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Review article

An analysis on self-management and treatment-related functionality and characteristics of highly rated anxiety apps



Nidal Drissi^{a,b}, Sofia Ouhbi^{a,*}, Mohammed Abdou Janati Idrissi^b, Mounir Ghogho^c

^a Dept of Computer Science & Software Engineering, CIT, UAE University, Al Ain, UAE

^b ENSIAS, Mohammed V University in Rabat, Rabat, Morocco

^c TICLab, International University of Rabat, Rabat, Morocco

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ABSTRACT

Background and objective: Anxiety is a common emotion that people often feel in certain situations. But when the feeling of anxiety is persistent and interferes with a person's day to day life then this may likely be an anxiety disorder. Anxiety disorders are a common issue worldwide and can fall under general anxiety, panic attacks, and social anxiety among others. They can be disabling and can impact all aspects of an individual's life, including work, education, and personal relationships. It is important that people with anxiety receive appropriate care, which in some cases may prove difficult due to mental health care delivery barriers such as cost, stigma, or distance from mental health services. A potential solution to this could be mobile mental health applications. These can serve as effective and promising tools to assist in the management of anxiety and to overcome some of the aforementioned barriers. The objective of this study is to provide an analysis of treatment and management-related functionality and characteristics of high-rated mobile applications (apps) for anxiety, which are available for Android and iOS systems.

Method: A broad search was performed in the Google Play Store and App Store following the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) protocol to identify existing apps for anxiety. A set of free and highly rated apps for anxiety were identified and the selected apps were then installed and analyzed according to a predefined data extraction strategy.

Results: A total of 167 anxiety apps were selected (123 Android apps and 44 iOS apps). Besides anxiety, the selected apps addressed several health issues including stress, depression, sleep issues, and eating disorders. The apps adopted various treatment and management approaches such as meditation, breathing exercises, mindfulness and cognitive behavioral therapy. Results also showed that 51% of the selected apps used various gamification features to motivate users to keep using them, 32% provided social features including chat, communication with others and links to sources of help; 46% offered offline availability; and only 19% reported involvement of mental health professionals in their design.

Conclusions: Anxiety apps incorporate various mental health care management methods and approaches. Apps can serve as promising tools to assist large numbers of people suffering from general anxiety or from anxiety disorders, anytime, anywhere, and particularly in the current COVID-19 pandemic.

1. Introduction

Anxiety is defined as “an emotion characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure” [1]. Anxiety is a common feeling that a person might experience now and then when facing certain situations: for example, when taking a test, giving an interview, making an important decision or speaking in public. Such situations may bring on feelings of

nervousness, worry, and fear. These context specific feelings usually disappear once the stressful situation has passed. But if these feelings of anxiety are intense, continue over a long period of time, and interfere with a person's day to day life, then they are most likely linked to an anxiety disorder [2]. Anxiety disorders are common emotional disorders. In 2017, 3.76% of the global world population was reported to have suffered from an anxiety disorder. This percentage has almost not changed since 1990 [3]. There are several types of anxiety disorders,

* Corresponding author.

E-mail addresses: drissi.nidal@uaeu.ac.ae (N. Drissi), sofia.ouhbi@uaeu.ac.ae (S. Ouhbi), ajanati@um5s.net.ma (M.A. Janati Idrissi), mounir.ghogho@uir.ac.ma (M. Ghogho).

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including: panic disorders, phobias, social anxiety disorder, obsessive-compulsive disorder (OCD), separation anxiety disorder, illness anxiety disorder, and post-traumatic stress disorder (PTSD) [2]. Depending on the severity of the condition, symptoms and complications might include increased heart rate (HR) and blood pressure (BP), rapid breathing or shortness of breath, feeling faint or dizzy, dry mouth, sweating, restlessness, trouble concentrating, difficulty falling asleep and numbness or tingling in the body [2]. Anxiety disorders can be disabling and can interfere with the individual's daily life, affecting their work, education, and relationships [4,2].

The exact causes of anxiety disorders are still unknown. According to the National Institute of Mental Health, it is likely to be a combination of genetic and environmental factors [5]. Other possible factors that can lead to susceptibility include brain chemistry, personality type, exposure to certain mental and/or physical disorders, trauma and stress [6]. The COVID-19 outbreak, in addition to being a public health emergency, is also affecting mental health in individuals on a global scale causing people to suffer from stress, anxiety, and depression [7,8]. The pandemic is also triggering feelings of fear, worry, sadness, and anger [9,10]. Quarantines, self-isolation, fear of the unknown, loss of freedom and other factors are causing psychological issues in people around the world [11,12]. These situations and circumstances can trigger several anxiety disorders, mainly separation anxiety disorder which is defined as fear of being away from home or loved ones, illness anxiety disorder which is defined as anxiety about a person's health (formerly called hypochondria) [2] and panic attacks that are affecting a large number of people because of excessive worrying. Psychiatric patients are additionally at a higher risk of experiencing symptoms related to psychological issues caused by the pandemic [13]. People with preexisting anxiety disorders are showing aggravation of their conditions, for example, many people with OCD are developing new fixations on the COVID-19 virus and are experiencing compulsive cleaning [9].

Due to the COVID-19 pandemic, social interactions have significantly decreased in several parts of the world. While this may have provided relief to some people with social anxiety, it is possible this lack of interaction may have negative consequences in the longer term [14]. Returning to work after a period of lockdown, while still in the state of pandemic, is also causing the workforce to exhibit symptoms related to PTSD, stress, anxiety, depression and insomnia [15]. The current COVID-19 situation is also affecting the mental well-being of health care workers, who are at a high risk of psychological distress [16], especially those who are experiencing physical symptoms [17]. The situation is further worsened by the recommended avoidance of in-person contact and fear of infection, as people with anxiety and other mental disorders might not be able to consult with a mental health professional.

There are various barriers to mental health care delivery, such as cost, stigma, lack of mental health care professionals, and distance from health care services [18,19]. Mobile mental health or m-mental health, which uses mobile technologies for providing mental health services, has the potential to help overcome mental health care delivery barriers, as it provides anonymous access to care, low to no cost care, and remote communication. Smartphones can be a convenient tool to reach a large number of people from different parts of the world. There are many mobile applications (apps) for mental health problems such as PTSD [20,21], stress [22], depression [23] and alcohol dependence [24], as well as other health issues such as obesity, that apps can help with, especially due to lack of exercise during circumstances similar to the current lockdown [25]. Smartphone apps have high rates of acceptance among the general public, and especially in young people [26] due to its cost effectiveness [27]. Many studies have reported that apps have

shown positive results in the treatment and management of anxiety [28–30].

This study aims to analyze the functionality and characteristics of highly rated anxiety apps to identify users' preferred features and management methods delivered for anxiety with a smartphone or a tablet. For the purposes of this study, only free apps were selected, as recent statistics in March 2020 showed that 96.3% of Android apps and 90.84% of iOS apps were freely available worldwide [31]. A total of 167 apps, 123 Android apps, and 44 iOS apps were selected. The anxiety management approaches used in these apps among other aspects of functionality have been extracted and analyzed.

2. Methodology

This section presents the methodology that was followed in order to select and analyze Android and iOS anxiety apps.

2.1. Review protocol

This paper follows the quality reporting guidelines set out by the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) group to ensure clarity and transparency of reporting [32].

2.2. Sources and eligibility criteria

Google Play repository and the App Store were used as sources to select anxiety apps. Both app repositories are very popular with a high number of available health care apps: more than 41,377 apps are available in the Google play store, and more than 44,384 apps are available in the App Store [33]. A general search string, composed of only one word "anxiety", was used. It was automatically applied to the titles and descriptions of Android and iOS apps.

Each app from the search result was examined by the first author to decide whether or not to be included in the final selection. The second author revised the final apps selection. The following inclusion criteria (IC) were applied:

- IC1: Anxiety related apps in Google Play Store and App store.
- IC2: Apps that have a free version.
- IC3: Apps that have 4+ stars rating.

IC3 reflects a level of user satisfaction with the app. The focus is on highly rated anxiety apps so as to discover the functionality features and characteristics that provide high user satisfaction. The following exclusion criteria (EC) were applied to the candidate apps to identify the final selection that would be included in this study:

- EC1: Apps that have less than 5 raters.
- EC2: Apps that could not be installed.
- EC3: Apps that crashed and could not be used after installation.

Apps that match any of the EC were excluded from the selection. EC1 is based on the heuristic guideline by Nielsen [34], which recommends having five evaluators to form an idea about the problems related to usability.

