# "This app said I had severe depression, and now I don't know what to do": the unintentional harms of mental health applications

Rachael M. Kang
University of Maryland, Baltimore County
Baltimore, MD, USA
rkang3@umbc.edu

Tera L. Reynolds
University of Maryland, Baltimore County
Baltimore, MD, USA
reynoter@umbc.edu

## ABSTRACT

A growing market for mental health applications and increasing evidence for the efficacy of these applications have made apps a popular mode of mental healthcare delivery. However, given the gravity of mental illnesses, the potential harms of using these applications must be continually investigated. In this study, we conducted a thematic analysis using user-comments left on depression self-management applications. We analyzed 6,253 reviews from thirty-six, systematically selected apps from the Google Play and Apple App stores. We identified four themes regarding the potential, unintentional harms caused by these applications. This study uniquely contributes to the literature by examining the reported harms to users caused by depression self-management apps and contextualizing them in an ethical framework. We provide recommendations to developers for creating ethical depression self-management apps and resources for practitioners and consumers to aid in screening apps.

## CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Empirical studies in HCI**; • **Applied computing** → *Consumer health.*

## KEYWORDS

depression apps, mental health apps, user reviews, thematic analysis

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## 1 INTRODUCTION

According to the National Survey on Drug Use and Health, in 2020, approximately 1 in 10 Americans and 1 in 5 young adults and adolescents disclosed having depression [26]. Some reports indicate that the occurrence of depression almost tripled during the COVID-19 pandemic [48], and projections suggest that the growing prevalence of mental health illness will cost the global economy an estimated $1 trillion [52]. Unfortunately, rates of seeking treatment remain low [26]. While mental health providers work towards better access to healthcare to address this issue, research has begun exploring the potentials of technology in scaling treatment and training to patients and practitioners [22]. Included in these technologies are mobile phone applications (apps), of which tens of thousands are available in app stores to aid in mental health and wellbeing [78].

Research supports the efficacy of mobile mental health apps. Randomized, controlled clinical trials have demonstrated that these apps can alleviate symptoms of depression, anxiety, and other affective disorders [19, 23, 30, 74, 77]. App review studies have also found positive results surrounding the quality of these apps. For example, in a study that evaluated the quality of depression self-management apps, researchers found the reviewed apps had acceptable quality according to the validated Mobile-Applications Rating Scale (MARS) [50, 73]. In a similar study that analyzed features and user reviews on mental health apps, researchers found that, while these apps could include more information on how to track and improve mood, users still expressed positive therapeutic outcomes such as better recognition of mood patterns [15].

However, even with the potential positive effects of these apps, it remains critical to be vigilant for potential negative outcomes. In a user review analysis of depression apps by Bowie-DaBreo and colleagues [10], researchers uncovered a pattern of usability problems that impeded user-experience and, ultimately, prevented users from accessing the potential benefits of those applications. In that same study, researchers discussed that these negative user-experiences may pose ethical issues when a user is prevented from receiving the care these apps market themselves to provide [10]. Similarly, a report published by the American Psychological Association (APA) [44] warns that a lack of regulatory oversight of these applications could cause adverse events that cannot be tracked and, therefore, remain unknown risks.

In this paper, we aim to investigate the potential "unknown risks" to users of depression self-management applications. We chose to focus specifically on depression self-management apps as depression can be a debilitating, chronic condition that has been linked to increase risk of suicide, self-harm, and suicidal ideations [58, 63, 69, 84]. Furthermore, studies have revealed an increasing interest in patients suffering from depression and other mental illnesses to utilize apps to help manage symptoms and aid in therapy [43, 51, 76]. We explored perceived harms users experienced because of depression self-management applications through a qualitative analysis of user reviews left on depression self-management mobile phone apps found in the Google Play and Apple App stores. Our research questions were as follows:



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- In what ways can interacting with a depression self-management app harm a user?
- What issues in depression self-management apps increase the risk of harm?

The themes discovered in this study underline potential harms that users may experience as a result of these apps. Specifically, themes revealed harms related to feelings of being unsupported, undeserving of mental healthcare, being deceived or taken advantage of, and feeling distressed due to privacy concerns. As researchers and members of the HCI community, it is our responsibility to understand both the positive and negative impacts health and mental health technologies can have on a user. This study contributes to these efforts by providing developers, mental health practitioners, and consumers with insights into potential areas of harm that may result from poor user experiences with depression self-management apps and identifying the features that enable these harms. We discuss the resulting themes as they relate to the American Psychological Association (APA) Ethical Principles of Psychologists [6] to better understand the ethical problems surfaced by our study and to guide recommendations for more ethical app development. While there is overlap between the APA Ethical Principles of Psychologists and other ethical frameworks such as the ACM Code of Ethics and Professional conduct [24], we chose the APA ethical principles because they provide more details on avoiding harms, which is the focus of this study, than alternatives. Additionally, because these apps are being used as depression self-management tools, we believed that these apps should also then follow the same ethical principles that psychologists follow in their practices. We end with recommendations to developers on how to avoid the most common design traps through ethical design practices, suggested actions for users on how to best protect themselves, and resources for mental health practitioners on how to stay aware of these apps.

## 2 RELATED WORK

### 2.1 Digital Mental Health Technology

In recent years, research into digital mental health technologies has grown exponentially [65]. In HCI, much research has been devoted to understanding the ability of these technologies to alleviate symptoms of mental illnesses such as depression [21, 37, 59, 65], improve access to treatment [36, 56, 60], enhance therapeutic treatments [16, 27, 61, 82], and detect the presence of depression [79]. The integration of technology into traditional therapy has shown to be effective in cultivating better clinician-patient rapport while also providing patients in-the-moment care if needed [70]. Furthermore, technology can also be utilized to scale up mental healthcare as seen in studies conducted by Doherty and colleagues [18, 19] where researchers utilized a mobile phone application to increase user engagement with wellbeing screening assessments and depression treatment.

Specifically, mobile phone applications seem to have become a popular avenue for technological innovation and intervention in mental healthcare [23, 77, 81]. In 2022, the mental health app global market grossed 5.2 billion US dollars, and, as apps continue to proliferate app stores, the projected 2030 revenue is estimated at 17.5 billion US dollars [62]. Apps have been developed to track mood symptoms [4, 34], support therapy through messaging [16], and provide in-the-moment care [39, 67, 68]. Systematic reviews of randomized, controlled clinical trials have supported the efficacy of mobile phone apps in alleviating symptoms of depression [23, 40, 44, 68, 72]. Though long-term adherence to these apps is an area of concern and continued research [42], users seem willing to engage with these applications [19, 47].

### 2.2 Concerns with Mental Health Applications

Despite the seemingly positive impact mental health technology and applications may have on improved patient outcomes, researchers in both the HCI and medical fields are concerned about certain features of mental health applications [10, 14]. In 2016, the National Institute of Mental Health (NIMH) published an article that outlined the positive and negative aspects of integrating mental health apps into practice, with the latter including questions around efficacy, data privacy, lack of regulation, and lack of evaluation standards [53]. Studies in HCI have also surfaced similar issues. For example, a content analysis of mobile phone apps designed to treat depression revealed that, despite many apps claiming to employ evidence-based interventions, none of the apps included in the study met the National Institute for Health and Care Excellence (NICE) guidelines on treatment and management of depression in adults [11].

Efficacy concerns arise from inconsistent delivery of key aspects of therapy such as crisis intervention [54], not adequately adhering to evidence-based therapies and practices in therapeutic interventions [11, 23, 71], and lack of adequate support in implementing those therapeutic interventions [15]. In regards to privacy, research has demonstrated the importance of privacy to users who engage with these apps [71] and to mental health practitioners whose patients may be engaging with these apps [20]. Lack of regulation and evaluation standards introduce the risk of apps not being equipped to effectively provide the services they promote to users [44] and may also lead to poor usability and user experience that negatively impacts patient outcomes [3, 10, 20]. Unfortunately, due to rapid advancements in mental health technologies such as mobile phone applications, current regulations may not be sufficient in addressing patient risks, potentially leading to unforeseen and unknown adverse events [20, 44]. Our study sought to further investigate these potential adverse events.

### 2.3 Depression Application User Review Studies

Research has demonstrated the ability to extract meaningful data regarding usability and user experience from online user reviews [29, 31]. As there are tens of thousands of mental health apps commercially available, the data from publicly available user reviews may be a rich source of information in assessing the usability of these apps [57]. There are several existing user review studies conducted specifically on depression apps. These studies have revealed that issues within these apps (e.g., loss of data, bugs, lacking features) can result in negative user experiences and sentiment [10, 71].

