Theory-based social media intervention for non-medical use of prescription opioids in young adults: Protocol for the development and feasibility evaluation of a randomized control trial via mixed methods

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Abstract

Background: Non-medical use of prescription opioids (NMUPO) in young adults in the US is concerning and is robustly influenced by many psychosocial factors. Given the advantages of flexibility, wide coverage, and real-time responses and assessment, social media appears to be promising and innovative approach to deliver psychosocial intervention to young adults. However, scant theory-based social media interventions are available for NMUPO targeting this at-risk population. Guided by the information-motivation-behavioral-skill (IMB) model, the proposed research addresses the critical gaps by theoretically exploring psychosocial contents associated with NMUPO among young adults via the formative assessment. These findings will then be utilized to develop and evaluate feasibility and preliminary efficacy of a peer-led social media intervention to reduce NMUPO among young adults.

Objective: The proposed study has three specific aims. Aim 1 is to conduct a formative study to inform a theory-based social media intervention for NMUPO among young adults in the US. Aim 2 is to develop a theory-based social intervention to reduce NMUPO among young adults. The intervention will be developed upon findings from the formative study. Aim 3 is to test feasibility and preliminary efficacy of the theory-based social media intervention with a randomized controlled design for NMUPO among young adults.

Methods: The proposed study will comprise serial research activities. First, formative research will be conducted through semi-structured interviews among 30 young adults engaged in NMUPO. Qualitative data will be synthesized using a pragmatic approach for identifying psychosocial contents associated with NMUPO. Second, qualitative findings will be used for developing a peer-led social media intervention to reduce NMUPO among young adults by integrating promising psychotherapy principles and incorporating with well-trained recovery coaches. Third, the social media intervention will be evaluated through a 12-week randomized controlled trial among 70 young adults (35 in the intervention group or control group) engaged in NMUPO via mixed methods, including pre- and post-intervention surveys, social media Paradata (e.g., time-series reactions to posts) collection, and ecological momentary assessment during the intervention. The control group will not receive an intervention but complete the pre- and post-intervention surveys. The primary outcomes will be feasibility, useability, and acceptability, while the secondary outcomes will be psychosocial and behavioral measures, such as past-three-month NMUPO, intention, psychological distress, self-efficacy, resilience, and coping strategies.

Results: N/A.

Conclusions: The proposed study will be the one of the first efforts to develop and deliver a theory-based peer-led intervention on social media, incorporating empirical findings on psychosocial mechanism of NMUPO. Findings of the proposed study will provide valuable insights into opioid risk reduction for young adults through an innovative approach. If the trial is tested feasible,

the proposed study will contribute to future scaled-up and fully powered psychosocial interventions among young adults and other key population at risk for NMUPO. Clinical Trial: This trial is registered at ClincialTrials.gov, registration number: NCT06469749, registered on June 25, 2024

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Abstract

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Trial Registration: This trial is registered at ClincialTrials.gov, registration number: NCT06469749, registered on June 25, 2024 (https://clinicaltrials.gov/study/NCT06469749?cond=non-medical%20use%20of%20prescription%20opioids&rank=2#more-information).

Keywords: non-medical use of prescription opioids, opioid misuse, young adults, social media, psychosocial intervention, randomized controlled trial, mixed methods

Introduction

Background

Non-medical use of prescription opioids (NMUPO) is a critical public health concern in the United

States (US), and young adults are particularly vulnerable to this behavior. NMUPO refers to aberrant use of prescription opioids in a manner other than as prescribed.[1-3] Substance use literature has paid increasing attention to NMUPO owing to its adverse consequences. National US data have shown a substantial increase of opioid-related overdose deaths from <5,000 in 1999 to >100,000 in 2022[4,5]. NMUPO has also led to extensive medical costs in the US (78.5 billion annually).[6] Young adults (aged 18-25) are at high-risk for NMUPO. In 2019, 5.5% of young adults in the US engaged in past-year NMUPO, compared to 2.3-3.5% for other age groups. This rate was even higher among those who were not enrolled in colleges (6.3%).[7] Besides risk of overdose and dependence, NMUPO is associated with other negative outcomes, including health-jeopardizing behaviors (e.g., driving under the influence), sexual victimization, and suicide attempts.[1,8-11] In response to this issue, many US jurisdictions have launched initiatives to monitor prescription opioids. [12]Despite an obvious reduction of prescribing rate (e.g., 80% in 2009 to 59% in 2018),[12] NMUPO-related deaths remain high (> 100,000 in 2022). Notably, NMUPO is strongly linked with initiation of heroin and synthetic opioid use (e.g., fentanyl) in young adults, posing a substantial risk for development of substance use disorder (SUD) and overdose. [13]Hence, interventions targeting young adults are urgently needed to address NMUPO, and they should be delivered beyond the college population.[14]

Interventions for NMUPO in young adults should take psychosocial factors into account. NMUPO literature has identified several important psychosocial factors associated with NMUPO in young adults, including perceived stress (e.g., academic strain, traumatic stress), psychiatric distress (e.g., depression, anxiety), perception of risk, peer and family influences, and sensation seeking.[15-18] My previous research on NMUPO in college students has indicated several additional factors that reduce risk for NMUPO, such as psychological resilience, positive coping, outcome expectancies, and self-esteem.[10,19-21] Importantly, psychosocial factors robustly contribute to NMUPO. A meta-analysis study revealed that pooled effect sizes of psychosocial factors on NMUPO (ORs = 2.14 to 2.45) were higher than those of somatic symptoms (ORs = 0.81 to 1.76), which are traditionally viewed as major NMUPO determinants.[22] These findings indicate that interventions should be guided by a structured framework between psychosocial factors and health actions for NMUPO.

There are a handful of interventions that have been recently developed to address psychosocial aspects of NMUPO in young populations.[23-25] Although these programs have shown some efficacy, they encounter numerous challenges. First, most programs have been adapted from existing substance use interventions that are not originally designed for NMUPO. For example, some contents specific to opioids (e.g., the risk for overdose and pain relief expectancy) are absent from these programs, yet these factors significantly contribute to health action related to NMUPO. Second, most programs were delivered in schools and failed to target young adults who did not attend college or who were difficult-to-reach. Third, the flexibility of these interventions was limited since they were delivered by professionals in an in-person setting. Further, literature on substance misuse prevention in young adults has revealed several drawbacks to the in-person context, such as limited trust and fear of being stigmatized.[26] These challenges highlight the critical need for an innovative intervention that is based on psychosocial theory, tailored to the NMUPO context, and flexible in real world settings.

Psychosocial theoretical framework for a NMUPO intervention

To guide an intervention addressing psychosocial aspects of NMUPO, a theoretical framework (see Figure 1) was developed based on the information-motivation-behavioral skills (IMB) model. [27] The IMB model has been applauded for its strength in considering a straightforward path diagram for health behavior changes. 28This model emphasizes that health behavior changes are driven by three arrays of psychosocial constructs—information, motivation, and behavioral skills. Information refers to knowledge contributing to a prerequisite for enacting the changes (e.g., misinformation of opioids). Motivation includes two belief components: personal motivation (e.g., outcome expectancies and risk perceptions) and social motivation (e.g., social norms and support). Behavioral

skills stand for cognitive capacities (e.g., self-efficacy and resilience) and behavioral skill sets necessary for adopting the changes (e.g., coping/self-regulation skills) or for managing barriers (e.g., stress management). [27,28] Information and motivation can directly affect the target behavior, as well as indirectly affect it through acquisition of adjacent behavioral skills. Such a well-structured framework offers a clear guidance for intervention practices and suggests that intervention delivery could benefit from targeting information and motivation factors in the initial sessions, along with enhancing the role of behavioral skill training gradually in the intervention. For instance, initial efforts ought to address misinformation and outcome expectancies of substance use, and, as the intervention progresses, sessions should facilitate action by helping participants develop planning strategies and coping skills. Indeed, existing evidence has shown efficacy of IMB-guided interventions on reducing substance use (i.e., tobacco and illicit drugs). [29-32] Thus, the IMB model is an ideal theoretical choice for developing an intervention for NMUPO.