2.3. Anxiety apps selection

The apps' selection process was established as follows:

1. The search string was used to identify candidate apps in the Google Play Store and App Store in order to create a broad selection from

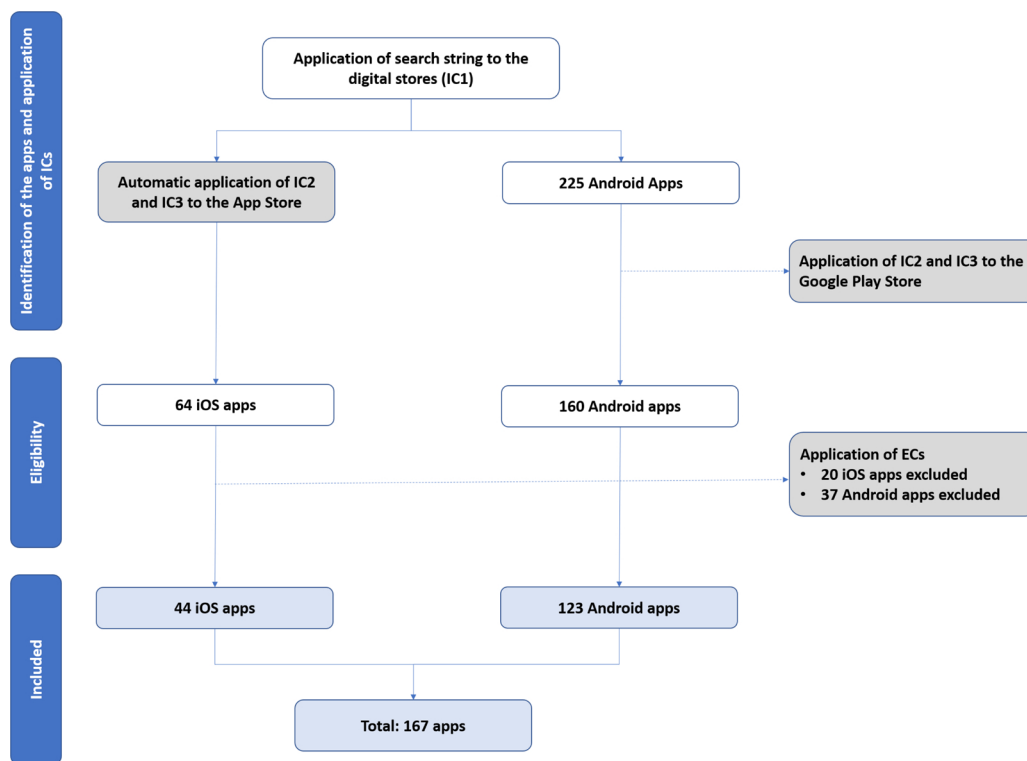


Fig. 1. Selection results.

- which to choose from.
- 2. IC were used to identify relevant apps.
- 3. Apps that met one or more of the EC were excluded.

The above actions were carried out in March 2020. A final selection of 123 Android apps and 44 iOS apps was identified after application of IC and EC. Fig. 1 presents the selection results.

2.4. Data extraction strategy

Data collection was carried out using the data extraction form presented in Table 1. Each app was installed and assessed to explore its functionality features and characteristics. The devices used for the apps' assessment were: OPPO A9 (Android 9), and iPad 3 (iOS 13). A template was designed in an Excel file to provide basic information about the apps as well as specifying their main features and functionality characteristics. Some of these characteristics and functionality features were retrieved from the app's description available in the app repository.

3. Results and discussion

This section presents and discusses the results of this study. A total of 167 apps, 123 Android apps, and 44 iOS apps were identified as both free and highly rated apps.

3.1. General information about the apps

0.02wTables A.11–A.16 in Appendix present general information about the apps such as name, link, rating, number of raters, number of installations (not available for iOS apps), and date of latest update. The majority of the selected apps (68%) offer in-app purchases for paid features and functionality. These apps are free to download and use, but many of their proposed functionality features are not available without

Table 1

Data extraction form.

<p>Apps general information:</p> <ul style="list-style-type: none"> -Name of the app. -Date of the latest update. -Users rating (scored out of 5): To report the level of user satisfaction from the apps. -Number of raters: To report the number of raters satisfied with the app. -Number of installations (not available for iOS apps): To identify the most installed apps. -In-app purchase: To identify whether free apps charge users for certain functionality features. <p>Management-related characteristics:</p> <ul style="list-style-type: none"> -Management method: To identify management and treatment methods for anxiety that could be delivered through an app, and the most used ones in the available apps. -Intervention approach: To identify approaches that could be transmitted through an app, and the most followed approaches in the available apps. -Targeted mental problem/symptoms: To identify anxiety related issues addressed by the apps and issues that might be managed with similar management methods and approaches as ones for anxiety, as well as to identify problems that could be treated and managed through apps. -Involvement of mental health care professional: This information was extracted from apps' descriptions in-App repositories and from apps' content. We consider mental health care professionals to be those professionals with a mental health background including psychiatrists, therapists, counselors and experts in psychological issues or management methods. -Physical health information such as HR and BP: To identify whether the app relies on physical indicators to assess the mental status of the user. <p>Other functionality features:</p> <ul style="list-style-type: none"> -Authentication method: To identify if the app provides users with the option to keep their personal health data inaccessible to other users of the same device. -Gamification features: To identify whether gamification features are included in the app to encourage and motivate the users to keep using it. -Social features which might include: links to communities, associations, and centers; interoperability with other apps or websites; the possibility to share content via social networks (SN); and contact information in case of emergencies. -Languages: Identify the availability of the apps in multiple languages, which reflects the degree of internationalization of the app. -Offline availability: Identify whether the app can be used without internet access.

Table 2
Management methods.

Management method	App ID	Total
Meditation	A1, A8, A9, A10, A13, A16, A18-A21, A23, A25, A30, A33-A37, A40, A41, A44, A56, A59, A62, A66, A67, A70, A82, A86, A92, A98, A105, A106, A111, A121, I1, I2, I6-I10, I11, I13, I16, I18, I23, I25, I29, I30, I32, I34, I40, I42	54
Breathing exercises	A3, A6, A20, A21, A23, A25, A29, A30A34, A37, A41, A45, A47, A53-A55, A59, A70, A72, A73, A76, A80, A83, A92-A94, A96, A98, A108, A110, A111, A115, A119, A120 I2, I4, I8, I10, I11, I13, I16, I18, I23, I25, I29, I30	46
Educational content	A1, A8, A12, A100, A103, A104, A113, A115, A119, A121, A22, A26, A33, A34, A40, A42-A44, A54, A57, A59, A61, A63, A70-A73, A76-A79, A86, A88, A90, I2, I6, I23, I30, I34	39
Relaxing music and sounds	A4, A7, A11, A15, A16, A18, A30, A36, A38, A42, A52, A59, A66, A68, A77, A79, A82, A87, A98, A99, A107, A109, I3, I8, I13, I16, I18, I25, I30, I32, I34	31
Mood and symptom tracking, journaling, diaries and day planning	A14, A22, A24, A25, A34, A39, A41, A44, A48, A49, A59, A63, A66, A69, A70, A75, A76, A78, A88, A91, A97, A100, A103, A114, A119, A120, A122, I29I33I7I9	31
Games	A31, A32, A43, A46, A51, A58, A60, A63, A65, A84, A96, A101, A112, A119, A120, I12, I14, I15, I17, I20-I22, I24, I27, I28, I31, I36-I39, I41, I43, I44	33
Assessment tests	A117, A12, A33, A34, A48, A66, A69, A70, A72, A78, A79, A88, A91, A103, A113, I19, I7	17
Stories	A8, A18, A30, A36, A49, A59, A82, A98, A118, I8, I9, I18, I29, I30, I32, I42	16
Mindfulness practices	A10, A12, A20, A25, A56, A98, A111, A115, I2, I6, I7, I11, I19, I23, I29, I30	16
Guided relaxation	A22, A23, A33, A34, A40, A42, A54, A103, A111, A115, I13, I16, I8, I9	14
Community chats with app users via the app	A8, A25, A27, A50, A61, A63, A78, A85, A119, A123, I19	11
Yoga and physical exercises	A1, A2, A5, A8, A28, A30, A47, A48, A55, A59, A77, A95, A102, A108, A116, A119, I11	17
Motivational and inspirational statements	A16, A44, A47, A63, A72, A74, A76, A78, A81, I5, I26, I33	12
Online therapy and coaching	A18, A26, A27, A34, A50, A89, A90, A92 I19, I35	10
Recommending activities and tips	A42, A64, A66, A100, A102, A108, A113, A120, I19	9
Interactive messaging	A17, A18, A48, A49	4

purchase. Thus, it can be said that users may not fully benefit from the app unless they purchase these specific features. However, it should also be noted that in-app purchases are a way for many developers to monetize their work [35]. The free version of the app is used by many developers as an advertisement tool to attract users into purchasing and unlocking more features [35]. Free apps with in-app options are becoming the norm in-app markets. In 2013, in-app purchases accounted for more than 70% of iOS app revenue in the US and 90% of revenue in Asia [36].

