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A SYSTEMATIC REVIEW OF THE EFFECTIVENESS, CONTENT, AND USAGE PATTERNS OF MOBILE MENTAL HEALTH INTERVENTIONS ON SMARTPHONE PLATFORMS FOR ANXIETY SYMPTOMS

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Abstract

This systematic review aims to examine the content, usage pattern and efficacy of mobile mental health interventions in reducing anxiety symptoms. A search of 10 electronic databases returned 44 408 studies in total and 27 studies met the inclusion criteria, including 4460 participants in total. The rate of attrition was 27% (*SD* = 22) among the participants who initiated the app use. The rate of significant reductions in measures of anxiety symptoms was 87% from within-subjects pretest to posttest assessments, yet this rate dropped to 46% when compared to a waitlist/control group. A vast majority of the studies used cognitive and/or behavioral interventions (*N* = 26, 96%), a few studies included professional support (*N* = 11, 41%), a structured form of delivering the interventions (*N* = 8, 30%) or tailored it to users' needs (*N* = 6, 22%). Few studies reported the actual time spent on the app per week (*N* = 4, *M* = 63.76, *SD* = 62.17). The mobile mental health interventions were effective in reducing anxiety symptoms, yet this effectiveness eroded compared to control groups. There is a need to develop consistent ways of reporting the usage patterns and testing evidence-based interventions other than cognitive behavioral treatments.

Keywords: generalized anxiety, panic attack, social anxiety, mHealth, systematic review.

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Introduction

The number of mobile phone users reached almost 5.3 billion, equating to approximately 67 percent of the total global population (Datareportal, 2021). Consistent with this high penetration of mobile phones worldwide, the recent years also witnessed advancement in the mobile health technologies (mHealth) utilized for the purpose of treating health concerns, tracking health related behaviors and maintaining health and wellbeing (Grand View Research, 2021). As of 2021, mHealth developers released thousands of mHealth applications (apps) surpassing a market size of $40 billion (Grand View Research, 2021). This widespread adoption of mobile technologies introduces "...a new and innovative way to improve health care delivery using smartphone apps" (Van Ameringen, Turna, Khalesi, Pullia, & Patterson, 2017, p. 1).

The mHealth interventions promise to increase access to mental health services for people with mental health concerns given that about 50% of individuals with severe mental health disorders in developed and 80% in developing countries did not receive mental health services in the prior 12 months in the given year (Demyttenaere et al., 2004). In addition, for those who receive help for their concerns, they refer to professional help as a last resort (Mojtabai et al., 2011; Yap, Reavley, & Jorm, 2013). mHealth apps may thus provide tools to increase this low use of mental health services by mitigating the barriers against professional help seeking. Researchers identified several factors as barriers to seeking professional psychological help like lack of available resources, stigma, self-reliance, financial cost and disbelief in the efficacy of psychological services (Gulliver, Griffiths, & Christensen, 2010; Mojtabai et al., 2011). Smartphone mHealth apps can be used at a low cost and private environment without challenging one's available resources and people can utilize/refer to their treatment at their own convenience. Therefore, mHealth interventions on smartphone platforms are revolutionary and may remedy the gap between evidence-based interventions and lack of use of these interventions among people with unmet mental health needs.

In the last two decades, psychotherapy researchers and smartphone application developers consequently have focused on inclusion of mHealth applications into the delivery of psychological services as a stand-alone or adjunct to psychological treatment. Numerous studies looked into the use and outcome of treatment delivered through mHealth applications, including smartphone apps (Firth et al., 2017; Pauley, Cuijpers, Papola, Miguel, & Karyotaki, 2021; Van Ameringen et al., 2017). The findings of these studies indicate that mHealth applications increase the access to psychological services, and they are cost efficient and effective (Firth et al., 2017; Hoffman et al., 2019; Pauley et al., 2021). However, there is an ongoing debate over the content and effectiveness of mHealth apps, and the users'

engagement with or adherence to these apps (Marshall, Dunstan, & Bartik, 2019; Van Ameringen et al., 2017; Werner-Seidler et al., 2019). The issues regarding content, efficacy and use patterns (adherence and app engagement) are even more essential considering the mobility of the treatment delivered through smartphone apps in daily life.

The Effectiveness of mHealth Applications

There is a growing body of literature that supports the efficacy of digital interventions for anxiety disorders (Pauley et al., 2021). Although there is an excitement about the effectiveness of mHealth applications, these applications have limited information regarding their efficacy (Van Ameringen et al., 2017) and even less so for the mHealth apps on smartphone platforms. While 64% of seventy-three applications claimed effectiveness in their services, for instance, only one provided scientific evidence to support its claim (Larsen et al., 2019). Drawing from a review including studies on obsessive-compulsive, trauma, anxiety and mood disorders, the results are not convincing to settle the discussion about the effectiveness of the mHealth apps (Van Ameringen et al., 2017). Consistently, Firth et al. (2017) comment that "the extent to which smartphone interventions can match (or exceed) the efficacy of recognized treatments for anxiety has yet to established" (p. 15).