Social media as a promising platform for a NMUPO intervention targeting young adults

The rapid development of social media technologies provides a novel tool for substance use interventions. Increasing substance use literature has highlighted the significant potential of social media, in which individuals can obtain substance use knowledge, communicate their experiences and thoughts of substance use problems, and seek out social support from peers with similar problems through available networks or groups. [33,34] It is worth noting that social media offers distinct merits in addressing existing challenges in interventions for NMUPO in young adults. First, recent research has validated the use of social media to reach people who engage in NMUPO from multiple venues across the US.[35,36] Ubiquitous connectivity enables interventions to deliver content remotely to young adults who are not enrolled in college, and, therefore, not able to access traditional models of education on safe substance use. Second, social media allows interactive posts in multiple formats (e.g., texts, images, polls, videos) and with customized functions (e.g., virtual goal setting tools, notifications) without time restrictions. This can facilitate exposure to intervention contents at the time when participants choose to engage.[37] Third, social media technologies are applicable to timely measurements, such as ecological momentary assessment (EMA) and Paradata (e.g., auxiliary data of engagement [frequencies of shares, comments, 'likes', etc.] analyses),[38,39] which allows tracking of intervention usability and acceptability on specific modules in real time. Extant literature has shown that EMA has been applied in intervention research for substance use reduction and psychosocial improvements.[40] Fifth, social media is extremely popular in young adults. The latest national data indicates that 72% of US adults use social media, most of which are young adults (84%) who use it daily (70%).[41]

Another notable feature of social media is that they are significantly favorable for the peer role model, which has been a robust intervention approach for reducing substance use, particularly among young adults. [42] Existing evidence has demonstrated that social media interventions are effective in promoting behavior change for stigmatizing behaviors, including substance use, with perceived peer influence and support playing an important role in the change. [43] Accordingly, emerging peer-led intervention programs have been initiated on popular social media platforms among young adults (i.e., Instagram, Facebook, Snapchat, and Twitter) and have indicated good feasibility and preliminary efficacy in reducing various substance use behaviors (e.g., risky drinking, cigarette use, and cannabis use).[37,42-47] Notably, promising findings have also been reported for NMUPO reduction. Young et al. conducted a pilot study of a peer-led trial on Facebook for chronic pain patients, who were randomly assigned to the peer-led intervention group or the control group (with no peer leaders). [45] The preliminary results suggested higher engagement and more discussion on NMUPO and coping in the intervention group than in the control group. Taken together the advantage for the peer role model with other promising aspects, social media appear to be a

promising platform for NMUPO intervention among young adults, and such programs would be strongly powered by psychosocial theory-guided contents and peer-led modules.

The aims of the current study

This study proposes to develop and pilot-test a theory-guided, peer-led social media intervention on Instagram, as well as examine its feasibility and preliminary efficacy among young adults engaged in recent NMUPO via a randomized controlled trial (RCT). The assessments will employ mixed methods to collect various types of data, including qualitative assessment of semi-structured interviews, psychometric measures in pre- and post-intervention surveys, real-time Paradata on social media platform, and brief, timely measures in EMA surveys during the intervention. The specific aims are to:

Aim 1

Conduct a formative study to inform a theory-based social media intervention for NMUPO among young adults in the US. By collaborating with 4 peer leaders trained as 'recovery coaches', the proposed study will recruit 30 US young adults (aged 18-25) who engage in NMUPO from social media (e.g., Instagram) and conduct in-depth semi-structured interviews to explore psychosocial contents associated with NMUPO. The interviews will be guided by the IMB model.

Aim 2

Develop a theory-based social intervention to reduce NMUPO among young adults. The intervention will be developed upon findings from the formative study and based on several promising strategies (e.g., peer support group, ambivalence resolving techniques, interactive training modules, virtual goal-setting, and video modeling). It will be delivered via Instagram private groups by peer leaders, with close supervision provided by experts and clinicians in the fields of health psychology and addiction medicine.

Aim 3

Test feasibility and preliminary efficacy of the theory-based social media intervention with a randomized controlled design for NMUPO among young adults. The intervention will be pilot-tested among young adults who engage in recent NMUPO (n = 35 for intervention, n = 35 for control) and will be evaluated in terms of feasibility, usability, acceptability, engagement, dose, and preliminary efficacy using mixed methods (e.g., surveys, EMA, Paradata, semi-structured interviews). During the intervention, EMA (a prompt every two days) will assess acceptability and usability of individual modules. Preliminary efficacy will be tested on behavioral outcomes (i.e., past-month NMUPO) and psychosocial factors (e.g., outcome expectancy, self-efficacy, action/coping planning, resilience, psychiatric symptoms).

Methods

Research settings and participants

Research platforms

The proposed formative and intervention study will be conducted on Instagram, which is a popular social media platform for US young adults (71% usage), [41,48]and home to many support groups for substance use prevention and reduction. [49,50]Recruitment sites will expand to Snapchat and Facebook (>65% usage)[41], which are identified as useful recruitment sources for substance use prevention in US young adults. [51,52]As a pilot study for a cross-platform trial, the module prototypes will be developed upon Instagram features available on other platforms (e.g., live streaming, voting polls, group chatting, multimedia posting). Recent interventions developed on these features indicated efficacy on behavioral changes, including drug use.[37,45,46,53-56]

Peer leaders

The study will engage four peer leaders who are serving in recovery programs at substance-use-related associations or communities for young adults (i.e., 'Gamecock Recovery' at University of South Carolina [USC]). The study takes advantage of this model in various aspects, including recruitment and intervention development/delivery. Eligible leaders will be those who are (1) aged 18-25 years; (2) formally trained as a recovery coach (> 40 hours); (3) have had successful recovery from opioid misuse or opioid use disorder (OUD), and (4) use social media (e.g., Instagram, Facebook, Snapchat) on a daily basis. The health psychologist and addiction treatment experts and doctoral-level clinical psychology trainees at the Integrated Care for Recovery (I-CaRe) Training Center at University of South Carolina will provide training and ongoing support for the peer leaders. E-gift cards will be provided to compensate for their time ($2 for each recruitment; $30/hour for intervention).

Participants and Recruitment

Participants for the formative study and intervention trial will be those who meet the inclusion criteria: (1) aged 18-25; (2) US residents; (3) engaged in NMUPO in the past three months; (4) using Instagram at least 3 times a week = in the past three months. NMUPO refers to the occurrence of following behaviors (one time or more): (1) taking a prescription opioid without a prescription; (2) taking more doses than as prescribed; (3) using for a non-medical reason (e.g., getting high). [1-3]Individuals will be excluded if they report: (1) receiving substance use interventions in the past three months, (2) are diagnosed with SUD; or (3) are not proficient in English. We anticipate a total sample size of 100, with 30 for the formative study and 70 for the intervention trial.

Recruitment will be conducted using two strategies: (1) peer outreach and (2) advertising campaign. For the peer outreach approach, peer leaders will distribute recruitment advertisements (ads) via online social networking (e.g., posting Ads on their social media accounts, inviting subscribers to re-post the Ads). Peers can also send direct invitations to young adults who they personally know to be eligible for the study. For advertising campaign approaches, we will target the accounts (on Instagram/Facebook) of colleges, local young adult communities (e.g., trade unions), and substance use support groups. Upon approval from their group administrators, we will post ads in the groups. Also, we will develop targeted advertising using Ads Manager. [57]The ads will display research-relevant images, hashtags, and headings, which are tailored to engaging contents for young adults. To ensure the appropriateness, the ads will be reviewed by a Community Advisory Board. The ads for Aim 3 will be improved in line with formative research. The Ads Manager will also determine the range of the ad campaign in terms of age, time, and locations (i.e., US). The designed ads will be delivered in various formats dependent on the platforms, such as linear posts within personal feeds on Instagram, News Feeds on Facebook, and Stories on Snapchat. To ensure representativeness, recruitment will be stratified based on key demographics (e.g., gender, race/ethnicity, and education) in line with the latest US national data on NMUPO.[58] The Ads will navigate potential participants to a screening survey on RedCap, which is a secured online platform monitored by USC. Pre-screening survey will include questions in terms of year of age, past-three-month NMUPO (NIDA-Modified ASSIST[59]), US residency, usage of social media, and SUD diagnosis/treatment history. Participants who are identified eligible will provide their preferred contact method (e.g., Zoom) in the survey for a brief online meeting with the study team in terms of informed consent. Young adults enrolled in the study will be provided with instructions of interviews (Aim 1) or intervention (Aim 3). Our recruitment approaches are considered feasible according to existing data. Feasibility research examined the advertising campaign approach on Facebook to reach young adults engaged in NMUPO, showing that it successfully recruited 689 participants over 2 weeks (91% past-year misuse). [35]The US national data indicates that majority of young people with NMUPO do not have SUDs (86%; 2801 in 3257). [60]Prior substance use studies indicated retention

rates of 75-93% among young adults reached by social media. [46,53,61]

Study design and procedures

Aim 1: Formative study

Young adults who are social media users (e.g., Instagram and Facebook) and indicate NMUPO will be invited to online 60-minute individual semi-structured in-depth interviews. The interview guide will be based on the IMB model and will aim to: (1) identify NMUPO patterns (e.g., drug classes, individual behaviors); (2) understand psychosocial factors contributing to reduce NMUPO; (2) extract vivid examples related to psychosocial content; (3) identify planning processes and coping skills facilitating the change; (4) assess the feasibility/acceptability of social media to manage NMUPO; (5) review recruitment ads. This will provide the foundational knowledge and materials to develop specific content (e.g., video and posts) for the intervention. The interviewers will be trained research assistants from the fields of psychology and/or public health. As suggested by the guideline of qualitative research,[62] the sample size will be 30 young adults. Participants will receive $50 e-gift cards as study incentives.