The majority of the selected apps (64%) updated their functionality and content in the three first months of 2020. This could be linked to the current COVID-19 pandemic situation. On December 31st, 2019 the WHO China Office was informed of a number of pneumonia cases from an unknown cause, that were later linked to the coronavirus [37], which has now spread to all regions of the world [38]. To limit the spread and risk of the virus, the WHO advised the public to practice social distancing and to stay home [39]. Many countries have declared obligatory lockdowns and people were quarantined, which has created a state of fear and worry that has elevated many individuals' anxiety and stress. Various existing anxiety apps have, thus, been updated to include COVID-19 related content.

3.2. Management-related characteristics

3.2.1. Management methods

Table 2 presents various management methods identified in the selected anxiety apps with meditation and breathing exercises being the most common.

The main goal of meditation is to help the user enter a deep state of relaxation or a state of restful alertness. It helps to reduce worrying thoughts, which play a key role in symptoms of anxiety, and bring about a feeling of balance, calmness, and focus [40]. Several studies have presented evidence supporting the use of meditation in anxiety treatments [41–43]. One study reported that it was beneficial for a group of Chinese nursing students in reducing anxiety symptoms and lowering systolic BP [44]. Another study reported that it showed

improvements in the reduction of anxiety for breast cancer patients [45]. A meta-analysis of controlled trials for the use of meditation for anxiety also reported a level of efficacy of meditative therapies in reducing anxiety symptoms [46]. Additionally, meditation has been shown to be effective in managing various types of anxiety such as panic disorder and agoraphobia [41].

Breathing exercises are another mechanism that can help to relax and relieve stress. While practicing deep breathing, a message is sent to the brain to calm down and relax. Biochemical changes subsequently decrease HR and BP and help the person to relax [47]. Studies have shown that breathing exercises can improve cognition and overall well-being [48], while also reducing anxiety [48–52]. Breathing exercises can also have a positive impact on psychological distress, quality of sleep [49], depression [50–52], everyday stress, PTSD, and stress-related medical illnesses [50,53]. Breathing exercises are also used to help with asthma, which was the case in A3 and A6. However, it should be noted that such exercises may help patients whose quality of life is impaired by asthma, but they are unlikely to reduce the need for anti-inflammatory medication [54].

Many of the selected apps provided educational content about anxiety and other mental issues, symptoms, and management methods, either in the form of courses, articles, videos, or others. Educating users about anxiety can help to reassure them and provide them with the necessary knowledge by answering questions and correcting misinformation that they might have. Educating users about the provided management method and its benefits may also increase their trust in the management approach and their willingness to try it. Mental assessment tests have been provided by some apps to give the user an idea about his/her mental status, anxiety, stress and/or depression levels.

Relaxing music and sounds, is a noninvasive and free of side-effects approach that has been used in 31 apps as a management method. It has been shown to be an effective tool for the reduction of anxiety, stress, and depression [55,56]. It has also shown positive results in the prevention of anxiety and stress-induced changes like HR and BP [57]. Developers should take into account the type of music and sounds used,

as well as the accompanying environment, as they both affect the effectiveness of this method [58,59].

Thirty-one apps provided journaling and writing diaries to help users plan their day, track their mood, and express their thoughts, feelings, and emotions. Securing the privacy and confidentiality of users' information is critical in such apps. All selected iOS apps providing journaling provide authentication methods, while only 41% of Android apps with this functionality provide users with the same level of authentication.

Eleven apps provide the user with the possibility of communicating with other users. In these apps, users are able to share their experiences, talk about their issues, help each other, and relate to others who are undergoing similar problems as their own. In the current COVID-19 pandemic, being in a state of isolation but having the ability to connect with an online community can be very helpful. The idea of enabling interaction with a community of people with similar issues is quite interesting and can be extremely helpful, especially given that people with anxiety often tend to avoid direct communication [60]. For users who prefer communication with mental health care professionals, there are ten apps available that provide online therapy and coaching, enabling users to communicate with mental health care professionals, without having to travel, while also avoiding obstacles like stigma and distance. Selected apps offering online therapy services charge fees for these services. These apps also provide information on the mental health care professionals' credentials. This information is important as it allows the user to check whether these professionals are appropriately accredited and decide which mental health care professional is most suited for his/her needs.

Thirty-three apps provide users with games like coloring books, puzzles, and slime simulations, as management methods for anxiety. These games help the user to relax, and to take his/her mind off worrying thoughts or feelings. Games are usually enjoyable and entertaining and this may motivate users to continue using these apps.

The variety of management methods identified in the selected apps points to the high potential of apps usage for coping with anxiety. Developers have integrated various promising and effective management methods in their apps' functionality features. Users can access these features at any time and in any place. This could be beneficial for

users with anxiety disorders, especially in situations where immediate help is needed (e.g., during panic attacks), or in cases where mental health care professional cannot be reached due to circumstances like distance or the current global lockdown situation.

3.2.2. Intervention approaches

Table 3 presents the selected apps which state the use of specific intervention approaches for anxiety management. The most used ones included mindfulness, cognitive behavioral therapy (CBT), and hypnosis.

Mindfulness was the most adopted management approach. It is defined as "bringing one's complete attention to the present experience on a moment-to-moment basis" [61]. Mindfulness practices allow practitioners to shift their concentration to their internal experiences occurring in each moment, such as bodily sensations, thoughts, and emotions, or to their external environment consisting of sights and sounds [62,63]. There are a number of interventions that are based on mindfulness, like mindfulness-based stress reduction, mindful meditation, and mindfulness-based cognitive therapy. Many approaches incorporate mindfulness in their process such as Dialectical Behavioral therapy (DBT) and Acceptance Commitment Therapy (ACT) [64], which are used in some of the selected apps. Mindfulness can be delivered through guided relaxation tools like guided relaxation audios, videos, or text. Studies have reported that mindfulness has shown promising results for treating anxiety and mood problems [65,66], and improving an individual's internal cognitive, emotional, and physical experience [67]. Some findings suggest that mindfulness can be more complicated than it might seem, as many elements like attention emotional balance, differences in emotion-responding variables, and clinical context can influence its effect [68-70]. Therefore, these elements should be taken into account while developing mindfulness-based anxiety apps.

CBT is a form of psychological treatment, mainly based on efforts to change thinking patterns [71]. Many studies have supported the effectiveness of CBT-based interventions for the treatment of anxiety, and have reported on the long-term positive effect it has on both children and adults [72,29]. A study examining available evidence on CBT have yielded positive results and confirmed its effectiveness for anxiety

Table 3
Intervention approaches.

Intervention approach	App ID	Total
Mindfulness	A8, A10, A12, A17, A20, A25, A29, A34, A40, A41, A48, A49, A56, A81, A86, A106, A111, A121, I2, I6, I7, I11, I18, I19, I23, I29, I30, I33, I42	29
Cognitive behavioral therapy (CBT)	A17, A18, A22, A24, A33, A34, A40, A41, A44, A46, A48, A49, A58, A63, A70, A76, A78, A89, A97, A100, A101, A103, A115, I7, I33	25
Hypnotherapy	A21, A36, A67, A105, A118, A121, I2, I5, I30, I40	10
Artificial intelligence (AI)	A17, A18, A49, A113, I29, I33	6
Brainwaves and special beats and frequencies	A77, A105, A107, I2, I34	5
Dialectical Behavioral therapy (DBT)	A18, A49, A78, A89, A100	5
Autonomous Sensory Meridian Response (ASMR)	A30, I17, I21, I28, I39	5
Acceptance Commitment Therapy (ACT)	A17, A40, A63, I7	4
Spiritual and religious basis	A35, I2, I9	3
Biofeedback	A6, A113	2
Positive Psychology	A48, I33,	2
Behavioral Activation Therapy	A66	1
Bilateral stimulation a part of Eye Movement Desensitization and Reprocessing therapy (EMDR)	A79	1
Horoscope based	A82	1
Neuro-linguistic programming (NLP)	A111	1
Tapping (EFT), combination of ancient Chinese acupuncture and modern psychology	A13	1

Table 4
Mental health problems addressed by the selected apps.

