did not complete. Participants completing the 6-month follow-up smoked more days than those who did not complete ($M=17.17$, $SD=21.33$ vs. $M=10.98$, $SD=8.03$; $p=0.028$).

3.2 Participant Characteristics at Baseline

RCT participants were $M=21.0$ years old ($SD=2.2$) and 55.7% reported biological female sex; 70.5% were White, 20.1% were Black/African American, and 9.4% were of other racial backgrounds, with 20.1% being Hispanic/Latinx. At enrollment, 51.7% resided in a state with legal recreational cannabis, and 48.3% did not. Cannabis use eligibility based on past-3-month frequency (0=never, 8=more than once a day) had a sample mean = 7.2 ($SD=1.1$). Additional details are in Tables 2 and 3.

Descriptively, smoking was the most common modality reported (Intervention [I]=93%, Control [C]=87%), followed by vaping (I=57%, C=55%), edibles (I=46%, C=39%), and dabbing (I=42%, C=34%). Regarding alcohol use, 78% of the intervention group and 61% of the control group drank, with 76% and 59%, respectively, reporting past-month same day cannabis+alcohol co-use. Many met screening criteria for depression (42.3%) or anxiety (45.0%). There were no significant differences between conditions on the variables in Table 2. Independent samples t-tests showed that baseline means on the following variables were significantly higher among the intervention group vs. the control group (denoted in Table 3): total cannabis frequency (times used; $p=0.012$), total cannabis use days ($p=.043$), total days smoked cannabis ($p=0.001$), total frequency of cannabis smoking (times used; $p=.043$), and total quantity smoked ($p=0.018$). No other cannabis variables differed at baseline between groups.

3.3 Intervention Engagement and Acceptability

Table 4 displays engagement and acceptability metrics. The intervention group displayed significantly greater interaction group versus the Control group, both in terms of posting/commenting and clicking reactions (e.g., $M = 28.1$ posts per intervention participant over 8 weeks vs. 1.4 for the control group); overall intervention participants engaged $M = 47.9$ times each over 8 weeks. On all items regarding e-coaches and their approach, intervention participants gave significantly higher ratings than control participants (e.g., helpfulness: $M = 3.5$ vs. 2.6; respect: $M = 4.5$ vs. 3.9). There were no significant differences between groups on content ratings. Intervention participants were significantly more likely to recommend the group ($M = 6.4$ vs. $M = 5.3$).

3.4 Cannabis and Alcohol Consumption Outcomes

Outcomes at 3- and 6-months are in Table 3, including percent reduction and results of adjusted models across total consumption and separated by modalities. Descriptively, at 3-months (1 month after the 8-week intervention ended), changes in cannabis consumption often showed similar reductions in both conditions with adjusted models showing non-significant results. Focusing on overall consumption at 3-months, the intervention and control groups both had 28% reductions in total times used cannabis, the intervention group reduced total estimated quantity by 7.9% (control group by 11.5%), and the number of cannabis use days declined 13.5% in the intervention (control=10.8%). When focusing on changes for different cannabis modalities (Table 3), in some cases, at 3-months, there were larger reductions in the control group (e.g., total times smoked -23.8% for control vs. -12.5%) whereas, in other cases, reductions were greater for intervention participants (e.g., total times vaped: 55.8% for intervention, -33.8% for control).

Focusing on overall consumption, compared to baseline, at 6-months the intervention group had reduced total frequency of cannabis use by 30.1% (control group increased 6.8%; *ns* adjusted model) and total days of cannabis use by 19.2% (vs. 5.1% control group reduction; *ns* adjusted model). For total estimated quantity the intervention group reduced by 27.8% and the control group by 12.2% (*ns* adjusted model). At 6-months, descriptive patterns across modalities (Table 3) showed generally greater reductions for intervention participants versus the control group for cannabis measures. There was inconsistency with regard to edibles: the intervention group reported reduced days and times used, but increased quantity consumed, though these changes were non-significant in adjusted models. The only adjusted model with a statistically significant difference between groups involved total days of vaping, where the control group increased by 16.7% and the intervention group decreased by 43.5% ($D = .40$, 95% Confidence Interval = 0.05–0.75, $p = 0.020$).