Interviews will be audio-recorded, transcribed, and coded using a pragmatic approach. The framework analysis [63] will be performed via a deductive process including five key steps: (1) familiarizing the data; (2) developing a coding scheme; (3) condensing and structuring the data; (4) rearranging the coded data and comparing patterns; (5) mapping and interpretation.[64] A codebook will be developed based on step (2) as a guide for coding. Coding disagreements will be resolved through group discussion. Data analysis will be conducted on NVivo 11.0. Interrater reliability will be assessed throughout the coding process with a goal of $\geq$.80.[65]

Aim 2: Intervention development

Intervention strategies

The intervention will apply various principles in psychotherapy. The intervention materials (texts, videos, and images) and activities will be developed using the findings from the formative study. To address particular factors in the IMB model, and will be based on peer support for behavioral change, motivational interviewing (MI),[66] cognitive behavioral therapy (CBT),[67] and solution-focused therapy (SFT),[68] which have been widely applied in substance use interventions.[69-71] Peer support is promising for facilitating social support and skill coaching. [72]MI is to resolve cognitive ambivalence (e.g., positive expectancies of substance use vs. benefits of making change), which is particularly beneficial for promoting motivation.[73] CBT is widely applied to distress management by reframing negative thoughts and facilitating adaptive coping.[74] SFT emphasizes a focus on problem solving and is favorable for setting concrete goals (action planning).[75,76] These contents/activities will be packed in different modules.

Incorporating inputs from peer leaders, the video contents will follow a video prompting strategy. [77]Videos will feature peer leaders and involve breaking tutorials into steps, allowing young adults to learn and rehearse cognitive and behavioral skills in a sequential fashion. For example, guided by CBT, a peer leader may lead participants to make reflections on the context, thoughts, and consequences, related to their last experience of NMUPO, and then practice adaptive responses (e.g., positive reframing, replacement behaviors). Video prompting has been effective for skill coaching in young adults. [78]

Intervention components

Incorporating Instagram functions, the intervention platform is proposed to consist of four intervention modules, each of which will address specific factors. Modules may include: (1) NMUPO knowledge module; (2) self-care module; (3) virtual goal setting/monitoring module; (4) peer support module (see Figure 2). These are planned, and final contents will be informed by or

modified in line with the formative research. The research team will work closely with the CAB and peer leaders to ensure appropriate contents and language. The intervention will last 12 weeks according to previous social media trials (typically 8-12 weeks).[37,44,79-86] Clinicians will review the intervention materials and ensure the scope is appropriate. Contents will be prompted daily as suggested by the IMB model (e.g., initially focus on information and motivation factors and gradually enhance the role of behavioral skills).

NMUPO knowledge module

A self-paced psychoeducation module will be developed targeting information and motivation factors. This module will provide the latest information about prescription opioids (e.g., illicit manufacture, the role of fentanyl, naloxone, and Xyalazine) and harms of NMUPO, introduce the benefits of use reduction, and clarify misconceptions. Each component will display vivid stories drawn from the formative study and delivered via multiple formats, including images, videos, and text. Participants can react to the posts by leaving comments or "like". Majority of contents will be based on MI strategies (e.g., ambivalence resolution). This media campaign strategy, combined with prevention education, has been identified as an essential approach for reducing NMUPO in young adults.25

Self-care module

This module will provide tutorial materials of behavioral skills for managing psychological distress and identifying strengths to make changes. Material formats (videos, texts, images), duration, and contents will be determined by the findings from the formative study. For example, serial 3-minute tutorial videos will introduce CBT strategies for reframing negative thoughts (e.g., "I'm a total failure") and exploring intra-/interpersonal strengths (e.g., resilience). Tutorials will be step-by-step based, allowing participants for role playing and rehearsals, presented with vivid examples extracted from the formative research (Aim 1). Such a self-guided CBT component has proven effective in reducing psychiatric distress.[87]

Virtual goal setting/monitoring module

This module aims to enhance action planning skills to reduce NMUPO. Specifically, it will assist young adults with setting personalized goals associated with NMUPO reduction and tracking progress towards meeting the goal. Online activities will be developed using SFT strategies. For example, the video will guide using scaling questions, which help participants identify their confidence levels to stop NMUPO and make a realistic plan based on it. Participants will then be instructed to explore barriers and their corresponding coping strategies for moving up the scale. Peer leaders will track their progress and provide support via online support group meetings. Also, tutorials will instruct participants to set daily reminders/notifications on their devices (e.g., mobile phone) to monitor the progress. This virtual self-monitoring has been a promising strategy to manage psychiatric distress and substance use.[88]

Peer support module.

This module will provide interpersonal activities for discussing NMUPO, sharing strategies, monitoring progress, providing social support, and increasing self-efficacy to take action, with themes based on Aim 1 findings. Activities include weekly (30-minute) online support groups, discussion polls, and campaign activities. Online support groups are live video meetings led by peer leaders and assisted by doctoral-level clinical psychology trainees at SSUDS-SC Center, who will be overseen by a licensed clinical psychologist and PI, under supervision from experts in health psychology and addiction medicine (Drs. Sayward and Litwin). Each meeting will discuss personal practices related to content in that week. Peer leaders will use techniques (e.g., active listening, insights, interpretation) [26] to facilitate cohesion and provide feedback. Discussion polls will be voting activities (e.g., selecting adaptive coping skills), aiming to stimulate discussions. Campaign activities will be held weekly with target-orientated themes (e.g., '#healthy coping challenge') to boost posting. Participants will be encouraged to leave comments and peer leaders will promptly provide feedback.

Intervention encouragement and monitoring

Several strategies that are shown useful for enhancing engagement will be utilized: [82,84,89-92](1) reminder notifications (via Instagram/emails); (2) prompt replies to participants' messages; (3) biweekly prize draws of $25 gift cards for those who post, attend meetings, and reply on the panels. The intervention will be overseen by PI and a licensed clinical psychologist at the SSUDS-SC Center, under supervision from experts in addiction medicine and psychotherapy for SUD. They will provide preintervention training (e.g., skills in MI/CBT techniques and findings from Aim 1) and weekly guidance to peer leaders. They will also advise on referrals to link participants to licensed mental and behavioral health professionals in their states of residence if necessary. The doctoral-level psychology trainees at SSUDS-SC Center will support intervention delivery by: (1) ensuring conversations intervention-related and ban inappropriate contents; (2) promptly replying to participants' comments; and (3) monitoring participants' safety (e.g., emotional reactions to the posts and in the online group meetings) and offering referrals for outside psychological services, if needed. They will also be responsible for reporting adverse events to the PI if observed.

Aim 3: Intervention feasibility and preliminary efficacy evaluation study

Randomized controlled trial and mixed method data collection

The intervention modules will be tested through a randomized controlled trial (RCT) design using mixed methods in 70 young adults who engage in NMUPO (see Figure 3). 93The primary purpose is to determine acceptability, usability, and feasibility, and initial efficacy. Participants reached by peer leaders/ads on social media will be navigated to a screening survey on RedCap and scheduling a meeting with the research team for inform consent. Participants will be required to comply with User Safety Agreement. Participants will then complete a baseline survey (NMUPO and psychosocial factor assessment; RedCap94). Participants will be randomly assigned to the intervention (n = 35) or control group (n = 35). Intervention group will be guided to join Instagram peer-led private groups (n = 10-15 each). Participants will be asked to provide their Instagram account to their assigned peer leaders for participating in intervention activities. Peer leaders will set up private and independent groups through their Instagram accounts and will send direct invitations to their assigned to join groups. Once group membership is confirmed, peer leaders will post intervention materials and lead group activities according to the plan as developed in Aim 2. Private groups will synchronously deliver intervention packages over 12 weeks.

During the intervention, intervention group will complete daily EMA (acceptability, usability, and dose) and their Paradata will be collected (engagement). At post-intervention, participants will complete a 12-week follow-up survey (NMUPO and psychosocial factor assessment; RedCap[94]), while intervention group will also complete semi-structural interviews (feasibility, acceptability, and usability; Zoom). E-gift-cards will be provided for the completion of assessments (baseline and 12 weeks; $30 each) and intervention ($60; complete 90% of tasks). Additional incentives will be offered for boosting intervention and EMA engagement.

Ecological momentary assessment (EMA)

EMA will be employed through brief evening surveys to screen the prompt acceptability and usability (USE questionnaire)[95] , and dose of particular modules in the intervention group. The EMA survey will be conducted once in every two days during the intervention. The daily EMA is widely used in behavioral trials.[39] Data will be collected through 20-second survey on a smartphone application (ExpiWell), which is user-friendly and customizable for EMA development and implementation. [96]A prompt will be sent at the moment for assessment and tailored for the intervention materials in the past two days. A reminder will be provided if no response is made in 30 minutes. For safety purposes, if an EMA occurs during an incompatible activity (e.g., driving),

participants will be instructed to ignore/postpone the prompt. A prorated incentive (e-gift card, $25 total) will be offered depending on a participant's EMA completion.

Measures

Demographic characteristics

In the baseline pre-intervention survey, participants will be asked to report their background information regarding gender (i.e., male, female, transgender, or other), race/ethnicity (e.g., Caucasian/White, African American/Black), age (years), socio-economic status, education, family/household characteristics, and physical health status (Patient Health Questionnaire-15).[97]

Primary outcomes: intervention feasibility outcomes

Multiple forms of data will be collected within 12 weeks during the intervention for the intervention feasibility evaluation.