Mental issue	App ID	Total
Stress	A1-A8, A10-A13, A16-A21, A24, A28-A30, A33-A38, A40, A41, A44, A48-A50, A52, A53, A56, A57, A59, A63-A65, A67-A69, A72, A77, A79-A88, A92, A95, A98-A100, A102, A103, A105, A106, A108-A113, A115, A116, A118, A121, I1-I3, I5, I8-I12, I16-I20, I23-I25, I27, I29-I34, I36, I37, I39-I43	107
Sleep problems	A2, A3, A6-A11, A13, A15, A16, A18-A21, A23, A30, A33, A35-A38, A44, A48, A52, A56, A59A67, A77-A79, A82, A83, A86, A87, A98, A105, A108, A109, A118, A121, I1, I2, I3, I5, I7-I10, I13, I16, I18, I23, I25, I29, I30, I32, I40, I42	59
Depression	A5, A11, A17, A18, A20, A27, A28, A33-A35, A38, A39, A41, A44, A45, A48-A50, A61, A63, A64, A66, A72, A75, A77, A78, A80, A83, A85, A87, A89, A90, A92, A95, A97-A101, A103-A105, A114, A120-A123, I7, I9, I11, I19, I26, I34, I35	54
Panic and panic attacks	A18, A22, A23, A40, A42, A54, A55, A69, A72, A73, A75, A80, A89, A94, A96, A97, A105, A106, A120, A122, I7	21
Anger	A18, A29, A38, A48, A50, A63, A98, A105, I8, I34, I41	11
Focus and concentration	A6, A11, A20, A29, A38, A86, A112, I1, I13, I18	10
Self-esteem and confidence	A18, A20, A21, A83, A88, A118, A121, I1, I2, I5, I18, I26	12
Pain	A12, A13, A37, A49, A64, A83, A107, I18, I23	9
Mood	A5, A14, A18, A39, A69, A77, A89, A95, A120	9
OCD	A26, A31, A32, A46, A58, A78, A89, A105	8
PTSD	A78, A80, A89, A97, A105, A123, I7	7
Weight issues	A6, A13, A21, A83, A121, I2, I30	7
Addiction and alcohol use	A35, A49, A78, A90, A123, I2, I30	7
Social anxiety disorder	A69, A70, A71, A89, A117, I7	6
Eating disorder	A61, A78, A120, A123	4
Suicide and self-harm	A61, A78, A120	3
Grief and loss	A18, A49, A83	3
Attention	A6, A65, A83	3
Phobias	A50, A70, I2	3
Problems related to pregnancy	A13, A38	2
Memory	A6, A65	2
ADHD (Attention Deficit Hyperactivity Disorder)	A107, I18	2
Separation anxiety	A71	1
Performance anxiety	A71	1

disorders [73]. CBT has also been used in the treatment of some specific anxiety disorders like PTSD [74] and OCD [75]. It has also been proved effective for depression, alcohol and drug use problems, eating disorders, and severe mental illness [71]. CBT and mindfulness-based therapy can also be useful in reducing anxiety during the COVID-19 pandemic [76].

Hypnosis is a therapeutic technique designed to bring relaxation and focus to the mind [77]. Many studies have reported the effectiveness of hypnosis for the treatment of anxiety. One study stated that it can reduce anxiety among palliative care patients with cancer [78], and

another reported on its considerable benefits to terminally ill patients [79]. Hypnosis is also used to treat and manage stress and phobias [80], as well as sleep and physical symptoms [78].

Other approaches have also been identified in the selected apps as shown in Table 3, but it should be noted that a few of them were not based on scientific approaches.

3.2.3. Targeted mental health problems/symptoms

Table 4 presents the different health issues besides anxiety that were addressed by the selected apps. All selected apps addressed general

Table 5
Apps reporting involvement of mental health care professionals.

ID	Mental health care professional involved
A8	Experts including Tara Brach, Ph.D (psychologist); Mark Williams (Emeritus professor of clinical psychology); and Richard Alpert (psychologist)
A12	Project team of PhDs and experts including Jason Owen (clinical health psychologist).
A17, I7	Team of doctors led by Dr. Jose Hamilton (psychiatrist and member of the American Psychiatric Association)
A21, I2	Glenn Harrold (hypnotherapist and self-help author)
A24	Licensed mental health professionals at Duke university
A25	Judson Brewer, MD, PhD (psychiatrist, neuroscientist and author)
A43	Silja Litvin (clinical psychologist)
A46, A58, A101	Dr. Guy Doron (clinical psychologist and researcher)
A49	Experts including Dr. Alison Darcy (psychologist); and Dr. Athena Robinson (psychologist)
A121	Mark Bowden (hypnotherapist)
I25	Expert including Elisha Goldstein (psychologist); Michael Apollo (registered psychotherapist and corporate consultant); Ashley Turner (marriage and family therapist and yoga instructor), Roger Nolan (mindfulness-based psychotherapist)
A18, A26, A50, A89, A92, I35	Therapists
A27, A90	Counselors and Coaches
A34, A119	Psychologists
A36, A105	Hypnosis experts
A48, I19	Psychiatrists and therapists
A66	Multiple mental health care professionals
A76	Clinician

Table 6
Authentication methods.

Authentication method	App ID	Total
No authentication required	A1, A3-A7, A9-A12, A14, A15, A18, A19, A21, A22, A24, A27-A29, A31-A33, A37-A39, A42, A43, A45, A46, A50-A53, A55, A57, A58, A60, A62, A65, A66, A68-A81, A83, A84, A87, A91, A93-A96, A98-A112, A114-A117, A120, A122, I1-I5, I8, I10, I12, I14-I17, I21, I22, I24, I25, I27, I28, I31, I36-I39, I41-I44	111
Email	A2, A8, A13, A16, A17, A20, A23, A25, A26, A34-A36, A40, A41, A44, A48, A49, A54, A56, A59, A61, A63, A64, A67, A82, A86, A88-A90, A92, A113, A118, A119, A121, A123, I6, I7, I9, I11, I13, I18, I19, I23, I26, I29, I30, I32-I35, I40	51
Facebook	A2, A8, A13, A16, A23, A30, A34, A36, A40, A44, A48, A56, A59, A61, A64, A82, A85, A86, A88, A89, A92, A113, A118, A123, I13, I18, I20, I23, I29, I30, I34, I35	32
Google account	A2, A13, A16, A23, A30, A34, A36, A44, A47, A48, A56, A61, A85, A86, A88, A89, A92, A113, A123, I20, I29, I35	22
Twitter	A86	1
Nickname and password	A97	1

anxiety. Some apps addressed specific types of anxiety like social anxiety, separation anxiety, performance anxiety, OCD, PTSD, and panic attacks.

Some apps addressed other mental and physical issues, which usually occur with anxiety like stress [80,53], sleep issues [78], and depression [71,41,53]. Some apps used management methods to treat addiction-related issues, eating disorders [71], phobias, [80], and asthma [54].

3.2.4. Physical health information used by apps

The majority of the apps do not use physical health information. HR and BP are impacted by anxiety and stress [57]. Both can be used by apps to indicate the anxiety level of the user [20]. Yet in our selection only two apps provided this functionality feature (A6 and A113). A113 collects data on HR variability, using the photoplethysmogram (PPG) technique to get insights on the user's health, including stress, energy, and productivity levels. The app also allows the user to manually enter BP as a convenient way of journaling. It should be noted that A6 provides cardiovascular tests, including HR and peripheral blood circulation, as an app purchase option.

3.2.5. Involvement of mental health care professionals

Only 19% of the selected apps reported involvement of mental health care professionals as presented in Table 5. Apps providing online therapy specified information about the therapists that the user can contact. This information includes their specialty, experience, and diplomas. Some apps shown in Table 5 provided names of the professionals involved in their co-creation. Providing names gives the user the possibility to look online for the credentials of the involved professionals and might increase the user's trust toward these apps. We cross-checked the names displayed in Table 5 and found them to be legitimate. Table 5 also shows apps that mention the involvement of mental healthcare professionals in their content creation without providing their names. Involvement of mental healthcare professionals in the apps, varied between involvement in the co-creation of the app, production of the content of the app, and in providing online therapy and care. For mental healthcare professionals cited to be involved in the co-creation, their input in the process cannot be exactly specified.

Table 7
Gamification features.

