Transdiagnostic digital mental health interventions for youth and young adults: approaches to effectiveness and implementation

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Abstract

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This dissertation is composed of three studies that broadly examine transdiagnostic digital mental health interventions designed to improve symptoms of common mental disorders among youth and young adults. The first study (Aim 1) systematically reviews the existing published literature to comprehensively catalogue and characterize transdiagnostic digital mental health interventions (DMHIs) for youth and young adults ages 13-25 in the United States. it examines the core components, delivery modality, clinical tools, and focal outcomes of the identified DMHIs, as well as the characteristics of the studies used to evaluate the interventions and any included implementation components. The second study (Aim 2) uses

Human Centered Design methods to adapt a WHO-developed DMHI called STARS (Sustainable Technology for Adolescents to Reduce Stress) for use among youth and young adults from immigrant and refugee families in Seattle. The third study (Aim 3) conducts a mixed method pilot test of the adapted STARS intervention among immigrant and refugee youth across the United States.

In Aim 1 we evaluated nine studies: the most common intervention components were modular or session-based delivery formats, elements of cognitive behavioral therapy as clinical tools, and symptoms of depression and anxiety as focal outcomes. Seven of the nine included studies contained an implementation component, most commonly to assess feasibility and/or acceptability of the intervention. The limited studies identified in the review shows the dearth of research about DMHIs for youth and young adults, despite the wide availability of mental health related apps and online programs.

In Aim 2 we used Human Centered Design methods to engage the intended end user in the adaptation process for the intervention. We modified the STARS intervention in three iterative cycles with 3-5 participants each. Major modifications included updating language to increase salience and familiarity to participants and reduce the resemblance to digital scams; adding non-text media including emojis, GIFs, and audio; and adding elements of choice so the user can select content that they believe is most relevant.

In Aim 3 we conducted a pre-post study among immigrant and refugee youth ages 14-25 in the US to evaluate the usability and preliminary clinical effectiveness of the adapted STARS intervention. Participants were evaluated for measures of intervention use and symptom severity of common mental disorders; a subset of participants also took part in qualitative

interviews that assessed barriers and facilitators to uptake and engagement with the intervention. Results included 129 participants from 53 countries of origin with a mean age of 17.9 (SD = 11.4) and generally high mental distress symptom scores at baseline. Participants completed an average of 7 out of ten sessions (SD = 3.9). Facilitators included the length of the intervention, personalized content, and mixed media. Barriers included time constraints, technical problems, and personal preference.

This dissertation informs the rapidly growing field of digital mental health, which can be especially relevant for underserved and hard to reach populations like youth and immigrant/refugee communities.

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Chapter 1: Introduction

Introduction

Mental health among youth and young adults in the United States is a great concern. Since the onset of the COVID-19 pandemic in 2020, the proportion of emergency department visits for mental health among youth ages 12-17 rose 31% compared to 2019[1]. Now, almost 3 years into the pandemic, evidence shows increased prevalence of depression and anxiety and a general deterioration of the mental health of youth and young adults over time[2]. Longitudinal studies suggest there could be long-term effects on youth mental health, and that these affects could be more pronounced among vulnerable youth[3], such as those who face increased barriers to care.

While mental health is a complex problem and handling the fallout from the COVID-19 pandemic will need to be multifaceted, digital mental health interventions (DMHIs) show promise as a part of the solution. DMIS can include apps that are downloaded on a phone or tablet, websites that provide information and/or facilitate communication, game-based interventions that focus on skill building or education, or other formats[4]. They can provide the advantages of being low cost, easily accessible, and anonymous[4], which make them suitable for reaching populations who may be unable or reluctant to engage with in-person mental healthcare. DMHIs may also be useful for detecting mental disorders early, monitoring symptom changes over time, and connecting people to further care. Transdiagnostic DMHIs, which focus on symptoms that may crosscut or be subthreshold to diagnostic categories instead of focusing on symptoms of any specific disorder, have the added benefit of an even broader reach.

Several systematic reviews about DMHIs have shown their effectiveness in treating common mental disorders like anxiety and depression[5–7]. Most studies of DMHIs assess them among adults, however, and few focus on their clinical effectiveness specifically for youth, nor for other populations that face barriers to mental healthcare, nor on transdiagnostic DMHIs specifically. Further, a substantial divide exists between mental health-related content that is *available* and evidence-based DMHIs that are *useful and effective*. More than 10,000 mental health apps were available for download in 2019[8], but few are supported by research or have an established evidence base. Among DMHIs that are developed to use evidence-based techniques, few have been successfully implemented into clinical settings or are widely used by public audiences.

There is a need for research that evaluates what transdiagnostic DMHIs exist for youth and young adults and quantifies the elements of these interventions that may contribute to clinical effectiveness and/or use by their intended focal audience. Additionally, there is a need for research that rigorously examines transdiagnostic DMHIs for effectiveness in alleviating symptoms of mental distress among youth and young people, especially those from vulnerable groups. Further, there is a need for implementation research to better understand the components of DMHIs that facilitate use by the intended audience, as well as techniques to connect these interventions with this audience. This work seeks to contribute to these topics in the following three chapters.

Chapter two, 'Transdiagnostic digital mental health interventions for youth and adolescents globally: a systematic review', is a systematic review of transdiagnostic DMHIs for youth and young adults. It fills in gaps in the literature about transdiagnostic DMHIs for youth

by characterizing the research that has been done on these interventions as well as by classifying aspects of these interventions. These classifications can be useful for identifying components of transdiagnostic DMHIs that are both clinically effective and that facilitate engagement with the intervention by the focal audience. This study also establishes the knowledgebase that sets the stage for chapters three and four in which we adapt and pilot test a transdiagnostic DMHI for use among immigrant and refugee youth.

Chapter three, 'Adapting a transdiagnostic digital mental health intervention for use among immigrant and refugee youth in Seattle: a human centered design approach', adapts a transdiagnostic digital intervention, called STARS (Sustainable Technology for Adolescents to Reduce Stress), from its original context in low- and middle-income countries for use among immigrant and refugee youth in Seattle. The study uses human centered design techniques to maximize relevance to its intended end users. The findings of this study can inform those looking to develop DMHIs in a way that actively engages the communities they are intending to benefit during the development process. It also contributes to the implementation literature on adaptation studies, as it employs the FRAME framework[9] to systematically document and justify intervention modifications.

Chapter four, 'Pilot testing a digital transdiagnostic mental health intervention for use among immigrant and refugee youth in the US: a mixed methods evaluation of clinical and implementation outcomes', pilot tests the adapted version of the STARS intervention among a national sample of youth and young adults from immigrant and refugee communities. It uses qualitative and quantitative techniques to assess preliminary clinical effectiveness as well as barriers and facilitators to uptake and engagement with the intervention. The findings of this

research will be one of few examples in the literature of studies of DMHIs that employ an implementation component to assess ways to reach and engage the intended end user.

Together, this work is designed to contribute evidence to the rapidly growing field of digital mental health. It is especially focused on youth and young adults as well as immigrant and refugee communities. These populations have high burdens of mental disorders and face barriers to care, both of which have been exacerbated by the COVID-19 pandemic, but have little research on digital mental health focused on addressing these issues.

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Chapter 2: Transdiagnostic digital mental health interventions for youth and adolescents globally: a systematic review

Title page

Transdiagnostic digital mental health interventions for youth and adolescents globally: a systematic review

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Abstract

Introduction

This systematic review sought to identify and assess the existing evidence for transdiagnostic (i.e., not specific to one diagnostic category) digital mental health interventions (DMHIs) available globally for youth and young adults.

Methods

A systematic search was conducted for all transdiagnostic digital mental health interventions for youth and young adults. The review considered all peer-reviewed studies about transdiagnostic digital mental health interventions for youth and young adults between the ages of 13 and 25.

Results

Nine studies met inclusion criteria and were assessed in the final review. Common delivery characteristics of interventions included a modular or session-based format (n = 5, 56%); of these, all used a website (n = 3, 60%) or mobile app (n = 2, 40%) interface. Components of cognitive behavioral therapy were the most prevalent clinical therapy (n = 7, 78%). Interventions focused on measuring symptom change for anxiety and depression (n = 8, 89%), general distress/psychopathology (n = 3, 33%), and sleep-related outcomes (n = 2, 22%). All studies reported preliminary effectiveness of interventions on primary outcome measures, though study design varied. Seven studies (78%) evaluated implementation outcomes of the intervention. Of these, most assessed feasibility and/or acceptability of the intervention (n = 7, 100% and n = 5, 71%, respectively).

Discussion

Few studies have been published about transdiagnostic DMHIs for youth and young adults or the implementation challenges of these interventions. Opportunities exist for rigorous implementation research to meaningfully facilitate the transition of DMHIs from research-based trials to widespread public or clinic-based availability.

Introduction

Mental health is an urgent concern, especially among youth and young adults. A 2021 UNICEF report called attention to this crisis, highlighting the toll of the COVID-19 pandemic and calling it 'merely the tip of the iceberg' of poor mental health in this demographic[1]. Common mental disorders like anxiety and depression affect an estimated 31% of adolescents globally[2]. Onset of psychopathology symptoms in youth can precede a pattern of chronic and severe psychosocial problems thereafter, highlighting the critical importance of early and effective intervention for reducing the likelihood of lifelong challenges[3,4]. However, young people face barriers to care, including lack of overall mental health services[5–7] and stigma, shame, and embarrassment associated with mental health issues[5,7–10]. Perhaps due to these barriers, help-seeking behavior among youth is low: in a Norwegian survey, only half of clinically depressed 15-year-olds had ever received mental healthcare[11], and in general only 18-34% of youth and adolescents experiencing symptoms of depression and anxiety seek professional help[12]. This aligns with trends in generally moderate health-seeking behavior among adults and children[12].

Digital mental health interventions (DMHIs) have promise for addressing many barriers to mental healthcare, especially among youth and young adults who have symptoms of distress or may be at risk for developing mental disorders. Among increasingly digitally literate adolescents, DMHIs have the advantages of anonymity, accessibility, low cost, and relevance to their lived experience[10]. These digital interventions can take the form of apps, website-based interventions, games, text-message based interventions, and others[10] and frequently use evidence-based psychological techniques to reduce symptoms of mental distress[13]. While

considerable heterogeneity exists regarding the format, content, and delivery of DMHIs, systematic reviews and meta-analyses of DMHIs among adults suggest modest effectiveness in treating depression and anxiety[13–15] and improving psychological well-being[15]. Few of these analyses, however, have evaluated these outcomes among youth specifically, nor across a diversity of settings and populations[16], despite the purported extensive applicability of DMHIs. More evidence is needed to quantify and evaluate the role of transdiagnostic interventions in DMHI research.

Implementation of evidence based DMHIs into settings in which they can reach their intended audience is advantageous in addressing gaps in mental healthcare delivery. Challenges include identification and access to DMHIs as well as integration into clinical care settings. While a multitude of DMHIs exist, many come in the form of commercially available smartphone applications (apps) with little to no evidence base for their effectiveness in reducing symptoms of mental distress among users[17]**.** A 2019 article estimated more than 10,000 mental health apps were available for download[18], but understanding which of these are evidence-based DMHIs is difficult. Further, downloadable apps may require a fee for download and/or a subscription for use, both of which are monetary barriers to access. Public availability and free access to evidence based DMHIs with known effectiveness is key to implementation. Among DMHIs that have documented effectiveness through research, few examples exist of successful implementation into clinical settings as part of routine care from providers. More research is needed to understand which DMHIs could benefit clinic-based patient care and how these interventions can be integrated into care settings. Other barriers to implementation include

technological issues. The time needed to conduct effectiveness research can mean that interventions rely on technology that has become outdated or obsolete before they are released[17]. This may include issues with integration of the technology used in the research with the newest, up to date versions during implementation, as well as challenges that users may encounter if interacting with an outdated intervention design. Technical issues like unexpected glitches, slowdowns, or crashes are often cited as major barriers to use[19], so uptake and engagement may be negatively affected. Uptake and engagement of publicly available DMHIs vary considerably; interventions with the most engagement still see fewer than 1/3 of users finish all intervention components, and some interventions see less than 0.5% of those who download or start the intervention complete al components[20]. Further, uptake of and engagement with DMHIs in public or clinic-based settings often varies from uptake and engagement reported in clinical trials[20].

Consistent with modern frameworks situating components of psychopathology on a set of related dimensional continua (e.g., Hierarchical Taxonomy of Psychopathology[21,22] and Research Domain Criteria[23,24]), transdiagnostic interventions are designed to target multiple symptom spectra rather than specific diagnostic categories. Using this framework, DMHIs address a broader array of both transdiagnostic processes, subthreshold distress, and symptoms clustering across diagnostic categories rather than being limited to those typical of a single syndrome. In DMHIs, this approach can facilitate interventions that are relevant to more users and that can address the heterogeneity of symptom presentation and the frequent comorbidity of psychiatric disorders. For instance, DMHIs may be especially useful in cases in

which a person experiences a range of distress symptoms and does not have access to a provider who could provide specialized treatment. They (DMHIs) may also be helpful situations in which a person experiences subclinical symptoms of multiple disorders but does not meet the full criteria for a single disorder; the intervention can address this clinically relevant distress. Further, many DMHIs that aim to deliver results to diverse and populations at scale will likely need to be transdiagnostic to address the range of symptomatology present among these populations. Despite the importance of this approach for broadening care, no comprehensive compilation of information regarding transdiagnostic digital mental health interventions is available for young people.

The present review systematically extracts and summarizes evidence on transdiagnostic DMHIs designed for young people. We specifically provide a description of the nature of these interventions, their core components, clinical tools, delivery modality and format, populations of interest, and clinical effectiveness. The systematic review also sought to describe implementation considerations for deployment in a real-world, non-trial settings, including the delivery modality (i.e., publicly available for download for individual use, part of clinic-based care, etc.) as well as barriers and facilitators to implementation.

Methods

Protocol, registration, and reporting guidelines

This project is registered in the International Prospective Register of Systematic Reviews (PROSPERO) under record ID CRD42022289294 with the title “Transdiagnostic digital mental

health interventions for young people: a systematic review". We followed the PRISMA 2020 checklist[25] for reporting for transparency and structure.

Search strategy

The primary author (KEF) conducted our review via an online search for peer-reviewed literature through the databases Embase, PubMed/MEDLINE, Web of Science, and all CINHAL databases, including PsychINFO. The review included any study types from any date that were published in English or included an English translation. Our search terms (applied to all fields including title, abstract, keywords, etc.) were: transdiagnos* AND (digital OR online OR internet OR smartphone OR app OR mobile application OR chatbot OR chat-bot OR cell phone OR "mobile phone*" OR tablet OR tablets OR computer OR mhealth OR ehealth OR "artificial intelligence") AND (mental OR psycholog* OR "mental health" OR stress OR mental illness OR mental disorder OR wellbeing OR well-being OR behavior*) AND (intervention OR treatment OR therapy) AND (youth OR adolescent* OR "young adult" OR teen* OR "young women" OR "young men"). Searches were performed on November 3, 2021.