Although alcohol was a secondary focus, and not all participants drank alcohol, models focused on alcohol use and co-use days were non-significant. Descriptively, reductions in alcohol use days were similar for each group at 6-months (-20.1% intervention, -15.3% control), whereas co-use days declined by 33.3% for intervention participants (-5.1% in the control group). None of the alcohol-related adjusted models were significant.

4. Discussion

This study demonstrated feasibility and acceptability of an RCT for a social media-based intervention targeting cannabis use among emerging adults. Consistent with calls to use this highly-accessed medium in prevention (Merchant, 2020), our intervention showed promise and we recommend examination in a fully-powered trial. First, the intervention was rated more positively than the control, which may reflect the MI style of facilitating rapport and trust in a non-judgmental atmosphere that is supported by our fidelity data. This is notable because intervention participants were non-treatment seeking. Importantly, intervention participants also engaged with the provided content throughout 8 weeks (e.g., $M = 28$ posts per participant), to a greater extent than those in the attention-control group, further demonstrating acceptability as participants gave more comments/posts than simply clicking a like/reaction button. In comparison, earlier group-based social media intervention studies related to substance use averaged 9 (EAs with tobacco use, including incentivized posting strategies in some conditions; (Thrul et al., 2015) to 15 (adult patients with chronic pain on opioids; (Young et al., 2018) posts per person over a 3-month period.

Next, this RCT was feasible with a high eligibility rate, likely due to targeted advertising, and low attrition. Although the baseline completion rate (45%) was lower than fully-powered trials, this may be due to limited pilot staffing as more staff delivering reminders via e-mails, phone calls, and texting helped us achieve a higher rate (66%) in a similar-aged nationally-recruited sample in a larger fully-staffed RCT (Bonar et al., 2020). Others have reported similar rates (55%) with youth (Guest et al., 2021), while noting that many online-screened individuals do not provide adequate contact information, or fail to open e-mailed invitations or surveys, reflecting a challenge of national electronic-based recruitment. Nonetheless, the per-participant cost (\$23.83) provides feasibility data for future studies. Such costs were less than recent Facebook-based trials involving youth/young adults (\$68.75) (Zlotorzynska et al., 2021) and on the lower end of the range in other trials recruiting on social media (\$1.51 - \$172.76) (Topolovec-Vranic and Natarajan, 2016).

Regarding behavioral outcomes, pilot trials are useful to inform larger efficacy trials, but estimates are potentially under-powered with large standard errors leading to possible under-estimation of true effect sizes (Kraemer et al., 2006; Leon et al., 2011). Noting such caveats, our results generally show greater declines for intervention participants versus control participants in most cannabis measures at 6-months (e.g., 30% decline in total times used, 19% decline in days used; 20–30% declines across smoking measures) with modest estimated effect sizes. These declines are encouraging for a future efficacy trial, particularly given the prevalence of smoking and the statistically significant medium-sized effect for total days of vaping. This is the first intervention documented to decrease cannabis vaping in a rigorous RCT design, which is key given the recent increases in vaping (Palamar, 2021) and associated high potency (Chadi et al., 2020). Further, reductions in cannabis use emerged more consistently at 6-months, than at 3-months as this assessment occurred only one month after intervention end, suggesting potentially longer-term behavior changes post-intervention. A RCT with a longer follow-up period could examine whether reductions are maintained, or different intervention lengths could be tested to determine the impact of dose.

Using the TLFB for estimated quantity (using pictorial aids) and frequency of cannabis is a strength of this investigation. Despite concerns some researchers have about self-report, self-report of substance use is valid (Simons et al., 2015), as is online TLFB administration (Hjorthøj et al., 2012; Martin-Willett et al., 2020; Martin-Willett et al., 2019). Nonetheless, this approach has potential limitations because estimating quantity of cannabis products is challenging across modalities and there is no gold standard, validated quantity measure (Loflin et al., 2020). Measurement challenges regarding edibles (e.g., unknown potency if home-made, wide variation of product potency, lack of pictures due to variations) exist and it's also possible that participants could reduce the frequency of edibles while increasing quantity or substituting with other modalities. Nonetheless, our novel TLFB involved measures of days used and times used per day across modalities, consistent with expert consensus (Loflin et al., 2020).