Gamification features	App ID	Total
Game	A31, A32, A43, A46, A51, A58, A60, A63, A65, A72, A84, A96, A101, A112, A119, A120, I14, I15, I17, I20-I22, I24, I27, I28, I31, I36-I39, I41, I43, I44	33
Graphics	A3, A6, A29, A30, A37, A41, A55, A59, A70, A73, A76, A80, A83, A93, A94, A98, A115, A120, I16, I4	20
Goals and achievements	A12, A14, A25, A36, A41, A47, A48, A54, A55, A56, A64, A76, A88, A100	14
Levels, steps and progress	A10, A34, A37, A56, A61, A91, A113, I19, I42, I9	10
Challenges	A10, A16, A22, A23, A34, A35, A56, A70, I30	9
Unlocking new features	A114, A17, I18, I33, I7	5
Score and points	A27, A48, A54, I8	4
Stickers, awards and stars	A14, A16, A20, A100, I11	5

Some apps involved professionals experienced in certain well-being fields, but did not have a mental health background. A1 involved Sadhguru (an Indian yogi, mystic, and author) who was also involved in A8; A23 was based on a book by Barry McDonagh (an author and creator of the Panic Away Program); A30 involved sleep professionals and experts; A56 involved meditation teachers; A74 involved Steve Maraboli (a motivational speaker and author); A108 was developed by a student counseling service; A111 involved Sanna Wikstrom (a Neuro-linguistic programming master practitioner); I6 involved Sam Harris (an author and a neuroscientist) who was also involved in A8; I34 involved spiritual teachers and healers; and I42 involved meditation experts.

It should be noted that many management methods and/or approaches might not be used correctly or efficiently if they are not under the supervision or approval of specialists, especially in the case of mental health. Including mental health care professionals in the co-creation of anxiety apps is critical for the correct use of psychological management methods.

3.3. Other functionality

3.3.1. Authentication method

Table 6 presents the authentication methods identified in the selected apps. The majority of the selected apps (66%) do not require authentication. The absence of authentication might give the user a sense of anonymity. However, authentication can help the user ensure the privacy of his/her data. The app A97 requests a nickname and a password, ensuring security and confidentiality as well as keeping the anonymity of the user, since it does not use any information or sources that could reveal the identity of the user like Facebook account, google account, or email.

3.3.2. Gamification features

Gamification is the use of game elements in non-gaming systems which are mainly used to improve user experience and user engagement [81]. Table 7 presents the different gamification methods identified in the selected apps. Note that some apps use more than one gamification method. The majority of the selected apps used gamification features to

Table 8
Social features.

Social feature	App ID	Total
Chat and connection to app users, either through the app or other means	A2, A6, A8, A19, A25, A27, A34, A47, A50, A61, A63, A72, A76, A78, A85, A90, A119, A123, I1, I6, I13, I19, I20, I29, I37	25
Sharing content and progress via SN and email	A14, A16, A20, A21, A30, A35, A36, A39, A41, A59, A74, A84, I20, I21, I26, I39, I7	17
Links to related centers, associations and websites	A1, A22, A63, A66, A117, A119	6
Emergency contacts' information	A12, A120, A34, A40, A54, A61, A63, A76, A91	9
Group treatment	I34, I35	2

encourage and motivate the user. Creating a fun, interactive user experience with the adoption of game elements can create an enjoyable user experience, which can further reduce boredom and motivate users keep using the app. This can also increase user engagement, leading to users providing more accurate information about their mental health status and to increased benefit for the user from the provided mental health care management method.

Gamification is a widely used approach that has shown effectiveness with anxiety and other mental health problems, such as depression and PTSD for military personnel [82,83], and aggression for veterans [84]. Combining game elements and knowledge on game players' behaviors with known mental health care management methods is an interesting approach that can result in the creation of effective anxiety apps.

3.3.3. Social features

Table 8 presents the different social features provided by the selected apps. Many apps provide social and communication features, which allow the user to connect with communities of app users as well as with centers and associations, or with others to share content and progress. Those social features could prove to be beneficial to the user. For instance, sharing progress and content from the app via social networks (SN) and emails helps provide social support to the user from family and friends. Social support is significantly associated with well-being and absence of psychological distress [85]. It has a favorable effect on certain psychological issues [86], and can serve as a mediator to stress and anxiety caused by life events [87]. Providing social support is also among the behavioral change techniques implemented in m-health apps to promote app usage [88]. Additionally, providing contacts in case of emergencies is crucial and might help the user in critical situations where he/she feels the need for immediate help. Links to associations, websites, and centers can provide the user with more helpful resources. Social features are very important as they help the user connect with others in a beneficial way.

3.3.4. Languages

Table 9 presents the languages available in the selected apps. The majority of the apps (127 app) are available only in English, which can be explained by the fact that the search string applied in app repositories was in English. Only one app (A98) automatically translates its content to the device's preferred language. While the rest of the apps are available in more than one language. Availability in multiple languages can help reach a larger number of users.

Table 9
App language.

Languages	Apps	Total
English	A3, A4, A5, A7, A9, A11-A13, A17-A29, A31-A33, A35, A36, A38-A43, A45, A47-A57, A61, A63-A84, A86, A87, A90-A97, A99, A100, A102-A112, A114-A119, A121-A123, I2, I4-I7, I9, I10, I11, I13, I14, I16, I21, I23-I26, I29-I35, I37, I38, I40-I44	129
More than one language	A1, A2, A6, A8, A10, A14-A16, A30, A34, A37, A44, A46, A58-A60, A62, A85, A88, A89, A101, A113, A120, I1, I3, I8, I12, I15, I17-I19, I20, I22, I27, I28, I36, I39	37
System's languages	A98	1

3.4. Offline availability

Table 10 shows whether an app requires internet access to function or not. Internet access is required to install and create accounts for all apps, but once that is done, many apps function without internet access.

Offline availability is an aspect that will help users benefit from the app without necessarily being in a setting with internet access. This will decrease the app's limitations and make it more accessible to users. However, some of the management methods identified do require internet access, like online therapy and communication with communities of app users. Additionally, offline availability may require downloading more data that could be permanently stored, which may affect a phone's memory and performance. Some apps were only partially available offline, resulting in limited functionality when internet access was not available. Other apps only made downloaded data available offline, meaning the user chooses and downloads content that he/she wants to be available while offline. These are convenient solutions to offline availability that do not compromise on app functionality.

3.5. Limitations

This study is subject to limitations, such as: (i) missing terms (e.g., stress, depression) in the search string that might have resulted in the selection of relevant apps, as usually an app targets more than one mental health issue. However, the search string used identified any app that mentions anxiety in its title and/or description, therefore this can alleviate the threat of missing relevant apps; and (ii) the first author conducted the search and applied the EC and IC to the initial selection. However, the final selection has been reviewed by the second author.

4. Conclusion and future work

With the current development in mobile communication and the wide ownership of mobile devices, m-mental health seems to be one of the most promising ways to deliver care to people in need regardless of their situation. Under certain circumstances like the current COVID-19 pandemic, the use of mobile communication and apps for anxiety might become a necessity. Panic attacks can mimic COVID-19 symptoms, which might worsen the condition of people with anxiety disorders [89]. Having an app on hand that can ease anxiety in such circumstances is useful.

This study highlights the functionality and characteristics of anxiety apps that are well rated by users. We plan to build on the reported

Table 10
Functioning offline.

Functioning offline	App ID	Total
No	A2, A13, A18, A26, A27, A35, A40, A41, A44, A46, A49, A50, A52, A54, A58, A61, A64, A65, A68, A71, A72, A79, A85, A89, A90, A92, A98, A99, A101, A103, A106, A109, A113, A118, A123, I6, I8, I9, I19, I29, I30, I33, I35, I42, I43	45
Yes	A3-A7, A11, A12, A14, A15, A17, A24, A28, A29, A31, A32, A37-A39, A43, A45, A48, A51, A53, A55, A57, A60, A62, A69, A73-A76, A80, A81, A83, A84, A87, A91, A93, A94-A97, A100, A102, A104, A105, A107, A108, A110-A112, A114-A117, A120, A122, I3, I4, I7, I10, I13-I15, I21-I24, I26-I28, I31, I36-I38, I41	77
Partially (Some functionality require internet access, while others do not require it even for the first use)	A25, A30, A34, A47, A59, A63, A66, A70, A77, A78, A88, A119, I11	13
Partially (When offline, users can only benefit from previously downloaded features and data of the app, like videos, courses, audios, etc.)	A1, A8, A9, A10, A121, A16, A19, A20, A21, A22, A23, A33, A36, A42, A56, A67, A82, A86, I1, I2, I5, I12, I16-I18, I20, I25, I32, I34, I39, I40, I44	32

findings to develop a reusable requirements catalog for anxiety apps. Mental health care professionals and people with anxiety disorders will be involved in the co-creation of this catalog. The catalog will also include software quality requirements based on the ISO/IEC 25020 standard and recommendations from the UK National Health Service (NHS) and the Health Insurance Portability and Accountability Act (HIPAA) on health apps. Since the reusable requirements catalog for anxiety apps will be based on functionality of existing highly rated apps, as well-being based on inputs from mental health care professionals and people suffering from anxiety, it could be used to assist developers to select relevant requirements for anxiety apps. Apps could therefore be designed based on the catalog to assist people dealing with anxiety. Requirements from the catalog could also be used to generate checklists for audit and evaluation purposes [90], either to evaluate apps or to compare their functionality and characteristics.

