Leveraging Social Media to Identify and Connect Teens with Eating Disorders to a Mobile Guided Self-Help Intervention

Randomized Controlled Trial (RCT)

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Introduction

A1 Study Abstract

Clinical or subclinical eating disorders (EDs) impact 10% of individuals in their lifetime and are marked by significant functional impairment, early mortality, chronicity, and emotional distress. ED symptoms often emerge in adolescence, with peak onset age in the teenage years. Early recognition and treatment of these devastating illnesses are needed to prevent long-term consequences and a chronic course. Most (80%) individuals with EDs, including teens with EDs (TwEDs), do not receive treatment. Due to major barriers to access and to the delivery of treatment for TwEDs, there is a need for a new model of service delivery that can identify and help TwEDs. We demonstrated our ability to harness social media to identify and efficiently recruit large numbers of TwEDs. Our team has successfully developed a guidedself-help cognitive behavioral therapy (CBT)-based mobile app for previous studies and have adapted this app to address the specific needs of TwEDs. In a previous pilot study, we have conducted usability testing on this updated mHealth intervention, which includes 1) simplified language and making content relevant to adolescent issues and 2) a social networking feature to facilitate group exchanges and support, among 45 TwEDs. In the current randomized controlled trial (RCT) we will again leverage online recruitment (i.e., social media, NEDA online screen) to recruit 165 TwEDs recruited from social media who are not engaged in treatment and pilot test the preliminary efficacy of the tool and garner feedback via a mixed methods approach on the efficiency, technical effectiveness, and satisfaction with mHealth intervention content and features.

A2 Primary Hypothesis

AIM #1: To develop the mHealth intervention specifically for use with TwEDs and to collect preliminary data on the feasibility and acceptability of this mHealth intervention to inform subsequent refinement. (*Pilot Study*)

- **Hypothesis:** We hypothesize that teens will report good efficiency, technical effectiveness, and satisfaction with the mHealth intervention, and will provide useful feedback for app improvements.

Aim #2: To implement a pilot RCT of the refined mHealth intervention (comparing mobile app with the social networking component, mobile app without the social networking component, and referral to usual care).

- **Hypothesis:** We hypothesize that the mobile app plus social networking feature will be most effective in reducing ED symptoms, improving quality of life, increasing uptake of care, and impacting targets that are associated with outcomes.

A3 Purpose of the Study Protocol

The purpose of this protocol is to outline the methods utilized in this study. As we are researching a vulnerable population (TwEDs), this protocol also details the protections we have taken to ensure the safety of our participants.

B Background

B1 Prior Literature and Studies

There is an urgent need to focus eating disorder (ED) intervention efforts on teens. EDs often emerge at a young age, with the peak age of onset being in the teenage years.[1,2] Health consequences related to EDs can harm every organ system and are often more severe and/or manifest themselves to a greater degree among teens (e.g., growth retardation, pubertal delay or interruption, peak bone mass reduction).[3,4] Despite their severity, there is an extremely wide treatment gap for EDs. Most individuals, including **t**eens **w**ith **ED**s (TwEDs) do not receive treatment.[5] Early intervention is especially important during adolescence, as untreated symptoms become more frequent, severe, and persistent over time, and shorter latency between ED onset and start of treatment is associated with better outcomes.[6,7] There are major barriers to access and to the delivery of treatment for TwEDs. These include: stigma; cost of mental health services; lack of urgency to seek services; and lack of access to care, including lack of quality, tailored ED treatments for this vulnerable, young age group.[8] These factors highlight the critical need for a new model of treatment delivery that can identify and help TwEDs.

We have developed an efficacious "disruptive innovation" that has the potential to help teens with EDs. Mobile health (mHealth) technologies have the potential to greatly improve access to treatment for TwEDs by overcoming treatment barriers, enhancing treatment precision, and reducing costs.[9] We have developed a guided self-help cognitive-behavioral therapy (CBT)-based mobile application ("app"), which has been adapted from an app used with college women with clinical/subclinical EDs with high efficacy and user acceptability. This mHealth intervention has great potential to bridge the wide treatment gap for TwEDs.

We have established an innovative outreach method to engage TwEDs with care. There is great potential for outreach via social media and online recruitment to connect TwEDs with care and bridge the treatment gap. In previous studies, we successfully recruited nearly 500 teens who socially network about EDs/body image and endorsed symptoms consistent with DSM-5 clinical/subclinical EDs. Most (85%) expressed an interest in using an mHealth app adapted for teens if available.