Although we recruited online and nationally, with representation from varied racial/ethnic groups, results may not generalize to the larger population or to those who do not use social media regularly. While it is a strength to engage EAs outside of college settings (i.e., 56% reported their highest education level was some college/technical school, suggesting up to half of participants were not actively in college when recruited), we did not assess current college involvement. Next, this pilot RCT is under-powered, and thus behavioral outcomes should be interpreted cautiously. Finally, we did not compare participants across non-legal (Wave 1) and legal (Wave 2) state types given that the COVID-19 pandemic also occurred during Wave 1, potentially confounding comparisons.

In the context of increasing EA cannabis consumption and legality, accessible, scalable, and acceptable interventions are needed. Our social media-based intervention could meet such needs, particularly in an era of increased telehealth due to COVID-19. If proven efficacious, this approach has potential to be engaging to young people given that our participants were only incentivized for assessments and not for participation in the groups. Although other issues associated with implementation of prevention-focused programs would need to be considered based on setting (e.g., reach, adoption), sustained prevention-focused resources are needed to reach people at this critical developmental juncture. Further, this manualized approach shares common elements of social media which support delivery over future platforms and can be easily updated over time for changing trends without expensive costs of software programming. Thus, we recommend future testing of this novel and promising approach.

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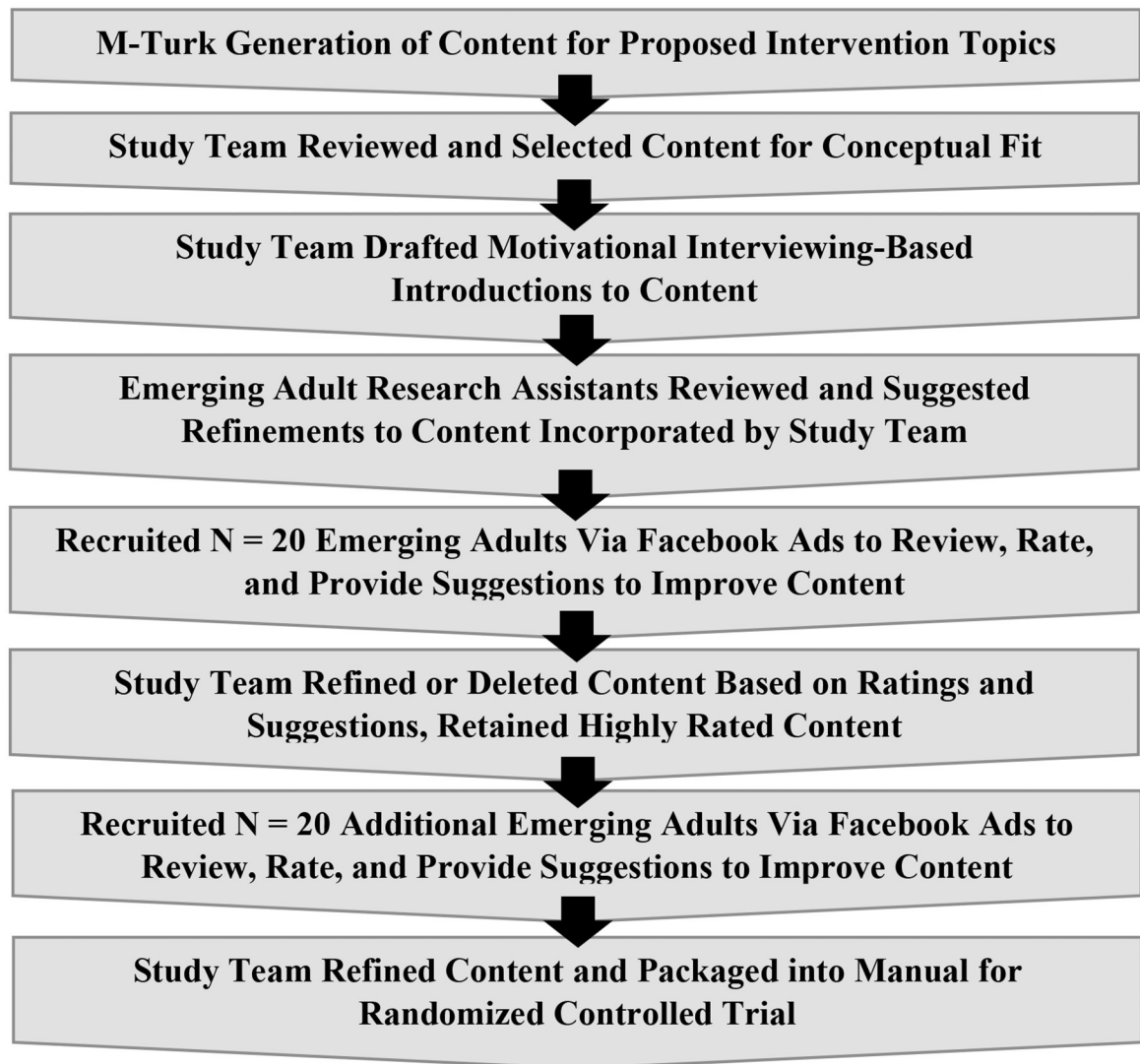