The findings from this study may also assist researchers and developers interested in the field of m-mental health, especially in the sub-field of anxiety, to have an overview of the characteristics and functionality of existing highly rated apps for anxiety. Our findings could also assist mental health professionals to find anxiety apps that could be integrated in their mental health care process, as well as assist people suffering from anxiety to find mobile apps best suited for their needs. During the COVID-19 pandemic, m-health can also help disseminate health information among health personnel and community workers [91].

Summary points

What was already known on the topic:

- Anxiety disorders are a common mental issue.
- There are many barriers to mental health care delivery, mainly cost, stigma and distance from health professionals.
- Apps were found to be effective tools to deliver mental health care, and overcome the aforementioned barriers.

What this study added to our knowledge:

- 167 free and high-rated anxiety apps were analysed: 123 Android apps, and 44 iOS apps.

- Anxiety apps addressed other health issues, such as: stress, depression, sleep issues, and eating disorders.
- Anxiety apps adopted various management, treatment and coping approaches such as, meditation, breathing exercises, mindfulness and cognitive behavioral therapy.
- Results showed that 51% of the selected apps use various gamification features to motivate users to keep using the apps; 32% provide social features including chat, communication with others and links to sources of help; 46% are available offline and 67% are available only in English; only 19% reported involvement of mental health professionals in their design; 68% offer in-app purchases to unlock features and functionality; and 64% updated their functionality and content in the three first months of 2020, which can be linked to COVID-19 outbreak.

Compliance with ethical standards

This article does not contain any studies with human participants or animals.

Author contributions

All authors contributed to the creation of the manuscript. ND: design, conception, acquisition and interpretation of data, classification of selected apps, drafting of the manuscript, revision. SO: design, conception, statistical support, interpretation of data, drafting of the manuscript, critical revision. MAJI and MG: critical revision. All authors read and approved this manuscript.

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Conflict of interest

The authors have no conflict of interest.

Appendix A. Selection results

Tables A.11–A.16

Table A.11
Selected Android apps. Part 1.

ID	App's name	App's link	# Installs	Rating	# Raters	Update
A1	Sadhguru – Yoga, Meditation & Spirituality	http://bit.ly/2Q4RFN6	1,000,000	4.9	22,641	20-Feb-20
A2	Yoga for Beginners Down Dog	http://bit.ly/2pZhkft	500,000	4.9	10,261	07-Jan-20
A3	Breath Ball: The Stress Relief Breathing Exercise	http://rb.gy/r0f6yl	50,000	4.9	1046	20-Mar-20
A4	Stress Buster- Relief from Stress and Anxiety	http://rb.gy/azh62n	500	4.9	29	26-Dec-19
A5	10 daily Stress Relief Yoga and Exercise	http://rb.gy/ecdtn4	1000	4.9	21	20-Dec-18
A6	Prana Breath: Calm & Meditate	http://bit.ly/2qzXc3M	1,000,000	4.8	52,428	28-Dec-19
A7	Atmosphere: Relaxing Sounds – Rain & Sleep sounds	http://bit.ly/2Cuvh7Z	1,000,000	4.8	51,782	17-Feb-20
A8	Insight Timer – Meditation	http://bit.ly/2qCTsyj	1,000,000	4.8	50,351	01-Nov-19
A9	Let's Meditate: Guided Meditation	http://bit.ly/2NybMld	1,000,000	4.8	45,530	18-Aug-19
A10	Serenity: Guided Meditation & Mindfulness	http://bit.ly/2Q2Phqj	100,000	4.8	6281	11-Feb-20
A11	Relaxing Sounds	http://bit.ly/2CsJ271	100,000	4.8	4865	02-Nov-19
A12	Mindfulness Coach	http://bit.ly/33yzHGH	100,000	4.8	3190	25-Sep-19
A13	The Tapping Solution	http://rb.gy/99knbb	100,000	4.8	1445	11-Mar-20
A14	Daylio – Diary, Journal, Mood Tracker	http://bit.ly/34NiKJ2	5,000,000	4.7	284,742	25-Mar-20
A15	Sleepa: Relaxing sounds, Sleep	http://bit.ly/2rmRhzd	1,000,000	4.7	66,240	17-Feb-20
A16	Meditopia: Méditation, Anxiété	http://bit.ly/34MMHsq	1,000,000	4.7	56,175	20-Feb-20
A17	Youper – Emotional Health	http://bit.ly/32AAnKq	1,000,000	4.7	46,031	15-Feb-20
A18	Wysa: stress, depression & anxiety therapy chatbot	http://bit.ly/2Q3NAss	1,000,000	4.7	36,225	21-Feb-20
A19	Meditation & Relaxation: Guided Meditation	http://bit.ly/2O9KJMn	1,000,000	4.7	35,822	16-Oct-18
A20	Stop, Breathe & Think: Meditation & Mindfulness	http://bit.ly/2X0XgWr	1,000,000	4.7	17,355	18-Dec-19
A21	Relax & Sleep Well: Hypnosis and Meditation	http://bit.ly/33yFa0l	500,000	4.7	6232	06-Nov-19
A22	Stop Panic & Anxiety Self-Help	http://bit.ly/2K5YaeS	100,000	4.7	2353	19-Aug-16
A23	Dare – Break Free From Anxiety	http://bit.ly/36ObhLt	100,000	4.7	2191	20-Feb-20
A24	CBT Thought Record Diary	http://bit.ly/2NyGHxH	100,000	4.7	671	24-Jan-20
A25	Unwinding Anxiety®	http://rb.gy/q8udfv	10,000	4.7	237	18-Oct-19
A26	NOCOD: OCD Treatment App	http://rb.gy/dhyrom	10,000	4.7	263	20-Mar-20
A27	Help – Depression, Anxiety, Relief, Social Texting	http://rb.gy/y2jsps	50,000	4.7	2084	29-Jan-20
A28	Stress Relief Yoga and Exercise Fitness App	http://rb.gy/lpdcpc	1000	4.7	17	22-Aug-19
A29	Breathing Exercise App: Breath – Just Breathe	http://rb.gy/prvzgt	1000	4.7	67	05-Nov-18
A30	Relax Melodies: Sleep Sounds	http://bit.ly/2NwfJHa	10,000,000	4.6	281,389	07-Feb-20
A31	Energy: Anti Stress Loops	http://bit.ly/36PTmUJ	5,000,000	4.6	249,874	18-Feb-20
A32	Harmony: Relaxing Melodies	http://bit.ly/2rucWpm	1,000,000	4.6	27,168	28-Jan-20
A33	Moodpath – Depression & Anxiety Test	http://bit.ly/2X6FelC	1,000,000	4.6	23,980	14-Feb-20
A34	Sanvello (ex Pacifica)	http://bit.ly/2rmJGAG	1,000,000	4.6	14,106	18-Feb-20
A35	Abide: Christian Guided Meditation & Daily Prayers	http://bit.ly/2O0pnkt	500,000	4.6	17,548	19-Feb-20

Table A.12
Selected Android apps. Part 2.