For example, Bowie-DaBreo and colleagues describe the ethical considerations of poorly constructed applications and uncovered themes among the user reviews left in the depression apps that pointed towards ethical violations regarding safety, autonomy, transparency, trust, and more because of usability issues within

the apps [10]. Researchers also outlined elements that should be considered to design ethical apps for depression, one of which is anticipation of risk (i.e., the duty of a developer to understand the potential adverse events associated with negative user experiences with the app).

In a user review study conducted by Stawarz and colleagues [71], researchers reported users experiencing severe emotional distress as a result of usability issues within depression apps. Similarly, in a user review study of mental health apps conducted by Haque and Rubya, reviews revealed user frustration surrounding a lack of transparency, consistency in standard of care, and features to assist in therapeutic support [28]. As stated above, a lack of regulatory oversight prevents proper documentation and anticipation of adverse events caused by these apps. User review studies on mental health apps have indicated potential areas of adverse events because of poor user experience with these apps and ethical considerations associated with usability issues within these apps.

Prior user review studies on depression apps have demonstrated user discontent with depression apps as well as usability problems stemming from bugs, lack of functionality or features, or improper implementation of therapeutic principles [10, 15, 28, 71]. However, these studies tend to present high-level issues without unpacking what the actual harm was that the user experienced because of these usability problems. This study explores the potential adverse events experienced by users with the aim of supporting developers in creating ethical depression self-management apps by contextualizing the adverse events against the APA Ethical Principles of Psychologists [6]. We also hope to provide both consumers and mental health practitioners insight into the potential, adverse events associated with these apps and how to mitigate the potential risks [44].

*2.3.1 Ethical Depression Self-Management App Development.* The importance of holding mental health apps including depression self-management apps to established ethical standards grows increasingly prevalent. In a study conducted by Larsen and colleagues [38], researchers investigated app store description pages for mental health apps, finding that 64% of apps included in their study claimed efficacy in reducing symptoms of mental illness or diagnosing a mental illness, and 44% of apps used "scientific language" to demonstrate efficacy claims. However, in a similar study conducted by Marshall and colleagues, it was reported that only 3% of anxiety and depression apps had published literature demonstrating the efficacy of the app [45]. The development and promotion of apps that may not be evidence-based raises ethical concerns.

In a review published in 2019 by Sanches and colleagues [65] on affective health in HCI, researchers analyzed 139 papers published within the last 10 years in SIGCHI proceedings on depression, anxiety, and bipolar disorder to find that only 48 papers addressed ethical issues of any kind. DaBreo and colleagues [10] described user experiences with depression apps via user reviews in the context of ethical principles adapted from either biomedical ethics [9] such as beneficence (i.e., having the welfare of the user as the goal), non-maleficence (i.e., obligation to not inflict harm on others), justice (i.e., equal distribution of benefits and risks), and respect for autonomy (i.e., a person's right to make decisions on their own behalf without external pressures), or general ethics [80] such as virtue (i.e., the expectation of positive intention). However, to the best of our knowledge, user-experiences with affective health technologies such as depression self-management apps have not been analyzed through the lens of the APA Ethical Principles of Psychologists [6]. There are five general principles of ethics that the APA states all psychologists should strive to follow (Table 1).

We argue that, because depression self-management apps are advertised as tools to aid in alleviating symptoms of depression (i.e., therapeutic psychological tools), even if there is no literature substantiating these claims, the developers who are creating and promoting these tools should be held to the same ethical principles to which psychologists are held. We examine our found themes against the APA Ethical Principles to provide an ethical analysis to articulate violations of the APA Ethical Principles.

# 3 METHODS

## 3.1 Application Identification and Selection

App identification and selection were completed using tenants of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [49]. First, we conducted an initial search for applications in the US Apple App and US Google Play stores, peer-reviewed journal publications evaluating mental health apps, and "psychologist recommended" apps that were promoted in articles by psychological societies (e.g., APA). Initial searches used "depression" as the search term with the assumption that the app store algorithms would return any apps with the word "depression" in either the description or title. After clicking into a specific app, the app store also provided a "similar app" or "recommended app" list. Apps on those lists were included if they did not appear on the main page of apps provided by the store as these are the apps the users would most likely also encounter in their search. After reviewing the apps in this initial search, we conducted a second search using the phrases "depression help" and "depression self-management" to ensure all relevant apps had been found. All app titles resulting from the app store searches, peer-reviewed publication, and "psychologist recommended" promotions were included in the identification stage. At the identification stage, apps were removed if they were duplicates and or abandoned (i.e., apps that had a blank description page and no developer information). For apps that were identified in peer-reviewed journals or "psychologist recommended," the title of the apps was searched in both app stores. If the app did not appear in either app store, they were labeled as "non-existent" in the identification phases.

Apps were first screened for relevance based on titles. App titles that misused "depression" such as "Depression Wallpaper," "Sad Depressed Quotes," and "Depression Quotes" were considered irrelevant apps, and apps with foreign titles such as those written in Arabic or Spanish were excluded. However, apps with nondescript titles such as "Shmoody" and "Mind Reset" were considered "potentially relevant" apps and moved into the next stage of screening as is specified in the PRISMA standard [49].

Following this, apps were screened based on their description. Using the definition of "self-management interventions" outlined by Jonkman and colleagues [33], we specifically targeted apps where the main features were mood tracking (either through check-ins, repeated assessments, or journaling) and in-app skills delivery. According to Jonkman and colleagues' definition of "self-management

**Table 1: The APA Ethical Principle's five general principles of ethics [6]**

| Ethical Principle | Description |
|---|---|
| Beneficence and Non-Maleficence | Strive to secure the welfare of those they interact with, take care to do no harm, and resolve conflict in a manner to avoid harm |
| Fidelity and Responsibility | Because of the trust cultivated between patient and psychologist, remain aware of professional responsibilities to the communities and societies they work with, clarify professional roles and obligations, accept responsibility for their behavior, and manage conflicts that could lead to harm |
| Integrity | Promote accuracy, honesty, and truthfulness, and do not steal, cheat, engage in fraud, or intentionally misrepresent facts |
| Justice | All persons have the rights to access and benefit from psychology and the right to equal quality in procedure, process, and services |
| Respect for People's Rights and Dignity | Respect the dignity and worth of all peoples of all backgrounds and the rights of every individual to privacy, confidentiality, and self-determination and provide necessary safeguards to protect the rights and welfare of vulnerable peoples |

interventions," such interventions *"aim to equip patients with skills to actively participate and take responsibility in the management of their chronic conditions"* by containing two or more listed features. Included in these features are "independent symptom monitoring," and "enhancing problem-solving and decision-making skills for medical treatment management." At the conclusion of the screening stages, we finalized the list of apps included in this study. We noted reasons for exclusion at each stage.

*3.1.1 Data Extraction and Thematic Analysis.* Meta-data and user reviews for the included apps were collected using Python app store scraping packages [30, 32, 41]. Application details such as version history, data privacy, and in-app purchase information were collected from the app description pages. Due to the uneven distribution of star ratings, with far fewer 1-, 2-, and 3-star reviews compared to 4- and 5-star reviews, the former were analyzed together. Because the scope of the study aimed to understand the potential harms of mental health applications on users, reviews were examined with specific attention placed on language relating to in-app experiences that led to negative outcomes or distress to the user.

User review data were analyzed using an inductive, reflexive thematic analysis approach as described in Braun and Clarke [12, 13]. A thematic analysis is a data analysis method that can be used to identify patterns and meaning across a qualitative dataset. A reflexive, inductive thematic analysis is one of several thematic analytic approaches whereby a researcher employs subjective skills to analyze the data and iteratively develop codes and themes in an organic and open process [13]. As Braun and Clarke [13] recommend against more than one researcher in this thematic analysis approach, one researcher was involved in the data review process, after which both researchers discussed and refined themes.

Reviews for all included applications were separated into star-rating tiers (e.g., a 1-star reviews tier) and sorted by date posted from newest to oldest reviews. It was assumed that newer reviews would better represent the impacts of the most up-to-date version of the app and would, therefore, be more relevant than older reviews based on outdated versions of the app. Then, within each of these tiers, one author (RMK) examined reviews in batches of 100 until thematic saturation was reached [66]. Saturation, according to Glaser and Strauss [25], occurs when "no additional data are being found." In our case, and following the model of saturation developed by Saunders and colleagues [66] for "inductive thematic saturation," we concluded saturation had been reached when no new themes regarding negative outcomes due to negative in-app experiences emerged. To confirm no new themes emerged in a star-rating tier in different applications, we took a stratified sampling approach [55], examining the 50 newest reviews for the remaining applications. Reviews that were not written in English, only contained emojis, and were less than 20 characters in length were excluded from the analysis.