Identified literature was independently reviewed by KEF and MT for inclusion in both the title and abstract review as well as the full text review to reduce the risk of bias in reporting. Studies were assessed on the basis of inclusion and exclusion criteria and disagreements were resolved through a discussion with both reviewers.

Eligibility criteria

This review considered all peer-reviewed studies that involve participants between the ages of 13 and 25, regardless of mental health treatment history. Interventions of interest include those that primarily utilize digital technologies, including: smartphone/tablet/computer applications, text/SMS, web or internet-based services (e.g., websites). Interventions described must be transdiagnostic (i.e., intended to address either multiple categorized conditions like anxiety AND depression or a spectrum of symptoms associated with mental distress rather than one condition). All studies (including preprints) that met these criteria were included, irrespective of measurement type and outcomes included. Because digital interventions are a relatively new phenomenon that are predicated on internet and/or computer accessibility, all date ranges were included. All studies related to digital interventions focused on improving mental health were considered, including exploratory/pilot studies, experimental studies, and observational studies. Excluded article types were reviews, editorials, clinical trial protocols, systematic reviews, meta-analyses, scoping reviews, or narrative reviews.

Studies reporting partial overlap with our population of interest (between the ages of 13 and 25) were included if either of the following criteria were met: 1. they included information about the intervention that specifically mentioned youth/adolescents/teens/young adults as a focal population; or 2. they included an analysis on a subset of data that focused the effectiveness of the intervention on youth/adolescents/teens/young adults. Studies were excluded if the overlap with our focal population was deemed incidental by both reviewers, i.e., studies about interventions targeting adults that included participants ages 18 and older.

Both reviewers used Rayyan software[26] to keep track of included and excluded studies at all stages of review. Rayyan software includes a feature that allows blinded, independent assessment of studies by multiple users.

Data abstraction

Following full-text review, data were abstracted from included studies independently by both reviewers. Reviewers extracted data based on a pre-defined template that included authors, year of publication, country in which the study took place, name of the intervention, intervention components (i.e., online modules, face-to-face sessions with providers, etc. as well as the length and duration of these components; any additional elements such as offline tasks), clinical tools (i.e., CBT and what components of CBT were utilized, mindfulness, etc.), delivery modality of the intervention (i.e., self-guided and/or clinician-guided, etc.), focal population, study type, outcomes measured, clinical effectiveness of primary outcomes, and sustainment of outcomes (i.e., follow-up sessions or measures, etc.). Data abstraction categories are in Table 2. Reviewers also used a second pre-defined template for identifying and extracting information from studies that included an intervention component. This template included authors, year of publication, implementation environment (i.e., clinical trial, pilot study), and implementation outcomes (i.e., feasibility, satisfaction). Implementation outcomes were coded according to Proctor's implementation outcomes framework[27]. After independent abstraction of full-text articles, reviewers compared all information abstracted and discussed and re-read full texts when necessary to resolve conflicts.

Results

Initial search returned 199 results. Removing duplicates led to the exclusion of 84 articles, resulting in 115 records. Title and abstract review led to exclusion of 88 additional results for a total of 27 to be reviewed in full text. Full text review led to exclusion of 18 results and yielded 9 studies to be included in final data abstraction and review. Most studies excluded during full-text review were excluded because of the study population; studies that specified a population of adults or 18+ in the abstract were further reviewed for any evidence of a focus on young adults rather than a generalized focus on all adults. Detailed information for included studies can be found in Table 2.

Characteristics of studies included

Nine results included 3 (33%) studies that took place in Australia[28–30], two (22%) in the United States[31,32], and one (11%) each from England[33], the Netherlands[34], Canada[35], and Spain[36]. The earliest study was from 2014 and the most recent was from 2021. Two study designs were randomized controlled trials (22%), two were retrospective comparisons between two previous trials (22%), one was an uncontrolled longitudinal design (11%), and four were uncontrolled pilot studies (44%).

Characteristics of participants

Studies included focal populations of youth and young adult participants. Across the 8 studies reporting age for participants, mean ages ranged from 9.5 to 21.5 years old. Heterogeneous

populations were sampled across studies with selection criteria covering community and/or university samples (n=4, 44%), depression and/or anxiety symptoms (n=4, 44%), misophonia (n=1, 11%), sleep problems (n=1, 11%), and autism spectrum disorder and ADHD symptoms (n=1, 11%).

Characteristics of interventions

Across 9 included studies, 5 (56%) studies evaluated unique interventions: Personality and Living of University Students (PLUS)[33], Delivering Online Zzz's with Empirical Support (DOZE)[35], EMIcompass[34], Empowered Brain System[32], and BRAVE-ONLINE[30]. Two (22%) of the studies utilized the Unified Protocol for Transdiagnostic Treatment of Emotional Disorders in Children and Adolescents (UP-C/A), one of which named the intervention Aprede a Manejar tus Emociones [learn to manage your emotions] (AMTE) and the other of which referred to the intervention as the Unified Protocol for Transdiagnostic Treatment of Emotional Disorders in Children and Adolescents (UP-C/A)[31]. The remaining two (22%) studies used the Mood Mechanics Course as their intervention[28,29].

Five interventions (56%) across seven studies (Mood Mechanics Course, PLUS, EMIcompass, UP-C/A [via AMTE in one study and via UP-C/A in the other], BRAVE-ONLINE) took a modular or session-based format in which participants completed one session or lesson at a time that were designed to deliver psychological techniques. The UP-C/A intervention allowed for patient-centered flexibility in delivery format in which modules could contain elements and/or be completed in an order that allows participants to choose and prioritize material according to

their preferences. In all other modular and session-based interventions, all participants completed the same modules or sessions in the same order. Durations of modular interventions varied from 4 to 10 sessions (mean = 6.3) and the durations of individual modules varied from approximately 10 minutes to approximately one hour (mean = 39 minutes). Three of the studies used a website interface for delivery (PLUS, BRAVE-ONLINE, and AMTE), two used an online mobile app (EMIcompass and DOZE), one used a smartglasses interface (Empowered Brain System), one used a telehealth platform (UP-C/A), and one intervention across two studies indicated delivery took place online but did not provide further details (Mood Mechanics Course). Four studies included some form of clinician guidance during the intervention (AMTE, EMIcompass, BRAVE-ONLINE, UP-C/A) while three were primarily or exclusively self-guided (PLUS, DOZE, Empowered Brain System). One study (Mood Mechanics Course via Staples et al. [2019]) allowed clinician contact via a phone or messaging system, but the intervention components did not include clinician guidance, and another study (Mood Mechanics course via Dear et al. [2018]) compared clinician-guided and self-guided versions of the same intervention. Clinician guidance varied from regular contact throughout the intervention and active delivery of psychotherapeutic techniques to passive support via encouragement emails and progress monitoring.

The clinical tools for 7 of the 9 studies (78%) primarily utilized cognitive behavioral therapy (CBT) techniques but tools from other modalities were included in some interventions. For example, one study (EMIcompass) was based in Compassion Focused Intervention[37] (CFI) characterized by third wave, acceptance-based CBT elements[38] while another study utilized a

communication and social skills coaching intervention (Empowered Brain System). While each study typically integrated multiple techniques within or across modalities, the two most frequently reported clinical elements of interventions were psychoeducation about the targeted symptoms (n=7, 78%) and the management of unhelpful or distorted thoughts (n=6, 67%). Other frequently utilized tools were the use of opposite action or exposure techniques to triggering situations or unpleasant emotions (n=5, 56%) and relaxation training (n=4, 44%).

Outcome measures

Interventions were designed to treat or address various primary clinical outcomes, including: anxiety and depression (n = 4, 44%; Mood Mechanics Course via Dear et al. [2018] and Staples et al. [2019], AMTE, PLUS); sleep disturbances (n = 2, 22%; DOZE and BRAVE-ONLINE); enhancing resilience (n = 1, 11%; EMIcompass); ADHD symptoms (n = 1, 11%; Empowered Brain System); misophonia (n = 1, 11%; UP-C/A). Two studies (22%; Carmona et al. [2021] via DOZE and Rauschenberg et al. [2021] via EMIcompass) had primary objectives unrelated to the clinical effectiveness of the intervention, so their secondary objectives are discussed.

The transdiagnostic nature of the interventions meant that studies measured a multitude of clinical outcomes, including and beyond primary outcome measures. Most studies (n = 8, 89%) measured depression and/or anxiety symptoms and several assessed general distress/psychopathology (n = 3, 33%) and sleep-related outcomes (n = 2, 22%). Other disorder-specific measures included psychotic symptoms, alcohol and drug use, symptoms of disordered eating, negative and positive affect, panic disorder severity, and misophonia severity. Many

studies assessed non-disorder specific outcomes such as worry, emotional avoidance, anxiety sensitivity, distress tolerance, hyperactivity, social communication, sensitivity to stress, paranoid ideation, quality of life, neuroticism, perfection, and self-esteem.

Effectiveness

Across the variety of outcomes, nine studies (100%) reported effectiveness of the intervention in reducing transdiagnostic mental health symptoms, as indicated by psychometrically validated measures. Studies did so by either demonstrating within-person reductions (n = 6, 67%) or reductions relative to a control group (n = 3, 33%). In five (56%) studies, this reduction was sustained through a follow-up period.

Six studies (67%) reported intervention effectiveness by demonstrating within-person reductions in transdiagnostic mental health measures. Carmona et al. [2021], in an uncontrolled pre-post study, reported that the DOZE intervention led to reductions in sleep-related outcomes immediately post-intervention, which was measured using the Insomnia Severity Index and the Composite Scale of Morningness. They also measured reductions in symptoms of depression via the Center for Epidemiological Studies Depression Scale – Revised 10-item Version for Adolescents, anxiety symptoms via the State-Trait Inventory of Cognitive and Somatic Anxiety and health-related quality of life with the RAND 36-item Short Form Health Survey 1.0. Sandín et al. [2020], in an uncontrolled pre-post pilot study using the AMTE intervention, measured disorder-specific symptoms of anxiety using the Anxiety Scale for Children and depression using the Depression Questionnaire for Children; anxiety and

depression symptoms were each also measured using subscales of the Revised Child Anxiety and Depression Scale-30 (RCADS-30).They reported statistically significant reductions post-intervention in anxiety symptoms via the EAN as well as via the RCADS-30 subscale for Generalized Anxiety Disorder. They also reported statistically significant reductions post-intervention in depressive symptoms via the RCADS-30 scale for Major Depressive Disorder. Raushenberg et al. reported in an uncontrolled pilot study that EMIcompass led to reductions in stress sensitivity, negative affect, and psychotic experiences as well as increases in positive affect in daily life using ecological momentary assessment (EMA) stress measures. They found reductions in depression anxiety symptoms immediately post-intervention and at 4-week follow-up. Both outcomes were measured by their respective subscales in the Brief Symptom Inventory. They also found reductions in general psychopathology using the Global Severity Index (which is also based on Brief Symptom Inventory items), psychosis using the Paranoid Thoughts Scale, and psychotic symptoms using the Prodromal Questionnaire. These reductions were measured immediately post-intervention and at 4-week follow-up. The study that assessed misophonia (Lewin et al. [2021] using the UP-C/A intervention) in an uncontrolled pilot design reported misophonia symptom reduction immediately post-intervention using the Clinical Global Impression Severity and Improvement scales as their primary outcome measure. The study that examined hyperactivity (Vahabzadeh et al. [2018] using the Empowered Brain System intervention) was uncontrolled and saw reductions in inattention, impulsivity, and hyperactivity using the hyperactivity subscale of the Abberant Behvaior Checklist at 24-hour and 48-hour follow-up. One study reported reductions in both the intervention and control groups. Staples et al. [2019], which used the Mood Mechanics course intervention, reported

significant reductions in depression scores via the PHQ-9 and anxiety scores via the GAD-7 in both the treatment group and the control group immediately post-intervention; they reported that these changes were sustained at 3-month follow-up.

Three studies (33%) reported intervention effectiveness through reductions of transdiagnostic mental health measures compared to a control group. Dear et al. [2018] in an RCT comparing a self-guided to a clinician-guided version of the Mood Mechanics course reported significant reductions in depression symptoms measured by PHQ-9 and anxiety symptoms measured by GAD-7 scores in both the self-guided and clinician-guided formats of the intervention; the changes in PHQ-9 score were sustained at 3- and 12-month follow-up and the sustainment of changes in GAD-7 scores varied by group. Musiat et al. [2014] reported that the PLUS intervention led to significant reductions in depression symptoms measured by the PHQ-9 and anxiety symptoms measured by the GAD-7 among the high-risk arm of their study compared to the control group; the low-risk arm did not show significant changes in these outcomes. Donovan et al. [2016] reported that BRAVE-ONLINE led to improvements to sleep-related problems, which were measured using the sleep-related questions of the Child Behavior Checklist. The secondary analysis of two controlled trials included a child group and an adolescent group; the child group demonstrated improvements immediately post-intervention as well as sustained improvement at 6-month follow-up. In the adolescent group, adolescents from both the intervention and control arms of the study showed improvements in these outcomes.

Implementation

Seven studies (78%) included questions, outcomes, or components related to implementation of the interventions in real-world, non-trial settings (Dear et al. [2018], Musiat et al. [2014], Carmona et al. [2021], Rauschenberg et al. [2021], Sandín et al. [2020], Staples et al. [2019], Lewin et al. [2021]). All seven studies assessed acceptability of the intervention post-intervention, most commonly with a follow-up quantitative questionnaire (n = 4), qualitative interview (n = 2), or both (n = 1). Five studies assessed feasibility of the intervention, four via questionnaire (Dear et al. [2018], Musiat et al. [2014], Carmona et al. [2021], Sandín et al. [2020]) and one via the successful recruitment, outcomes assessment, compliance with the intervention manual, and a rating scale answered by participants (Rauschenberg et al. [2021]). Three studies assessed adoption of the intervention through the collection and analysis of uptake and usage statistics (Carmona et al. [2021], Rauschenberg et al. [2021], Staples et al. [2019]). One study assessed appropriateness of the intervention by asking the participants' willingness to undergo treatment pre-intervention (Carmona et al. [2021]). One study (Rauschenberg et al. [2021]) also assessed the safety of the intervention, which is considered a 'service outcome' by Proctor's implementation outcomes framework[27]. Safety was assessed through the documentation of adverse events and considering the potential mental health impacts of the app-based intervention use on participants. One study (Carmona et al. [2021]) used user-centered design techniques to co-design the intervention with the focal population. While not an implementation outcome, this technique has direct downstream effects on implementation outcomes. Table 3 shows implementation aspects of these seven studies.