ID	App's name	App's link	# Installs	Rating	# Raters	Update
A36	Deep Meditate – Meditation, Relaxation, Sleep App	http://bit.ly/2K5WWJP	500,000	4.6	8358	09-Feb-20
A37	Relax Lite: Stress Relief	http://bit.ly/2NyGwCM	500,000	4.6	3342	28-Jul-16
A38	Music for Meditation	http://bit.ly/2K7gX9F	100,000	4.6	4034	02-Jan-20
A39	eMoods Bipolar Mood Tracker	http://bit.ly/2q12QM6	100,000	4.6	4009	28-Oct-19
A40	Pocketcoach – Anxiety Helper	http://rb.gy/dmhl0	5000	4.6	63	17-Mar-20
A41	Moodfit – Tools & Insight to Shape Up Your Mood	http://rb.gy/gcelks	10,000	4.6	280	20-Mar-20
A42	Panic Attacks?	http://rb.gy/snlpqx	10,000	4.6	257	23-Apr-14
A43	eQuoo: Emotional Fitness Game	http://rb.gy/wmj4uh	10,000	4.6	1811	18-Dec-19
A44	feel better – Mood & CBT therapy to manifest goals	http://rb.gy/wynqt3	50,000	4.6	539	11-Mar-20
A45	Cure Depression & Anxiety with Breath	http://rb.gy/yj1xy0	100	4.6	45	25-Sep-18
A46	GG Relationship Doubt & Obsessions (ROCD)	http://rb.gy/3iuxei	10,000	4.5	163	01-May-19
A47	Fabulous! Coach Lifestyle, Meditation & Relaxation	http://bit.ly/34OCxHI	5,000,000	4.5	292,099	08-Feb-20
A48	InnerHour: Calm, Sleep, Depression & Anxiety Therapy	http://bit.ly/2pNLOBn	500,000	4.5	4109	11-Feb-20
A49	Woebot: Your Self-Care Expert	http://bit.ly/33ySI1g	100,000	4.5	6223	15-Jan-20
A50	Online therapy – mental help. Support groups.	http://bit.ly/36PpE2g	100,000	4.5	3561	20-Feb-20
A51	#SelfCare	http://bit.ly/2pWe8Bi	100,000	4.5	2057	29-Jul-19
A52	Deep Calm – Meditate, Sleep, Relax	http://bit.ly/33ytoTF	100,000	4.5	1712	18-Sep-19
A53	Kardia Respiration Relaxation	http://bit.ly/32BweWt	100,000	4.5	1248	08-Nov-19
A54	Rootd – Panic Attack & Anxiety Relief	http://bit.ly/2ruaM9g	100,000	4.5	800	08-Feb-20
A55	PanicShield – Panic Attack Aid	http://rb.gy/omstc7	10,000	4.5	124	05-Apr-18
A56	Brightmind – Meditation for Stress & Anxiety	http://rb.gy/lnpjmm	1000	4.5	54	04-Dec-19
A57	Stress Management – Effectively Reduce Stress	http://rb.gy/jpralx	10,000	4.5	12	15-Jan-20
A58	OCD Daily Exercise by GG (GGOC)	http://rb.gy/cigs17	10,000	4.5	153	28-Aug-19
A59	Calm – Meditate, Sleep, Relax	http://bit.ly/2K9jgcq	10,000,000	4.4	196,515	07-Feb-20
A60	My Oasis – Tap Sky Island	http://bit.ly/2CvIPA8	5,000,000	4.4	155,749	21-Feb-20
A61	TalkLife – Lonely, Stressed or Battling Anxiety?	http://bit.ly/2K9ij3Q	500,000	4.4	25,333	17-Feb-20
A62	Meditation Game	http://bit.ly/36NqOes	500,000	4.4	4444	02-Apr-18
A63	What's Up? – A Mental Health App	http://bit.ly/2Q2Hzwj	500,000	4.4	3126	02-Jun-19
A64	SuperBetter	http://bit.ly/2Q08lp7	100,000	4.4	5838	05-Oct-18
A65	SRCH! Brain training & anti stress coloring games	http://bit.ly/33zmf6	100,000	4.4	5156	10-Feb-20
A66	MoodTools – Depression Aid	http://bit.ly/2K644wy	100,000	4.4	3057	07-Sep-19
A67	Harmony – Hypnosis Meditation	http://bit.ly/36S8Uak	100,000	4.4	2946	05-Dec-19
A68	Relaxing Music for Stress – Anxiety Relief & Sleep	http://bit.ly/2Q2ykbB	100,000	4.4	715	13-Jan-20
A69	Anxiety Tracker – Stress and Anxiety Log	http://rb.gy/mik3xa	10,000	4.4	167	17-Mar-20

Table A.13
Selected Android apps. Part 3.

ID	App's name	App's link	# Installs	Rating	# Raters	Update
A70	FearTools – Anxiety Aid	http://rb.gy/vols56	50,000	4.4	96	22-Sep-19
A71	Anxiety Symptoms + Treatment	http://rb.gy/vkhhyv	10,000	4.4	93	10-Jan-15
A72	Anxiety Cures – Relieve Stress, Increase Happiness	http://rb.gy/rsrefn	10,000	4.4	83	16-Jul-18
A73	Breathing exercises	http://rb.gy/t5f6ek	50,000	4.4	293	05-Aug-17
A74	Anxiety Quotes	http://rb.gy/dau7md	1000	4.4	10	04-May-19
A75	Mood Log	http://rb.gy/kh9fkx	50,000	4.4	1156	02-Dec-19
A76	Clear Fear	http://rb.gy/rcepoh	100,000	4.4	173	07-Feb-20
A77	Fight Depression Naturally	http://rb.gy/vsgmtp	50,000	4.4	366	27-Jan-20
A78	Psychiatry Pro-Diagnosis, Info,Treatment,CBT &DBT	http://rb.gy/r8bmet	10,000	4.4	185	19-Mar-19
A79	Sleep Restore	http://rb.gy/wjhfxi	5000	4.4	31	19-Apr-19
A80	Breathe Easy	http://rb.gy/ks6ph4	10,000	4.4	202	23-Jun-16
A81	TOBEE mindfulness coach	http://rb.gy/pgqysy	100,000	4.4	2943	18-Jul-18
A82	Mindrise: Sleep, Meditation, Music &Astrology	http://rb.gy/vxjdoq	10,000	4.4	391	21-Mar-20
A83	Breathing Exercises	http://rb.gy/19vwqa	10,000	4.4	231	03-May-19
A84	Antistress – relaxation toys	http://bit.ly/2NzaA0W	10,000,000	4.3	119,257	13-Feb-20
A85	Friend Shoulder: Advices and Vent Anonymous – chat	http://bit.ly/34Qp7LD	1,000,000	4.3	26,466	14-Feb-20
A86	The Mindfulness App: relax, calm, focus and sleep	http://bit.ly/2pLLWkN	1,000,000	4.3	10,828	31-Jan-20
A87	Relaxing Anti-Stress Sound	http://bit.ly/2X1ITkl	1,000,000	4.3	10,006	1-Oct-17
A88	Remente: Self Improvement	http://bit.ly/36UyJqD	500,000	4.3	9013	19-Feb-20
A89	BetterHelp: Online Counseling &Therapy	http://bit.ly/32svl2A	500,000	4.3	7392	12-Feb-20
A90	rTribe – Coaching for Anxiety/ Addiction/Depression	http://bit.ly/2CsUC23	100,000	4.3	3705	18-Feb-20
A91	Booster Buddy	http://bit.ly/33tOPoR	100,000	4.3	1445	10-Sep-19
A92	Online Therapy, Emotional diary, Mindfulness tools	http://bit.ly/2WZJkvw	100,000	4.3	1120	12-Feb-20
A93	Breathing Relaxation Exercices	http://bit.ly/2NUyNxP	100,000	4.3	684	24-Aug-19
A94	Panic Attack Anxiety Relief: Breathing Exercises	http://rb.gy/mettgv	10,000	4.3	116	23-Jul-18
A95	Yoga for Relief of Anxiety, Stress and Depression	http://rb.gy/sbmhom	10,000	4.3	82	12-Sep-18
A96	Flowy Beta	http://rb.gy/czt5tn	10,000	4.3	443	01-Dec-15
A97	UP! – Mood Tracker for Burnout and Bipolar	http://rb.gy/2jbdw9	50,000	4.3	1859	30-Jul-19
A98	Peace: Calm, Sleep, Meditation	http://rb.gy/jzyna2	50,000	4.3	162	19-Jan-20
A99	Depression Relief &Treatment – Music Helper	http://rb.gy/uglxfv	10,000	4.3	247	13-Jan-20
A100	De-StressMe: CBT Tools to Manage Stress	http://rb.gy/bflzeu	5000	4.3	42	14-Oct-19
A101	Self-manage Depression: Daily exercise (GGDE)	http://rb.gy/vvw47u	1000	4.3	33	15-Sep-19
A102	Yoga For Stress Relief	http://rb.gy/og3tg1	10,000	4.3	62	09-Jan-19
A103	Depression CBT Self-Help Guide	http://bit.ly/36Olfvh	100,000	4.2	1446	03-Nov-16
A104	Dealing with Depression	http://rb.gy/3markt	1000	4.6	90	16-Jan-20

Table A.14
Selected Android apps. Part 4.