Figure 1.
Iterative process used to develop intervention content

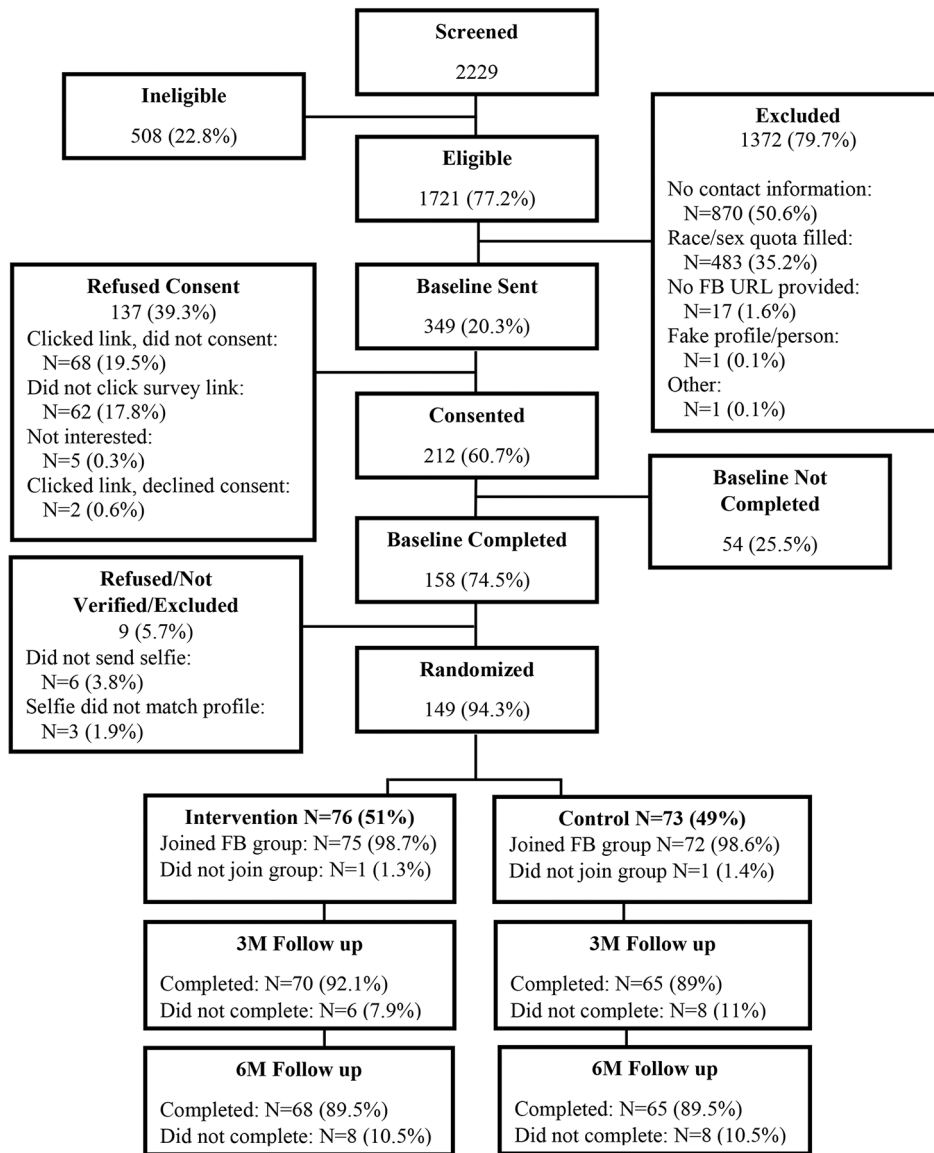


Figure 2.
Study Flow

Table 1.

Weekly intervention themes with sample topics for each week

Week	Overarching topics
Week 1	Dealing with stress <ul style="list-style-type: none"> Elicit and reinforce non-substance-focused coping skills/tools for managing stress Psychoeducation about different coping skills (e.g., meditation, physical activity, self-talk) and effects of cannabis depression/anxiety Elicit strengths and respond with affirmations Elicit consequences of using cannabis or other substances as related to stress and mental health
Week 2	What young adults do <ul style="list-style-type: none"> Psychoeducational norm re-setting regarding age-specific cannabis consumption and cannabis use disorder rates Elicit strategies for reduced use/lower consumption when peers are using (e.g., setting boundaries, spending less time together) Elicit and reinforce non-substance using activities with friends Elicit motives for cannabis use and ways to address motives without substances
Week 3	Strategies to stay safe while using <ul style="list-style-type: none"> Psychoeducational information about research on harms/effects of cannabis consumption on health/mental health Elicit strategies for harm reduction when using with peers (e.g., safe ride home, limiting consumption, avoid mixing substances) Elicit prior negative experiences with cannabis/consequences of use (e.g., greening out)
Week 4	Dealing with difficult situations <ul style="list-style-type: none"> Psychoeducation about dependence/cannabis use disorder Eliciting consequences of over-consumption (e.g., loss of control) Noticing the impact of cannabis during periods of increased anxiety/depression symptoms Ways to manage triggers/urges to use when cutting back/quitting Reinforce strengths from other challenges that have been overcome