Preliminary Study 1: Leveraging social media to target TwEDs. In a previous study, we have examined individuals who socially network about EDs across multiple social media platforms (Instagram, Twitter, Facebook, and Reddit). Our team designed e-flyers that were distributed as social media ads targeting English-speaking U.S. residents who had demonstrated an interest in and/or followed accounts that were SN'ing about EDs or ED-related topics (e.g., body image, body shape, dieting). Following 2 rounds of recruitment that lasted about 10 days each, we recruited 483 adolescents 15-17 years old who screened positive for a DSM-5 clinical/subclinical ED. Nearly all (89%) were female and most were recruited from Instagram (91%).

Our participants want to engage with a mobile intervention. Nearly all of our TwED participants were not currently engaged in treatment for EDs (87%). Most (79%) felt comfortable with our use of social media for connection to treatment, and 85% expressed interest in using a mobile app to address their ED. Most (72%) requested a SN'ing feature to receive support from other online peers working toward recovery. Of concern, 94% of TwEDs had seen peers post on social media about eating/weight/body image in the past month, suggesting the need for a healthy SN'ing outlet that has health professional oversight and encourages ED recovery.

Preliminary Study 2: Treatment of EDs using a guided self-help CBT app. The efficacy of CBT-based apps in preventing and reducing EDs and associated risks has been shown in multiple studies. Specifically, such apps have been shown to prevent ED onset and reduce weight/shape concerns, a key ED risk factor, among college women compared to controls across 2-year follow-up.[10] In addition, tailored versions have prevented ED onset in a subgroup with highest shape concerns (20% in treatment vs. 42% in waitlist, p=.025, NNT=5),[11] reduced depressive symptoms,[11] prevented ED progression,[12] and reduced clinical ED symptoms. [13-16] In a previous randomized controlled study, 690 women with EDs at 28 U.S. colleges were randomized (at the school level) to the SB-ED app or usual care. The within-intervention 6-month effect size was d=.77 for ED psychopathology (p<.001), and the between-group effect size was d=.38 (p<.001)—in line with meta-analytic findings on the efficacy of online ED programs.[17] Notably, among 18-year-old participants in this study, the within-intervention 6-month effect size was d=.64 for ED psychopathology and the between-group effect size was d=.44, suggesting that the apps such as this have high potential for helping younger individuals.

Preliminary Study 3: Machine learning to flag concerning SN'ing posts and extract themes. Previous studies have used machine learning to determine which ED SN'ing posts indicate a need for intervention by collecting and analyzing the top 1000 posts that were rapidly gaining popularity on 6 ED-focused discussion forums on Reddit. Reddit is a popular and anonymous social media platform where we previously performed a content analysis of a pro-ED forum.[18] That is, 6,000 posts were analyzed; after removing stopwords [e.g., very common words that provide little information about content, such as "and" and "the"] and selecting for posts >10 words, n=4,759 posts remained for analysis. For example, if a person discusses recently engaging in disordered eating behaviors or is expressing strong urges to engage in disordered eating, this would indicate the need for intervention. This manually coded training data set was used with five different text classification models using term frequency-inverse document frequency (TF-IDF) representation and word embedding representation (based on logistic regression, Positive and Unlabeled Learning, and Word Mover's Distance) to determine which model provided the best selection accuracy. A nearest-neighbor classifier using positively coded training data and unlabeled testing data with word mover distance (with k=5) proved to be the most accurate (only 6% error rate). That is, we have demonstrated that we can identify posts in need of intervention using machine learning techniques with only a 6% error rate relative to that of a human coach. This machine learning approach to flagging and extracting concerning posts will be piloted to support the current aims of the current study.

B2 Rationale for this Study

- **Digital therapeutics can help to combat eating disorders in teens**. The current study aims to pilot a mobile guided self-help app tailored for TwEDs, to test the usability and feasibility of such an app, and to garner feedback on how this intervention can be improved. Utilizing this feedback, an RCT will follow the initial study to determine the efficacy of this mobile health intervention on reducing ED symptoms, improving quality of life, increasing uptake of care, and impacting targets that are associated with outcomes.

- **Waiving parental consent for teen participants.** Previous studies with adolescents have been granted a parental waiver of consent due to the vulnerable nature of their adolescent research population (e.g., sexual minorities, substance use, eating disorders),[19-21] including several studies utilizing text-based and digital therapeutics.[22-24]
- The current study aims to investigate the feasibility and efficacy of a mobile app for teens with eating disorders. Given the features of this study, which will be clearly outlined during the informed assent process with all adolescents prior to participation, attempting to obtain parent or guardian consent could result in negative social and/or psychological outcomes for

the adolescent. Additionally, if the parent is unaware of the adolescent's mental health concerns, requiring parental consent to take part in the study may cause the child to be dishonest with their parent about their symptoms and may bias survey responding and app utilization. Requiring teen informed assent rather than parental consent could bridge the gap to support for many teens who are not yet ready to disclose their symptoms to their parents but that may still benefit from additional resources and support. Waiving parental consent would not adversely affect the rights and welfare of the participants as the study poses minimal risk and the study team will implement rigorous procedures to protect the confidentiality of participants.