Feasibility, acceptability, and usability

Mixed methods will be used. Acceptability will be assessed using EMA on Likert items that rate how helpful the module is (1 = not at all to 5 = extremely). Usability will be measured using EMA on the Usefulness, Satisfaction, and Ease of use (USE) questionnaire 95 which assesses perceived usefulness, satisfaction, and ease of use for the module. At week 12, participants will join semi-structural interviews measuring: (1) feasibility, usability, and acceptability; (2) reactions to the contents, format, concepts, visual presentation, assessments (survey and EMA), and adaptation to other platforms. The interview guide will be based on mHealth studies.98

Engagement

Paradata on participants' interactions with specific modules will be collected, including their frequency of reactions (i.e., comments, 'likes', questions, and replies on specific posts) and personal posts to Instagram groups.37 Retention will be assessed by calculating the percentage of participants engaging in the group at varying time points. Data will be collected in real time.

Dose of intervention

Participants' engagement in particular intervention modules will be measured in EMA surveys as guided by dose operationalization for mHealth interventions. [99] Dose for specific modules will be assessed in 3 domains (1 yes/no item each): (1) intervention actions (if viewing a post); (2) participant actions (if practicing a skill/completing an assignment); (3) behavioral target actions (if adopting skills outside of the intervention).

Secondary outcomes: psychosocial and behavioral outcomes

NMUPO behaviors and relevant psychosocial factors will be measured in the intervention and control groups in pre- and post-intervention surveys.

Non-medical use of prescription opioids (NMUPO)

The past-three-month NMUPO will be measured using relevant items from the Tobacco, Alcohol, Prescription medication, and other Substance use (TAPS) tool. [100] The scale includes two sections, with a screener followed by a brief assessment. The screener contains one items asking frequency of NMUPO (i.e., used just for feeling, more than prescribed, or without a prescription) with five response options (daily or almost daily, weekly, monthly, less than monthly, or never). Participants with a response other than "never" will be led to the brief assessment including three dichotomous questions regarding their level of use, dependence, concern from others related to the past-three-month NMUPO. The sum score of the brief assessment will be calculated, with a higher score indicating a greater level of NMUPO.

NMUPO knowledge

Information about NMUPO and relevant topics, such as misconceptions, the role of fentanyl, naloxone, and Xyalazine, will be assessed using a the NMUPO knowledge scale. [61] This scale will be developed according to the measure in POP4Teens and the formative study. This scale is proposed to include 15 statements related to opioids or non-medical use of prescription opioids. Participant will

be asked to determine if a statement is true or not (0 = False, 1 = True). Responses will then be rated by the research team, with higher scores indicating better knowledge of non-medical use of prescription opioids.

Outcome expectancies

Beliefs on positive or negative consequences of engaging in NMUPO will be assessed using a scale adapted from the Behaviors, Expectancies, Attitudes and College Health Questionnaire (BEACH-Q). [101] A total of 50 Items will be scored on a five-point Likert-type scale ranging from 0 (Not at all) to 4 (Very often or always) with higher sum scores standing for the greater level of expectancies. The scale consists of eight dimensions related to specific expectancies of opioids, including pain reduction, tension reduction, academic preference, emotion enhancement, social enhancement, guilt and dependence, cognitive impairment, and physical discomfort.

NMUPO risk perception

Perceived vulnerability and severity of engaging in NMUPO will be assessed using the Perceived Risk Scale for Prescription Drug Abuse. [102] This scale includes 5 items with four rating options (1="strongly disagree" to 4 = "strongly agree"). The sum score will be generated, with higher score indicating a greater level of perception risk for NMUPO.

Action self-efficacy and coping self-efficacy

Perceived control on making actions to stop/reduce NMUPO or confidence on coping with barriers against the actions will be assessed using an adapted version of Self-Efficacy Scale. [103] A total of six Items will be rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and can be organized into 2 subscales (coping self-efficacy and action self-efficacy) with 3 items each. The sum scores will be generated for each subscale, with higher scores indicating greater levels of self-efficacy.

Psychological distress

Depression and anxiety symptoms in the past two weeks will be assessed using the Patient Health Questionnaire-9 (PHQ-9) [104] and General Anxiety Disorder-7 (GAD-7) [105], respectively. PHQ-9 is composed of nine items asking the frequency of depressive mood experiences (e.g., ‘feeling down, depressed, and hopeless’), while GAD-7 comprises seven items assessing the frequency of feelings of nervousness or worry (e.g., ‘Not being able to stop or control worrying’). Two scales have 4 response options ranging from 0 (not at all) to 4 (nearly every day). Sum scores for two scales will be generated, with higher scores indicating greater levels of depression or anxiety.

Resilience

The Connor-Davidson Resilience Scale (CD-RISD) will be utilized for assessing psychological resilience. [106] This scale has 25 items asking about personal capacities in response to stress, including tenacity, tolerance of negative affect, positive acceptance of change, and positive view of adversities. Items will be rated on a 5-point scale (1 = not at all to 5 = nearly all the time). The sum score will be generated, with a higher score indicating a greater level of resilience.

Other substance use

The engagement in the use of alcohol, illicit drugs, and cigarette in the past three months will be assessed using the NIDA-Modified Alcohol, Smoking and Substance Involvement Screening (NIDA-ASSIST). [59] The scale includes 12 dichotomous items (0 = No, 1 = Yes) asking if a participant has engaged in using or misusing any of 12 individual substances.

Data analysis

The intervention trial will employ multiple data analytic methods according to the format of data.

Qualitative analyses

Post-intervention interviews will be audio-recorded, transcribed, and coded using a pragmatic approach. The framework analysis [63] will be performed via a deductive process including five key steps: (1) familiarizing the data; (2) developing a coding scheme; (3) condensing and structuring the

data; (4) rearranging the coded data and comparing patterns; (5) mapping and interpretation.[64] A codebook will be developed based on step (2) as a guide for coding. Coding disagreements will be resolved through group discussion. Data analysis will be conducted by the PI and graduate assistants on NVivo 11.0. Interrater reliability will be assessed throughout the coding process with a goal of ≥.80.[65] Analyses for post-intervention interviews will synthesize the comments on feasibility, acceptability, and usability of the intervention, as well as summarize suggestions for improvements.

Quantitative analyses

Bivariate analyses

Data of online surveys (i.e., pre- and post-intervention) will be screened for missing, outliers, and normality. If data are not missing (completely) at random or have high missing rate (>5%), multiple imputation will be employed.[107] Transformations will be conducted if violating normality (square-root for moderate skew or log for greater skew). Attrition tests will be employed (i.e., chi-square tests and analysis of variance) on demographics and outcomes at baseline. Descriptive statistics will be reported on primary (feasibility outcomes) and secondary outcomes (psychosocial and behavioral outcomes).

Multivariate analyses

Preliminary outcomes from baseline and 12-week will be tested using repeated measures Analysis of Covariance (ANCOVA), controlling for demographics. EMA data will be tested using multilevel modeling (i.e., random-coefficient regression model) to examine intervention usability and acceptability, capable for incorporating tests of time-serial characteristics including linear trend over time and cyclicity. Prior to multilevel modeling, unconditional means models will be tested for between- and within-subjects variation in each measure and determination of appropriate within-person error covariance structure. [108]

Mixed method analysis

Qualitative and quantitative data on feasibility will be triangulated with a complementary proposition, [109]in which the qualitative findings will provide in-dept understanding for the quantitative results in terms of intervention feasibility outcomes.

Power analysis

The primary aim is to evaluate the feasibility, acceptability, and usability of the intervention to support a future large-scale RCT. We estimate an effect size according to previous review on digital interventions for illicit drug use[110] and found small-to-medium effect sizes (d = -0.17 to -0.34) with a 6-month follow-up assessment. G-power analysis[111] estimated a sample size of 10-35 per arm for a RCT (repeated measures ANCOVA). According to previous mHealth trials for substance use with retention rates ranging from 75% to 93%,[46,53,61] a sample of 70 appears to be feasible and provide adequate power for proposed analytic plans. Despite a small sample size, this is appropriate for the aim of developmental research.

Discussion

In response to the growing evidence on psychosocial aspects of opioid addiction and relevant disorder concerns in the US, the current proposed study aims to apply a psychosocial theoretical framework and peer role model techniques to develop and implement an evidence-based intervention for reducing non-medical use of prescription opioids risk in US young adults. The intervention will be established through a serial research activity, from a formative semi-structured in-dept interview study to feasibility evaluation of a 12-week interactive peer-led trial. By leveraging the merits of social media, the proposed intervention study will be powered by adopting innovative approaches, including a tailored recruitment strategy (e.g., paid Ads campaign), intervention delivery that transcends time and space constraints, and the application of mixed-method and time-series assessments (e.g., Paradata and EMA measures). As one of the first attempt to deliver peer-led

interventions on social media specifically targeting NMUPO, the findings from this mixed-method design will offer valuable insights into the utilization of innovative approaches for reducing opioid risk among young adults.

Notably, the proposed intervention will be developed and implemented based on qualitative findings on psychosocial mechanism of NMUPO, incorporating tailored psychotherapy strategies, such as cognitive behavioral therapy, motivation interviewing, and peer role model. As highlighted in recent research, NMUPO in young adults are robustly driven by psychosocial factors, with influences comparable to biological and medical factors which are traditionally viewed as prominent determinants. [22] However, scant theory- and evidence-based intervention programs have designed to empower psychosocial skills for the US young adults, especially for those who have engaged in NMUPO but do not develop addiction or substance use disorders. Preliminary findings on efficacy of psychosocial measures would contribute to the growing literature on psychosocial aspects of NMUPO and offer clinical evidence for using psychosocial intervention to manage the risk of opioid misuse in young population.