Week 5	Relationships with friends and family <ul style="list-style-type: none"> Impact of cannabis use on relationships with family, friends, significant others Elicit how to watch out for friends when they are using cannabis Identify supportive and non-supportive relationships and their qualities
Week 6	Reducing use/avoiding too much use <ul style="list-style-type: none"> Reflect on stories of individuals who have changed their cannabis use and strategies used How to avoid getting “too high” when using higher potency products/consequences of using too much Elicit benefits of and strategies for tolerance breaks and cutting back or quitting
Week 7	Staying healthy <ul style="list-style-type: none"> Strategies to avoid injury due to substance use Elicit concerns about the impact of cannabis on physical health and mental health Psychoeducation about potential health impacts of cannabis consumption, particularly higher potency products
Week 8	Free time activities <ul style="list-style-type: none"> Elicit and reinforce non-substance related free time and leisure activities

Week	Overarching topics
	<ul style="list-style-type: none"><li data-bbox="355 254 1146 275">• Prompt reflection on times cannabis has impacted productivity or other important activities<li data-bbox="355 289 1317 310">• Elicit benefits of reduced use on free time (e.g., saved money for more activities, greater enjoyment of activities)

Note. Although each week had a primary theme, topics could also be mentioned in other weeks (e.g., impaired driving is addressed in multiple weeks) to allow for variety in content over time.

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Table 2.