Discussion

This review sought to compile and assess evidence about transdiagnostic digital mental health interventions for youth and young adults and to characterize the nature of these interventions and examine whether they included measures for implementation-related outcomes. Nine studies met the inclusion criteria and were reviewed. Most interventions included utilized session- or module-based online platforms for delivery. Most also relied on CBT techniques, though the combination and application of these techniques varied. The majority of interventions were self-guided, despite the growing evidence of boosts to clinical effectiveness of DMHIs that include a guidance component[39]. Relatedly, all included studies were not explicitly recruiting participants from clinical populations or with high-severity symptoms, which may partially explain why most interventions were self-guided. Converging evidence of self-guided interventions for transdiagnostic problems highlights continued promise for maximizing accessibility and low cost at scale[15]. All studies were from the last ten years, with the earliest from 2014.

The paucity of research in this area is surprising when compared to the popularity and proliferation of mental health apps and other digital tools focused on mental health available for download on smartphones and other electronics. More research is needed to close the gap between the evidence-based supporting clinically effective DMHIs and the available technology marketed for this purpose. Youth and young adults have thousands of choices of mental health

related apps and online programs, but there is little evidence that can provide guidance about what could be most appropriate and helpful.

Results synthesized across studies covered in this review highlight the underutilization of both transdiagnostic interventions and DMHIs specifically focused on youth. Other studies have quantified DMHIs for youth[13], and while many exist, their primary focal outcomes are anxiety and depression symptoms. Even in our review, most studies assessed these as primary outcomes. While anxiety and depression are highly prevalent conditions among youth and young adult mental health, these disorders are often accompanied by symptoms that may not fit this particular diagnostic criteria as well as non-specific symptoms in areas such as self-esteem and social functioning. Transdiagnostic interventions are suitable for providing a broader treatment focus and can address non-clinical sequalae. Further, given the suitability of digital delivery platforms for mental health interventions for youth and young adults, opportunities exist for more transdiagnostic interventions to utilize these platforms.

Most studies in this review utilized components rooted in CBT principles as the clinical intervention. This aligns with other research and systematic reviews about DMHIs in various populations that have found CBT to be effective at reducing symptom severity via DMHIs[40–42] as well as easily adaptable to a digital format, and are commonly used for DMHI development. Study results were mixed in terms of following a self-guided or clinician-guided delivery format. These approaches provide different benefits and drawbacks; self-guided interventions can be inexpensive, convenient, and accessible to a broad audience, though time constraints and a lack

of face-to-face interaction can be barriers to uptake and adherence[19,43]. Interventions with some guidance component can increase user engagement and have been shown to be associated with better mental health improvements than self-guided interventions[16,44,45]. The format and level of guidance varied in our results from video calls with a clinician to weekly emails, and other interventions outside of this review have included non-clinician coaching and online peer groups. Additional implementation science research is needed to understand the benefits associated with various forms of guidance in DMHIs and to further gain insight on the tradeoffs between the accessibility of self-guided interventions and the added clinical effectiveness of interventions with a guidance component.

Seven of the studies included in this review contained components or measures related to implementation of the intervention in a real-world setting. The format of most of these implementation components were follow-up questionnaires that asked minimal questions regarding feasibility and acceptability of the intervention. Further, these questionnaires were only administered to participants who completed the study procedures and therefore were likely biased towards positive responses; there were few to no attempts to quantify and/or follow up with those who dropped out or were lost to follow up. Also, because none of these questionnaires took place as part of a real-world implementation project, these assessments may not represent barriers and facilitators to the scale-up of the intervention. While these assessments have value, rigorous implementation assessments that employ implementation science frameworks and outcomes can help refine interventions and facilitate uptake. Only one of the included studies (Carmona et al. [2021]) used a design process in which end users from

the focal population were involved in the co-design of the intervention. Meaningfully engaging the participant population in the formulation of the intervention itself through techniques like human-centered design can correspond to improved implementation outcomes[46]. The fact that only one of the included studies used these techniques aligns with existing evidence that has shown limited co-design procedures during the development of DMHIs[47], despite the benefits that these techniques can have on user uptake, completion, and satisfaction. User engagement in particular has been shown to be associated improved mental health outcomes in DMHIs[48]. Three of the studies with implementation components were pilot studies and only two were clinical trials, so the early/formative research stage may have been a factor in the lack of rigorous implementation component, though opportunities exist such as human centered design techniques that can engage end users in the development process of interventions.

Limitations

Our systematic review had several limitations. First, our review was limited to peer-reviewed articles published in English or that included an English translation. A more language-inclusive review that explored literature outside of academic journals would have reduced bias and likely produced more results. Second, the ascertainment of results is affected by linguistic limitations. Our search criteria included the word 'transdiagnostic', which has become an often-utilized term to refer to interventions that address more than one mental disorder and/or cut across diagnostic categories. We recognize, however, that this language is not ubiquitous, and studies likely exist that do not use this terminology. Many DMHIs may in fact be transdiagnostic, though they may be used in settings in which a diagnosis is not known (such as community

settings). There are outstanding empirical questions about what constitutes a transdiagnostic intervention/treatment, which warrant further research. Relatedly, there are many transdiagnostic processes that may cause distress and be considered risk factors but do not (by themselves) meet the criteria for a mental disorder (for example, rumination, risk-taking behavior, negative affect, self-harm, reward processing). While inclusion of these items may have generated more results, it would have complicated the synthesis of information into this review because these processes may not be equally addressed by DMHIs. For instance, if addressing rumination or reward processing is more compatible with DMHIs than addressing risk-taking or self-harm behaviors, DMHIs addressing rumination and reward processing are likely to show more favorable results in terms of compatibility, relevance, and effectiveness than DMHIs addressing risk-taking or self-harm behaviors. This would lead to results that could misleadingly characterize an overall systematic review of transdiagnostic DMHIs as middlingly effective and appropriate. A better solution, which future research could assess, would be conducting reviews for DMHIs addressing each transdiagnostic process separately.

Conclusion

Mental health of youth and young adults is an urgent public health concern, to the point that authorities in mental health research and care globally are calling for increased attention funding for this problem. Digital mental health interventions offer an avenue to broaden the accessibility of mental healthcare, and transdiagnostic DMHIs can address numerous and often indistinct and overlapping symptom profiles. Few transdiagnostic DMHIs focused on youth and young adults have been studied, and fewer have been tested in rigorous RCTs. All studies

identified in our search took place in high-income countries; there is a dearth of research on transdiagnostic DMHIs among low and middle-income countries even though these countries often have broad internet access but limited access to mental health providers, making them particularly appropriate for DMHI implementation. Our search identified no studies that document the implementation and scale-up of evidence-based transdiagnostic DMHIs for youth for public or clinic-based delivery. There is a need for more research on transdiagnostic DMHIs for youth and young adults in general, and researchers and clinicians must take the additional step to extend research findings into real-world settings via rigorous and systematic implementation methodologies.

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Tables and figures

Table 1: characteristics of all studies

Characteristic	N (%)
Year (mean, range)	2019 (2014-2021)
Country	
Australia	3 (33.3%)
Canada	1 (11.1%)
England	1 (11.1%)
Netherlands	1 (11.1%)
Spain	1 (11.1%)
United States	2 (22.2%)
Study type	
Individual RCT	2 (22.2%)
Pilot	4 (44.4%)
Other study type	3 (33.3%)
Intervention delivery modality	
Self-guided	4 (44.4%)
Clinician guided	3 (33.3%)
Combination	2 (22.2%)
Clinical tools	
Cognitive behavioral therapy	7 (77.8%)
Compassion Focused Intervention	1 (11.1%)
Communication and skills coaching	1 (11.1%)
Most common outcomes measured	
Depressive/anxiety symptoms	8 (88.9%)
General distress/psychopathy	3 (33.3%)
Sleep-related outcomes	2 (22.2%)
Implementation characteristics	
Contained any implementation characteristic	7 (77.8%)
Measured feasibility/acceptability	4 (44.4%)
Measured satisfaction	3 (33.3%)
Measured safety	1 (11%)
Co-design with participants	1 (11%)
Intervention usage	2 (22.2%)

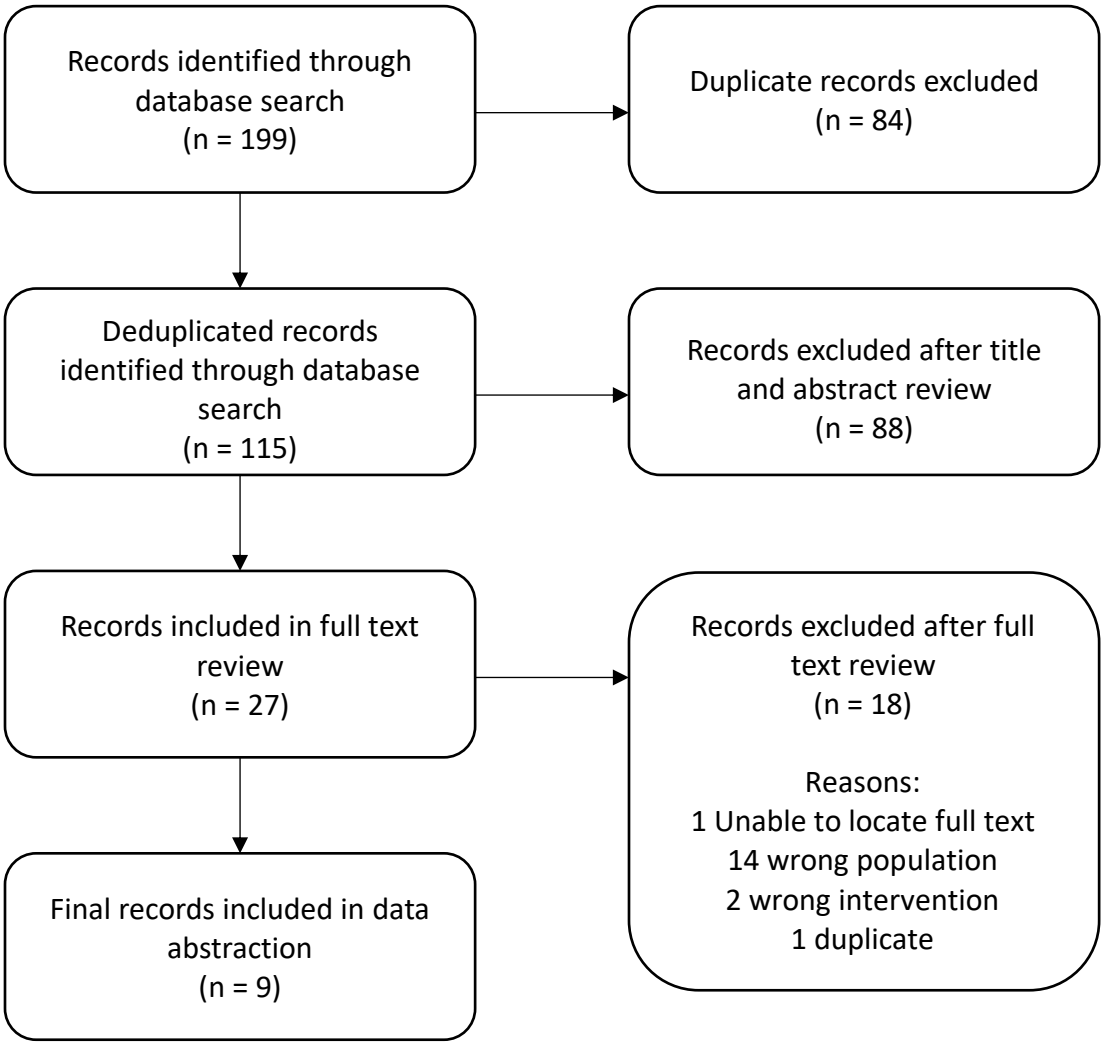
Table 2: (supplemental): detailed information for included studies (n = 9)

Table 3: studies with implementation outcomes (n = 7)

Author	Date	Study design	Proctor Implementation Outcomes	Assessment methods
Dear et al	2018	Clinical trial	acceptability, feasibility	Post-intervention questions to participants
Musiat et al	2014	Clinical trial	acceptability, feasibility	Post-intervention questions to participants
Carmona et al	2021	Longitudinal	acceptability, feasibility, adoption, appropriateness	Questionnaires at baseline and post-intervention; qualitative interview post-intervention; user-centered design process to develop the intervention
Rauschenberg et al	2021	pilot uncontrolled	acceptability, adoption, safety (service outcome), feasibility	Questionnaires post-intervention; participant interview post-intervention; documentation of adverse effects and potential negative mental health effects of app-based intervention usage
Sandín et al	2020	pilot uncontrolled pre post	acceptability, feasibility	Questionnaire post-intervention
Staples et al	2019	retrospective compare RCT and routine	acceptability, adoption	Questionnaire post-intervention

Lewin et al	2021	pilot uncontrolled	acceptability	Semi-structured interview post-intervention

Figure 1: flowmap of included studies



Chapter 3: Adapting a transdiagnostic digital mental health intervention for use among immigrant and refugee youth in Seattle: a human centered design approach

Title page

Adapting a transdiagnostic digital mental health intervention for use among immigrant and refugee youth in Seattle: a human centered design approach

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Abstract

Introduction: Digital mental health interventions show promise in addressing mental health needs, especially among youth and marginalized communities. This study adapted the WHO-developed STARS (Sustainable Technology for Adolescents to Reduce Stress) digital mental health intervention for use among youth and young adults aged 14-25 from immigrant and refugee communities in Seattle, Washington.

Methods: Human centered design methods centered around qualitative semi-structured interviews were used to contextually and culturally adapt the intervention and prioritize the needs and preferences of the intended end user. Intervention prototypes were modified and then presented to the target groups in iterative cycles until saturation was achieved. Qualitative interviews occurred in 3 iterations of 5 participants each.

Results: Modifications were documented according to the FRAME implementation science framework. Modifications aligned with the FRAME process elements of: a. tailoring/refining, which included adapting language to less resemble digital phishing scams; b. changes in packaging or materials, which included naming the chatbot and adopting a corresponding avatar; c. adding/removing, which included changing existing emojis and adding additional media types including GIFs, pictures, and voice memos; d. shortening/condensing, which included shortening the length of individual text sections as well as deleting redundant language; e. lengthening/extending, which included allowing the user to choose to receive content catered to teenagers or to adults; and f. loosening structure, including giving users options to skip parts of modules or to engage with additional material.