The proposed intervention would encounter several potential challenges related to social media, including inefficient recruitment (e.g., scams) and intervention delivery affected by the policy changes to social media platforms. Several contingency plans will be employed if these occur. To address recruitment challenges, the eligibility of participants will be thoroughly evaluated by a two-step approach. Young adults who have signed up for participation via social media will be navigated to complete a screening survey regarding their age, current NMUPO, history of substance use disorders, and their preferred online meeting methods. The research team will then contact the participants by their preferred methods and evaluate their eligibility in-person. In addition, the recruitment plan will be supplemented by additional in-person approaches, including snowball strategy (i.e., allowing participants to invite eligible peers), outreach approach (i.e., advertising at local young adult communities, colleges, and associations), and CAB-assisting recruitment in their networks. To address the policy challenges to social media, the research team will transfer multimedia files to a publicly available but password-secured platform (e.g., Discord), which also allows member reactions, and implement all interactive activities (e.g., livestreaming) via alternative social media applications (e.g., WhatsApp).

Guided by a theoretical framework, the proposed intervention study is dedicated to reducing NMUPO behaviors and the risk for opioid-related addiction and disorders by empowering psychosocial competencies among young adults through the application of social media. The proposed program is informed by substantial literature on NMUPO in young adults and formative qualitative findings of psychosocial mechanisms associated with NMUPO behavior management. Findings from rigorous methods are anticipate informing a future scaled-up RCT study to optimize intervention contents and effectiveness of a fully powered cross-platform social media intervention.

Study dissemination

To promote the academic and social benefits of the proposed intervention study, several strategies will be employed to disseminate the study findings. First, the findings will be published in international and national scientific journals and presented at national and international scientific meetings or conferences held by substance use disorder research institutes. Second, the access to the de-identified data will be available for registered users through our selected data repository, the Inter-university Consortium for Political and Social Research (ICPSR), with high security standards. Third, documentation and support materials regarding the intervention will be available at ClinicalTrials.gov and compatible with its Protocol Registration Data Elements. Fourth, we will capitalize on social media and professional networks that can increase the research and accessibility of findings, such as webinar, files and video available on websites and publicly available channels (e.g., YouTube), to increase visibility and impact of the scientific publications and presentations. We hope that the anticipated success of the proposed intervention will prompt policy attempts for

prescription drug intervention and treatments. The lessons learned from the proposed study and the intervention strategies tested can be scaled-up to reduce NMUPO risk in young adults and other high-risk populations.

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Conflicts of Interest

This protocol has no conflicts of financial interest to declare.

References

1. Benotsch EG, Koester S, Luckman D, Martin AM, Cejka A. Non-medical use of prescription drugs and sexual risk behavior in young adults. *Addictive Behaviors*. 2011;doi:10.1016/j.addbeh.2010.08.027
2. Substance Abuse and Mental healt Services Administration. The NSDUH Report: Nonmedical Use of Prescription-Type Drugs, by County Type. Accessed February 19, 2021. https://www.samhsa.gov/data/sites/default/files/NSDUH098/NSDUH098/sr098-UrbanRuralRxMisuse.htm
3. United Nations Office on Drugs and Crime. *The non-medical use of prescription drugs policy direction issues*. 2011. https://www.unodc.org/documents/drug-prevention-and-treatment/nonmedical-use-prescription-drugs.pdf
4. Wide-ranging online data for epidemiologic research. *National Center for Health Statistics*. 2021. http://wonder.cdc.gov
5. Srinivasan N, Mandowara K. US drug overdose deaths top 109,000 in the past year. Accessed July 10, 2023. https://www.reuters.com/world/us/us-drug-overdose-deaths-top-109000-past-year-2023-06-14/#:~:text=June%2014%20(Reuters)%20%2D%20More,(CDC)%20released%20on%20Wednesday
6. Florence C, Luo F, Xu L, Zhou C. The economic burden of prescription opioid overdose, abuse and dependence in the United States, 2013. *Medical care*. 2016;54(10):901.
7. Substance Abuse and Mental healt Services Administration. Key substance use and mental health indicators in the United States: Results from the 2019 national survey on drug use and health. Accessed May 13, 2021. https://www.samhsa.gov/data/sites/default/files/reports/rpt29393/2019NSDUHFFRPDFWHTML/2019NSDUHFFR1PDFW090120.pdf
8. Benotsch EG, Martin AM, Koester S, Mason MJ, Jeffers AJ, Snipes DJ. Driving under the influence of prescription drugs used nonmedically: associations in a young adult sample. *Substance abuse*. 2015;36(1):99-105.
9. Arria AM, Wilcox HC, Caldeira KM, Vincent KB, Garnier-Dykstra LM, O'Grady KE. Dispelling the myth of "smart drugs": Cannabis and alcohol use problems predict nonmedical use of prescription stimulants for studying. *Addictive Behaviors*. 2013;38(3):1643-1650. doi:10.1016/j.addbeh.2012.10.002

10. Tam CC, Benotsch EG, Li X. Sexual enhancement expectancy, non-medical use of prescription drugs, and sexual risk behaviors in college students. *Substance Abuse*. 2020:1-10.
11. Juan W, Jian-Xiong D, Lan G, et al. Non-medical use of psychoactive drugs in relation to suicide tendencies among Chinese adolescents. *Addictive Behaviors*. 2015;51:31-37. doi:10.1016/j.addbeh.2015.07.003
12. Centers of Disease Control and Prevention. Prescribing Practices. Accessed May 13, 2021. https://www.cdc.gov/drugoverdose/data/prescribing/prescribing-practices.html
13. Jones CM, Clayton HB, Deputy NP, et al. Prescription opioid misuse and use of alcohol and other substances among high school students—Youth Risk Behavior Survey, United States, 2019. *MMWR supplements*. 2020;69(1):38.
14. McCabe SE, Teter CJ, Boyd CJ, Wilens TE, Schepis TS. Sources of prescription medication misuse among young adults in the United States: the role of educational status. *The Journal of clinical psychiatry*. 2018;79(2):0-0.
15. Nargiso JE, Ballard EL, Skeer MR. A systematic review of risk and protective factors associated with nonmedical use of prescription drugs among youth in the United States: a social ecological perspective. *Journal of studies on alcohol and drugs*. 2015;76(1):5-20.
16. Drazdowski TK. A systematic review of the motivations for the non-medical use of prescription drugs in young adults. *Drug and alcohol dependence*. 2016;162:3-25.
17. Bonar EE, Coughlin L, Roche JS, et al. Prescription opioid misuse among adolescents and emerging adults in the United States: a scoping review. *Preventive medicine*. 2020;132:105972.
18. Tapscott BE, Schepis TS. Nonmedical use of prescription medications in young adults. *Adolescent medicine: state of the art reviews*. 2013;24(3):597.
19. Tam CC. *CONSTRUCTION AND VALIDATION OF A NON-MEDICAL USE OF PRESCRIPTION OPIOIDS OUTCOME EXPECTANCIES SCALE AMONG COLLEGE STUDENTS IN CHINA*. Dissertation. Virginia Commonwealth University; 2019.
20. Tam CC, Benotsch EG, Li X. Self-Esteem and Non-Medical Use of Prescription Drugs among College Students: Coping as a Mediator. *Substance use & misuse*. 2020;55(8):1309-1319.
21. Tam CC, Benotsch EG, Weinstein TL. Resilience and psychiatric symptoms as mediators between perceived stress and non-medical use of prescription drugs among college students. *The American Journal of Drug and Alcohol Abuse*. 2019:1-11.
22. Cragg A, Hau JP, Woo SA, et al. Risk factors for misuse of prescribed opioids: a systematic review and meta-analysis. *Annals of emergency medicine*. 2019;74(5):634-646.
23. Spoth R, Trudeau L, Shin C, et al. Longitudinal effects of universal preventive intervention on prescription drug misuse: three randomized controlled trials with late adolescents and young adults. *American journal of public health*. 2013;103(4):665-672.
24. Moore SK, Grabinski M, Bessen S, Borodovsky JT, Marsch LA. Web-based prescription opioid abuse prevention for adolescents: program development and formative evaluation. *JMIR formative research*. 2019;3(3):e12389.
25. Scaglione NM, Buben A, Williams J, et al. A Latent Class Analysis of Prevention Approaches Used to Reduce Community-Level Prescription Drug Misuse in Adolescents and Young Adults. *The Journal of Primary Prevention*. 2021:1-18.
26. Center for Substance Abuse Treatment. SAMHSA/CSAT Treatment Improvement Protocols. *Using Technology-Based Therapeutic Tools in Behavioral Health Services*.