Descriptive characteristics of the sample by group

	Total Sample N = 149 M (SD) or N (%)	Control N=73 M (SD) or N (%)	Intervention N=76 M (SD) or N (%)
Age	21.0 (2.2)	20.9 (2.0)	21.2 (2.3)
Female sex	83 (55.7%)	40 (54.8%)	43 (56.6%)
Male sex	66 (44.3%)	33 (45.2%)	33 (43.4%)
Gender identity			
Male	63 (42.3%)	31 (42.5%)	32 (42.1%)
Female	71 (47.7%)	36 (49.3%)	35 (46.1%)
Trans Man	6 (4.0%)	3 (4.1%)	3 (4.0%)
Trans Woman	1 (0.7%)	0 (0.0%)	1 (1.3)
Other identities (e.g., non-binary genderqueer, etc.)	8 (5.4%)	3 (4.1%)	5 (6.6%)
Race			
Black/African American	30 (20.1%)	15 (20.6%)	15 (19.7%)
White	105 (70.5%)	51 (69.9%)	54 (71.1%)
Other	14 (9.4%)	7 (9.6%)	7 (9.2%)
Hispanic/Latinx	30 (20.1%)	13 (17.1%)	17 (23.3%)
Highest Education			
Less than high school	5 (3.4%)	2 (2.7%)	3 (4.0%)
Completed high school	34 (22.8%)	14 (19.2%)	20 (26.3%)
Some college/tech school	84 (56.4%)	41 (56.2%)	43 (56.6%)
Completed college or higher	10 (13.2%)	16 (21.9%)	10 (13.2%)
Job status			
Not working	68 (45.6%)	30 (41.0%)	38 (50.0%)
Full time work (30+ hrs/week)	37 (24.8%)	18 (24.6%)	19 (25.0%)
Part time work (< 30 hrs/week)	41 (27.5%)	27 (36.9%)	14 (18.4%)
Other (e.g., disability, internship)	11 (7.4%)	2 (2.7%)	8 (11.8%)
State recreational cannabis			
Recreational cannabis	77 (51.7%)	39 (53.4%)	38 (50.0%)
No recreational cannabis	72 (48.3%)	34 (46.6%)	38 (50.0%)
Past-month cannabis frequency ^a	7.2 (1.1)	7.1 (1.1)	7.2 (1.1)
Positive anxiety screening	67 (45.0%)	31 (42.5%)	36 (47.4%)
Positive depression screen	63 (42.3%)	33 (45.2%)	30 (39.5%)
Facebook frequency ^b	5.0 (1.1)	5.0 (1.2)	5.1 (1.1)
Instagram frequency ^b	4.9 (1.4)	5.2 (1.0)	4.7 (1.7)
Snapchat frequency ^b	4.7 (1.6)	4.8 (1.5)	4.7 (1.7)
Twitter frequency ^b	3.2 (2.1)	3.2 (2.0)	3.2 (2.2)

^a0= Never, 1= Once, 2= 2 – 3 times, 3= Once a week, 4= Twice a week, 5= 3 – 4 times a week, 6= 5 – 6 times a week, 7= Once a day, 8= More than once a day

^b₁= Never, 2= Less Than Monthly, 3= Monthly, 4= Weekly, 5= Daily or Almost Daily, 6= Several times a day

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Table 3.

Cannabis, alcohol, and cannabis/alcohol co-use at baseline, 3-months, and 6-months follow-up (Intervention Group = I, Control Group = C)