## 4 RESULTS

A total of 521 applications were identified using the search strategy described above. Of the 460 unique applications that still existed after removing duplicates and screening, 40 met our definition of a self-management app, offering both mood tracking and in-app skills delivery features. Applications that were excluded were typically 1) providing teletherapy services as the main mode of therapeutic services (e.g., BetterHelp), 2) primarily artificial-intelligence (AI) chatbots, 3) games, or 4) chat forums. Figure 1 displays the PRISMA Flow Diagram of the screening process for the applications. In addition, during the data extraction process, we determined that an additional app did not meet the inclusionary criteria, two apps did not contain enough user reviews (<4 reviews), and all of one app's reviews were not in English. As such, we extracted data and analyzed user reviews for 36 applications.

Of the selected applications, three were exclusive to the Google Play store, 12 were exclusive to the Apple App store, and the remaining 22 were available on both stores. Table 2 displays descriptions of the Top 3 rated applications among Android exclusive, iOS exclusive, and both groups. Thirty-five of the 36 apps promoted either the use of an evidence-based or research-based therapy (e.g., Cognitive Behavioral Therapy) or partnership with a mental health professional. Ten apps found in the Apple Store and 3 found in the Google Play store stated the efficacy of their app. Nine apps in the Google Play store included a disclaimer in the app description that the app should not replace professional treatment or help, and 15 apps on the Apple Store included a disclaimer.

Three apps shared the same developers, leading to a total of 33 unique app developers. 19 developers were from the US, four were from England, two were from Germany, one from the Czech Republic, one from Australia, one from Lithuania, and one from Korea. The country of four app developers were unavailable for discovery. A full table of all included app ratings, descriptions, and developer information can be found in Appendix A. A total 27,222

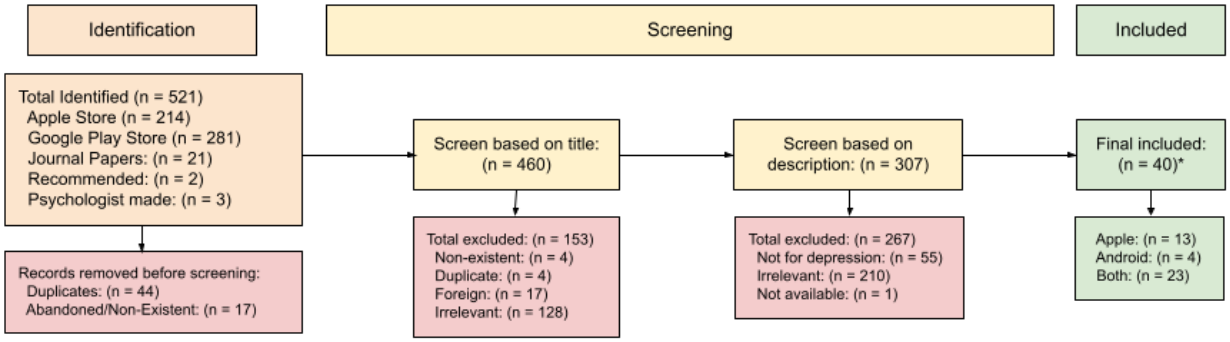


**Figure 1: PRISMA flow diagram of app selection process.**

*Neurocycle, Mentalia, Depression Manager, and Aime were excluded during data extraction process. A total of 36 apps were analyzed.

**Table 2: Top 3 rated applications' descriptions among apps available on Apple Store, Google Play, and both**

| App Name | Platform | Num. Ratings | Num. Reviews | Avg Rating | Release Date |
|---|---|---|---|---|---|
| CBT Guide to Depression & Test | Android | 1561 | 415 | 4.25 | 2012-02-26 |
| CBT Thought Diary: Depression | Android | 75 | 11 | 4.22 | 2015-03-04 |
| MoodSpace - Stress, Anxiety, & ... | Android | 3751 | 1080 | 3.86 | 2015-03-04 |
| Bloom: CBT Therapy & Journal | iOS | 10850 | 877 | 4.82 | 2019-08-13 |
| Enlighten: Guided Wellbeing | iOS | 42 | 7 | 4.86 | 2018-12-08 |
| Feelmo: Mental Health Support | iOS | 62 | 17 | 4.90 | 2021-01-06 |
| Bearable: Symptom & Mood Tracker | Both | Android: 5145<br>iOS: 1235 | Android: 1742<br>iOS: 199 | Android: 4.65<br>iOS: 4.74 | Android: 2020-03-12<br>Apple: 2020-03-17 |
| CBT Thought Diary | Both | Android: 6162<br>iOS: 15495 | Android: 2064<br>iOS: 224 | Android: 4.53<br>iOS: 4.84 | Android: 2014-06-28<br>Apple: 2015-07-08 |
| Moodlinks Anxiety & Depression | Both | Android: 175<br>iOS: 186 | Android: 70<br>iOS: 6 | Android: 4.52<br>iOS: 4.91 | Android: 2020-03-28<br>Apple: 2020-03-31 |

reviews were collected across all applications in both app stores. We analyzed 6,253 reviews in total following the procedure described in the methods. Table 3 shows the number of reviews analyzed by star-rating.

**Table 3: Number of reviews by star rating and number of analyzed reviews by star rating.**

| Star Rating | Num. Reviews | Num Analyzed |
|---|---|---|
| 1 - star | 2524 | 1224 |
| 2 - star | 1021 | 743 |
| 3 - star | 1584 | 930 |
| 4 - star | 4119 | 1195 |
| 5 - star | 17974 | 2161 |
| Total | 27222 | 6253 |

## 4.1 Negative User Review Analysis: Potential Harms of Depression Self-management Applications

We identified four major themes that appeared across applications' "negative" reviews (i.e., 1-, 2-, and 3- star ratings), with the last theme emerging primarily in the reviews from the Google Play store:

- Theme 1: Feeling unsupported due to bugs and poorly designed features
- Theme 2: Feeling undeserving of mental healthcare due to poor accessibility
- Theme 3: Feeling deceived or taken advantage of due to deceptive marketing tactics or updates
- Theme 4: Feeling distressed and worried due to disclosure threat of their mental health data

Figure 2 displays the distribution of themes across the applications.

*4.1.1 Theme 1: Feeling unsupported due to bugs and poorly designed features.* This theme speaks to potential harms that result when apps do not provide sufficient support for their users whether by design or because of malfunctions. Specifically, user comments point to a lack of information on how to improve mood or access help, poorly thought-out features that negatively affect the user's mood, and technical issues that rendered the therapeutic component of an application unavailable. This theme highlights a potential harm on the user as it could lead to the user feeling both distressed and helpless.

For example, applications that use jargon and tools designed for mental health professionals without fully decoding this information

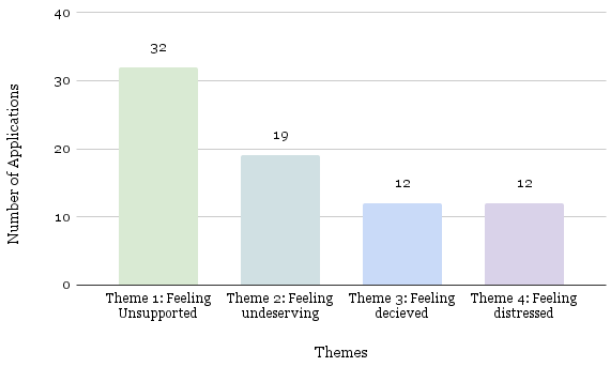


**Figure 2: Theme Distribution among applications**

for their lay-person target audience may result in users misinterpreting the results and feeling distressed, which can be made even worse if the app also provides little guidance or unhelpful advice on what to do next. One user wrote about the iOS app Depression Test, *"Is it bad that I have a 20/27. This app helps but I don't know what to do."* This quote suggests that the user does not understand how to interpret their result from the in-app depression test and there may not be sufficient guidance on how to do so or what to do next. Another review of the same app shows the harm this lack of knowledge and support can cause, especially for vulnerable individuals:

> *"I'm still 12 years old, and [. . . ] I took the test [PHQ-9] and got a 16/24. It [the application] told me I have severe depression, and that makes me really anxious. [. . . ] I'm still not sure why I'm depressed, but it did make me feel really scared for the future and myself."* (Depression Test, iOS).

In another app, Mood Tools on Android, one user commented, *"[. . . ] She [in-app chat feature] told me I was bipolar and [to get] over it with prayer and talking to friends ha!!"* These comments highlight the potential harms when apps assume users know how to interpret the information about their mental health that is provided by the app. When the user knows something is wrong but does not have sufficient support to address the problem, it can result in feelings of fear, anxiety, and more distress.