Substance Abuse and Mental Health Services Administration (US); 2015.
27. Fisher WA, Fisher JD, Harman J. The information-motivation-behavioral skills model: A general social psychological approach to understanding and promoting health behavior. *Social psychological foundations of health and illness*. 2003;22(4):82-106.
28. Chang SJ, Choi S, Kim S-A, Song M. Intervention strategies based on information-motivation-behavioral skills model for health behavior change: a systematic review. *Asian Nursing Research*. 2014;8(3):172-181.
29. Cooperman NA, Lu S-E, Richter KP, Bernstein SL, Williams JM. Pilot study of a tailored smoking cessation intervention for individuals in treatment for opioid dependence. *Nicotine and Tobacco Research*. 2018;20(9):1152-1156.
30. Tseng T-Y, Krebs P, Schoenthaler A, et al. Combining text messaging and telephone counseling to increase varenicline adherence and smoking abstinence among cigarette smokers living with HIV: a randomized controlled study. *AIDS and Behavior*. 2017;21:1964-1974.
31. Junnual N, Sota C, Chaikoolvatana A. Effectiveness of a smoking cessation program on self-esteem, attitude, perception, and practice regarding control over smoking among male high school. *Journal of Health Research*. 2019;33(5):366-374.
32. Margolin A, Avants SK, Warburton LA, Hawkins KA, Shi J. A randomized clinical trial of a manual-guided risk reduction intervention for HIV-positive injection drug users. *Health Psychology*. 2003;22(2):223.
33. Kim SJ, Marsch LA, Hancock JT, Das AK. Scaling up research on drug abuse and addiction through social media big data. *Journal of medical Internet research*. 2017;19(10):e353.
34. Anderson LS, Bell HG, Gilbert M, et al. Using social listening data to monitor misuse and nonmedical use of bupropion: a content analysis. *JMIR Public Health and Surveillance*. 2017;3(1):e6174.
35. Lord S, Brevard J, Budman S. Connecting to young adults: an online social network survey of beliefs and attitudes associated with prescription opioid misuse among college students. *Substance use & misuse*. 2011;46(1):66-76.
36. Hanson CL, Cannon B, Burton S, Giraud-Carrier C. An exploration of social circles and prescription drug abuse through Twitter. *Journal of medical Internet research*. 2013;15(9):e189.
37. Bonar EE, Schneeberger DM, Bourque C, et al. Social media interventions for risky drinking among adolescents and emerging adults: protocol for a randomized controlled trial. *JMIR research protocols*. 2020;9(5):e16688.
38. Doherty K, Balaskas A, Doherty G. The design of ecological momentary assessment technologies. *Interacting with Computers*. 2020;32(3):257-278.
39. Heron KE, Smyth JM. Ecological momentary interventions: incorporating mobile technology into psychosocial and health behaviour treatments. *British journal of health psychology*. 2010;15(1):1-39.
40. Roth AM, Felsher M, Reed M, et al. Potential benefits of using ecological momentary assessment to study high-risk polydrug use. *Mhealth*. 2017;3
41. Auxier B, Anderson M. *Social media use in 2021*. 2021. April 7, 2021. https://www.pewresearch.org/internet/wp-content/uploads/sites/9/2021/04/PI_2021.04.07_Social-Media-Use_FINAL.pdf
42. Bonar EE, Bauermeister JA, Blow FC, et al. A randomized controlled trial of social media interventions for risky drinking among adolescents and emerging adults. *Drug and alcohol dependence*. 2022;237:109532.
43. Evans W, Andrade E, Pratt M, et al. Peer-to-peer social media as an effective

prevention strategy: quasi-experimental evaluation. *JMIR mHealth and uHealth*. 2020;8(5):e16207.
44. Young SD, Cumberland WG, Lee S-J, Jaganath D, Szekeres G, Coates T. Social networking technologies as an emerging tool for HIV prevention: a cluster randomized trial. *Annals of internal medicine*. 2013;159(5):318-324.
45. Young SD, Koussa M, Lee S-J, et al. Feasibility of a social media/online community support group intervention among chronic pain patients on opioid therapy. *Journal of addictive diseases*. 2018;37(1-2):96-101.
46. Young SD, Lee S-J, Perez H, Gill N, Gelberg L, Heinzerling K. Social media as an emerging tool for reducing prescription opioid misuse risk factors. *Heliyon*. 2020;6(3):e03471.
47. Bonar EE, Goldstick JE, Chapman L, et al. A social media intervention for cannabis use among emerging adults: randomized controlled trial. *Drug and alcohol dependence*. 2022;232:109345.
48. PEW Research Center. Teens, Social Media and Technology 2022. Accessed September 20, 2022. https://www.pewresearch.org/internet/2022/08/10/teens-social-media-and-technology-2022/
49. Ferguson C. Predatory behavior runs rampant in Facebook's addiction support groups. Accessed May 13, 2021. https://www.theverge.com/2018/5/21/17370066/facebook-addiction-support-groups-rehab-patient-brokering
50. Bell K. Instagram will use hashtags to support people struggling with opioid abuse. Accessed September 20, 2022. https://mashable.com/article/instagram-opioid-notifications
51. Ramo DE, Meacham MC, Kaur M, Corpuz ES, Prochaska JJ, Satre DD. Development of a social media-based intervention targeting tobacco use and heavy episodic drinking in young adults. *Addiction science & clinical practice*. 2019;14(1):14.
52. Thomas VL, Chavez M, Browne EN, Minnis AM. Instagram as a tool for study engagement and community building among adolescents: A social media pilot study. *Digital Health*. 2020;6:2055207620904548.
53. Vogel EA, Ramo DE, Meacham MC, Prochaska JJ, Delucchi KL, Humfleet GL. The put it out project (POP) Facebook intervention for young sexual and gender minority smokers: outcomes of a pilot, randomized, controlled trial. *Nicotine and Tobacco Research*. 2020;22(9):1614-1621.
54. Maher C, Ferguson M, Vandelanotte C, et al. A web-based, social networking physical activity intervention for insufficiently active adults delivered via Facebook app: randomized controlled trial. *Journal of medical Internet research*. 2015;17(7):e174.
55. Thrul J, Ramo DE. Cessation strategies young adult smokers use after participating in a Facebook intervention. *Substance use & misuse*. 2017;52(2):259-264.
56. Meacham MC, Ramo DE, Prochaska JJ, et al. A Facebook intervention to address cigarette smoking and heavy episodic drinking: A pilot randomized controlled trial. *Journal of Substance Abuse Treatment*. 2021;122:108211.
57. Meta. Advertsing Terms and Policy. Accessed September 20, 2022. https://www.facebook.com/policies_center/ads
58. Substance Abuse and Mental Health Services Administration. Results from the 2018 National Survey on Drug Use and Health. *Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration, Rockville, MD*. 2019;
59. NIDA. Smoking, and Substance Involvement Screening Test: NM-ASSIST. Accessed

May 13, 2021. https://www.drugabuse.gov/sites/default/files/pdf/nmassist.pdf
60. Hudgins JD, Porter JJ, Monuteaux MC, Bourgeois FT. Prescription opioid use and misuse among adolescents and young adults in the United States: A national survey study. *PLoS medicine*. 2019;16(11):e1002922.
61. Marsch LA, Moore SK, Grabinski M, Bessen SY, Borodovsky J, Scherer E. Evaluating the Effectiveness of a Web-Based Program (POP4Teens) to Prevent Prescription Opioid Misuse Among Adolescents: Randomized Controlled Trial. *JMIR public health and surveillance*. 2021;7(2):e18487.
62. Creswell JW, Miller DL. Determining validity in qualitative inquiry. *Theory into practice*. 2000;39(3):124-130.
63. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. *Analyzing qualitative data*. Routledge; 2002:187-208.
64. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & health sciences*. 2013;15(3):398-405.
65. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. *Biometrics*. 1977:363-374.
66. Hettema J, Steele J, Miller WR. Motivational interviewing. *Annu Rev Clin Psychol*. 2005;1:91-111.
67. Beck JS, Beck AT. *Cognitive therapy: Basics and beyond*. Guilford press New York; 1995.
68. De Shazer S, Berg IK, Lipchik E, et al. Brief therapy: Focused solution development. *Family process*. 1986;25(2):207-221.
69. Jensen CD, Cushing CC, Aylward BS, Craig JT, Sorell DM, Steele RG. Effectiveness of motivational interviewing interventions for adolescent substance use behavior change: a meta-analytic review. *Journal of consulting and clinical psychology*. 2011;79(4):433.
70. Hofmann SG, Asnaani A, Vonk IJ, Sawyer AT, Fang A. The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive therapy and research*. 2012;36(5):427-440.
71. Gingerich WJ, Peterson LT. Effectiveness of solution-focused brief therapy: A systematic qualitative review of controlled outcome studies. *Research on Social Work Practice*. 2013;23(3):266-283.
72. Tracy K, Wallace SP. Benefits of peer support groups in the treatment of addiction. *Substance abuse and rehabilitation*. 2016:143-154.
73. Resnicow K, McMaster F. Motivational Interviewing: moving from why to how with autonomy support. *International Journal of Behavioral Nutrition and Physical Activity*. 2012;9(1):1-9.
74. Mills H, Reiss N, Dombeck M. Cognitive Restructuring. Accessed May 13, 2021. https://www.mentalhelp.net/stress/cognitive-restructuring/#:~:text=Cognitive%20restructuring%2C%20also%20known%20as,inducing%20thought%20patterns%20and%20beliefs.&text=Cognitive%20restructuring%20was%20first%20developed,Therapy%20for%20depression%20(in%20Dr.
75. Lutz AB. *Learning solution-focused therapy: An illustrated guide*. American Psychiatric Pub; 2013.
76. De Shazer S, Dolan Y, Korman H, Trepper T, McCollum E, Berg IK. *More than miracles: The state of the art of solution-focused brief therapy*. Routledge; 2021.
77. Franzone E, Collet-Klingenberg L. Overview of video modeling. *Madison, WI: The National Professional Development Center on Autism Spectrum Disorders, Waisman*