C Study Objectives

C1 Primary Aim

To develop an mHealth intervention specifically for use with TwEDs and to collect preliminary data on the feasibility and acceptability of this mHealth intervention to inform subsequent refinement.

Activities for Aim #1: First, we will adapt the intervention for use among TwEDs by: a) simplifying language and making the content relevant to adolescent issues; and b) adding interactive, social media features to facilitate group exchanges. Second, we will further refine the mHealth intervention based on feedback from an initial pilot of its use among 45 TwEDs garnering feedback via a mixed methods approach. Third, we will use participants' social networking data from this pilot to refine our current machine learning algorithms to allow prompt responses to potential recovery setbacks.

This pilot study has been completed (IRB ID# 202001103).

C2 Secondary Aim

To implement a pilot RCT of the refined mHealth intervention (comparing the mobile app with the social networking component, the mobile app without the social networking component, and referral to usual care).

Activities for Aim #2: We will iteratively refine the intervention based on feedback and findings from the pilot study, and will then recruit 165 TwEDs using social media and online recruitment. We will compare the uptake and preliminary effectiveness of the mHealth intervention to referral to usual care, examine whether the intervention engages TwED and improves ED symptoms and functioning, determine the utility and efficacy of machine learning technologies to assist with identifying at-risk social networking posts, and assess perspectives on the inclusion of parent-facing content in future versions of the intervention.

C3 Rationale for the Selection *of Outcome Measures*

This study will use a combination of quantitative and qualitative measures to examine the usability characteristics of and engagement with the mHealth intervention (Aim #1) and the impact of this intervention on reducing ED symptoms, improving quality of life, increasing uptake of care, and impacting targets that are associated with outcomes (Aim #2).

D Study Design

D1 Overview or Design Summary

In the pilot study, we recruited 45 teens (14-17 years) with eating disorders from social media (i.e., Instagram, Facebook, Snapchat, TikTok, Reddit, YouTube). All participants received access to the mobile app and a social networking component for 2 months and were asked to complete a baseline survey and a 2 month survey (with additional questions assessing usability of the app). They were also asked to participate in a qualitative interview where they were asked about their experience with the app and the relatability of the content. Participants were provided with gift card compensation for their participation.

In this RCT, we will recruit 165 teens (14-17 years) with eating disorders using online recruitment methods (i.e., social media, NEDA online screening). Following TwED assent and completion of the baseline survey, participants will be randomized to an experimental or control group. 50 participants will have access to the full mobile app with a social networking component, 50 participants will have access to the full mobile app without a social networking component, and 50 participants in the control group will receive a referral to nationwide resources and access to a self-help version of the app (i.e., without personalized coaching). All participants will be assessed at baseline, 6 weeks post randomization, 3 months post-randomization, and 6 months post-randomization using secure online surveys. Additional items will be included on the 3 month survey to assess TwED's feedback on the usability and acceptability of the mobile app. Participants will be provided with gift card compensation for completing these assessments.

D2 Subject Selection and Withdrawal

2.a Inclusion Criteria

1) U.S. Resident
2) English-speaking
3) 14-17 years old (birthdate provided online during screen)
4) Own an Android or iOS smartphone
5) Screen Positive for a DSM-5 subclinical/clinical ED other than anorexia nervosa (AN) or at risk for an ED

2.a Exclusion Criteria

1) Screen Positive for Anorexia Nervosa
2) Currently engaged in ED treatment
3) Ward of the State or Foster Children

2.b Ethical Considerations

Participation in this study is voluntary. Due to the low risks associated with this study, parent/legal guardian consent will be waived for this study, and teens may agree to participate via electronic check box.

2.c Subject Recruitment Plans and Consent Process

Eligible participants (RCT N=165) will be recruited for this study using two online recruitment approaches:

1) Targeted ads for this population (e.g., individuals social networking about body image, body shape, National Eating Disorders Association (NEDA), and/or dieting) on social media (i.e., Instagram, Facebook, Snapchat, TikTok, Reddit, YouTube)
2) Social media posts or online promotions from nationwide agencies (e.g., National Eating Disorders Association (NEDA), National Association of Anorexia Nervosa and Associated Disorders (ANAD), other nationwide agencies related to teen mental health)
3) Self-directing to take an online screener on the National Eating Disorders Association (NEDA) website (https://www.nationaleatingdisorders.org/), screening eligible (ED or risk for ED, not in ED treatment, 14-17 years old), and clicking an online link to "Learn More" about the study after and eligible screen

When a teen clicks on one of these ads or completes the NEDA screen and indicates interest in the study, they will be routed to a Qualtrics landing page with a summary of study activities and a video describing the details of the study. If they wish to continue after reviewing the landing page, they will click to view the informed assent document online with further details on the description of the study purpose, duration, and activities. Teens will be asked to confirm their willingness to continue via an electronic check box at the bottom of the informed assent document screen and those who assent will be routed to a screening survey.