Similarly, technical problems (i.e., bugs in the application) can also leave the user feeling distressed and unsupported. For example, when one user of Bloom on iOS lost their data after an update to the app, they lamented, *"[. . . ] Imagine doing months of work toward healing trauma and anxiety, and documenting it, only to realize all of your entries can not be [retrieved] for alter reflection?! I literally cried and panicked for two days [. . . ]."* Another user on What's Up Android faced a similar scenario when a bug made the diary feature inaccessible. *"[. . . ] Keeping a journal and writing down my thoughts is apart of the current personal therapy program and quite contrary to what the app is supposed to do, losing my content to cyber space is discouraging and makes me feel like I should give up."* As evident in these comments and the others like them, users who rely on these apps to track their "healing" progress may be distraught to learn that their progress has been deleted, is irretrievable, or not trackable due to a bug in the application.

Furthermore, persistent bugs in an application could directly impede therapy efforts if the application is actively being used in a user's therapy sessions. For example, in two reviews left on DBT Diary Card & Skills for iOS, an app created by clinicians to be used in their practices, users reported the same bug on a key feature of the application – being able to email their therapist their weekly diary card – that directly and negatively impacted their therapy progress. One user wrote, *"[. . . ] This is frustrating because it set my therapy session back by 2 weeks,"* while another user wrote, *"[. . . ] I RELY on this app [. . . ] If I cannot send this [diary card] to my therapist, nor can I export to .pdf or .csv, it is a work stoppage issue."*

When technical issues arise with key therapeutic features, users may be left feeling distressed and hopeless. These feelings could be made worse when developers do not fix these bugs in a timely manner or, in some cases, seem not to address them at all. Taking one last comment from the DBT Diary Card & Skills for iOS, a user mentioned feelings of abandonment about developers not fixing the bugs identified in the application: *"[. . . ] Things are breaking within the app and you've either decided to do nothing or have completely forgotten about us altogether."*

Finally, based on evidence in reviews, a lack of diversity in user testing may contribute to poorly thought-out features in an application that could unintentionally cause harm on the unrepresented user. For example, one user commented on Being my mental health friend for Android that the application's exercises were not sensitive to their condition, leaving them feeling worse than before. This user stated, *"Most of the [prompts] [were] about work or owning a business, which made me more depressed because I cant work and am on disability. Thanks for making me feel worse about myself than I already did. [. . . ]"* For this user and others, depression symptoms are exacerbated by features that do not recognize the diversity of the user and their situations.

Another instance of this was seen in the Shmoody application for iOS. A user suggested to the developers to be more inclusive of women using the app, specifically referring to women with depression and experiences with sexual assault. The comment explained, *"[. . . ] Many women who have depression [. . . ] have experienced sexual assault and may be especially triggered on bad days by you recommending Bill Cosby and Louis CK at the top of your comedy list [. . . ] That really shut me down when I was looking for something to cheer me up this evening."* These comments suggest that content in depression self-management apps should be carefully curated to avoid unintentionally triggering negative reactions and emotions in users.

*4.1.2 Theme 2: Feeling undeserving of mental healthcare due to poor accesibility.* The second theme that we identified related to accessibility problems that elicited feelings of hopelessness from the users. These comments mentioned how discouraged or frustrated users felt about not being able to access mental healthcare due to factors such as the pricing of the applications and accessibility issues within the applications. Though many apps were free to download, a majority contained in-app purchases that ranged in price depending on the type of purchase (i.e., weekly vs. monthly subscription) (Table 4).

Negative user comments about "paywalls" centered mostly around the subscription-based applications that prevented the user from

**Table 4: Top 3 expensive apps available on Apple Store, Google Play, and both. Full table of included apps' prices in Appendix A.**

| App Name | Platform | Price \| In-app Purchase |
|---|---|---|
| *Moodspace - Stress, Anxiety, & ... | Android | Free \| $3.00 - $ 22.99 |
| Bloom: CBT Therapy & Journal | iOS | Free \| $3.99 - $159.99 |
| Enlighten: Guided Well-being | iOS | Free \| $9.99 - $399.99 |
| Uplift - Depression & Anxiety | iOS | Free \| 12.99 - $99.99 |
| Mindshine: Mental Health Coach | Both | Android: Free \| $12.99<br>Apple: Free \| $12.49 - $129.99 |
| Mooditude: Mental Health App | Both | Android: Free \| $6.49 - $124.99<br>Apple: Free \| $6.49 - $149.99 |
| Simple DBT Skills Diary Card | Both | Android: Free \| $3.99 - $119.99<br>Apple: Free \| $0.99 - $12.99 |

* Moodspace was the only included app available on both app stores that required any form of payment.

accessing either the whole application or a large portion of the application without signing up for a subscription. Many users commented on the injustice of this broadly. For example, *"Stop putting mental health help behind paywalls. It's inaccessible. It carries the message that people who can't pay don't matter. I am so sick and tired of it."* (CBT Thought Diary, iOS). Other users specifically talked about how it impacted them:

> *"I used this for over a year on my old phone with no problems. This week, I switched to a different phone and most of the stuff I used [...] is suddenly hidden behind a paywall of $50 a year. It might not be much to some but that's a lot for me and I won't be able to afford it. It makes me sad because this was the first mood app that I used regularly and it was really helping me track my manic and depressive episodes [...]"* (MindDoc, iOS).

While some comments simply stated that the pricing of the application was too exorbitant, many comments like the ones above expressed sentiment around feeling disheartened, unimportant, or frustrated that they could not access mental healthcare or were barred from accessing previously accessible mental healthcare solely because they could not afford the application. Though it is not a secret that mental healthcare can be expensive, research has suggested that technology could be used to mitigate these expenses [22]. Yet, when users turn to mental health applications for support and are met with paywalls, they face another barrier to accessing necessary care [5].

Accessibility issues can also be barriers to using these applications for users with visual impairments. Users called out the applications' lack of customizability for those with different needs, "**Developers* PLEASE update so we can choose different font sizes or in dark mode vs black lettering"* (Sensa, iOS), as well as the incompatibility with accessibility tools such as screen readers or voiceover functionality, *"[...] There are major accessibility issues for blind users. I use voiceover for the iPhone and this app doesn't work with it really at all"* (Tochi, iOS). These accessibility issues made it difficult or even wholly prevented users from being able to utilize the applications at all.

While it may be difficult for developers to create applications that are accessible to all people with disabilities, the potential harms of not making these applications accessible range from impeding care to not being able to receive care at all. One user succinctly stated the issue, *"Please consider making this app accessible to all, not just sighted users. Blind people need DBT, too. Thank you."* (DBT Coach, Android).

*4.1.3 Theme 3: Feeling deceived or taken advantage of due to deceptive marketing tactics or updates.* The third theme highlights situations where users felt that they had been lied to or taken advantage of due to being unfairly charged or being coerced into paying through deceptive methods. As a result of being deceived, users described facing harmful consequences such as being put into financially stressful situations or having their data held "hostage." In comments regarding users being unfairly charged by the application, users revealed that they were not made aware that they would get charged until after the fact or were charged even after cancelling their subscriptions. While many of the comments regarding being unfairly charged described anger, frustration, and stress due to feeling as though they had been robbed, other comments arose about how the unexpected costs put them in a financially distressing situation. For instance, the following review of Bloom on iOS:

> *"I had downloaded this app and quickly cancelled my subscription to avoid being charged any money. Only to have $60 taken out of my account regardless. For someone who can barely make enough money to eat, I'm beyond infuriated there's no way to contact anyone on this app to dispute the issue. Not only did this app make my mental health worse at this point, but now half my food budget for the month is gone. Disgusted."*

The potential harm resulting from unexpected charges goes beyond mental and emotional distress for some, as seen in the comment where the user spoke to losing half their food budget for the month. Additionally, such practices may undermine trust in specific apps. But, even more worrisome, they may undermine trust in mental health apps more broadly as can be seen in a user comment left on the Being my mental health friend application for Android: *"They [app developers] are cruel, they don't make you feel safe, they made me feel like I could trust them and in the long run I got severely hurt, I felt violated, my trust issues got [severely] worse even more than they already are. [...]"*

In addition to feeling deceived from being unfairly charged, some users revealed feeling lied to when their mental health tracking data was taken "hostage" until they paid for a subscription. Applications would accomplish this by allowing the user to interact with the features for a time-period before requiring a user to purchase a subscription without first letting them know in the app's description this would happen. For example, one MindDoc for Android user stated, *"It'll give you a couple months free, then hold your mood results*

*ransom. This is exploitative and scammy. [...] It's ransomware that preys on the mentally vulnerable."* Another user of the iOS version of this app wished that, at a minimum, the app was upfront about the trial period: *"This paywall completely eliminates my purpose for having this app. [...] At least specify that months are going to be blocked off unless you have a MindDoc subscription."* Other apps seemed to use a similar strategy, with a user of Bearable on Android, reporting: *"This app was amazing, kept track of everything I needed it to do. Then all of a sudden features that WERE FREE are behind a paywall that most disabled people cant afford. I cant even look at any of my old notes that I need to share with my doctors."*

As described in Theme 1, the inability to access previous records of care can result in distress to a user, especially if those records were important to a user's mental health journey and interactions with their provider. However, the users here were left feeling unsupported specifically because the inability to access their records stemmed from a ploy to pressure users into buying a subscription. Moreover, these comments reveal that the users were not made aware of these practices, which made them feel as though they had been deceived. We checked descriptions of these apps and found no mention of lacking access to historic data without a subscription. While this may be a nuisance in other types of apps, pressuring users into buying a subscription to gain access to historical mental health tracking data is perceived as unethical by users and could cause serious harm.