Discussion: The modified STARS intervention shows promise for engagement with immigrant and refugee youth in Seattle and can be examined for clinical effectiveness. Adaptations increased the relevance of content to the intended end user, expanded options for personalization and customization of the user experience, and utilized language that was age appropriate, engaging and did not invoke feelings of stigma or distrust. Adaptations of digital mental health interventions should focus on modifications that maximize acceptability and appropriateness to intended audiences.

Introduction

Common mental disorders such as depression and anxiety are highly prevalent among immigrants and refugees: they are estimated to affect up to 88% of refugees[1], and up to 71% of immigrants[2]. Youth and adolescents from these communities are at particularly high risk of developing common mental disorders because of increased stressors, including trauma from the experience of migration, changes in socioeconomic status, adjusting to a new cultural context, navigating changes in ethnic identity, and experiences of discrimination[3]. Among immigrant and refugee communities, there may be additional barriers to navigating an unfamiliar health system and seeking mental healthcare, such as language, cost, and for some, concerns associated with being undocumented[2].

Digital mental health interventions (DMHIs) show promise for addressing many barriers to mental healthcare, especially among youth and adolescents who may be at risk for mental distress, hard to reach, or have been historically underserved by mental health systems. These interventions have advantages among increasingly digitally literate adolescents, including anonymity, accessibility, low cost, and relevance to their lived experience[4]. Studies have indicated that DMHIs can be effective in reducing depression and anxiety symptoms among immigrant and refugee recipients[5,6], and that people from immigrant and refugee communities view DMHIs positively and with high levels of satisfaction[6]. DMHIs can respond to barriers to mental healthcare for people from immigrant and refugee communities; language barriers, for instance, which are a well-documented barrier to care for people in these communities[7], can be overcome through translation of digital materials, which may be easier for some to access than finding linguistically diverse providers. Further, DMHIs can be culturally

adapted to increase relevance and suitability for use among immigrant and refugee communities; increased effect sizes in depression and anxiety symptom reduction have been documented in culturally adapted DMHIs in comparison to interventions that were not adapted[8]. Issues related to stigma, confidentiality, and privacy, which are more general barriers to care not specific to immigrant and refugee communities, may also be addressed by DMHIs, as they are offer individual-level care that is easily made discrete and anonymous.

STARS (Sustainable Technology for Adolescents to Reduce Stress) is a transdiagnostic digital intervention designed to reduce symptoms of common mental disorders using evidence-based psychotherapy techniques. Transdiagnostic, in this context, means the intervention was not developed for a specific disorder, but rather to address symtpoms that can crosscut common mental health disorders like anxiety and depression. The STARS program was developed by the World Health Organization (WHO) in response to a lack of mental healthcare access in low- and middle-income countries for those aged 15-18. In developing the STARS intervention, the WHO conducted formative qualitative research in the form of individual interviews and focus groups with a total of 154 adolescents and 66 community members in Pakistan, Jamaica, South Africa, Nepal, the West Bank, and Gaza and found the intervention to be acceptable and appropriate for use among adolescents ages 15-18. The prototype STARS intervention in low- and middle-income countries (LMICs) uses a pre-programmed decision tree conversational agent (i.e., a chatbot) that interacts through messaging on popular chat platforms like WhatsApp and Facebook Messenger. It delivers evidence-based psychological content that is designed to reduce symptoms of common mental disorders, including psychoeducation, emotional regulation, behavioral activation, problem solving, challenging negative thoughts, and consolidating gains, in a modular

format individualized to the user's needs and specified preferences. While the WHO's formative work focused on adolescents ages 15-18 in LMICs, their eventual goal is to expand the user-base enough that the intervention is publicly available and widely suitable to a broader audience in settings worldwide. Randomized controlled trials testing efficacy of the WHO intervention are ongoing. Adapting and testing STARS in the United States will add to the evidence base for the intervention as well as assess its applicability among young adults (as old as 25), and among immigrant and refugee populations in a high-income setting. The objective of this study is to adapt the STARS digital mental health intervention using a Human Centered Design (HCD) approach for use among youth ages 14-25 from immigrant and refugee communities in Seattle.

Methods

Study setting

This study commenced in September of 2020, and as such, due to the ongoing COVID-19 pandemic all activities were conducted online through Zoom meetings. Participants were recruited from the greater Seattle/King County area. As of 2016, 20% of residents in King County were born outside of the US[9]. Also as of 2016, 28% of students grades 8-12 in the greater Seattle area/King County reported feelings of depression in the past year[10].

Participants

Study participants included youth and young adults age 14-25 living in the Seattle/King County area who self-identified as being from immigrant and/or refugee families. Participants were recruited through outreach to community organizations that serve immigrant and/or refugee communities in the Seattle/King County area. Information about the study and contact

information for the research team was distributed to organizations who were then able to pass along these materials to potential participants. Participants reached out to the study team who assessed eligibility via a brief questionnaire and initiated enrollment. Eligibility criteria included age (14 to 25) and self-identification as part of an immigrant and/or refugee family.

The intervention

The STARS intervention guides the user through ten daily sessions that introduce the psychological content in modules designed to be completed in 10-15 minutes. Each session is presented through interaction with a chatbot that provides preprogrammed choices to guide the user through the conversation (Figure 3). The intervention includes daily message cues asking users to engage with the chatbot as well as reminders to re-engage if the user has not interacted with the chatbot for more than 24 hours. It uses a variety of media to convey concepts, including videos, audio files, and text. Users specify their preferences for content they feel is most relevant to them; for instance, a user may choose to read a short story about a character who is experiencing difficulties with a school project or a different character who is continually arguing with their parents. Core psychological concepts are present for all users while the details of delivery vary according to user preference. Core psychological concepts are evidence-based and include psychoeducation[11], emotional regulation[12], behavioral activation[13,14], problem solving[15], challenging negative thoughts[16], and consolidating gains[17]. Table 1 outlines daily modules and associated psychological concepts for the STARS intervention. Psychological concepts are delivered via a modular approach, in which each concept is presented in a self-contained session or module. This evidence-based technique allows for flexibility to adapt the order and content of psychological concepts[18–20]. The intervention uses language designed to

avoid stigma related to mental health and facilitate understanding among youth irrespective of background knowledge regarding mental health. Consequently, words like 'stress' and 'emotions' are used in lieu of more stigmatized, complex clinical labels like 'mental illness', 'depression', 'anxiety', etc. STARS was developed using human-centered design methods that give users an instrumental role in co-creating the intervention, allowing it to respond to specific needs of youth in a given context.

Study design

Human Centered Design is a community-based approach to research. HCD endeavors to address health disparities by approaching problem solving in a way that allows the intended recipients of the intervention to dictate the form of the intervention. HCD's problem solving process is based on three phases: 1. Inspiration, in which an problem is identified and the barriers and solutions to that problem are examined from the perspective of lived experience; 2. Ideation, in which multiple solutions are elicited and considered using the thoughts, feelings, and experiences of intended users; and 3. Implementation, in which prototypes are generated and tested in an iterative process. New information and feedback is incorporated in each iteration until a finalized intervention is reached[21]. HCD facilitates innovation and scalable impact by centering intended end-users in the design and problem solving process[22]. It promotes equity by prioritizing the needs and experiences of the end user and approaching health disparities as design challenges[23]. Including refugee and immigrant youth in the design process is critical; digital interventions that do not meaningfully engage underserved populations in the design process are at risk of reinforcing existing health inequalities[24].

Procedures

Participants took part in 4 to 5 recorded video chat interviews in which they were shown aspects of the STARS chatbot prototype via video chat and screensharing and asked to give their opinions and feedback. The number of interviews was determined by how long it took to go through all aspects of the intervention with each participant. Interviews utilized the 'think-aloud' technique, a HCD research method in which participants are encouraged to verbalize their thoughts as they occur while they interact with the intervention, rather than waiting for the interviewer to ask specific questions[25]. This method is useful for understanding the cognitive process while a person accomplishes a task and is frequently used to test the usability of prototype computer systems[26]. In the context of this study, interviewers guided participants through each module as if they were truly using the intervention and asked them to voice their thoughts as they came up without filtering or second guessing them. Interviewers explained that the goal was improvement of the intervention and that therefore participants would not encounter judgement for positive or negative thoughts about the content. Following HCD principles, participant interviews occurred across iterations of prototype testing for the STARS intervention. The first group of participants were shown the STARS prototype that was originally developed by the WHO for use in South Africa. After participants from the first iteration group shared their feedback, the study team modified the intervention accordingly. This process was repeated with a naïve group of participants until a finalized version of the intervention was developed. Discrepancies between participant comments were resolved by taking the majority opinion among participants or, if a majority opinion did not exist, no changes were made until additional feedback was gathered from additional iterations of the feedback process. The intervention was considered to be finalized when participants had few to no additional

suggestions for changes and overall expressed satisfaction with the intervention. Oral assent (for minors) or consent (for non-minors) was deemed appropriate for study procedures by the Institutional Review Board and was provided by all participants as well as parents/guardians when applicable.

FRAME implementation science framework

Adaptations to the STARS intervention were systematically coded according to the Framework for Reporting Adaptations and Modifications – Expanded (FRAME) implementation science framework[27] (Figure 1). The FRAME framework is particularly well-suited for systematically adapting and documenting changes to interventions. The *process* of modifications, according to the FRAME framework, seeks to document information about "who", "what", "where", and "when" decisions were made regarding intervention adaptations. The *reasons* associated with the modifications then seeks to define the "why", or the purpose of the adaptations. The results discuss the *process* and the *reasons* for each modification, and is organized according to the recommended elements of the FRAME-IS framework[27].

Results

Five participants were interviewed in each of 3 iterations of adaptations, resulting in a total of 15 interview participants. Participant ages ranged from 14 to 25 with a mean age of 17.7 (SD = 3.8). Of all participants, 73% were female (n = 11) and 27% were male (n = 4). 53% of participants self-identified as belonging to an immigrant family (n = 7) and 47% (n = 8) to a refugee family. Participants' country of origin was Iraq (n = 12), Afghanistan (n = 2), and Eritrea (n = 1).

FRAME Adaptation Process

1. When did modifications occur and were they planned: All modifications to the intervention occurred in the planning phase of a broader pilot study designed to assess the clinical effectiveness of the STARS intervention. In a global-to-local approach, the research team proactively planned the adaptation study in order to optimize the STARS intervention for use among adolescents from immigrant and refugee communities in high-income settings.

2. Who participated in decision-making: The research team, based in the US, made the decision to modify the content of the STARS intervention to this context. After the decision to modify the intervention was made, end users from the intervention's focal population took part in the adaptation process. Participant feedback was used for decision-making for all modifications to the intervention.

3. At what level of delivery: The modifications focused on the intervention as it would be implemented at the individual level, i.e., users who have access to the intervention complete it on their own, but future modifications could facilitate an additional level of delivery (i.e., introducing the intervention to individuals via organizational outreach or clinic recommendations).

4. What is the nature of the modifications: The nature of the content modifications included tailoring and refining to reflect the experiences of immigrant and refugee youth, adding and removing elements, shortening/condensing as well as lengthening some aspects, and loosening structure.

4a. Tailoring and refining: The language of the chatbot was modified from British to American English (i.e., favourite to favorite), and we corrected lingering spelling and grammatical

mistakes from the original version. We changed the names of characters within the chatbot to more recognizable names using a database of the most common names worldwide (for instance, Xhanti was changed to Angelo, Melokuhle to Kenji, Pearl to Maria, etc.). This was done in response to user feedback; names were changed in an early iteration using the most common names worldwide and then tested for acceptability in a later iteration. Relatedly, the emojis representing characters within the chatbot were changed to include a wider variety of skin tones, clothing, and hair color and texture. An example of this is seen in Figure 4. This was done to more realistically reflect the broad audience of the chatbot. Participants expressed appreciation for the broad representation of character appearances. The in-text emojis were changed to add more variety and to modify the ones with implied meanings that did not match the content of the text. Participants indicated that repeated emojis were boring and made them lose interest in the chatbot. See Figure 4 for examples of original and updated emojis. The introductory text of the chatbot was modified and personal questions for the user were removed. Participants indicated that the original language used was similar to phishing scams they had encountered, and that it felt 'creepy' or 'scammy'. See Figure 4 for original and modified introductions. The modified introduction focuses on explaining exactly how the chatbot was meant to be used and asks the user to input what they prefer to be called by the chatbot, rather than being asked to disclose their name. According to one participant, "I feel like the message where it says you don't have to say your real name, people my age might be weirded out by that. I'd be worried that it's trying to scam you. Scammers start like saying this same thing." – Participant, 14.

4b. Changes in packaging or materials

Chip was chosen as the name for the chatbot character. Participants in the first iteration were asked to suggest names for the chatbot, and participants from later iterations chose their favorite name from the generated list. The name Chip was chosen by the most participants. The image representing the chatbot character was changed to a blue robot illustration with a friendly expression (Figure 2). Participants suggested that a non-human cartoon image was the most favorable. Taken together, these packaging choices allowed the chatbot to be perceived as a benevolent non-human entity. According to one participant, "the overall tone seems friendly, and it does feel like a robot so the picture could be a robot. It should be minimal, it shouldn't be something that has a lot of color, and it shouldn't be too kid-ish" – Participant, 14.

4c. Adding and removing: New media types were added (graphics interchange format images [GIFs], pictures). Participants cited their frequent use of GIFs and pictures in routine text conversations and indicated that these can help explain concepts in the text as well as encourage participation because they are more interesting that text. According to one participant, "I liked the emojis and I also really liked the GIFs, it reminds me of talking to my friends." – Participant, 17. Figure 5 shows an example of additional media in the modified chatbot. Additional choices were added for how the user can respond to the chatbot. This was done to increase variety to maintain interest and to more realistically reflect the way users would choose to respond. Information was added when participants indicated confusion about psychological content.

4d Shortening/condensing: Several modules were shortened to be more concise, and redundant text boxes were eliminated. Participants indicated that the original version of several modules were too long and contained redundant information. The original introduction module, for instance, prompted the user to set goals for themselves while using the chatbot and then

repeated the goals back to the user for reinforcement. Participants indicated annoyance with the chatbot when it repeated the goals, so this feature was removed. Large sections of text were broken into several smaller sections, as users said they were more likely to read multiple short sections than one long section. Participant feedback suggested these modifications would increase engagement and decrease dropout: "Our attention span is very limited. And if we don't get what we want in the beginning, we get bored. So I would not put on full advice… I would to give something short, you know, so they can keep going" – Participant, 15.