Screening: Those recruited from social media and online promotions (Recruitment Approaches #1-2) will be asked to complete a screener including demographic questions and the Stanford-Washington eating Disorder Screen (SWED) to assess ED symptoms, and will receive personalized feedback about their results. The personalized feedback will be automated through Qualtrics, allowing for an efficient yet individualized feedback approach. Those recruited from the NEDA online screener (Recruitment Approach #3) will be asked to complete a screener with demographic questions only as they have already completed the SWED, were screened eligible, and received personalized feedback about their ED symptoms on the NEDA website.

All teens will be asked to provide their birthdate during the screening process as a means to assess age eligibility. Requesting age verification as a screening question is feasible and a method often used to prevent underage exposure to adult online content. Teens meeting full study eligibility criteria will be asked to provide their contact information (email, phone number, name) and confirm their preferred method of contact (opting out of text messages if preferred). They will then receive an end of screen message letting them know the research team will review their screen responses and will contact them in 1-2 business days via email to either 1) Notify them of their confirmed eligibility and to provide a personalized link to their BL survey, 2) Ask additional questions to confirm their eligibility, or 3) Notify them that they are not eligible based on our administrative data review process and to provide other resources.

Screening Data Review and Validation: Screen responses from social media and online promotions (Recruitment Approach #1-2) will be reviewed manually by the research team to ensure each response is a unique entry (i.e., the only screen from that person), that each response is from a human (i.e., not a bot), and that each response is an eligible and valid entry, excluding completed screens with contact information based on the following criteria:

1) Screens completed with altered question responses after multiple screen failures from the same IP address or location tag

2) Screens with the same location tag as a previously completed screen or survey

3) Screens completed with the same IP address as a previously completed screen or survey

4) Patterns within screen responses that could indicate invalid entries (e.g., completing the screen repeatedly in short succession with similar answers, selection of the same response options for an entire measure, open-ended responses that do not relate to the question asked, etc)

Those entries which are suspicious based on criteria 1-3 will be sent an email letting them know they are ineligible for the study. Those entries which are questionable based on manual data review but are not excluded based on criteria 1-4 above will be sent a validation email asking participants to confirm their information to ensure the survey is a unique entry. Such steps to ensure data validity have been used in the past with social media and online recruitment methods, particularly those offering incentives for study activity completion.[25-27] For those confirmed participants who do not complete their baseline survey after being provided their personalized link, the study team will continue to follow up via email and phone (including text if participant approved) to ensure completion of the baseline survey.

NEDA has a publicly available screen for ED symptoms on their website. For eligible participants recruited from the results page of NEDA's online screen (Recruitment Approach #3), their response ID from the NEDA screen will be piped into and included within their WUSTL screen data (assent, demographics screen) collected. The research team will have a secure login to access NEDA's de-identified online screen dataset, and will use the response IDs gathered in the WUSTL screen dataset to pull NEDA ED symptom screening data for only those who have assented to the study. Accessing and analyzing NEDA screen data has been approved for members of the research team in previous studies (Dr. Fitzsimmons-Craft: IRB# 201707076).

Enrollment: Confirmed participants who have completed their baseline survey will then be randomized and will be sent an email with their study group assignment, the timeline of study follow up activities, additional information on how to download the app and/or the social networking feature. The research team will continue to follow up with participants via email and phone (including through text messaging) throughout the study for completion of study activities and follow-up surveys. An optional introductory phone call with in-app coaches will be offered to participants as well, and this call will use a secure Zoom phone number generated specifically for each meeting.

In this RCT, participants will be randomized into one of three conditions:

1) Intervention A: Full mobile app with social networking component
2) Intervention B: Full mobile app without social networking component
3) Control: Self-help version of the app and referral to nationwide resources

It will not be possible to blind participants to group assignment due to the nature of the intervention. Blinding the assessment of outcomes measures is not needed, because all assessments will be completed by self-report via secure online surveys; therefore, there is no chance for interviewer bias.

2.d Risks and Benefits

Potential Risks
The potential risks to respondents from participating in this study are unlikely and low risk. The mobile app, online questionnaires, and interviews will be confidential.