Center, University of Wisconsin. 2008;
78. Mechling LC, Ayres KM, Bryant KJ, Foster AL. Comparison of the effects of continuous video modeling, video prompting, and video modeling on task completion by young adults with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities*. 2014:491-504.
79. Cavallo DN, Tate DF, Ries AV, Brown JD, DeVellis RF, Ammerman AS. A social media–based physical activity intervention: a randomized controlled trial. *American journal of preventive medicine*. 2012;43(5):527-532.
80. Kernot J, Olds T, Lewis LK, Maher C. Effectiveness of a facebook-delivered physical activity intervention for post-partum women: a randomized controlled trial protocol. *BMC public health*. 2013;13(1):1-7.
81. Valle CG, Tate DF, Mayer DK, Allicock M, Cai J. A randomized trial of a Facebook-based physical activity intervention for young adult cancer survivors. *Journal of Cancer Survivorship*. 2013;7(3):355-368.
82. Haines-Saah RJ, Kelly MT, Oliffe JL, Bottorff JL. Picture Me Smokefree: a qualitative study using social media and digital photography to engage young adults in tobacco reduction and cessation. *Journal of medical Internet research*. 2015;17(1):e27.
83. Jaganath D, Gill HK, Cohen AC, Young SD. Harnessing Online Peer Education (HOPE): integrating C-POL and social media to train peer leaders in HIV prevention. *AIDS care*. 2012;24(5):593-600.
84. Ramo D, Thrul J, Delucchi K, et al. The tobacco status project: Three month outcomes for a randomized controlled trial of a Facebook smoking cessation intervention for young adults. *Drug and Alcohol Dependence*. 2017;100(171):e173.
85. Bull SS, Levine DK, Black SR, Schmiege SJ, Santelli J. Social media–delivered sexual health intervention: a cluster randomized controlled trial. *American journal of preventive medicine*. 2012;43(5):467-474.
86. Moreno MA, VanderStoep A, Parks MR, Zimmerman FJ, Kurth A, Christakis DA. Reducing at-risk adolescents' display of risk behavior on a social networking web site: a randomized controlled pilot intervention trial. *Archives of pediatrics & adolescent medicine*. 2009;163(1):35-41.
87. Karyotaki E, Riper H, Twisk J, et al. Efficacy of self-guided internet-based cognitive behavioral therapy in the treatment of depressive symptoms: a meta-analysis of individual participant data. *JAMA psychiatry*. 2017;74(4):351-359.
88. Schuman-Olivier Z, Borodovsky JT, Steinkamp J, et al. MySafeRx: a mobile technology platform integrating motivational coaching, adherence monitoring, and electronic pill dispensing for enhancing buprenorphine/naloxone adherence during opioid use disorder treatment: a pilot study. *Addiction science & clinical practice*. 2018;13(1):1-14.
89. Cheung YTD, Chan CHH, Lai C-KJ, et al. Using WhatsApp and Facebook online social groups for smoking relapse prevention for recent quitters: a pilot pragmatic cluster randomized controlled trial. *Journal of medical Internet research*. 2015;17(10):e4829.
90. Cobb NK, Jacobs MA, Wileyto P, Valente T, Graham AL. Diffusion of an evidence-based smoking cessation intervention through Facebook: a randomized controlled trial. *American journal of public health*. 2016;106(6):1130-1135.
91. Pechmann C, Delucchi K, Lakon CM, Prochaska JJ. Randomised controlled trial evaluation of Tweet2Quit: a social network quit-smoking intervention. *Tobacco control*. 2017;26(2):188-194.
92. Ramo DE, Thrul J, Chavez K, Delucchi KL, Prochaska JJ. Feasibility and quit rates of

the tobacco status project: a Facebook smoking cessation intervention for young adults. *Journal of medical Internet research*. 2015;17(12):e5209.

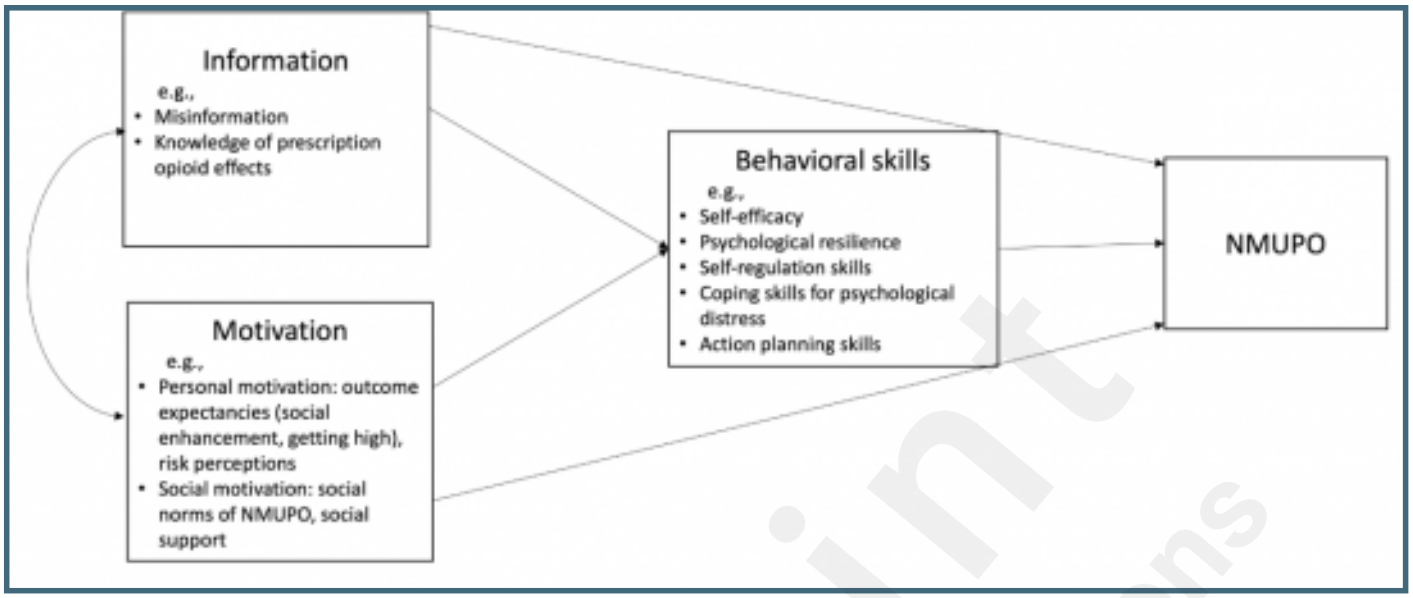
93. Wingood GM, DiClemente RJ. The ADAPT-ITT model: a novel method of adapting evidence-based HIV Interventions. *JAIDS Journal of Acquired Immune Deficiency Syndromes*. 2008;47:S40-S46.
94. Patridge EF, Bardyn TP. Research electronic data capture (REDCap). *Journal of the Medical Library Association: JMLA*. 2018;106(1):142.
95. Lund AM. Measuring usability with the use questionnaire12. *Usability interface*. 2001;8(2):3-6.
96. Kiekens G, Hasking P, Nock MK, et al. Fluctuations in affective states and self-efficacy to resist non-suicidal self-injury as real-time predictors of non-suicidal self-injurious thoughts and behaviors. *Frontiers in psychiatry*. 2020;11:214.
97. Kroenke K, Spitzer RL, Williams JB. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. *Psychosomatic medicine*. 2002;64(2):258-266.
98. Compernolle S, Cardon G, van der Ploeg HP, et al. Engagement, acceptability, usability, and preliminary efficacy of a self-monitoring mobile health intervention to reduce sedentary behavior in Belgian older adults: mixed methods study. *JMIR mHealth and uHealth*. 2020;8(10):e18653.
99. McVay MA, Bennett GG, Steinberg D, Voils CI. Dose–response research in digital health interventions: Concepts, considerations, and challenges. *Health Psychology*. 2019;38(12):1168.
100. McNeely J, Wu L-T, Subramaniam G, et al. Performance of the tobacco, alcohol, prescription medication, and other substance use (TAPS) tool for substance use screening in primary care patients. *Annals of internal medicine*. 2016;165(10):690-699.
101. Bavarian N, Flay BR, Ketcham PL, Smit E. Development and psychometric properties of a theory-guided prescription stimulant misuse questionnaire for college students. *Substance use & misuse*. 2013;48(6):457-469.
102. Netemeyer R, Burton S, Delaney B, Hijjawi G. The legal high: Factors affecting young consumers' risk perceptions and abuse of prescription drugs. *Journal of Public Policy & Marketing*. 2015;34(1):103-118.
103. Vayisoglu SK, Zincir H. The Health Action Process Approach-Based Program's Effects on Influenza Vaccination Behavior. *The Journal for Nurse Practitioners*. 2019;15(7):517-524.
104. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine*. 2001;16(9):606-613.
105. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*. 2006;166(10):1092-1097.
106. Connor KM, Davidson JR. Development of a new resilience scale: The Connor-Davidson resilience scale (CD-RISC). *Depression and anxiety*. 2003;18(2):76-82.
107. Meyers LS, Gamst G, Guarino AJ. *Applied multivariate research: Design and interpretation, 2nd ed*. Applied multivariate research: Design and interpretation, 2nd ed. Sage Publications, Inc; 2013:xx, 1078-xx, 1078.
108. Bryk AS, Raudenbush SW. *Hierarchical linear models: applications and data analysis methods*. Sage Publications, Inc; 1992.
109. Östlund U, Kidd L, Wengström Y, Rowa-Dewar N. Combining qualitative and quantitative research within mixed method research designs: a methodological review. *International journal of nursing studies*. 2011;48(3):369-383.