4e. Lengthening: An option was added at the beginning of the chatbot for the user to choose a version for adults or a version for teenagers. Content in the teenager version included examples of stressors relating to school, parents, and extracurriculars whereas the adult option included examples relating to challenges common for young adults, such as living with roommates and managing finances. One character example, for instance, struggles in the teenage version to manage his time while attending school, seeing friends, and working a part-time job. The same character, in the adult version, wants to make music but has trouble finding time after working two jobs. Both examples show a character who recognizes that his signs of stress include headaches and sleeplessness, but the packaging of the content is catered to each age group. Adult participants indicated that the original version of the chatbot, which was created for users ages 15-18, contained examples that seemed juvenile and irrelevant. The adult version also contained fewer emojis and GIFs, which adult participants indicated were distracting. As one participant indicated, "The emojis are childish; [answer choices] should be words instead of emojis." – Participant, 18. Psychological content remained the same in both versions.

4f. Loosening structure: Options were added to allow users to skip non-essential sections, for example, information about how to erase messages. Participants expressed the desire for more control over the content they received in the chatbot, so extraneous information that is not included in the psychological content was modified to include the skip feature. For example, users were given the choice to skip the explanation of the privacy features of the app, including how to delete messages and conversations. Users are also given the option within modules to read extra stories or participate in extra practice of psychotherapeutic techniques in order to lengthen or shorten their daily interaction with the chatbot according to their preferences. According to one participant, before this modification was made, "[There's] no option to skip but there should be. Some other apps have this feature where you can skip around." – Participant, 14.

Relationship to fidelity/core elements

The core elements of the intervention which included the evidence-based psychotherapeutic techniques and their presentation in a modular format, were maintained throughout the intervention. Only peripheral elements of packaging, structure, and presentation were modified.

Rationale

The goal of creating a modified STARS intervention was to improve fit with the intended recipients and address cultural factors, to increase engagement and retention, improve feasibility, increase satisfaction, and ultimately lead to improved clinical effectiveness in reducing symptoms of common mental disorders like anxiety and depression. This is in response to existing sociopolitical factors including funding and resource availability as well as societal and cultural

norms that result in low mental health service utilization among youth as well as people from immigrant and refugee communities. Modifications were not made to any of the psychotherapeutic material itself, but rather the contextual factors in how this information was delivered to users.

Discussion

Our study modified a WHO-developed digital psychological intervention for use among immigrant and refugee youth. Using HCD methods, intended recipients of the intervention informed adaptations that were made throughout three iterations of prototype testing. The resulting finalized version of the intervention was met with satisfaction and positivity by participants, who did not express the need for additional changes. The final version was described in qualitative interviews as “a good and beneficial app” that was “interesting” and can “actually help me cope with stress”. Participants indicated that they would download the intervention as an app, and that they would recommend the app to a friend or family member who was struggling with stress or mental distress “because some people are alone, no mom or dad or kids”. The finalized version of the intervention designed for immigrant and refugee youth in high-income settings like Seattle/King County and can be further tested for clinical effectiveness in pilot research.

The adapted STARS intervention aligns with literature specifying components of digital mental health interventions that are important for clinical effectiveness and relevance to the intended recipients of the intervention. Privacy and anonymity are frequently cited favorable aspects of digital mental health interventions[28], and a lack of perceived trustworthiness is a

barrier to engagement[29]. The adapted STARS intervention contains optional instructions that explain to users how to delete the conversation with the chatbot from the Facebook Messenger platform. In this way, users are aware when starting the intervention that they have the option to erase any evidence of engagement. Further, the adapted intervention never asks the user any personal information that could discourage participation or provoke distrust, but rather allows the user to choose how the chatbot addresses them.

Favorable intervention content has also been cited as a facilitator to DMHI engagement, including relatability of material, ease of use, and appealing aesthetics[28,30]. Our adaptations aimed to improve these aspects through character stories and the use of digital media. Character stories were modified to include relevant context to teenagers and young adults; material for teenagers included challenges regarding living with family, attending high school, maintaining friendships and making decisions about next steps after graduation, whereas material for young adults included challenges about living with roommates, attending classes post-high school, financial difficulties, and employment. Characters were also given names and avatars that were intended to be recognizable to a variety of user backgrounds. Digital media was added to the intervention according to the preferences of each user group. While both young adults and teenagers expressed the desire to see more pictures, GIFs, emojis, and voice clips, the young adult group indicated that too many of these were distracting. In both groups, however, the amount of digital media was increased substantially from the original version of the intervention.

DMHI literature suggests customization and personalization functionalities are desirable[31,32]. The adapted STARS intervention increased the opportunities that users have to express preferences for their experience with the intervention. At the beginning of their

interaction with the chatbot, users choose if they would like to see content focused on the experiences of teenagers or of young adults. Within each chatbot module, users are given the opportunity to decide which character stories they would like to read according to what is most relevant for them. Throughout the intervention, users are given a variety of options on how to respond to each line of text from the chatbot. Specific user responses are saved and 'remembered' by the chatbot, which is designed to give the intervention a more personalized feel. The chatbot will, for instance, remember the user's name, goals, and signs of stress, which it will mention in later modules to create conversation continuity.

Strengths and limitations

Our study had several strengths. First, the original intervention was developed by mental health experts using evidence-based techniques and has undergone formative research in other settings. The evidence base of the intervention itself, as well as the evidence base for its delivery modality in a modular, digital format means that the study began with a robust template from which to explore adaptations. Second, the use of HCD techniques that directly engage the end user during the adaptation process is associated with increased effectiveness and relevance to the focal audience. Third, incorporating implementation science through the FRAME adaptation framework allows for replication and standardization of the techniques used in this study and broadens their applicability to a wider audience.

Our study had several limitations. First, the inclusion criteria for participants was broad and did not require participants to have a history of mental distress. Because we did not specifically include youth and young adults with current or former mental distress, we could not assess the intervention's suitability and/or impact for people with higher levels of distress. An

intervention specifically for those with high levels of mental distress could require further adaptations. We also did not focus on any particular immigrant/refugee communities in our inclusion criteria, so it is possible some adaptations could be more or less relevant to some cultural contexts but not others. Relatedly, our limited sample size may have further hindered generalizability. Second, the intervention is in English, and was not adapted to any other languages. Future adaptations could result in a non-English version, and indeed the intervention is designed for flexibility that could accommodate this, but in its current form the STARS intervention is only accessible to those who can read and understand English. Third, our adaptations were limited to the peripheral aspects of the chatbot rather than the evidence-based techniques themselves. Because not all evidence-based practices may be acceptable to all populations, our inability to change these aspects, while not necessarily a limitation as the goal of the research was adaptation of an existing intervention rather than tailoring the therapeutic components of the intervention, is important to acknowledge.

Conclusion

Design considerations in which the needs of the end user are central to the intervention development have been suggested to increase the relevance and effectiveness of digital mental health interventions for youth[4,29,33]. Our study's use of HCD methods prioritizes these perspectives and the resultant adapted STARS intervention reflects user needs and preferences. Future research can determine the clinical effectiveness of STARS in reducing mental distress among immigrant and adolescent youth.

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Tables and figures

Figure 1: the FRAME implementation science framework from Stirman et al.[27]

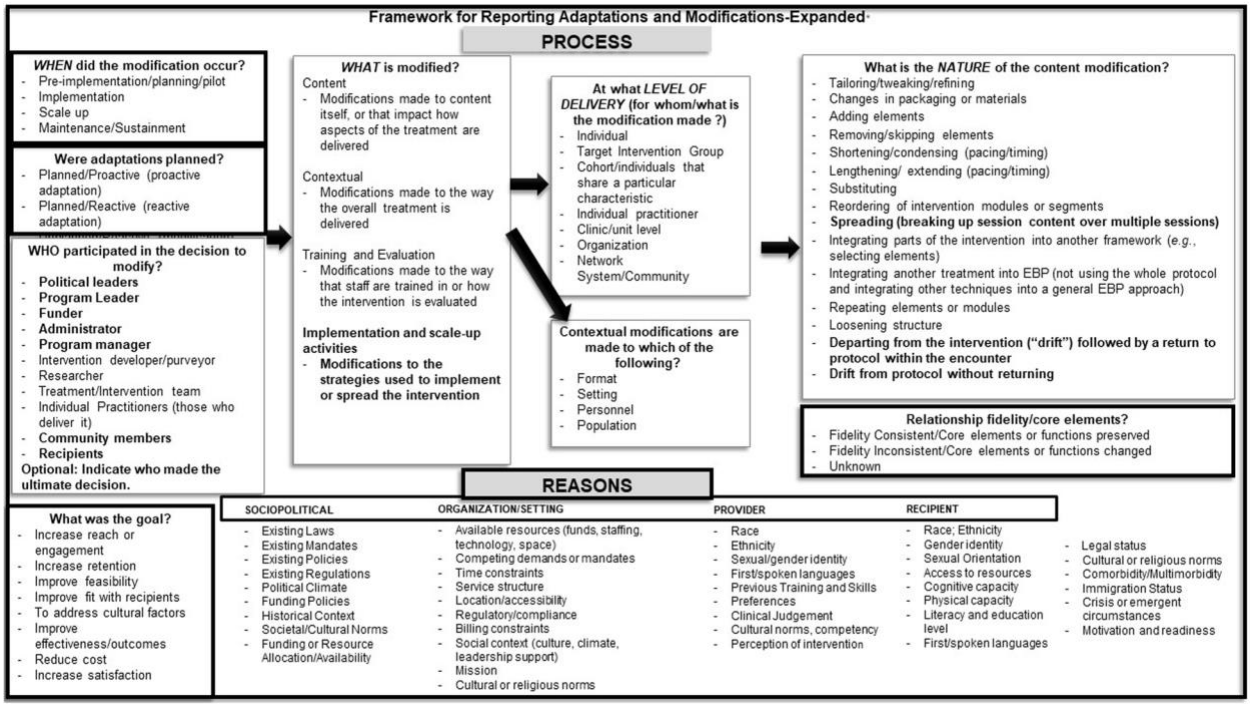
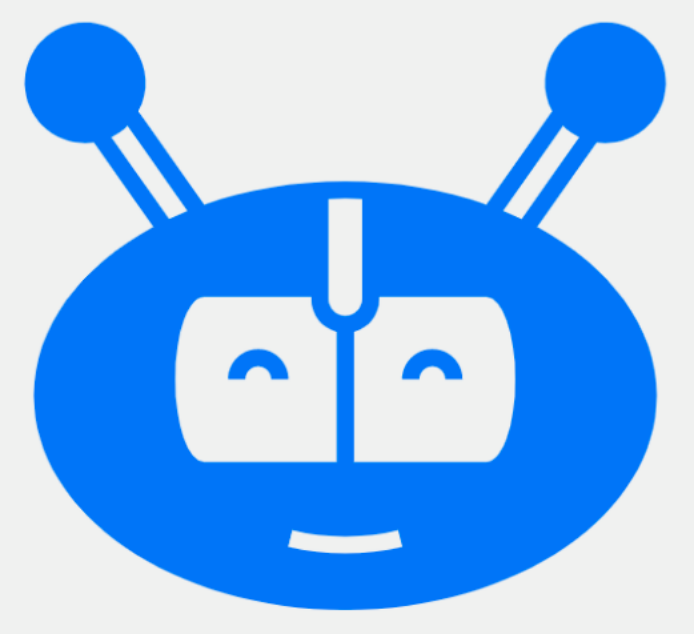


Table 1: STARS daily modules and psychotherapeutic concept

Day/Module	Psychological Concept
1	Goal setting/introduction
2	Psychoeducation
3	Emotional management
4	Emotional management
5	Behavioral activation
6	Behavioral activation
7	Problem management
8	Challenging negative thoughts
9	Challenging negative thoughts
10	Consolidating gains

Figure 2: the avatar chosen to represent Chip the chatbot



Source: The Noun Project

Figure 3: screenshot of interaction with chatbot with pre-programmed conversation choices shown (a).

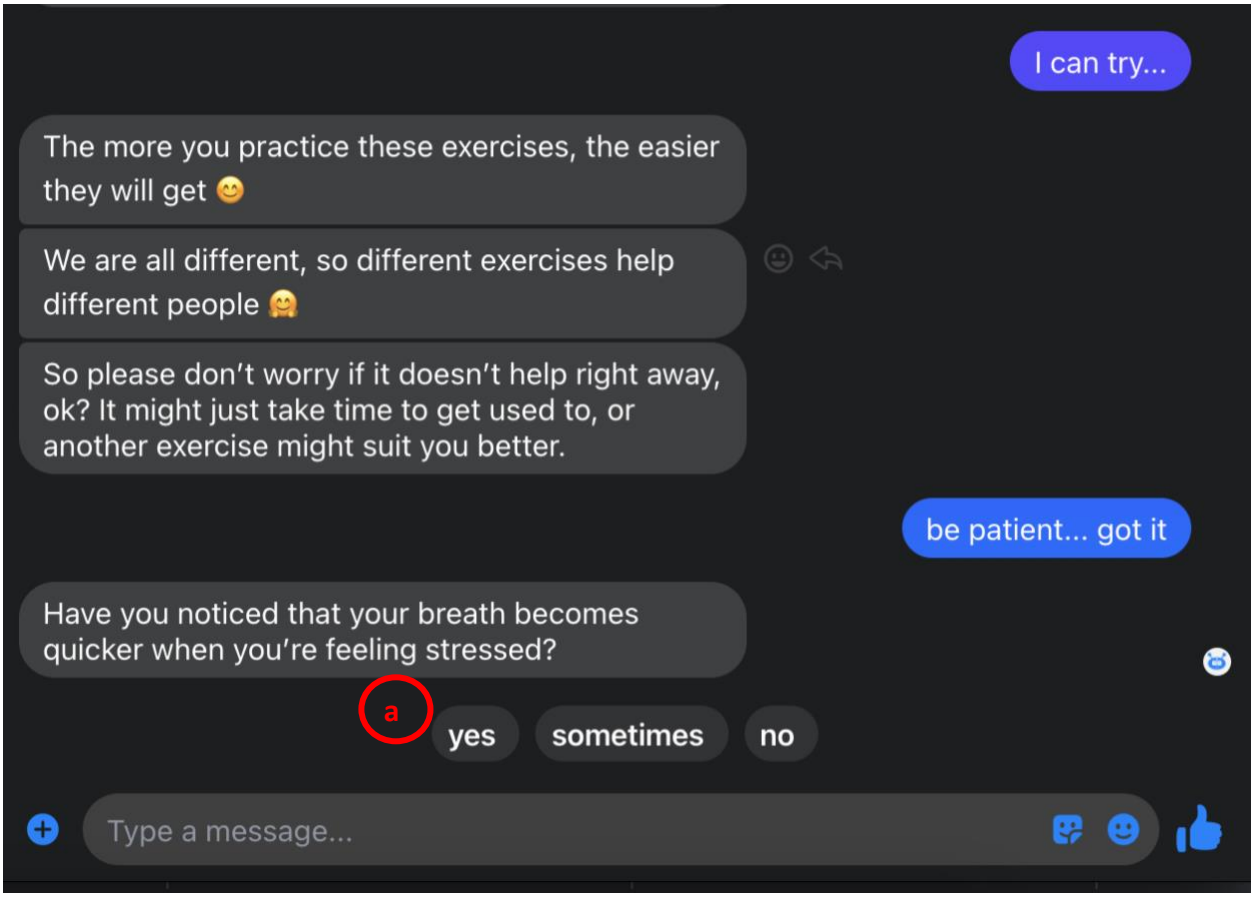


Figure 4: original and modified introductions. Original version uses language that users identified as “creepy” or “scammy” (a), whereas modified version was more acceptable (b). Modified version also uses a wider variety of emojis than original (c).