Teens participating in this study will be recruited from social media (i.e., Instagram, Facebook, Snapchat, TikTok, Reddit, YouTube). Participants are provided crisis line information and nationwide ED resources within the assent document and also receive this crisis resource information within their SilverCloud app invite. If there is any concern for a participant's safety during conversations with the in-app coach or posts on the social networking component, participants will be provided with this list of nationwide resources via email and encouraged to reach out to their parents or healthcare professional. If a teen marks "Yes" on questions assessing lifetime suicidal ideation in their baseline or follow up survey, they will also automatically receive this crisis line and ED resource information at the end of their Qualtrics survey:

Your responses indicate that you may currently be experiencing a high level of psychological distress, and we are concerned about whether you are receiving the support you may need. We strongly suggest you consider reaching out to the resources below if you feel you need additional support at this time:

National Suicide Prevention Lifeline
Phone: 1.800.273-TALK (8255)
Website: http://www.suicidepreventionlifeline.org

National Eating Disorders Association Helpline
Phone: 800.931.2237 (available Monday through Thursday, 9am-9pm, Friday 9am-5pm ET)
Online chat: http://www.nationaleatingdisorders.org/helplinechat

NAMI Helpline
Phone: 1-800-950-NAMI (6264) (available Monday through Friday, 10 am–8 p.m ET)
Online chat: https://www.nami.org/help (click "Chat with us")

Crisis Text Line (text HOME to 741741)

Participants indicating lifetime use of prescription medication or illicit drugs within surveys willalso be provided with a list of nationwide resources within their Qualtrics Survey:

If you are struggling with misuse of these substances, we strongly suggest that you consider reaching out to these resources for support.

The Recovery Village: https://www.therecoveryvillage.com/teen-addiction/related/hotlines/

Substance Abuse and Mental Health Services Administration: https://www.samhsa.gov/find-help/national-helpline

National Drug Helpline: https://drughelpline.org/teens/

Further, if a participant's symptoms levels have not improve relative to baseline at the 6 week mark of the study, they will be provided an in-app message encouraging them to seek in-person

support for their eating disorder symptoms, and will be provided a list of nationwide resources in addition to continuing with the current mHealth intervention.

Participation in all aspects of the study will be on a volunteer basis; participants will have the right to refuse answering and/or taking part in particular aspects of the study, and they will be told of their right to refuse and/or withdraw from this study at any time. Participants will also be instructed of the risks and benefits of their participation in the research and of all the procedures to be followed in case of adverse events. These details will be outlined for to participants in age-appropriate language during the informed assent process.

Potential Benefits
The mHealth intervention in this study aims to educate and motivate TwEDs toward improved ED-related behaviors and outcomes. We expect that after engaging with this intervention, participants may have reduced ED symptoms, improved quality of life, increased uptake of care, and improved behaviors related to targets that are associated with outcomes. Additionally, there are important potential benefits to the medical community seeking to improve eating disorder treatment and its outcomes. Our findings would help to demonstrate whether this intervention has the potential to be a beneficial tool for TwEDs, and could help to bridge the gap for teens who are not yet engaged with in-person treatment interventions.

2.e Early Withdrawal of Subjects

Participants will be able to stop participating in the study at any time. If a participant chooses to withdraw from the study, they will be provided with a list of resources, they will no longer have access to the app or social networking group, and they will only be compensated for study activities completed.

2.f When and How to Withdraw Subjects

Participants may be discharged from the study based on PI discretion to ensure participant safety or the scientific rigor of the study. In the case of an adverse event (detailed below), the research team could determine that it is no longer safe for a participant to continue in the study, the research team will inform both the participant that they are being removed from the study and additional resources/referrals will be provided.

2.g Data Collection and Follow-up for Withdrawn Subjects

In the event that a participant withdraws from the study, there will be no further data collection or follow-up.

D3 mHealth Intervention

3.a Description

The mHealth intervention in this study will consist of several features designed to support TwEDs, including interactive CBT-based units, personalized coaching, a social networking feature, and machine learning detection to respond quickly to recovery setbacks. It will also include general tools to promote healthy eating behaviors, such as meal tracking and goal setting tools.

CBT-based Units: The mobile app (hosted by SilverCloud Health) delivers information in short 5-10 minute sessions that are aimed to meet the clinical and developmental needs of teens with eating disorders. Content includes information on relationship wellness, coping strategies,

identifying negative thought patterns, engaging safely with media/social media, health and body wellness, meal planning, and more in an interactive and engaging format (e.g., text, videos, fill-in and short answer tools). This information is "front-loaded" so that key targets are addressed within the initial units, and reinforced and expanded upon in later units. Additional content on managing stress and anxiety is available within the program to be unlocked by in-app coaches based on participant assessments and communications within the app.