*4.1.4 Theme 4: Feeling distressed and worried due to disclosure threat of their mental health data.* The last theme that emerged from the data surrounded user comments and negative feelings towards ambiguous privacy policies as well as concerns for data privacy. Data privacy concerns and issues may lead to harmful consequences for a user as a breach of privacy could result in their mental health information being unknowingly or unwillingly disclosed. For example, one user commented on MindDoc for Android, *"SHARES YOUR DATA WITH FACEBOOK EVEN WHEN YOU DON'T CREATE A USER THROUGH FACEBOOK. [...] Was quite a shock to see in my data overview on Facebook."* The Facebook feature mentioned in this comment is a list of places Facebook receives data about a user, which, according to Facebook's Meta Privacy Policy, are then used by Facebook to *"provide and improve our products"*, including *"personalizing features, content, and recommendations."* However, the exact nature of these "improvements" and "personalization" are ambiguously described. Another comment for this app revealed that this was stated in the app's privacy policy and drew other potential users' attention to this:

> *"After reading the privacy policy, I discovered that the app has facebook software development kit integrated in app, which means that all data from app is accessible for facebook. I don't recommend installing it if you don't want your mental health used against you and sold to advertisers."* (MindDoc, Android)

When users' personal, mental health information is shared with other people or parties, there exists many potential harms relating to the exposure of health information.

> *"People use this app in order to work through their most private and vulnerable thoughts and feelings. This means that the app developers have not only a duty but a responsibility to protect the private information written in this app because it's purpose is therapeutic not financial. [...] These predators are using private information milked from vulnerable individuals who are uninsured and under-insured in order to fill their own coffers. Apps of this nature need more federal oversight."* (CBT Thought Diary, iOS).

Users are aware of the sensitivity of the data being inputted into these mobile phone apps. A user's willingness to use an app relies heavily on the trust the user has that their data remains private and that the developer protects that private information. However, trust in an application extends beyond just how the application handles the data on the backend. Individuals who utilize the application to track their mood and other mental health information will sometimes purposefully seek out applications that have security features. When those features break, not only is trust in the application lost, but there also may be potentially negative, real-life consequences for the user if others access the information stored in the app.

> *"Love this app but the big update caused the passcode lock to not work. Please bring back/fix passcode lock. I have so much personal stuff in here and can't afford for it to get out. Need security beyond my phone passcode because my family has access to my phone but I don't want them to have access to my DBT info."* (DBT Diary Card & Skills, iOS).

As all the comments above describe, the data stored in these applications may be very sensitive, some being "personal problems" and others being "personal stuff" that the user "can't afford to get out." While the exact reason is unclear as to why users may be worried about their mental health information being disclosed, many are concerned and want this sensitive data to be protected as any health information should be.

## 5 DISCUSSION

Numerous 4- and 5- star ratings suggest users are more than willing to engage with depression self-management applications. However, the unintentional harms caused by these applications as seen in the 1-, 2-, and 3-star reviews, even if experienced by a relatively small proportion of users, tend to affect particularly vulnerable or marginalized users such as those with disabilities, and must be addressed as they speak to a broader discussion about ethical concerns regarding mental health apps. Based on our results, we argue that there is an urgent need for action on multiple fronts; specifically, we call for: Ethical Depression Self-management App Development, Privacy for Users, and Resources for Clinicians.

### 5.1 Ethical Analysis

After conducting the thematic analysis, we view our themes through the lens of the APA Ethical Principles as a framework. Results from the thematic analysis demonstrate the harmful consequences when apps violate these ethical principles. Our ethical analysis highlights poor content maintenance and moderation, financial and accessibility barriers, lack of transparency, and privacy violations as design traps into which depression self-management app developers tend to fall. We discuss tensions around key design decisions as reasons why developers fall into these traps and provide recommendations on how they may be addressed.

*5.1.1 Poor maintenance and content moderation.* When users download an app marketed as an aid in depression self-management, especially when an app promotes itself as developed in tandem with clinicians or employing "evidence-based" techniques, a certain amount of trust is afforded to these apps by virtue of the professionals and researchers who supposedly supported the development. Developers then have a responsibility to their users. And when such apps cause users more emotional suffering, this is a violation of the ethical principles of fidelity and responsibility. We see the violation of this principle in Theme 1. Poor app maintenance resulting in bugs as well as poor content moderation such as unclear therapeutic guides or insensitive material led users to feeling fearful, anxious, angry, or even distressed.

While it is impossible for apps to never have bugs and for developers to be aware of every nuance in psychological content being received by the user, we recommend that developers be more proactive and transparent in their communication and design practices to avoid the common design trap of poor maintenance and content moderation and to better adhere to the principle of fidelity and responsibility. Specifically, developers should consider:

- Issuing notices when bugs are identified so that users know the developer is aware of the problem and is actively trying to fix it.
- Employing user-centered design processes [1] during app development to pinpoint key features and content of apps.
- Including a "last updated" date on psychological information to demonstrate the frequency of content maintenance to users.
- Providing users a "report" option on content in case app content becomes outdated or harmful.
- Actively communicating with users on app updates to maintain the afforded trust and remain responsible for the well-being of the user.

*5.1.2 Financial and accessibility barriers.* According to the APA Ethical Principle of Justice, all persons have a right to access and benefit from psychology as well as a right to equal quality in services. In Theme 2, we saw many comments about money, the ethics around placing paywalls on mental health apps, and accessibility issues. User reviews mentioned once free apps becoming subscription based, subscriptions suddenly jumping up price, and app features not being accessible to visually impaired users. Users also revealed harms associated with being prevented from accessing to the care provided by these apps.

Although approximately 68% of mental health applications found on Apple App and Google Play stores appear to be commercially developed [3], by advertising these applications as support for mental healthcare, developers should be held responsible for keeping the welfare of the user as the goal over making a profit from the application. However, this is easier said than done. In a review study that compared applications found on both Apple App and Google Play stores [2], researchers spoke to application developers about app costs. The developers revealed that creating and maintaining applications, no matter which store they are hosted on, requires extensive time, money, and resources. Some developers revealed that they had no choice but to require apps to be bought or have in-app purchases. Therein lies the dilemma where Theme 2 arose: who should be the ones financing the app? Creating and maintaining an application, in general, is a time intensive and costly endeavor [2]. As a result, certain accessibility features may be overlooked, and paywalls may be required to fund the maintenance of the application. However, the negative impact of these occurrences results in obstacles to obtaining care for low-income individuals (who also may have limited access to traditional mental health resources) and individuals with visual impairments, increasing the risk of unintentional harm due to making mental healthcare inaccessible to all users.

We recommend that apps adhere to accessibility best practices [8], be transparent in their fee structures, and provide mechanisms for low-income individuals to access the app to avoid the design trap of financial and accessibility barriers and to adhere to the ethical principle of justice. Specifically, based on issues highlighted in our results, developers should consider:

- Including dark-mode capability to increase contrast between content and background.
- Allowing for font and colour scheme customization to provide better accessibility options to users
- Ensuring the interface is accessible by a screen-reader.
- Warning users in advance of increasing subscription prices or a new subscription policy so that they can prepare accordingly.
- Providing multiple methods of payment such as weekly, monthly, or yearly subscriptions or a one-time fee, or providing alternative payment plans such as a sliding scale fee structure and discounts for certain populations (e.g., students).

*5.1.3 Lack of Transparency.* The design trap of lacking transparency could be most seen in Theme 3 where users felt intentionally tricked by the developer and is in violation of the ethical principles of integrity as well as beneficence and non-maleficence. In this theme, users revealed deceptive practices such as a lack of transparency regarding the "free trials" given by an app that led them to feeling forced to pay for a subscription lest not have access to their historic health data. Essentially, users felt that their data were being held hostage for ransom by the developers or that they had been tricked into paying for a subscription through a "free trial" ad. By not being explicit about what constitutes a "free trial," and by not being explicitly clear about the accessibility of historic data, developers were in violation of the principle of transparency. Moreover, because users indicated being put at financial risk of harm due to being unjustly charged by the app by either needing to pay for their ransomed data or being tricked into a subscription, the principle of beneficence and non-maleficence was violated.