ID	App's name	App's link	# Installs	Rating	# Raters	Update
A105	Anxiety Relief Hypnosis – Stress, Panic Attacks	http://bit.ly/32yWvVF	100,000	4.2	1302	3-Jul-19
A106	Mindfulness: Guided Meditation for Stress, Anxiety	http://bit.ly/2rw5lXp	100,000	4.2	605	20-Jul-17
A107	Healing Sounds-Anxiety Relief	http://rb.gy/wzxxar	50,000	4.2	279	05-Jun-14
A108	Exam Stress	http://rb.gy/gps6bj	1000	4.2	10	18-Sep-17
A109	Relaxing Music for Sleep and Anxiety Relief	http://rb.gy/tu47je	10,000	4.2	49	15-Mar-20
A110	Calm Meditation Stress Relief Breathing Exercises	http://rb.gy/mzbymd	10,000	4.2	174	23-Jul-18
A111	Stress Less Cards	http://rb.gy/miz5bi	10,000	4.2	39	11-Jun-17
A112	Balloon Pop – Balloon Game	http://rb.gy/tsj29p	10,000	4.2	19	31-May-17
A113	Welltory: EKG Heart Rate Monitor and Stress Relief	http://bit.ly/2qHihcg	500,000	4.1	7320	21-Jan-20
A114	Mood Tracker &Journal. Anti Depression (Reflexio)	http://bit.ly/2CuE3ml	500,000	4.1	4182	21-Feb-20
A115	Stress &Anxiety Companion	http://rb.gy/ewjzuf	10,000	4.1	14	20-Feb-20
A116	Yoga for Anxiety	http://rb.gy/msmoqj	10,000	4.1	160	27-Sep-18
A117	Social Anxiety Test	http://rb.gy/iuzffm	10,000	4.1	38	03-Apr-18
A118	Elaine Martin Kids Hypnosis	http://rb.gy/l22ffl	1000	4.1	25	28-Feb-20
A119	Self-help Anxiety Management	http://bit.ly/2Q158Wb	500,000	4.0	2944	22-Feb-17
A120	Do not panic – Depression and panic help	http://rb.gy/xjveir	10,000	4	383	01-Feb-20
A121	Live Life: Guided Meditation & relaxation with CBT	http://rb.gy/nmh0ua	1000	4	27	02-Jan-20
A122	Health Log	http://rb.gy/k3i4x9	10,000	4	394	09-Oct-19
A123	We are more – our support network	http://rb.gy/hgoxdi	10,000	4	402	24-Feb-20

Table A.15
Selected iOS apps. Part 1.

ID	App's name	App's link	Rating	# Raters	Update
I1	Meditation and Relaxation Pro by FITNESS22 LTD	http://apple.co/2S0wuvM	5.0	9	03-Jan-19
I2	Relax &Sleep Well Hypnosis by Diviniti Publishing Ltd	http://apple.co/2VO9n8V	5.0	6	10-Oct-19
I3	Atmosphere: Relaxing Sounds by Peak Pocket Studios	http://apple.co/3eRbblE	5.0	6	16-Oct-19
I4	Connected Breath by Marc B	http://apple.co/3cw1hsm	5.0	6	13-Feb-19
I5	Clementine by Lewis &Palmer Ltd.	http://apple.co/3cCjODm	5.0	5	22-Feb-20
I6	Waking Up: A Meditation Course by Waking Up Course, LLC	http://apple.co/2RY1jRU	4.9	32	11-Mar-20
I7	Youper by Youper, Inc.	http://apple.co/3cPNRHZ	4.9	30	04-Mar-20
I8	Zen: Meditation &Sleep by MoveNext, Ltd	http://apple.co/2KmKR9C	4.9	17	11-Mar-20
I9	Abide – Christian Meditation by Carpenters Code Inc.	http://apple.co/3eHpyxk	4.9	142	11-Mar-20
I10	Breathe – 1 min Meditation by Slay	http://apple.co/34XkDEa	4.9	10	25-Apr-19
I11	Stop, Breathe &Think by Stop, Breathe & Think	http://apple.co/34V7ATG	4.9	51	26-Feb-20
I12	Color4u: Adult Colouring Games by Cool GamApp Limited	http://apple.co/2KvpxP7	4.9	7	10-Mar-20
I13	Pzizz – Sleep, Nap, Focus by pzizz	http://apple.co/3aA808h	4.9	15	17-Dec-19
I14	Poly Island: Coloring Art Book by Huckleberry BV	http://apple.co/2wW2JVE	4.9	9	08-Jan-20
I15	Cross-Stitch: Color by Number by BINGJIA LIANG	http://apple.co/2VqSMsN	4.9	21	27-Dec-19
I16	Breeze – Meditation &Sleep by PentaHealth Tech HK Co., Limited	http://apple.co/2RZawJC	4.8	6	24-Sep-19
I17	Scratchable – Anti-stress Game by Apalon Apps	http://apple.co/3avHmZ7	4.8	16	17-Oct-19
I18	Mindfulness with Petit BamBou by FeelVeryBien	http://apple.co/2VSTWMV	4.8	29	12-Feb-20
I19	7 Cups: Anxiety &Stress Chat by 7 Cups of Tea	http://apple.co/3asz9Vx	4.8	16	04-Mar-20
I20	Adult Coloring Book Color Page by MingMing Fan	http://apple.co/2W2Svvt	4.8	8	10-Oct-19
I21	Super Slime Simulator by Dramaton LTD	http://apple.co/3buuJ1N	4.8	2100	19-Feb-20
I22	I Love Hue by Zut Games Ltd	http://apple.co/3eHJznx	4.8	33	19-Feb-19

(continued on next page)

Table A.15 (continued)

ID	App's name	App's link	Rating	# Raters	Update
I23	Mindfulness Daily by inward inc	http://apple.co/350j0Wq	4.7	10	04-Nov-19
I24	My Oasis:Calming and Relaxing by Buff Studio Co.Ltd.	http://apple.co/3bskiji	4.7	31	04-Mar-20
I25	Meditation Studio by InteraXon	http://apple.co/2RWk5sO	4.7	6	06-Feb-20
I26	Motivation – Daily quotes by Monkey Taps	http://apple.co/2XSwF09	4.7	1400	16-Mar-20
I27	Lake: Colouring Books by Lake Coloring	http://apple.co/3buv30v	4.7	619	21-Mar-20
I28	Unicorn Slime Simulator by Shake It	http://apple.co/3art0Jm	4.7	32	19-Feb-20

Table A.16

Selected iOS apps. Part 2.

ID	App's name	App's link	Rating	# Raters	Update
I29	Aura: Meditation & Mindfulness by Aura Health Inc.	http://apple.co/2Y3f2um	4.6	87	02-Mar-20
I30	Breethe: Meditation & Sleep by OMG. I Can Meditate! Inc.	http://apple.co/2Vsewo2	4.6	138	09-Mar-20
I31	Zen Sand: Relaxing Games by Antti Lehtinen	http://apple.co/2wW4IJA	4.6	14	11-Dec-19
I32	Moshi Twilight Sleep Stories by Mind Candy Ltd	http://apple.co/2RY7AwZ	4.6	30	11-Mar-20
I33	Reflectly by Reflectly	http://apple.co/2Vx1aat	4.6	243	01-Mar-20
I34	Soulvana: Spiritual Meditation by Mindvalley Creations Inc.	http://apple.co/2VOq5VB	4.5	15	02-Mar-20
I35	BetterHelp – Online Counseling by BetterHelp	http://apple.co/2VrrMcL	4.5	49	03-Mar-20
I36	Stress Anxiety Relief Games by ROMAN SAFRONOV	http://apple.co/2XY3GrU	4.5	29	09-Jul-17
I37	Colorfly: Coloring Book by JoyCastle	http://apple.co/2XVZPv7	4.5	21	10-Mar-20
I38	Relaxing Book: Pixel by Number by Dao Thang	http://apple.co/3bwjQfJ	4.5	15	26-Dec-19
I39	TeasEar – ASMR Slime Simulator by Facemetrics Limited	http://apple.co/2RVWTLu	4.4	216	05-Mar-20
I40	Harmony Hypnosis Meditation by Darren Marks	http://apple.co/3eHEhbs	4.4	5	06-Dec-19
I41	AntiStress Anxiety Relief Game by CONTENT	http://apple.co/2zfhweS	4.4	13	12-Mar-20
I42	Present – Guided Meditation by Meditation to Relax and Sleep – – Mindfulness Free App	http://apple.co/3eHdts7	4.3	219	21-Nov-19
I43	Recolor Coloring Book to Color by Sumoing Ltd	http://apple.co/2Vt98Bd	4.2	168	20-Feb-20
I44	Colorfull – Calm Coloring Book by Amelia and Co	http://apple.co/3atBHmf	4	23	17-Mar-20

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.ijmedinf.2020.104243>.

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