Personalized coaching: Within the in-app messaging feature, participants will be encouraged to directly communicate with a coach. Dr. Cavazos, a licensed psychologist and PI of this study, will oversee members of the research team directly involved with coaching participants. Coaches will support participants as they engage with this guided self-help program, which has been shown to be effective in online cognitive-behavioral interventions[28-30].This model is especially conducive to digital therapeutics because it allows for flexibility in tailoring interactions and encourages an empathetic social listening style while soliciting individuals to reflect on their unique reasons for behavior change.

Social Networking Component: The social networking component will be a private Instagram account page run moderated by the research team. The research team will post content to the Instagram account (e.g., discussion questions, inspirational quotes, graphics related to the mobile app content) and the study participants will have the opportunity to network with each other in the comment sections. As moderators, the research team's roles include providing support and guidance for the group discussion, promoting support among group members, keeping the discussion on topic, and removing potentially unhelpful comments. The overall goal of moderation of the social media feature is to create a supportive environment where users can receive the necessary support to make changes in their own lives, as well as support others in similar circumstances. Study participants will be asked for their Instagram usernames in the baseline survey. Those assigned to the intervention condition including this social networking component will be provided the Instagram username of the private account for the study along with a direct link to the profile and then asked to submit a follow request. If participants in this intervention condition do not have an Instagram account, they will be asked to create one to access this intervention feature, and then contact the research team with their new username. The research team will verify that the Instagram usernames in the follow request queue match those provided by participants assigned to this intervention condition so that only these participants can view and interact with the account. All follow requests unaffiliated with this intervention condition will be denied. Participants will be encouraged to put the Instagram accounts that they are using for the study on private.

3.b Treatment Regimen

Participants will have access to the mobile app and social networking feature 3 months in the RCT, depending on randomize group assignment (see above). They will be encouraged to use all app and social networking group features during this time.

3.c Administration of the mHealth Intervention

After completing the baseline assessment, participants will be given access and provided with instructions on how to download the mobile app via email (email will come from host site SilverCloud) and with instructions on how to request to follow the private Instagram account for social networking on this platform during the study.

3.d Technical Development of the mHealth Intervention

SilverCloud is a mobile health development company that has developed a digital platform comprised of proprietary software in communication with an online database that works to enable behavioral health providers to deliver digital content and interact with their clients. SilverCloud has a proven track record of working successfully with various mental health organizations and has partnered with our research team to develop the current mobile app tailored for teens.

E Study Procedures

E1 Screening for Eligibility

Advertisements will be placed on social media (i.e., Instagram, Facebook, Snapchat, TikTok, Reddit, YouTube). When a teen clicks on one of these ads, they will be routed to an online assent and a screening survey (Stanford-Washington eating Disorder Screen (SWED)). Based on their responses, participants will be notified automatically about their general eligibility and asked to confirm their willingness to participate in the study by provision of contact information (name, email, phone number). Their screen responses will the be manually reviewed for validity by the research team, who will send the participant email confirmation of their eligibility and their personalized link to the baseline survey. Those who do not complete their baseline survey will not be randomized into the intervention.

E2 Schedule of Measurements

RCT: Table 1 lists the assessments to be collected during the RCT (see also IRB attachment detailing data points to be collected). Participants will be assessed at baseline, 6 weeks post-randomization, 3 months post-randomization (end of intervention period), and 6 months post-randomization (i.e., 3 months after the intervention period ends) using secure online surveys. Data automatically captured within the app platform will also be used to calculate a composite measure of app engagement. At the end of the intervention period, we will quantitatively and qualitatively assess TwED's perspectives on feasibility and acceptability of additional intervention components or adaptations needed.

Table 1. Assessments	Baseline	6 wks (mid-INT)	3 mos (end of INT)	6 mos (3 mos post-INT)	Primary purpose+
Demographics	√				Mod
Expectancy/credibility	√				Mod
Eating disorder symptoms	√	√	√	√	TO/Mod
Eating disorder chronicity	√				Mod
Anxiety and depression	√		√	√	Mod
Impairment/quality of life	√		√	√	TO
Motivation for treatment	√	√	√	√	Mod
Utilization and uptake of care	√	√	√	√	TO
Target engagement: restraint; weight/shape concerns	√	√			Med
Perception of app usability (INT condition)			√		Pred
Perception of parental involvement (INT condition)			√		N/A
Txt process					
Engagement with app	automatically captured in INT condition				Pred

+ Mod = moderator; TO = TXT outcome; Med = mediator; Pred = predictor

E3 Safety and Adverse Events

3.a Safety and Compliance Monitoring

We go to great lengths to protect the confidentiality of our subjects and are especially sensitive to data regarding disordered eating behaviors and mental health-related concerns among a particularly vulnerable population.