Additionally, while not a theme discovered through the app reviews, an examination of the descriptions for the apps revealed that nearly all apps promoted the inclusion of evidence-based practices such as Cognitive Behavioral Therapy or the inclusion of a mental health professional in development. Several apps also indicated the efficacy of the app in alleviating symptoms of depression, but only two apps provide citations to clinical trials that support these claims. The lack of evidence to support the truthfulness of these apps potentially violates the principle of integrity if these apps

were misrepresenting themselves as being evidence-based or clinically efficacious by capitalizing on the reputation of well-known psychological therapies or therapists to gain more users.

The lack of transparency surrounding the pay-structure and efficacy of these apps – despite promoting their use of evidence-based practices – it would seem that the goal of the developer is monetization rather than doing no harm and having the welfare of the user as the goal. To ensure that apps adhere to the principles of beneficence and non-maleficence and integrity, we suggest that developers consider:

- Being explicit both on the app's description page and within the app about the terms of a free trial.
- Being explicit on what features are available with and without subscriptions.
- Providing in-app warnings of consequences associated with not having a subscription.
- Using easy-to-understand language when describing the details of a free-trial or a subscription.
- Avoiding denied access to historic data when a user does not have a subscription and, instead, preventing further access to subscription-only features.
- Describe what features are evidence-based.
- Avoid promoting efficacy without scientific evidence to support claims.

*5.1.4 Privacy violations.* As seen in Theme 4, users who are worried about their information being released to third-parties comment on more than just the ownership of their data; they specifically mention that sensitive and personal information being shared and sold is harmful and unethical. These sentiments demonstrate a violation of the ethical principle of respect for people's rights and dignity that includes privacy, confidentiality, and necessary safeguards to protect the rights and welfare of vulnerable people. Our results show that, whether perceived or real, breaches of privacy are a major unintended harm of existing depression self-management apps. Reviews spoke to users being nervous about their mental health information being tied back to them and unauthorized persons accessing that information. Research has shown that those with mental illnesses are subjected to social stigmas, prejudices, and social exclusion [64] as well as impeded ability to seek mental healthcare [17, 75], all of which can have a harmful impact to an individual's wellbeing. If a user's mental health data were to be sold and exposed, they could potentially face harms associated with stigmas surrounding mental illnesses.

Some may say that "it's up to the user to read the privacy policy," but research suggests that app privacy policies are prone to misunderstandings and confusing language that negatively impact their usefulness [83]. As stated above, financing applications can be difficult without using paywalls, potentially leading some developers to sell data to third-party companies such as Facebook or Google. Unfortunately, due to the nature of the data being collected, this poses a serious ethical issue regarding user's right to privacy and confidentiality.

Ethical considerations surrounding data privacy is a multi-faceted discussion that includes different dimensions of what constitutes "privacy" on mental health applications. Moreover, should mental health applications officially be considered healthcare support tools, these unintentional harms become more than just ethical violations. They become legal matters that must answer to laws pertaining to therapeutic devices and electronic patient health records. Unfortunately, due to a lack of regulations surrounding mental health apps [20, 44], it is up to users to be aware of their data privacy and safety in order to safeguard against the potential harms associated with privacy breaches. Furthermore, because developers for these apps may reside in countries outside of the US, it can be difficult to ascertain what privacy laws these apps and developers should and do follow. We suggest developers consider the following to help ensure users' right to privacy and confidentiality:

- Encrypting sensitive user data on data collection servers.
- If based out of the US, complying with the Health Information Portability and Accountability Act (HIPAA) in regards to the storage, transfer, and usage of user mental health data.
- If not based in the US, clearly stating developer country of residence in the app description page.
- Not selling sensitive user data to third parties or using this data for purposes that users feel violate the contextual integrity expectations of the app.
- Providing locking features on the app such as a password requirement for accessing the app or information on the app.
- Using accessible language in the app privacy policy.
- Avoiding the collection of unnecessary data (e.g., tracking data).

## 5.2 Resources for Consumers and Mental Healthcare Practitioners

With the growing number of applications on the market, it can be difficult to navigate which apps can be trusted. App descriptions promoting the use of evidence-based practices or being developed alongside a mental health practitioner makes this endeavor even more challenging. Without being fully aware of all the potential harms of these applications, it can be almost impossible to recommend any one application to patients or for a user to find one for themselves. Fortunately, resources exist to help guide both practitioners and users towards more reliable applications. The APA released a report in 2019 that outlines important ethical and legal considerations for mental healthcare practitioners regarding the use of mental health applications in their practices [20]. The APA also provides a guide to help screen applications based on factors such as privacy, safety, clinical foundation, and usability [7]. Practitioners, specifically, should be wary of the ethical and legal responsibilities that may fall to them when using an app in their practice [20].

Additional tools exist to guide practitioners and consumers such as One Mind PsyberGuide (onemindpsyberguide.org), which offers app reviews created by clinicians and researchers working in the field. Scores are provided for credibility, user experience, and transparency. For example, MoodKit, one of the clinician-developed applications included in this review, has a credibility score of 4.33 out of 5.00, a user experience score of 3.68, and acceptable transparency [35]. Among the apps included in this review and available in this database, there appears to be alignment in their quantitative assessment and our qualitative analysis. Unfortunately, the extent to which clinicians and consumers are using such resources

remains unclear. It continues to be important for practitioners and consumers to stay up to date on available mental health apps and to increase their ability to traverse the growing, digital sea of mental health technologies. We acknowledge the challenges in using apps that our results demonstrate; they can be unreliable with features unmaintained or suddenly put behind paywalls. This means that even when practitioners and consumers use available resources to select an app, the reliability of the app may change.

We also acknowledge that the APA provided guide and One Mind PsyberGuide may not be comprehensive when reviewing apps. Therefore, we also encourage practitioners and consumers to look at user reviews left on these applications. User review studies have been shown to provide valuable and meaningful insight into user experience with applications [10, 28, 29, 31, 57, 71]. Until there is a standardization of quality checks and feature regulations for these apps, practitioners and consumers can look to user reviews and user review studies to gather information for themselves on the efficacy and safety of an application.

While One Mind PsyberGuide, user reviews, and guides set out by the APA may have their limitations, these tools can still help practitioners and consumers stay better informed about the potential harms clients face when interacting with mental health mobile applications. We hope to bring to attention just a few resources clinicians and consumers can utilize, and we encourage them to utilize these resources to aid in their assessment of apps and judgement of whether or not an app is appropriate for them.

### 5.3 Limitations and Future Works

This study has several limitations. Because apps and reviews were taken from US app stores, there is a possibility that different themes may emerge from apps and reviews available in different countries based on the way mental health is institutionalized in those countries. Similarly, because we were specifically interested in applications marketed to help with depression self-management because of the high prevalence of depression in adults and adolescents [26], there may be other unintentional harms for other types of mental health applications (e.g., anxiety self-management apps) as well as apps that offer therapy services such as BetterHelp or utilize AI chatbots.

In addition, while saturation is a common and valid method for data analysis in qualitative research [66], there is always a risk that themes could be missed in the uncoded reviews. Future research may utilize topic modeling or content analyses to analyze all reviews and compare results from a quantitative, computational approach to a qualitative, manual approach.

Furthermore, because the present study aimed to explore perceived harms experienced by users because of depression self-management apps, we did not conduct an app feature analysis or privacy policy content review. As such, there is a possibility that user concerns may have stemmed from a misunderstanding or lack of knowledge regarding the app's privacy policies or its features. Future research may investigate the validity of user concerns by conducting usability studies regarding app features and comparing those features to app privacy policies.

Lastly, several user comments mentioned the presence of "fake" 5-star reviews left on some of the applications to inflate the overall star-rating of those applications. In an study conducted by Martens and Mallej [46], researchers estimated that 22.2 million out of the 62.6 million reviews on the Apple App store could, potentially, be fake reviews. As of right now, there is no definitive way to discern fake reviews from real reviews. Because our analysis focused on negative reviews, this was not as much of an issue. However, we did encounter fake reviews in our analysis of positive reviews (e.g., multiple reviews copied and pasted verbatim) and attempted to address this by only reviewing unique comments left on the applications. We did not exclude any reviews we were not sure were fake, so it is possible some fake reviews were included in this analysis. Future research should continue to investigate effective methods of identifying fake reviews.

## 6 CONCLUSIONS

At their core, mental health applications are tools that people can use to assist in their mental healthcare journey. Overall ratings and previous research suggest that these applications can have positive therapeutic benefits for users. However, the potential, unintentional harms due to these applications should not be ignored amongst the excitement surrounding their usage. Our ethical analysis demonstrates the importance of ethical app development for depression self-management apps, and results indicate the real, potential harms users may face due to unethical design traps.