	Baseline (N=149) M (SD)	3-Months (N=135) M (SD)	3-Month Model Results (Cohen's D, CI) and % Change from Baseline	6-Months (N=133) M (SD)	6-Month Model Results (Cohen's D, CI) and % Change from Baseline
Overall Consumption					
Total times used cannabis					
I	106.1 (131.0)	76.4 (88.5)	D = -.15 (-.61, .31), <i>p</i> = .40	74.2 (103.3)	D = .26 (-.20, .72), <i>p</i> = 0.14
C	80.7 (158.0)	57.9 (96.3)	-28.0% -28.2%	86.2 (169.8)	-30.1% +6.8%
Total quantity					
I	21.5 (22.3)*	19.8 (26.7)	-7.9%	15.5 (21.7)	-27.9%
C	13.1 (17.6)	11.6 (15.6)	-11.5%	11.5 (15.0)	-12.2%
Total cannabis use days					
I	20.8 (9.3)*	18.0 (11.5)	-13.5%	16.8 (12.2)	-19.2%
C	16.7 (11.1)	14.9 (11.7)	-10.8%	15.8 (11.8)	-5.1%
Smoking Outcomes					
Total days smoked					
I	16.5 (10.6)**	14.7 (11.8)	-10.9%	12.9 (12.4)	D = .12 (-.24, .48), <i>p</i> = .51 -21.8%
C	10.7 (11.0)	9.9 (11.3)	-7.5%	10.1 (11.1)	-5.6%
Total times smoked					
I	50.5 (55.1)*	44.2 (56.2)	-12.5%	39.3 (52.7)	D = -.17 (-.52, .19), <i>p</i> = .35 -22.2%
C	32.8 (49.8)	25.0 (34.3)	-23.8%	28.5 (42.4)	-13.1%
Total quantity smoked					
I	20.3 (22.3)*	18.9 (26.4)	-6.9%	14.4 (21.1)	D = .04 (-.31, .41), <i>p</i> = .82 -29.1%
C	12.4 (17.4)	11.1 (15.8)	-10.5%	10.7 (15.0)	-10.5%

	Baseline (N=149) M (SD)	3-Months (N=135) M (SD)	3-Month Model Results (Cohen's D, CI) and % Change from Baseline	6-Months (N=133) M (SD)	6-Month Model Results (Cohen's D, CI) and % Change from Baseline
Vaping Outcomes					
Total days vaped					
I	4.6 (7.2)	3.1 (6.1)	D = .12 (-.22, .47), <i>p</i> = .48	2.6 (5.6)	D = .40, (.05, .75), <i>p</i> = .02
C	4.8 (8.4)	4.0 (6.8)	-32.6%	5.6 (9.6)	-43.5%
Total times vaped					
I	19.7 (47.6)	8.7 (17.4)	D = .20 (-.14, .55), <i>p</i> = .25	9.3 (23.2)	D = .28, (-.07, .63), <i>p</i> = .11
C	20.7 (59.8)	13.7 (26.5)	-55.8%	32.3 (118.3)	-52.8%
Total quantity vaped					
I	0.1 (0.3)	0.04 (0.1)	D = .16, (-.18, .51), <i>p</i> = .35	0.06 (0.2)	D = .15, (-.20, .50), <i>p</i> = .39
C	0.1 (0.3)	0.06 (0.1)	-60.0%	0.09 (0.3)	-40.0%
Dabbing Outcomes					
Total days dabbed					
I	4.7 (9.6)	4.6 (9.3)	D = -.01, (-.35, .33), <i>p</i> = .94	4.6 (9.7)	D = .15, (-.29, .58), <i>p</i> = .53
C	3.1 (7.7)	3.0 (7.7)	-2.1%	3.8 (8.4)	-2.1%
Total times dabbed					
I	33.8 (104.9)	21.3 (66.8)	D = .00, (-.34, .35), <i>p</i> = .99	24.7 (70.4)	D = .15 (-.20, .50), <i>p</i> = .39
C	23.9 (115.1)	18.3 (91.4)	-37.0%	23.8 (117.0)	-26.9%
Total quantity dabbed					
I	(3.0)	0.7 (2.2)	D = -.03, (-.42, .35), <i>p</i> = .87	0.9 (2.5)	D = .11, (-.29, .51), <i>p</i> = .60
C	0.7 (2.6)	0.5 (1.7)	-36.4%	0.6 (2.1)	-18.2%
Edibles Outcomes					
Total days used edibles					
I	1.8 (4.1)	1.5 (3.3)	D = -.29, (-.72, .13), <i>p</i> = .23	0.8 (2.1)	D = .12, (-.22, .47), <i>p</i> = .48
			-16.7%		-55.6%