Participant safety: Dr. Cavazos (PI) and Dr. Fitzsimmons-Craft will closely monitor all coaching interactions with participants. As licensed clinical psychologists they are well qualified for this role and will work to ensure participant safety during this study.

Emotional discomfort: Participants who report discomfort as a result of participation will be reminded that their participation is voluntary. They can refuse to answer any questions that they are not comfortable with, or discontinue app use or survey assessments/interview at any time.

HIPAA compliance: All project staff will have fulfilled Washington University's mandatory HIPAA training requirements. All aspects of the protocol and study implementation will meet the HIPAA requirements specified by the Human Studies Committee and the Privacy Office at Washington University.

3.b Definitions of Adverse Events

Because the online intervention follows standard practice guidelines that have been used in research trials without significant adverse events, we do not anticipate any significant adverse events. However, coaches will be trained to monitor for adverse events, including Serious Adverse Events (SAEs) such as deaths, hospitalizations, and life threatening events and will report any potential adverse events immediately upon their identification to the PI. We will also monitor for adverse events at all follow-up assessments and via all other communication with study participants. Any potentially adverse events will be evaluated by the PIs within 72 hours.
Data Collection Procedures for Adverse Events
Adverse event assessment, recording, reporting and investigation will be accomplished through structured/standardized assessments and self-reported information provided in the in-app coaching feature.

3.c Reporting Procedures

The PI has ultimate responsibility for ensuring that AEs are detected and reported in a timely manner. AEs will be reported to the IRB in accordance with the IRB's policy.

3.d Adverse Event Reporting Period

A safety report will be generated monthly. Any AEs will be reported directly to the PI. As required by the Washington University IRB, the PI will subsequently report in accordance with the IRB's policy.

E4 Study Outcome Measurements and Ascertainment

Quantitative measurements: ED symptoms, quality of life, uptake of care, and other treatment outcomes as well as social media/technology use will be assessed via self-report surveys using Qualtrics during the RCT at baseline, at 6 weeks post randomization, at 3 months post randomization, and at 6 months post randomization. App usability will also be assessed via self-report in this way. Qualtrics is a secure, web-based application designed to support data capture for research studies. Surveys will be formatted for use on either a computer or a mobile device. Branching logic will be incorporated into the survey for measures based on participant demographics (i.e., measures applicable for gender/sexual minority groups). We will also collect short weekly in-app assessments on eating disorder symptoms, anxiety, and depression to track patient progress and to tailor support provided by in-app coaches.

Engagement with the mobile app (e.g., number of times logged in, time spent in the app, time difference between app log-ins, and number of interactions with the coach) is automatically collected within the app platform (SilverCloud). Number of likes, comments, and story engagements on Instagram intervention component will also be collected.

We will also ask participants to provide social media usernames for various platforms to allow the research team to examine and better understand risk factors and themes related to eating disorder symptoms and recovery among teens and the impact of social media. This data will be analyzed using both qualitative human coding as well as machine learning techniques.

F Statistical Plan

F1 Sample Size Determination and Power

The primary purpose of the initial study is intervention feasibility, while the primary purpose for the RCT is to test intervention efficacy. We pilot tested the mHealth intervention with 45 participants, and will complete the current RCT with 165 participants; these sample size is feasible to recruit from social media, is within the range of samples sizes for other pilot tests of digital therapeutics,[31-37] and is sufficient for data saturation for qualitative interviews.[38]

F2 Interim Monitoring and Early Stopping

Data that are reviewed at the routine monitoring meetings include the number and type of participants enrolled, that all subjects meet eligibility criteria, the number and reasons for exclusions from enrollment, drop-outs and any protocol deviations, the number of participants using the app, and that the study is following the IRB-approved protocol. A summary of adverse events (AE) and an individual review of serious adverse events (SAE) will also occur in real-time

as they happen and at these routine monitoring meetings. AEs or SAEs that raise concerns will be immediately reported to the PI, who will determine an appropriate course of action.

Because the online interventions follow standard practice guidelines that have been used in research trials without significant adverse events, we do not anticipate any significant adverse events. However, coaches will be trained to monitor for adverse events, including Serious Adverse Events (SAEs) such as deaths, hospitalizations, and life threatening events and Unanticipated Problems (UPs), and will report any potential adverse events immediately upon their identification to the PI. We will also monitor for adverse events at all follow-up assessments and via all other communication with study participants.