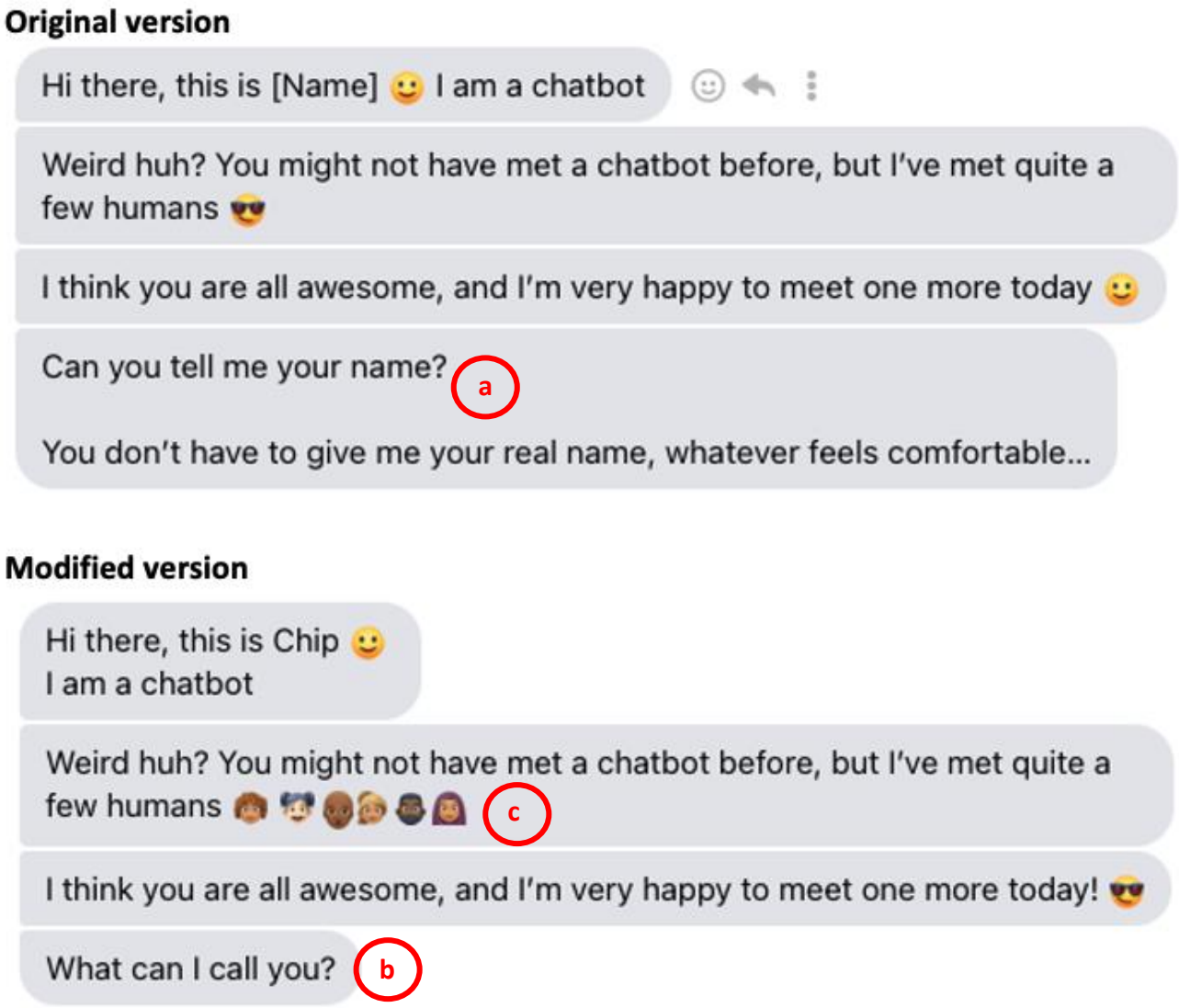


Figure 5: example of additional media (GIFs) added to modified version. Note that in digital format the images are animated. GIFs sourced from https://giphy.com/

Original Version

Too much stress can stop us from acting in ways we would like to. For example, we might stop seeing friends, have difficulties concentrating at school or argue with our families.

Everyone experiences stress differently. Some people notice it in their body through aches and pains, their heart beating fast or sweating...

Mmm hmm 😴

Some people may not want to eat, some may have difficulties sleeping or concentrating.

Others may act differently. They may argue, fight or shout more with friends or family 😡

Modified version

Some people may not want to eat, some may have difficulties sleeping or concentrating.

Others may act differently. They may argue, fight or shout more with friends or family 😡

Chapter 4: Pilot testing a digital transdiagnostic mental health intervention for use among immigrant and refugee youth in the US: a mixed methods evaluation of clinical and implementation outcomes

Title page

Pilot testing a digital transdiagnostic mental health intervention for use among immigrant and refugee youth in the US: a mixed methods evaluation of clinical and implementation outcomes

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Abstract

Introduction
Digital mental health interventions show promise for populations with barriers to mental healthcare access, including youth as well as immigrant and refugee communities. Given the high burden of stressors and common mental disorders in the ongoing COVID-19 pandemic, these interventions can provide early screening for mental disorders, symptom monitoring, and connections to further care. This study pilot tests a transdiagnostic digital mental health intervention for immigrant and refugee youth in the US for preliminary clinical effectiveness and implementation outcomes.

Methods
The pre-post pilot study design took place from May-September 2021. STARS (Sustainable Technology for Adolescents to Reduce Stress) is a transdiagnostic digital mental health intervention that delivers evidence-based psychological content designed to reduce symptoms of common mental disorders like anxiety and depression. Content is delivered via a chatbot that provides daily interactive 10-20-minute sessions for 10 days. Participants were self-identified immigrant and refugee youth ages 14-25 recruited via advertising on social media. Baseline assessments were performed followed by a 10-day intervention usage period and subsequent follow-up assessment. Measures included severity of symptoms of common mental disorders, intervention usage statistics, and a usability survey. A subset of participants took part in semi-structured interviews to assess barriers and facilitators to implementation, which was structured according to the CFIR framework.

Results
129 participants completed all baseline and follow-up procedures. The majority (62.8%, n = 81) of participants were female, 31.8% were male (n = 41), and 5.4% (n = 7) were non-binary or another gender identity. Participants had been living in the United States for an average of 17.9 years (SD = 11.4), had a mean age of 19.5 (SD = 2.9), and reported 53 countries of origin. Baseline mental health scores were generally high using all measures. Participants completed an average of 7 sessions out of ten (SD = 3.9). Regression results showed each additional intervention session completed was associated with negative estimated mental health symptom severity scores, but these associations were non-significant. Barriers and facilitators to uptake and engagement with the intervention fell into three CFIR categories: characteristics of the intervention, inner setting, and characteristics of individuals. The short, module-based delivery of the intervention was well received, as was personalized content, use of mixed media (text, video, audio), and the ability for the user to control aspects of the intervention (i.e., how to respond to the chatbot). Barriers included time constraints, technological problems, and perceptions that the content was suitable for a younger age group.

Discussion
The STARS transdiagnostic digital mental health intervention was well-received by participants and showed initial evidence of suitability for immigrant and refugee youth. More research is needed to maximize clinical effectiveness and bridge the gap between publicly available online

mental health resources and evidence based digital mental health interventions tailored to specific populations.

Introduction

Youth and adolescents experience high rates of mental disorders each year, and the isolation, disruption, and uncertainty from the ongoing COVID-19 pandemic has exacerbated this problem. In December 2021, the US Surgeon General released an advisory calling youth mental health a crisis, saying 'mental health challenges in children, adolescents, and young adults are real and widespread'[1]. Even before the onset of the COVID-19 pandemic, a 2011 national survey indicated almost one third (28.5%) of high school students reported feeling so sad and hopeless for intervals of 2 weeks or more that they had stopped doing some usual activities[2]. By 2020, after the beginning of the pandemic, this figure had increased to 44%[3]. Recent research comparing youth and adolescent mental health to before the pandemic has found significant increases in symptoms of depression and anxiety[4]; a recent review found 79% of included studies showed worsening depressive symptoms and 76% showed worsening anxiety symptoms[5]. Youth and adolescents from immigrant and refugee communities face additional barriers (challenges?) that can exacerbate mental health outcomes. Studies on mental health among youth from immigrant and refugee communities report resilience and adaptation in response to the pandemic, as well as challenges related to food and housing insecurity, family employment uncertainty, isolation, and education disruption[6,7].

Digital mental health interventions (DMHIs) are a rapidly growing method to detect and address mental health challenges. The integration of technology allows for benefits including an

extended reach for populations who may not engage in traditional techniques like in-person therapy and/or pharmacological interventions. It also provides opportunities for connecting people to further care, the potential for earlier screening and diagnosis than in-person approaches, increased monitoring of symptom changes over time, and other benefits. DMHIs may be particularly relevant for youth who may have barriers to engagement with in-person services yet who are literate and open-minded about technology. Transdiagnostic DMHIs (which are DMHIs that focus on common elements across diagnoses) have the added advantage of being able to address mental health symptoms that are not necessarily from one specific diagnostic category, but instead can address general mental distress or symptoms that may be a part of various diagnoses. Transdiagnostic interventions are particularly well-suited for DMHIs because they can address sub-threshold symptoms that may not lead to a diagnosis in a clinical setting but are still causing distress. For this reason, they have the potential to reach an even wider audience than DMHIs that are intended to address symptoms of a specific disorder or condition.

Digital mental health interventions have increased in popularity with the ubiquity of mobile phones, and as of 2018, over 10,000 are publicly available for download in the app stores of mobile devices[8], though this figure is likely much higher now. These interventions have advantages including wide availability, the convenience of being able to access anywhere, privacy, confidentiality, and cost-friendliness. However, there are concerns; few of these apps have been rigorously tested for clinical effectiveness[8]. Interventions are largely unregulated; privacy and security of user data varies widely and is not governed by centralized legislation[9].

With the onset of the COVID-19 pandemic, the FDA further relaxed regulations pertaining to DMHIs[10] by not enforcing compliance with existing regulations[11]. Few studies of DMHIs have included cultural adaptations, which can extend the relevance of interventions to underserved communities[12] that are often disproportionately affected by mental health issues. Further, DMHIs by nature disproportionately benefit those with access to technology and digital literacy[13], and therefore may leave behind a subset of the population who could benefit from such interventions. For these reasons, help seekers using DMHIs may have difficulty finding an intervention that is appropriate, safe, and evidence based.

This study builds on previous research that sought to adapt a DMHI for stress reduction that was originally developed for use in low-and middle-income country (LMIC) settings for use among youth and young adults from immigrant and refugee communities in the United States (Fabian et al, forthcoming). The aim of the present study is to pilot test the resultant adapted DHMI called STARS (Sustainable Technology for Adolescents to Reduce Stress) for preliminary clinical effectiveness and implementation outcomes.

Methods

Study design

Data collection for this pre-post pilot study took place from May-September 2021. Participants were recruited remotely from anywhere in the United States via Facebook advertising. Enrolled participants provided informed assent to participate and were immediately directed to

complete baseline survey instruments. Participants then completed a second baseline survey 24 hours after completing the first, in order to address potential regression to the mean. Following both baseline surveys, participants were connected to the STARS chatbot for use over a 10-day period. Following this 10-day period, participants completed a follow-up survey. Qualitative interviews were conducted with a subset of participants to understand barriers and facilitators to engagement with the intervention. Participants were given a 50 USD gift card for completing baseline and follow-up procedures. All study procedures took place remotely via video chat and surveys were administered in REDCap electronic data capture software hosted at the University of Washington[14,15].

The intervention

STARS (Sustainable Technology for Adolescents to Reduce Stress) is a transdiagnostic digital mental health intervention that delivers evidence-based psychological content designed to reduce symptoms of common mental disorders like anxiety and depression. Originally developed by the World Health Organization for use in LMICs, the STARS intervention has been adapted for use by immigrant and refugee youth ages 14-25 in the US (Fabian et al, forthcoming). Psychological content includes psychoeducation, emotional regulation, behavioral activation, problem solving, thought challenging, and consolidating gains. The intervention guides users through ten daily sessions that introduce the content in modules designed to be completed in 10-15 minutes. The intervention includes daily message cues asking users to engage with the chatbot as well as reminders to re-engage if the user has not interacted with the chatbot for more than 24 hours. It uses a variety of media to convey

concepts, including videos, voice memos, audio files, and text. Users specify their preferences for content they feel is most relevant to them; for instance, a user may choose to read a short story about a character who is experiencing difficulties with a school project or a different character who is continually arguing with their parents. Users also choose their age group to receive content further catered to their individual experiences; adult (18-25) users have access to stories and examples about jobs, continuing education, living with roommates, etc. while teenage (14-17) users have access to content about school, parents, friendships, etc. Core psychological concepts are present for all users while the details of delivery vary according to user preference.

Participants

Participants were youth ages 14-25 who self-identified as immigrants and/or refugees living in the US. Exclusion criteria included people living outside of the US, people unable to read and understand English, people without internet access at least once per day, and people unable or unwilling to access Facebook Messenger.

Measures

Sociodemographic information was collected from all participants at baseline and included age, gender, education, employment status, self-identification as an immigrant, refugee, or both, country of origin, years living in the US, and current US city and state of residence. Age appropriate and validated screening tools were used to measure participants' mental health-related stigma and symptoms of common mental disorders.