	Baseline (N=149) M (SD)	3-Months (N=135) M (SD)	3-Month Model Results (Cohen's D, CI) and % Change from Baseline	6-Months (N=133) M (SD)	6-Month Model Results (Cohen's D, CI) and % Change from Baseline
C	2.0 (4.8)	0.9 (2.4)	-55.0%	1.3 (3.6)	-35.0%
Total times used edibles					
I	2.1 (4.8)	2.1 (4.5)	D = -.27, (-.74, .19), p = .29	.9 (2.4)	D = .14, (-.21, .50), p = .42
C	3.7 (14.1)	1.0 (2.8)	0.0%	1.7 (4.3)	-57.1%
			-73.0%		-54.0%
Total quantity of edibles					
I	.08 (.15)	.14 (.45)	D = -.22, (-.57, .12), p = .20	.14 (.71)	D = -.12, (-.59, .36), p = .65
C	.09 (.27)	.05 (.20)	+75.0%	.05 (.20)	+75.0%
			-44.4%		-44.4%
Alcohol-Related Outcomes					
Total alcohol use days^a					
I	6.2 (6.7)	6.0 (8.0)	D = -1.1, (-.53, .31), p = .60	4.9 (7.6)	D = .16, (-.27, .60), p = .46
C	7.2 (7.2)	6.1 (8.1)	-3.2%	6.5 (7.8)	-20.1%
			-15.5%		-15.3%
Total alcohol drinks^a					
I	15.9 (15.6)	17.1 (28.1)	D = -.27, (-.69, .16), p = .21	14.3 (27.5)	D = -.11, (-.54, .32), p = .62
C	17.4 (18.3)	12.4 (15.4)	+7.5%	13.5 (15.8)	-10.1%
			-28.7%		-22.4%
Total alcohol+cannabis co-use days^a					
I	5.7 (6.5)	5.4 (7.6)	D = -0.25, (-.72, .23), p = .18	3.8 (6.7)	D = .31, (-.13, 0.75), p = .16
C	5.9 (6.3)	4.1 (6.0)	-5.3%	5.6 (8.0)	-33.3%
			-30.5%		-5.1%

^a restricted those reporting alcohol use at baseline (N = 59 intervention, N = 43 control)

^b restricted to those reporting co-use days at baseline (N = 58 intervention, N = 41 control)

** p<.01 for tests of baseline equivalence;

* p<.05 for tests of baseline equivalence

Table 4.

Eight-week engagement metrics and 3-month acceptability ratings by intervention and control groups

	Control N=65 M (SD)	Intervention N=70 M (SD)
Engagement (Mean per participant over 8 weeks)		
Posts/comments ^{***}	1.4 (3.6)	28.1 (46.3)
Reactions (e.g., likes, hearts) [*]	9.5 (15.5)	19.8 (38.3)
Total ^{***}	10.9 (17.6)	47.9 (82.8)
Acceptability		
Coach ratings		
How helpful were the e-coaches? ^{a***}	2.6 (1.3)	3.5 (1.0)
How helpful was it to interact with other peers in the group? ^{a**}	2.2 (1.3)	2.9 (1.3)
I felt the e-coaches were caring, supportive, and warm ^{a**}	3.6 (1.2)	4.2 (0.9)
I felt the e-coaches treated me with respect ^{a***}	3.9 (1.2)	4.5 (0.6)
I felt the e-coaches understood me ^{a.b*}	3.1 (1.3)	3.6 (1.1)
Content ratings		
I enjoyed the memes ^a	3.6 (1.4)	3.6 (1.2)
I enjoyed the quizzes ^a	2.9 (1.5)	3.2 (1.2)
I enjoyed the news articles ^a	2.9 (1.3)	3.4 (1.2)
I enjoyed the videos ^a	2.9 (1.4)	3.1 (1.2)
Overall rating		
How likely is it that you would recommend the group to someone you know? ^{b,c*}	5.3 (3.2)	6.4 (2.7)

^aResponse scale: 1 = not at all, 2 = a little, 3 = somewhat, 4 = very much, 5 = extremely

^b1 person did not complete this item and therefore had missing data.

^cRange = 1 to 10

^{*} $p < .05$;

^{**} $p < .01$;

^{***} $p < .001$