It is important to remember that users are more than just a comment or star-rating. They are real people who are looking for tools to help manage their mental illnesses. And, if using the application results in them experiencing distress, they are the ones who suffer. Mental health apps are gaining more popularity in being supportive tools in one's mental health journey. However, more regulation is needed over these applications in order to ensure more good than harm is being done as the wellness of one person should not come at the cost of another.

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# A APPENDIX

## A.1 Supplementary Tables

**Table 5: Table of app descriptions for all apps included in study.**

| App Name | Platform | Num. Ratings | Num. Reviews | Avg Rating | Release Date (yyyy-mm-dd) |
|---|---|---|---|---|---|
| CBT Guide to Depression & Test | Android | 1561 | 415 | 4.25 | 2012-02-26 |
| CBT Thought Diary: Depression | Android | 75 | 11 | 4.22 | 2020-05-20 |
| MoodSpace - Stress, Anxiety, & ... | Android | 3751 | 1080 | 3.86 | 2015-03-04 |
| Aetheria | iOS | 21 | 56 | 3.9 | 2015-09-26 |
| Bloom: CBT Therapy & Journal | iOS | 10850 | 877 | 4.82 | 2019-08-13 |
| CBT Self-Care Journal | iOS | 503 | 29 | 4.71 | 2020-08-27 |
| CBT Therapy: Mental Healthcare | iOS | 359 | 12 | 4.77 | 2022-03-14 |
| DBT Diary Card & Skills Coach | iOS | 799 | 226 | 4.45 | 2011-11-14 |
| Depression Test | iOS | 1487 | 104 | 4.69 | 2013-07-12 |
| Enlighten: Guided Wellbeing | iOS | 42 | 7 | 4.86 | 2018-12-08 |
| Feelmo: Mental Health Support | iOS | 62 | 17 | 4.9 | 2021-01-06 |
| MoodKit | iOS | 218 | 333 | 4.32 | 2011-05-12 |
| Moodnotes: Mood Tracker | iOS | 10478 | 1283 | 4.66 | 2015-08-06 |
| StressCenter | iOS | 23 | 8 | 2.7 | 2020-03-12 |
| UpLift - Depression & Anxiety | iOS | 309 | 37 | 4.51 | 2020-03-02 |
| Bearable: Symptom & Mood Tracker | Both | Android 5145<br>iOS: 1235 | Android 1742<br>iOS: 199 | Android 4.65<br>iOS: 4.74 | Android 2020-03-12<br>Apple: 2020-03-17 |
| being: my mental health friend | Both | Android 5194<br>iOS: 35 | Android 2216<br>iOS: 17 | Android 4.45<br>iOS: 4.03 | Android 2020-02-03<br>Apple: 2021-03-26 |
| Catch It | Both | Android 171<br>iOS: 7 | Android 59<br>iOS: 3 | Android 3.97<br>iOS: 3.14 | Android 2014-08-29<br>Apple: 2014-07-30 |
| CBT Companion: Therapy app | Both | Android 3280<br>iOS: 370 | Android 834<br>iOS: 101 | Android 4.44<br>iOS: 4.65 | Android 2019-01-05<br>Apple: 2019-01-05 |
| CBT Thought Diary | Both | Android 6162<br>iOS: 15495 | Android 2064<br>iOS: 224 | Android 4.53<br>iOS: 4.84 | Android 2014-06-28<br>Apple: 2015-07-08 |
| DBT Coach: Guided Therapy | Both | Android 1938<br>iOS: 947 | Android 623<br>iOS: 220 | Android 4.34<br>iOS: 4.58 | Android 2019-02-25<br>Apple: 2019-02-22 |
| Don't Panic | Both | Android 1498<br>iOS: 1 | Android 53<br>iOS: 0 | Android 4.10<br>iOS: 5.00 | Android 2019-03-10<br>Apple: 2019-04-20 |
| MindDoc: Your Companion | Both | Android 38169<br>iOS: 29155 | Android 8047<br>iOS: 1004 | Android 4.22<br>iOS: 4.71 | Android 2017-08-02<br>Apple: 2015-11-11 |
| Mindshine: Mental Health Coach | Both | Android 1593<br>iOS: 230 | Android 332<br>iOS: 28 | Android 4.40<br>iOS: 4.7 | Android 2018-10-31<br>Apple: 2018-11-06 |
| Mind Reset - Just 2 min a day! | Both | Android 165<br>iOS: 17 | Android 51<br>iOS: 10 | Android 3.91<br>iOS: 3.94 | Android 2020-05-05<br>Apple: 2020-05-07 |
| Moodfit: Mental Health Fitness | Both | Android 762<br>iOS: 917 | Android 278<br>iOS: 170 | Android 4.27<br>iOS: 4.67 | Android 2017-01-04<br>Apple: 2015-12-19 |
| Mooditude: Mental Health App | Both | Android 189<br>iOS: 287 | Android 42<br>iOS: 84 | Android 4.31<br>iOS: 4.58 | Android 2021-10-08<br>Apple: 2019-04-20" |
| Moodlinks Anxiety & Depression | Both | Android 175<br>iOS: 186 | Android 70<br>iOS: 6 | Android 4.52<br>iOS: 4.91 | Android 2020-03-28<br>Apple: 2020-03-31 |
| MoodMission - Cope with Stress | Both | Android 27<br>iOS: 27 | Android 0<br>iOS: 9 | Android 3.60<br>iOS: 3.96 | Android 2021-08-03<br>Apple: 2016-10-13 |
| MoodTools- Depression Aid | Both | Android 3243<br>iOS: 228 | Android 922<br>iOS: 35 | Android 4.17<br>iOS: 4.82 | Android 2014-07-03<br>Apple: 2015-07-21 |
| Sensa | Both | Android 2286<br>iOS: 925 | Android 886<br>iOS: 378 | Android 3.72<br>iOS: 3.02 | Android 2021-10-04<br>Apple: 2021-10-04 |
| Shmoody: Improve your mo... | Both | Android 657<br>iOS: 651 | Android 104<br>iOS: 49 | Android 4.33<br>iOS: 4.80 | Android 2021-01-19<br>Apple: 2020-11-20 |
| Simple DBT Skills Diary Card | Both | Android 115<br>iOS: 149 | Android 64<br>iOS: 94 | Android 3.57<br>iOS: 4.29 | Android 2014-02-25<br>Apple: 2013-07-16 |
| Tochi - Mood Tracker, Journal | Both | Android 2849<br>iOS: 530 | Android 496<br>iOS: 21 | Android 4.49<br>iOS: 4.73 | Android 2021-07-28<br>Apple: 2021-07-31 |
| uMore - mental health tracker | Both | Android 175<br>iOS: 20 | Android 63<br>iOS: 1 | Android 4.03<br>iOS: 5.00 | Android 2020-10-01<br>Apple: 2021-07-07 |
| What's Up? - Mental Health App | Both | Android 3535<br>iOS: 256 | Android 1003<br>iOS: 116 | Android 3.86<br>iOS: 4.40 | Android 2015-03-04<br>Apple: 2015-03-11 |