Mental health-related stigma

Participants were asked to answer the 5-question Stigma Scale for Receiving Psychological Help (SSRPH)[16] to assess stigma related to mental health and mental health treatment. The tool uses Likert scale responses to assess agreement with questions like "a person should keep quiet if he/she has seen a counselor". Our study employed a version of the tool that has been adapted for comprehension at an 8th grade level[16] and was therefore appropriate for all participants. The response scale ranged from 0-20.

Symptoms of common mental disorders

Our study chose measures designed to capture a wide range of symptomatology for common mental disorders, from subclinical to syndromic. Syndromic symptomatology was captured using the DSM-5 Self-Rated Level 1 Cross-Cutting tool[17]. This tool measures the presence and symptom severity of psychiatric symptom domains that can span multiple diagnostic categories[18,19]. Questions pertaining to psychotic symptoms, substance use, and suicidality were removed, resulting in a 14-question and 13-question adult version and child version of the tool, respectively. Domains in the adult version of the tool include depression, anxiety, anger, mania, somatic symptoms, sleep disturbances, memory problems, and dissociation. Domains in the child version included depression, anger, irritability, mania, anxiety, somatic symptoms, sleep disturbances, and inattention. We used both the adult version and the child version of this tool; the adult version is validated for use among adults 18 and over and the child version is

validated for use among youth 11-17[19]. Response scale ranged from 0-56 for the adult version and 0-52 for the child version.

Subclinical symptomatology was captured using the mini Mood and Anxiety Questionnaire (mini MASQ)[20]. The mini MASQ was designed to assess symptoms of anxiety and depression using a dimensional approach, which measures symptoms that may be present in both anxiety and depression rather than siloing each condition into mutually exclusive categories. This transdiagnostic approach measures three dimensions of symptomatology: anxious arousal, anhedonic depression, and general distress[21,22]. The mini MASQ is a 26-question assessment that is validated for use in adolescents and adults[21]. The response scale ranged from 0-104.

Usability of the STARS intervention

We measured the usability of the STARS chatbot using the System Usability Scale (SUS)[23]. The SUS is designed to assess how user-friendly a technology is by asking questions about learnability, satisfaction, memorability, efficiency, and accessibility, among others[24]. The 10-question Likert scale assessment includes questions such as “I found [the STARS chatbot] unnecessarily complex” and “I needed to learn a lot of things before I could get going using [the STARS chatbot]”.

We added one additional question to the follow-up survey to further assess usability. The question “Overall I would rate the user-friendliness of [the STARS chatbot] as’ gave each participant the option to answer ‘poor’, ‘fair’, ‘good’, ‘excellent’, and ‘best imaginable’.

Analyses

Quantitative analysis

Basic descriptive statistics were computed to gather information regarding the sociodemographic information of participants as well as baseline mental health characteristics. Usability statistics were calculated using the results of the SUS survey and intervention usage statistics were calculated from user data built into the STARS chatbot. Exploratory regression analyses examined associations between sociodemographic characteristics, baseline mental health characteristics, intervention usage data, and follow-up mental health outcomes. Regression analysis included unadjusted analyses and analyses adjusted for age, gender, and years in the US.

Qualitative analysis

Follow-up interviews were recorded and transcribed. Two members of the research team independently coded the transcribed interviews, and then discussed discrepancies between the codes. Taguette[25] qualitative software was used to code transcribed interviews according to barriers and facilitators to implementation, which were organized using the domains and constructs of the Consolidated Framework for Implementation Research (CFIR)[26]. The CFIR was used to uncover insight into aspects of the intervention and implementation environment that could facilitate eventual scale-up in clinical or real-world environments outside of this trial.

Ethics

This study was reviewed and approved by the Internal Review Board at the University of Washington. Participants provided online written informed assent (if under 18) or consent (if 18 or older) for enrollment in the study. As participants could be from anywhere in the United States, and given that the online nature of the study could make follow-up and connection of people to local resources challenging, communicating resources for significant mental distress to all participants proactively was deemed appropriate by the IRB and the mental health professionals on the study team. Participants who completed all study procedures were given a $50 digital gift card. All participants were given health information at the start of the chatbot about accessing formal and informal mental health services and distress/crisis hotlines. Participants who expressed high levels of mental distress during their interaction with the chatbot were sent further information reinforcing available resources.

Results

Quantitative results

Through the duration of the Facebook advertisement for the study, which ran from May – September 2021, the ad reached a total of 15,843 users, with 36,219 impressions and 739 link clicks. 347 people initiated the eligibility survey, 158 enrolled in the study and completed baseline procedures, and 129 completed all baseline and follow-up procedures. Sociodemographic information and baseline mental health and stigma scores were evaluated for 129 participants who finished all baseline and follow up procedures. Of all 129 participants, 29.5% were teenagers ages 14-17 (n = 38) and 70.5% were young adults ages 18-25 (n = 91).

The majority (62.8%, n = 81) of participants were female, 31.8% were male (n = 41), and 5.4% (n = 7) were non-binary or another gender identity. About a quarter of participants had completed some high school education or were still enrolled in high school (24.8%; n = 32), 35.7% had graduated high school (n = 46), 19.4% had attended some college, technical school, or post-high school education (n = 25) and 20.2% had completed college, technical school, or post-high school education (n = 26). Participants had been living in the United States for an average of 17.9 years (SD = 11.4). Participants reported 53 countries of origin (the country of origin of the participant and/or the participant's immediate family). The most represented countries were India (n = 27), China (n = 19), Mexico (n =16), and Nigeria (n = 9).

Baseline mental health scores were generally high using all measures. Young adults scored positive in an average of 3.1 domains out of 8 (SD = 2.3), which included depression, anxiety, anger, mania, somatic symptoms, sleep problems, memory problems, and dissociation. Among these domains, 72.5% (n = 66) scored positive for anxiety and 59.3% (n = 54) scored positive for depression. Teenagers averaged a continuous score of 17.6 out of 52 on the DSM-5 cross-cutting tool for teenagers and scored positive in an average of 4.2 domains out of 8 (SD = 2.4). These domains included depression, anxiety, irritability, mania, somatic symptoms, sleep problems, and inattention. Among these domains, 63.2% (n = 24) scored positive for anxiety and 65.8% (n = 25) scored positive for depression. Adult and teenage participants averaged 76.5 (SD = 23.7) on the continuous mini-MASQ measure, which was out of 104. Full descriptive statistics and baseline mental health scores can be seen in Table 1.

Results of usage statistics

Participants completed an average of 7 sessions out of ten (SD = 3.9). Of all 129 participants who completed baseline and follow-up procedures, 29 did not complete any sessions. Of these 29, 11 (38%) engaged with the chatbot but did not complete the first session and 18 (62%) did not engage with the chatbot. Of the 100 users who completed at least one session, 55 (55%) completed all ten sessions and 67 (67%) completed at least 9 of ten sessions. Sessions were designed to be completed once a day; reminders were sent to participants 24 hours after completion of the previous session. The median time in between sessions was 25.2 hours (IQR = 11.9 hours). Full results of intervention usage are in Table 2.

Usability survey results

Of the 129 participants who completed baseline and follow-up procedures, 125 (96.9%) completed the System Usability Scale survey during follow-up. The intervention scored an overall usability score of 89.0 points out of a possible 100[23], in which higher scores represent better usability[27]. A score of 89 is generally considered 'excellent' in the adjective ratings of 'worst imaginable', 'poor', 'ok', 'good', 'excellent', and 'best imaginable'[27]. Responses to the added question of: "Overall I would rate the user-friendliness of [the STARS chatbot] as" saw 1.6% of participants answer 'poor', 5.6% answer 'fair', 25.6% answer 'good', 48.8% answer 'excellent, and 18.4% answer 'best imaginable'. Full usability results are in Table 2.

Pilot clinical mental health effectiveness outcomes

The number of intervention sessions completed was not associated with lower follow-up scores for all MH and stigma measures. This was true for crude estimates as well as estimates adjusted for age, gender, and years living in the US. Each additional intervention session completed was associated with an adjusted estimate of -0.04 points on the SSRPH (95% CI [-0.14, 0.07], p = 0.49); an adjusted estimate of -0.17 points on the DSM-5 cross-cutting tool (95% CI [-0.65, 0.32], p = 0.50); and an adjusted estimate of -0.44 points on the Mini-MASQ (95% CI [-1.08, 0.20], p = 0.18). Full regression results can be found in Table 4. Age was not associated with completing more intervention sessions (β = -0.01, 95% CI [-0.27, 0.25], p = 0.95), nor was gender or years living in the US (β = 0.47, 95% CI [-1.1, 2.1], p = 0.56 and β = 0.4, 95% CI [-0.02, 0.10], p = 0.16, respectively). Demographic regression results can be found in Table 3. Subgroup analysis resulted in non-significant associations between number of sessions of the intervention completed and follow-up scores among participants with high mental distress at baseline (those who screened positive for any MH category using the DSM cross-cutting tool as well as those who screened positive for depression with a MASQ depression subdomain score of >23) as well as among 'high utilizers' (i.e., those who completed all 10 sessions of the intervention) and 'low utilizers' (i.e., those who completed fewer than 10 sessions of the intervention).

Qualitative results

Participant interviews uncovered barriers and facilitators to the uptake of and engagement with the intervention, which are organized according to the CFIR domains and constructs.

<u>Intervention characteristics</u>

Relative advantage

Participants cited the manner of the chatbot character as a relative advantage because it seemed more human, friendlier, and more interactive/engaging than other chatbots and DMHIs that they had used in the past. Participants pointed out the relative advantage of an instantaneous intervention that doesn't require finding a provider and making an appointment. Participants also recognized the relative advantage of having a mental health intervention online because it allows for vulnerability and openness compared to the embarrassment and judgement that some may feel in person.

> *I think people have an easier time opening up online. There's no face to stare at, there's no one to be embarrassed by. It's almost permission to be more vulnerable. – Female participant, age 23, country of origin: Mexico*

Barriers of the intervention related to the relative advantage construct included participants' experiences using popular commercially available mindfulness apps. Participants preferred the user interface of these apps compared to the STARS intervention, citing the ability to instantly choose programs within the app (rather than having to wait for daily sessions to become available, as was true in the STARS app).

Complexity

The complexity of the STARS intervention was only cited as a facilitator to engagement and uptake. Participants said the intervention was self-explanatory, familiar, uncomplicated, and easy to use.

> *I feel like a variety of ages could use [the intervention] with confidence.*
>
> *– Female participant, age 22, country of origin: India*

Design quality and packaging

Design quality and packaging comprised by far the most feedback from participants, both as a barrier and as a facilitator. The facilitators cited by participants included the length of the intervention, both in terms of individual modules as well as the 10 days in which the intervention is designed to be completed. Participants felt that daily modules that took an average of 20 minutes to complete were efficient and held their attention. Participants also responded favorably to the organization of the content that included reflections from the previous sessions; the examples of stress reduction strategies embedded in the content; the variety of options, both in terms of content choices as well as text response options; and the opportunity to give feedback about the session and the intervention itself after each module. Many participants also expressed favorable opinions about the use of GIFs and emojis, the use of mixed media including audio as well as text, and the relatable persona of the characters in the stories as well as the chatbot itself. Participants also appreciated the reminders that were built into the intervention to prompt daily use. Similarly, participants appreciated when the

chatbot would remember earlier participant responses and repeat them later as a check-in; this made participants feel the intervention was personalized.

> *I definitely liked how it … tried to portray itself as a human companion in certain ways. – Male participant, age 18, country of origin: Ecuador*

Barriers related to design quality and packaging included the repetitive nature of some conversations. Participants were sometimes averse to the auto-generated responses, which participants felt seemed robotic and impersonal. Some also expressed a preference for free-text responses; they felt like the pre-programmed responses did not allow for enough specificity to express their feelings and didn't allow for alternative ways of expressing distress. Participants also commented on the tone and content of some stories and characters, which some participants felt sounded juvenile, patronizing, or cliché. Some felt that the content was too basic and therefore suitable for a younger audience. Some participants also felt the length of the individual modules as well as the intervention itself was too long or too short. They also expressed frustration with the linear nature of the intervention that only allows for completion of one module per day, as well as the inability to revisit previous modules. Participants also expressed the desire to see the intervention in a language other than English.

> *It felt a little bit, not patronizing, but a little like it was talking to someone who doesn't talk to people very much. – Male participant, age 22, country of origin: Poland*

Inner setting

Compatibility

Compatibility was a facilitator because participants generally recognized that people in their age group have an openness to and familiarity with technology, as most people in this demographic have been exposed to and used technology most of their lives. Many participants talked of the compatibility of the intervention to them and their peers, saying the stories and examples used in the intervention (about stressors from work, school, friends & family) were relevant. The social media and message-based platforms were also mentioned as aspects of the intervention that were compatible with their demographic.

Compatibility was cited as a barrier in that some immigrant and refugee communities have stigma regarding mental health. Others expressed that some cultures prefer to handle stress on an individual basis and may be hesitant or averse to using an intervention. Some participants referred to members of their communities that express a general distrust in technology and would therefore not be favorable to a digital intervention. Some participants who believe their demographic has a high level of mental-health related knowledge in general and would therefore not find the intervention useful, or conversely, some have little mental health-related knowledge and would not want to use the intervention or perceive it as unhelpful. Others felt the stories and examples used throughout the intervention were too basic or more relevant towards younger age groups. Many participants liked the social media-based delivery platform,

but several felt Facebook was not the best choice, as other social media platforms are more popular in their demographic.

Tension for change

Most participant comments related to tension for change indicated a perceived need for the intervention. Participants reasoning for this tension included opposition to in-person therapy, a general lack in social support for MH conversations, difficulties in finding MH care due to financial barriers as well as a lack of providers, and a high burden of MH struggles among participants' peers and community. Other participants cited the general usefulness of stress management strategies for the general population. While most participants cited a tension for change, others felt there was not a strong need for the intervention among their peers or in their communities.

> *Is there a need? Yeah. The counseling center that does this at my university has a backlog of 2 months. These kinds of things are important to fill the gaps where there isn't enough mental health professional service and for people who can't afford it. – Female participant (id 329), age 19, country of origin: India*

<u>Characteristics of individuals</u>

Knowledge and beliefs about the intervention

Participants' knowledge and beliefs about the intervention were both barriers and facilitators to uptake and engagement. Barriers centered around the fact that participants felt they and

their peers already have a high level of mental-health related knowledge and therefore would not find the strategies offered in the intervention helpful. Some participants cited the strategies as 'obvious' or more appropriate for younger participants who might not have yet reached that level of knowledge. Participants also cited skepticism that the intervention would be useful because of the chatbot delivery format. They cited feeling like a pre-programmed non-human intervention could not provide useful mental health information. Some participants, however, said their knowledge and beliefs about the intervention changed, often positively, once they started to use it. Other participants cited positive knowledge and beliefs about the intervention from the beginning; they were excited and curious about a chatbot intervention, and often cited their openness and familiarity to technology as reasoning.