110. Wood SK, Eckley L, Hughes K, et al. Computer-based programmes for the prevention and management of illicit recreational drug use: a systematic review. *Addictive behaviors*. 2014;39(1):30-38.
111. Erdfelder E, Faul F, Buchner A. GPOWER: A general power analysis program. *Behavior research methods, instruments, & computers*. 1996;28(1):1-11.

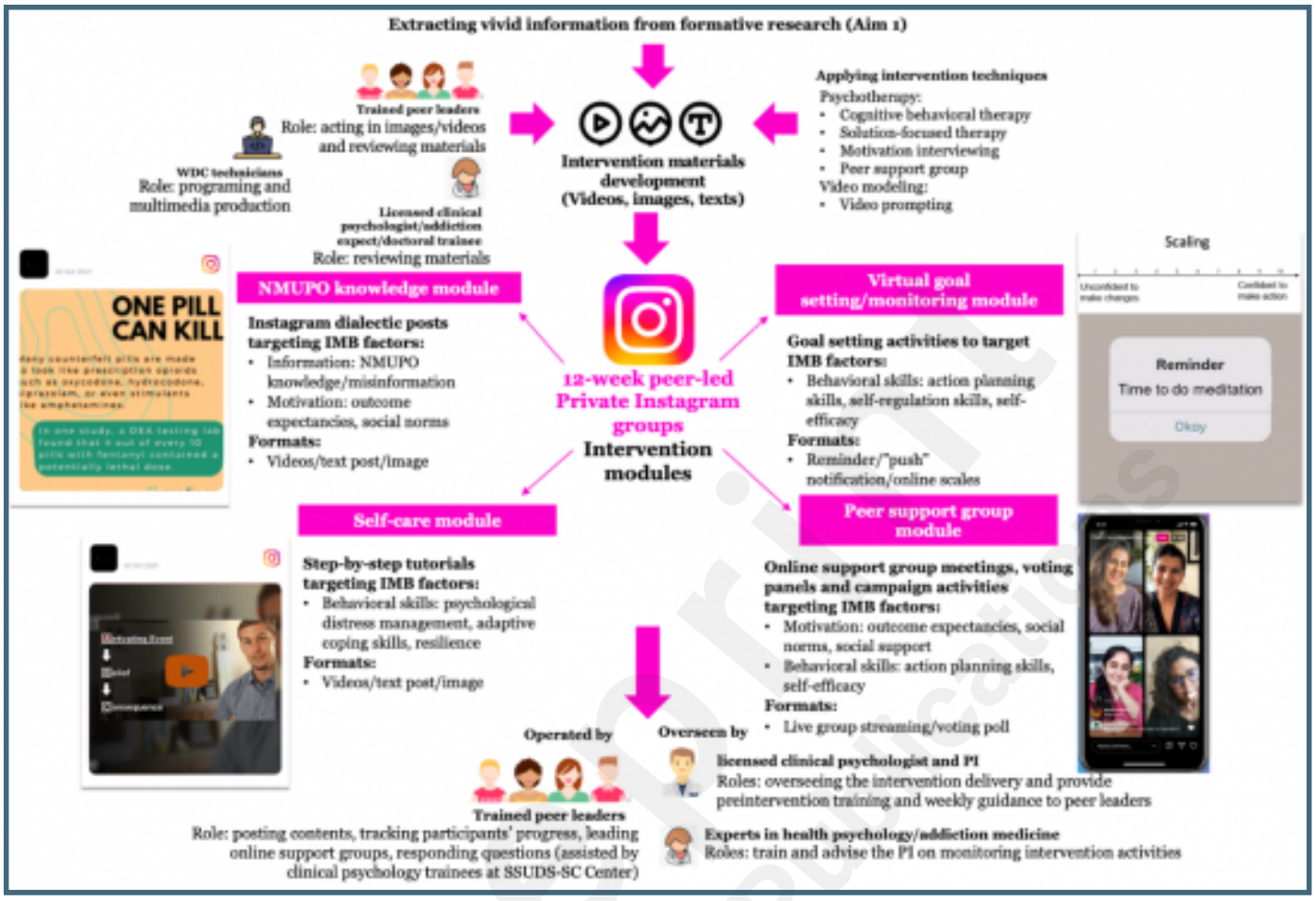
Supplementary Files

Figures

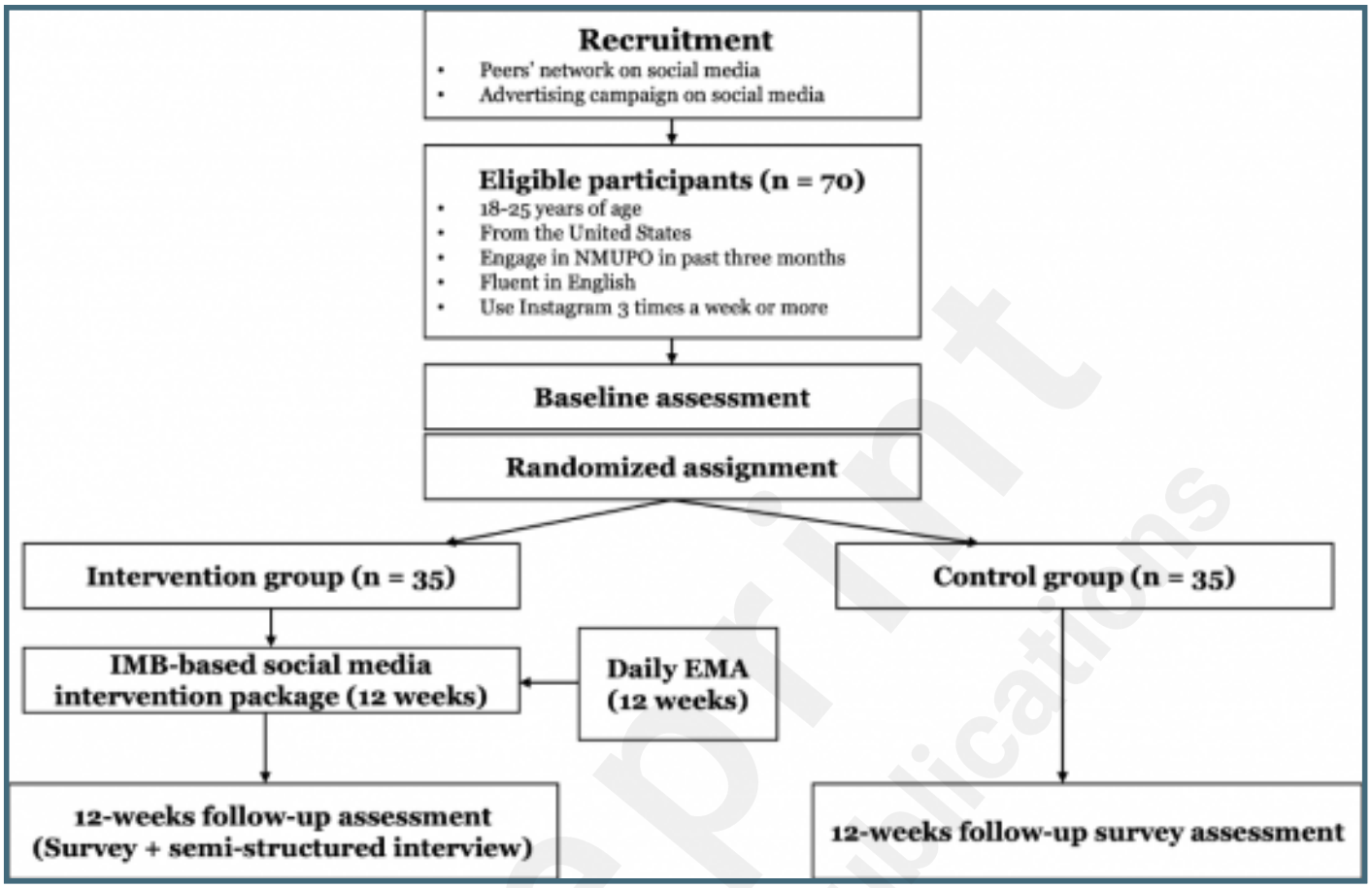
Theoretical framework for the proposed study.



Planned intervention modules and strategies.



Consort diagram for the proposed IMB-based social media intervention study.



Multimedia Appendixes

Peer-review report from NIH.
URL: http://asset.jmir.pub/assets/55f4e76054106b78e17d7e19d6510c66.pdf