**Table 6: Table of cost descriptions for all apps included in study.**

| App Name | Platform Offered | Price/In-app Purchases | In-app Purchases |
|---|---|---|---|
| CBT Guide to Depression & Test | Android | Free | None |
| CBT Thought Diary: Depression | Android | Free | None |
| Mentalia: Mental Health | Android | Free | $12.99 - $59.99 |
| MoodSpace - Stress, Anxiety, & ... | Android | Free | $3.99 - $22.99 |
| Aetheria | iOS | Free | No |
| Bloom: CBT Therapy & Journal | iOS | Free | $3.99 - $159.99 |
| CBT Self-Care Journal | iOS | Free | $3.99 - $19.99 |
| CBT Therapy: Mental Healthcare | iOS | Free | $9.99 - $49.99 |
| DBT Diary Card & Skills Coach | iOS | $4.99 | None |
| Depression Manager | iOS | Free | None |
| Depression Test | iOS | Free | $0.99 - $4.99 |
| Enlighten: Guided Wellbeing | iOS | Free | $9.99 - $399.99 |
| Feelmo: Mental Health Support | iOS | Free | None |
| MoodKit | iOS | $4.99 | None |
| Moodnotes: Mood Tracker | iOS | Free | $9.99 - $39.99 |
| StressCenter | iOS | Free | $1.99 - $12.99 |
| UpLift - Depression & Anxiety | iOS | Free | $12.99 - $99.99 |
| Aime Mental Health & Wellbeing | Both | Android Free<br>Apple: Free | Android None<br>Apple: None |
| Bearable: Symptom & Mood Tracker | Both | Android Free<br>Apple: Free | Android $4.99 - $39.99<br>Apple: $4.49 - $34.99 |
| being: my mental health friend | Both | Android Free<br>Apple: Free | Android $0.99 - $299.99<br>Apple: $9.99 - $99.99 |
| Catch It*** | Both | Android Free<br>Apple: Free | Android None<br>Apple: None |
| CBT Companion: Therapy app | Both | Android Free<br>Apple: Free | Android $9.99 - $99.99<br>Apple: $9.99 - $49.99 |
| CBT Thought Diary | Both | Android Free<br>Apple: Free | Android $4.99 - $59.99<br>Apple: $.499 - $69.99 |
| DBT Coach: Guided Therapy | Both | Android Free<br>Apple: Free | Android $9.49 - $47.99<br>Apple: $11.99 - $59.99 |
| Don't Panic | Both | Android Free<br>Apple: Free | Android None<br>Apple: None |
| MindDoc: Your Companion | Both | Android Free<br>Apple: Free | Android $6.49 - $84.99<br>Apple: $4.49 - $69.99 |
| Mindshine: Mental Health Coach | Both | Android Free<br>Apple: Free | Android $12.99 - $149.99<br>Apple: $12.49 - $129.99" |
| Mind Reset - Just 2 min a day! | Both | Android Free<br>Apple: Free | Android $0.99 - $69.99<br>Apple: $4.99 - $69.99 |
| Moodfit: Mental Health Fitness | Both | Android Free<br>Apple: Free | Android $9.99 - $39.99<br>Apple: $9.99-$39.99 |
| Mooditude: Mental Health App | Both | Android Free<br>Apple: Free | Android $6.49 - $149.99<br>Apple: $6.49 - $149.99 |
| Moodlinks Anxiety & Depression | Both | Android Free<br>Apple: Free | Android None<br>Apple: None |
| MoodMission - Cope with Stress | Both | Android Free<br>Apple: Free | Android $5.99 - $14.00<br>Apple: $4.99 - $11.99 |
| MoodTools- Depression Aid | Both | Android Free<br>Apple: Free | Android $1.00 - $49.99<br>Apple: $4.99 - $199.99" |
| Sensa | Both | Android Free<br>Apple: Free | Android $35.99 - $69.99<br>Apple: $29.99 - $59.99" |
| Shmoody: Improve your mo... | Both | Android Free<br>Apple: Free | Android $2.49 - $99.99<br>Apple: $14.99 - $99.99 |
| Simple DBT Skills Diary Card | Both | Android Free<br>Apple: Free | Android $3.99 - $119.99<br>Apple: $0.99 - 12.99 |
| Tochi - Mood Tracker, Journal | Both | Android Free<br>Apple: Free | Android $1.99 - $19.99<br>Apple: $1.99 - $17.99 |
| uMore - mental health tracker | Both | Android Free<br>Apple: Free | Android $0.99 - $19.99<br>Apple: $1.99 - $19.99 |
| What's Up? - Mental Health App | Both | Android Free<br>Apple: Free | Android $1.19 - $4.99<br>Apple: $0.99 - $3.99 |

**Table 7: Supplementary App Descriptions extracted from app description pages**

| App Name | Platform | Developer (Dev) | Dev Country |
|---|---|---|---|
| CBT Guide to Depression & Test | Android | Excel At Life | US |
| CBT Thought Diary: Depression | Android | Hlist studio | Unknown |
| MoodSpace - Stress, Anxiety, & ... | Android | Chachi Productions | England |
| Aetheria | iOS | Astra Labs | US |
| Bloom: CBT Therapy & Journal | iOS | Meemo Media Inc. | US |
| CBT Self-Care Journal | iOS | baris sarer | Unknown |
| CBT Therapy: Mental Healthcare | iOS | Lollipop Technology (Hangzhou) Co.,Ltd | US |
| DBT Diary Card & Skills Coach | iOS | Durham DBT, Inc. | US |
| Depression Test | iOS | baris sarer | Unknown |
| Enlighten: Guided Wellbeing | iOS | Kevin Esherick | US |
| Feelmo: Mental Health Support | iOS | Feelmo Ltd | England |
| MoodKit | iOS | ThrivePort, LLC | US |
| Moodnotes: Mood Tracker | iOS | ThrivePort, LLC | US |
| StressCenter | iOS | Joy From Within LLC | US |
| UpLift - Depression & Anxiety | iOS | UpLift Health Inc. | US |
| Bearable: Symptom Mood Tracker | Both | Bearable | England |
| being: my mental health friend | Both | Android: House Of Being<br>iOS: Being Cares Inc. | Unknown |
| Catch It | Both | The University of Liverpool | England |
| CBT Companion: Therapy app | Both | Resiliens, Inc | US |
| CBT Thought Diary | Both | Inquiry Health LLC | US |
| DBT Coach: Guided Therapy | Both | Resiliens, Inc | US |
| Don't Panic | Both | Nepanikar z. s. | Czech Republic |
| MindDoc: Your Companion | Both | MindDoc Health | Germany |
| Mind Reset - Just 2 min a day! | Both | Mind Help LTD | US |
| Mindshine: Mental Health Coach | Both | Android: Mindshine<br>iOS: Greator GmbH | Germany |
| Moodfit: Mental Health Fitness | Both | Roble Ridge Software LLC | US |
| Moodlinks Anxiety & Depression | Both | Recovery Record | US |
| MoodMission - Cope with Stress | Both | MoodMission Pty Ltd | Australia |
| MoodTools- Depression Aid | Both | Inquiry Health LLC | US |
| Mooditude: Mental Health App | Both | Android: Mooditude, Inc.<br>iOS: PYNTAIL, LLC | US |
| Sensa | Both | Mental Health Solutions UAB | Lithuania |
| Shmoody: Improve your mo... | Both | Moodworks Inc | US |
| Simple DBT Skills Diary Card | Both | POP POP LLC | Unknown |
| Tochi - Mood Tracker, Journal | Both | Android: The Lazy Hippo Development<br>iOS: Hae Bum Kim | Korea |
| uMore - mental health tracker | Both | uMore Inc | US |
| What's Up? - Mental Health App | Both | Jackson Tempra | US |

**Table 8: Supplementary App Descriptions extracted from app description pages continued**

| App Name | Platform | Promoting EBP or partnership with mental health expert | Promotion of efficacy | Disclaimer |
|---|---|---|---|---|
| CBT Guide to Depression & Test | Android | Yes | No | Yes |
| CBT Thought Diary: Depression | Android | Yes | No | Yes |
| MoodSpace - Stress, Anxiety, & ... | Android | Yes | No | Yes |
| Aetheria | iOS | Yes | No | No |
| Bloom: CBT Therapy & Journal | iOS | Yes | Yes | No |
| CBT Self-Care Journal | iOS | Yes | No | Yes |
| CBT Therapy: Mental Healthcare | iOS | Yes | Yes | Yes |
| DBT Diary Card & Skills Coach | iOS | Yes | No | No |
| Depression Test | iOS | Yes | No | Yes |
| Enlighten: Guided Wellbeing | iOS | Yes | No | No |
| Feelmo: Mental Health Support | iOS | Yes | Yes | No |
| MoodKit | iOS | Yes | Yes | No |
| Moodnotes: Mood Tracker | iOS | Yes | No | No |
| StressCenter | iOS | Yes | Yes | No |
| UpLift - Depression & Anxiety | iOS | Yes | Yes | No |
| Bearable: Symptom Mood Tracker | Both | Android: No<br>iOS: No | Android: No<br>iOS: No | Android: No<br>iOS: No |
| being: my mental health friend | Both | Android: Yes<br>iOS: Yes | Android: Yes<br>iOS: Yes | Android: No<br>iOS: Yes |
| Catch It | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| CBT Companion: Therapy app | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: Yes |
| CBT Thought Diary | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: Yes | Android: No<br>iOS: No |
| DBT Coach: Guided Therapy | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |
| Don't Panic | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: Yes |
| MindDoc: Your Companion | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| Mind Reset - Just 2 min a day! | Both | Android: Yes<br>iOS: Yes | Android: Yes<br>iOS: Yes | Android: No<br>iOS: Yes |
| Mindshine: Mental Health Coach | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |
| Moodfit: Mental Health Fitness | Both | Android: Yes<br>iOS: Yes | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No |
| Moodlinks Anxiety & Depression | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |
| MoodMission - Cope with Stress | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| MoodTools- Depression Aid | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| Mooditude: Mental Health App | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| Sensa | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| Shmoody: Improve your mo... | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |
| Simple DBT Skills Diary Card | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |
| Tochi - Mood Tracker, Journal | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: Yes |
| uMore - mental health tracker | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: Yes<br>iOS: Yes |
| What's Up? - Mental Health App | Both | Android: Yes<br>iOS: Yes | Android: No<br>iOS: No | Android: No<br>iOS: No |