> *When I first started using [the STARS intervention], I know it's just an algorithm and it's programmed. But as I went through each lesion, I started looking forward to … what this chatbot could teach me to manage my stress. – Male participant (id 58), age 18, country of origin: China*

Self-efficacy

Participants in general felt like they had high self-efficacy during and after using the intervention. Participants referred to a variety of situations in which they used strategies in their daily life that they learned from the intervention. Some participants talked of using new strategies that they were previously unaware of, while others already knew the strategies but felt that the active use of the intervention served as a helpful reminder to use the strategies

throughout their day. Several participants mentioned having already forgotten some of the strategies after discontinuing daily use of the intervention while others said they have incorporated some of the strategies into their routine.

> *It helped me recognize my own triggers or how I act under stress, so when I do go through those feelings or scenarios, I know what to do. – Female participant (id 333), age 16, country of origin: Cambodia*

Other personal attributes

Other personal attributes were mostly cited as barriers, and these varied widely across participants. Some mentioned personal attributes such as not having the time, attention or interest kept participants from engaging with the chatbot. Others mentioned that individual attitudes towards technology would influence whether people chose to engage with the intervention.

<u>Other barriers and facilitators</u>

Some barriers and facilitators did not fit easily in the selected CFIR domains and constructs. Issues with technology were a barrier that participants encountered throughout the study period. These included general glitches related to the messenger delivery platform and/or the chatbot itself, communication issues and confusion regarding directions, and performance issues that could be related to the chatbot, the messenger delivery platform, or the participant's device or internet connection.

Discussion

This study pilot tested the STARS transdiagnostic digital mental health intervention to assess implementation outcomes to assess barriers and facilitators to uptake and engagement with the intervention and to assess the preliminary clinical effectiveness. Implementation outcomes were assessed quantitatively via engagement statistics and qualitatively via interviews, which were organized according to the CFIR framework. The intervention was piloted via Facebook Messenger among youth and young adults ages 14-25 who self-identified as being from an immigrant and/or refugee community. In total, 129 participants from 53 countries of origin completed all study procedures. Participants reported high mental health symptomatology at baseline: between 63.2% and 72.5% of participants scored positive in anxiety domains and between 59.3% and 85.8% scored positive in depression domains. The number of sessions of intervention completion was associated with lower mental health screening tool scores in all domains, but results were not statistically significant. Participants completed an average of 7 out of 10 intervention sessions, and most rated the user-friendliness of the intervention as 'good' or 'excellent'. In follow-up interviews, participants identified barriers and facilitators to uptake and engagement with the intervention, most of which aligned with the CFIR domains of intervention characteristics, inner setting, and characteristics of individuals.

Barriers and facilitators to uptake and engagement with the intervention largely aligned with established literature about DMHIs. Female participants had the highest completion percentage; this aligns with other studies of DMHIs in which female gender was associated with

greater intervention adherence[28]. Systematic reviews about DMHIs have also found that time constraints are frequently cited as barriers to use[29]; this was similarly cited by STARS participants, and the presence of daily reminder messages was often mentioned as a facilitator. Many participants did, however, cite the short length (10-20 minutes) of modules as a facilitator. Other DMHIs for youth have been criticized as 'too juvenile' or 'patronizing'; some participants also felt that this was the case for the STARS intervention. More strategies are needed to create age-appropriate content, but balancing the specificity of content with the intended broad reach of DMHIs remains a challenge. A systematic review that examined intervention-specific influences on intervention use found that factors like mixed media like videos as well as text positively influenced engagement. This same review found that interventions that allowed the user the ability to personalize content were viewed favorably[30]. STARS participants cited both the personalization aspect of the intervention and the inclusion of non-text media (videos, sound clips) as elements they liked and would not change. Issues with technology are frequently mentioned barriers to DMHI uptake and engagement, both in the literature[28–30] as well as in this study. The ubiquity of this complaint highlights the need for dedicated and ongoing tech support with DMHIs, though the costs associated with this could make DMHIs less affordable. In many studies, mental distress has been found to be a barrier to uptake and engagement with DMHIs[29]. Conversely, however, in studies about DMHIs created specifically for youth, baseline depression was found to predict more adherence to the intervention[28]. Results of the STARS intervention saw those who screened positive for any domain in the DSM cross-cutting tool completed more sessions (though this finding was non-significant), while those who screened positive for depression on the MASQ tool completed

fewer sessions (also non-significant). Non-significant findings were unsurprising considering the study's small sample size.

Our findings regarding the STARS intervention differed from findings in the literature in several ways. Other research has found higher mental health literacy to be associated with DHMI completion[29]. Conversely, the qualitative findings in this study suggest that those with higher mental health literacy may find the STARS intervention too basic and therefore be less likely to engage. Research about DMHIs specifically developed for youth have found the educational components of interventions as a barrier to uptake and engagement[28]. The STARS intervention contains psychoeducation components and in general is based on education of stress reduction strategies, yet no participants expressed dislike for the educational components. This may indicate opportunities to package educational components of DMHIs in a way that is acceptable to young people. Evidence exists in the DMHI literature that including an element of guidance to the intervention, i.e., a clinician, peer, parent, or lay support person with whom the user interacts, can substantially increase the effectiveness of the intervention as well as engagement and adherence[31,32]. The STARS intervention did not incorporate an element of guidance; future research could explore the integration of a guidance component.

Strengths and limitations

This study had strengths. First, the study took place entirely online, which allowed the participation of youth and young adults from anywhere in the US and from a diversity of immigrant and refugee communities. Second, the transdiagnostic nature of the intervention

meant that it could be used by participants with symptoms of mental distress from a variety of diagnostic categories with any level of severity. Third, the study assesses an intervention that underwent a rigorous, participant-led adaptation process prior to pilot testing. Interventions specifically tailored and adapted to the community they are intended to serve are uncommon, especially if those communities include racial/ethnic minorities[33].

The study also had several limitations. First, the small sample size limited our ability to generate statistically significant results in regression analyses. Second, the heterogeneity of immigrant and refugee communities represented in the study means that results may not be generalizable to every community. Third, the study did not include a control group and therefore limited inference can be made about clinical effectiveness. Fourth, statistics about uptake of and engagement with the intervention were likely biased due to the monetary incentive that participants received for participating in the study. Similarly, qualitative results could have been affected by social desirability bias. Last, this study took place fully online during the crisis environment of the COVID-19 pandemic, which may have lessened our ability to detect decreases in mental health symptoms that may have been driven up by this external event.

Conclusion

Mental health is an urgent concern among youth and young adults, especially given the ongoing stressors of the COVID-19 pandemic. Youth and young adults from immigrant and refugee

communities face additional stressors as well as barriers to mental healthcare. The STARS transdiagnostic digital mental health intervention was well-received by participants and showed initial evidence of suitability to this population. More research is needed to maximize clinical effectiveness and bridge the gap between publicly available online mental health resources and evidence based DMHIs tailored to specific populations.

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Tables and figures

Table 1: Descriptive statistics of 129 study participants

Variable	*N (%)*
Demographics	
Age (mean, SD)	19.5 (2.9)
Age category	
Teenagers (14-17)	38 (29.5)
Young adults (18-25)	91 (70.5)
Gender	
Female	81 (62.8)
Male	41 (31.8)
Non-binary or other gender identity	7 (5.4)
Education level	
Some high school, or still in high school	32 (24.8)
High school graduate	46 (35.7)
Some college/technical school/post high-school education	25 (19.4)
Completed college/technical school/post high-school education	26 (20.2)
Years living in United States (mean, SD)	17.9 (11.4)
Mental health at baseline	
Stigma Score, out of 20 (mean, SD)	10.3 (2.5)
DSM-5 adult tool score, domains, out of 8 (mean, SD)	3.1 (2.3)
Depression	54 (59.3)
Anxiety	66 (72.5)
Anger	26 (28.6)
Mania	42 (46.2)
Somatic symptoms	34 (37.4)
Sleep problems	30 (33.0)
Memory problems	13 (14.3)
Dissociation	18 (19.8)
DSM-5 teenager tool score, domains, out of 8 (mean, SD)	4.2 (2.4)
Depression	25 (65.8)
Anxiety	24 (63.2)
Irritability	12 (31.6)
Mania	17 (44.7)
Somatic symptoms	22 (57.9)
Sleep problems	19 (50.0)
Inattention	26 (68.4)
Mini-MASQ score, continuous, out of 104 (mean, SD)	76.5 (23.7)
Anxious Arousal (mean, SD)	31.6 (12.0)
Anhedonic Depression (mean, SD)	23.1 (6.5)
General Distress (mean, SD)	16.6 (7.4)

Table 2: Intervention usage and engagement among study 129 participants

Intervention usage	*N (%)*
Sessions completed (mean, SD)	6.9 (3.9)
No sessions completed	29 (22.5)
1-3 sessions	19 (14.7
4-6 sessions	13 (10.1)
7-9 sessions	13 (10.1)
Completed all sessions	55 (42.6)
System Usability Scale rank	
Poor	2 (1.7)
Fair	7 (5.8)
Good	32 (36.4)
Excellent	61 (50.4)
Best imaginable	19 (15.7)

Table 3: Associations between intervention sessions completed and mental health and stigma follow-up scores

	Crude			*Adjusted***		
	Estimate	95% CI	p-value	Estimate	95% CI	p-value
SSRPH	-0.04	-0.14, 0.07	0.49	-0.04	-0.14, 0.07	0.49
DSM-5 (adult)*	-0.29	-0.84, 0.25	0.29	-0.21	-0.79, 0.36	0.46
DSM-5 (child)*	-0.01	-1.1, 1.1	0.98	-0.07	-1.27, 1.13	0.91
DSM-5 (all)	-0.20	-0.68, 0.28	0.41	-0.17	-0.65, 0.32	0.50
Mini-MASQ	-0.43	-1.1, 0.21	0.19	-0.44	-1.08, 0.20	0.18

*Measured continuously. Should I include dichotomized here?

**Adjusted for age, gender, years living in the US

Table 4: Associations between intervention sessions completed and demographic factors and baseline mental health scores.

	Estimate	95% CI	p-value
Age (years)	-0.01	-0.27, 0.25	0.95
Gender			
Female	-	-	-
Male	0.48	-1.13, 2.09	0.56
Non-binary*	-1.54	-4.82, 1.74	0.35
Years living in US	0.04	-0.01, 0.10	0.16
Depression (MASQ-AD >23)	-0.44	-1.91, 1.04	0.56
Any positive domain in DSM cross-cutting tool	0.30	1.84, 2.45	0.78

*Includes non-binary or other gender identity

Chapter 5: Conclusion

Conclusions and future research

This dissertation includes three publishable manuscripts that contribute to the field of digital mental health. They specifically examine transdiagnostic digital mental health interventions (DMHIs), especially among communities with high burdens of mental disorders but barriers to accessing traditional in-person mental healthcare.

This work has several important findings. We found a dearth of literature about transdiagnostic DMHIs for youth and young adults, despite the availability of mental health-related programs and tools on smartphones and other devices. Among the nine studies that met our systematic review inclusion criteria, we found that most employed therapeutic techniques that were based on or contained aspects of cognitive behavioral therapy (CBT). Most were delivered in a session or module-based format that were designed to most commonly address symptoms associated with depression and/or anxiety. The majority of interventions were self-guided by the user, despite existing evidence that a guidance component can substantially increase clinical effectiveness of DMHIs[1]. We also found that the majority of included studies assessed implementation of the intervention, though most did so minimally. Most employed few follow-up questions pertaining to the feasibility and acceptability of the intervention, and most questions were directed at participants who completed the study procedures rather than sampling those who dropped out or were lost to follow up.

The adaptation and pilot study of the STARS intervention also have several important findings. First, the successful adaptation and high acceptability and usability of the intervention showed the applicability of a global-to-local approach in digital mental health research. Much

global mental health research has focused on creating culturally relevant care that considers the needs, perspectives, and contexts of the communities it is intended to benefit. The STARS intervention, which was originally developed by the WHO for use in low- and middle-income countries, was able to be adapted for use in the high income setting of Seattle. Using Human Centered Design (HCD) methods with iterative prototyping allowed us to develop a DMHI for immigrant and refugee youth that actively engaged this community during the adaptation process. Approaches like HCD methods can increase the relevance and uptake of technologies[2]; further, introducing interventions that have been developed without these techniques runs the risk of low adoption[3].

The applicability of this approach was reinforced in the pilot study, which found good uptake, engagement, and usability of the intervention. This was further examined by qualitatively assessing barriers and facilitators to uptake and engagement. These barriers and facilitators largely aligned with established literature, but aspects of the findings add to the literature about transdiagnostic DMHIs and DMHIs specifically for youth and young adults and for immigrant and refugee communities. For example, technical problems were a barrier in this study as well as the literature[4–6], but the educational components of the STARS intervention were viewed favorably despite literature indicating this is often a barrier to uptake and engagement[5]. These findings can inform future development of DMHIs, especially for populations with high prevalence of mental disorders and barriers to care.

Future directions

The field of digital mental health is rapidly growing, both in and outside of the research world, spurred both by the ongoing COVID-19 pandemic and the ubiquity of technology. Estimates from 2022 show that only 27.7% of the mental healthcare need is being met in the United States, and that 7,871 additional clinicians are needed to alleviate this burden[7]. This figure may be lower for youth, since not all mental health professionals work with patients under 18. At the same time, the number of mental health related digital tools has likely never been higher.

Future research can benefit the digital mental health field in several ways. First, it is needed to assess what components of DMHIs have the most therapeutic benefit, both in terms of the clinical tools as well as other aspects like guidance, delivery modality, length, etc. Second, future research can try to balance generalizability with specificity: transdiagnostic DMHIs can have broad reach and applicability, but can also be catered to specific audiences or communities, such as those who are vulnerable for negative mental health outcomes. Third, there is a need for research that can support people seeking digital mental healthcare. Tools and guidance can be developed to better connect those who would benefit from DMHIs to evidence-based interventions. Relatedly, implementation research can develop strategies for the integration of DMHIs into clinical settings and as part of routine care. Last, research can create strategies to bring together multidisciplinary expertise for the development of DMHIs. Collaboration between mental health researchers and clinicians can benefit from integration with experts on information technology and UX design to maximize clinical effectiveness as well as function and product design.

Moving forward, we hope this work will contribute to the important field of digital mental health and inform the development of meaningful interventions that help alleviate mental suffering.

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