F3 Analysis Plan

Quantitative assessments will be recorded using Qualtrics online survey tool. Qualtrics is a secure, web-based application designed to support data capture for research studies. The data will be exported from Qualtrics and imported into SAS Windows version 9.4 for analyses. App usability will be examined using descriptive measures (mean, standard deviation, median, range) on the efficiency, technical effectiveness, and satisfaction components of the USE questionnaire. Descriptive statistics will also be used to describe engagement with the app (e.g., median number of log-ins, time spent in the app, number of interactions with the coach, etc.), as well as the characteristics of our patient sample (demographics, mental health and eating disorder symptoms). Generalized linear mixed models will be used intervention effects in outcomes are observed at 3 months post-randomization and whether the obtained treatment effect is sustained during subsequent follow-up (6 months post-randomization). Effect sizes and 95% confidence intervals will be reported. We will also use moderated mediation analysis to examine whether clinical targets (i.e., reduced dietary restraint and reduced weight/shape concern) affect outcomes of interest (ED symptom severity, quality of life), and whether these effects differ by intervention group.

Transcripts from interviews will be collected to assist with qualitative data management and coding. Inductive thematic analyses will be conducted by two research team members using the six steps described by Braun and Clarke[39] (getting familiar with the data, creating initial codes, looking for themes, reviewing and refining themes, defining and naming themes, producing the report). Other pilot studies of apps have used a similar approach to analyze the qualitative discussion of app content and/or user experience.[32,33] Feedback from the qualitative interviews will help to refine app format, content, and coaching for future studies.

G Data Handling and Record Keeping

G1 Confidentiality and Security

All surveys will be completed on the secured survey platform Qualtrics. Survey data will be directly downloaded onto a protected server. SilverCloud will also receive the email address of the participants in order to send them an automatic email to sign-up for the program and assist with password resets.

SilverCloud will host the mobile app and all data collected within the app. SilverCloud has partnered with many health care providers to aid in mental health recovery, has been reviewed by Washington University WU IT security, has been approved for other studies, and is HIPAA compliant.

Study data will be kept on secure, password-protected servers, with identifying information always kept separate from other study data (such as assessment responses). The data will only be accessible at any given time to the small number of study team members who need to use the data at that time.

G2 Training

Dr. Cavazos (PI) and Dr. Fitzsimmons-Craft will be responsible for managing and overseeing the individuals involved with coaching participants in this study. Both Dr. Cavazos and Dr. Fitzsimmons-Craft have years of experience working with individuals mental health concerns, including eating disorders.

G3 Source Documents

All interviews will be recorded and transcribed verbatim. Transcripts will be removed of all identifiers and only labeled with the Participant's ID number.

All other participant assessments will occur online using Qualtrics.

G4 Records Retention

All participant records are stored on a password protected server that is managed by Washington University School of Medicine. Only research team members listed on the IRB-approved team will have access to study materials. These materials will be stored for at least three years as required by the IRB.

H Study Administration

H1 Organization and Participating Centers

All study activities will take place at Washington University School of Medicine.

H2 Funding Source and Conflicts of Interest

This study is funded by the National Institute of Mental Health (NIMH). There are no conflicts of interest to declare.

H3 Subject Stipends or Payments

During the pilot study, participants were paid $20 in Amazon e-gift cards for the baseline survey, $20 for the 2 month survey, and $30 for completing the 2 month qualitative interview. During the RCT, participants will be incentivized with Amazon gift cards of $20 for the baseline assessment, $20 for the 6-week assessments, $30 for the 3-month assessment, and $20 for the 6-month assessment.

H4 Study Timetable

The general proposed timeline for the study is as follows:

Year 1

- Adapt mobile app content for teens and develop social networking and machine learning components

- SilverCloud Updates and Tests new mobile app content and features
- Enroll 45 participants from social media (i.e., Instagram, Facebook, Snapchat, TikTok, Reddit, YouTube)
- Pilot test mHealth intervention
- Gather feedback and analyze data

Year 2-3

- Update mHealth intervention and recruitment methods based on pilot study
- Recruit 165 participants from Social Media
- RCT of mHealth intervention experimental groups versus control
- Gather feedback and analyze data

I Publication Plan

The work proposed in study will support the development of a sustainable, accessible, low-cost digital therapy tool that could be disseminated widely to support and motivate ED recovery. We are also enthusiastic about the potential for our study findings to alter public health practices by catalyzing the use of social media to educate and engage teens with mental health problems who are a subpopulation that is often in critical need but tend to be challenged by numerous barriers to treatment. Our approach to disseminate study findings to scientific and practice stakeholders will be through manuscripts, presentations, lay reports, and a website. All participant information will be de-identified in publications developed. The research team will follow the NIH Guidelines with a plan to disseminate this clinical trial information. We will register and submit the study aims, design, eligibility, and methods for this trial to ClinicalTrials.gov as outlined in NIH policy. Informed assent document for the clinical trial include a specific statement relating to posting of clinical trial information at ClinicalTrials.gov.

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