The Content of mHealth Applications

The previous research does not settle the discussion about the effectiveness of mHealth apps along with the content. A review of mHealth apps claiming therapeutic content for depression and anxiety showed that only a small portion of apps (3.41%) indeed had scholarly findings to justify their claims of effectiveness of their content (Marshall et al., 2019). Most of these apps were developed by or involved experts (~30%), and government employees, academic institution or medical facility (~20%), thereby creating questions about the therapeutic quality of the content. A smaller portion of the apps (~33%) included a health professional during the development process, let alone the apps health professionals developed, and it is even tinier the apps that have been tested in terms of their effectiveness (3.8%) (Sucala et al., 2017). In addition, the majority of the apps reviewed (63%) did not clarify the interventions that they used to treat the symptoms of anxiety. Similarly, Alyami and colleagues (2017) investigated the apps for social anxiety disorders and found out that only four out of 38 apps had therapeutic purposes while others had other content domains like psychoeducation, self-assessment and support. Some mHealth apps do not offer clear guidelines or evidence-based treatment, and the question remains unanswered whether and how users practiced the therapeutic content and interventions properly and regularly.

Users' Engagement with and Adherence to mHealth Interventions

Adherence to the treatment procedure presented in mHealth apps is a legit concern since the interventions do not occur in the presence of a mental health professional. Regarding the app engagement, there is a variety of concerns, including the lack of evidence regarding effectiveness and usefulness, users' privacy and security, and the overuse of technology (Lipschitz et al., 2019). In addition, the app engagement is also malleable to the need for wireless connection, technical issues (e.g., having problems with phone) or the app itself (technical issues experienced within the app) (Werner-Seidler et al., 2019). These reported barriers hindering the app use raise question whether individuals would actually continue to use the app and how much time they would spend on the app delivered therapeutic interventions.

The Present Study

There is a growing interest in developing mHealth apps for anxiety symptoms (Van Ameringen et al., 2017). Anxiety disorders are among the most prevalent mental health concerns worldwide (Baxter, Scott, Vos, & Whiteford, 2013; Demyttenaere et al., 2004; Somers, Goldner, Waraich, & Hsu, 2006) and cause major losses in individuals' productivity and labor power, and create financial burden on countries (Chisholm et al., 2016). Even though there are evidence-based treatments for anxiety disorders like pharmacological agents (Baldwin et al., 2016) and effective behavioral interventions (Bandelow, Michaelis, & Wedekind, 2017), it might be difficult for people with anxiety disorders to have access to these treatment modalities. The mHealth apps are well accepted by many users and growing findings support its efficacy (Lipschitz et al., 2019; Pauley et al., 2021; Van Ameringen et al., 2017). The mHealth technologies on smartphone platforms are in the development phase and there is need for more research about the efficacy, content and use patterns of these mHealth apps for anxiety disorders. The present systematic review aims to contribute to the understanding of the prevailing use and increasing niche of mHealth smartphone technology in treating anxiety symptoms. The present study aims to review 1) the effectiveness of mHealth interventions on smartphone platforms (e.g., iOS, Android) in treating anxiety symptoms, 2) the content of mHealth interventions, and 3) users' engagement with and adherence to the mHealth interventions.

Method

In conducting the present review, the authors followed the guidelines published in previous research (Shea et al., 2007) and used the PICOs as a framework (Higgins et al., 2019). The present systematic review was interested in studies, which delivered interventions through smartphone mHealth apps to reduce the participants' anxiety symptoms. The studies must include a pretest and posttest assessment of anxiety symptoms, providing quantitative data about the efficacy of the mHealth interventions operated on a smartphone.

Information Sources and Search Strategy

The databases reviewed included Pubmed, Psychinfo, Ebscohost, Proquest Database, Project Muse, JSTOR, Web of Sciences, Taylor – Francis, Wiley Online Library, and Sage Journals. The authors used the entire database, to which they had institutional access. The keywords for anxiety symptoms included "anxiety," "phobi*" or "panic." The keywords for smartphone mHealth apps included "mHealth," "mobile health," "apps," "smartphone," "smart-phone," "smart phone," "smart app*," "smartphone app*," "mobile app*". The keywords were entered into the search engines by "OR" function and screened in abstract and title in order to retrieve as many studies as possible. The search process was completed in March, 2020.

Study Selection and Data Extraction

Figure 1 presents the search flow. The initial research returned 44 408 articles in total. After dividing studies and databases into two equal groups, the authors independently read the abstracts for eligibility for the review and removed any study not meeting the inclusion criteria. At this phase, the authors worked independently and selected 107 studies for the Eligibility Phase. The authors independently read the full article in the Eligibility Phase. In the second phase, the authors independently reviewed the entirety of article in detail. During this phase, the authors removed the 64 studies, which clearly did not meet the inclusion criteria. The studies were included for the review if they (1) used a pre- and post-intervention design, (2) used mobile health interventions targeting anxiety symptoms, (3) measured symptoms of anxiety, (4) measured anxiety symptoms not context-dependent (e.g., math anxiety, dental anxiety, pregnancy, etc.) or if condition dependent, it had a phobic component, (5) provided original data (e.g., not a meta-analysis or systematic review). At this phase, the authors moved the articles to the next phase if they had a doubt about it and selected 43 studies for the full review –

Review Phase. During the Review Phase, the authors extracted data or removed the studies, which did not meet the inclusion criteria.

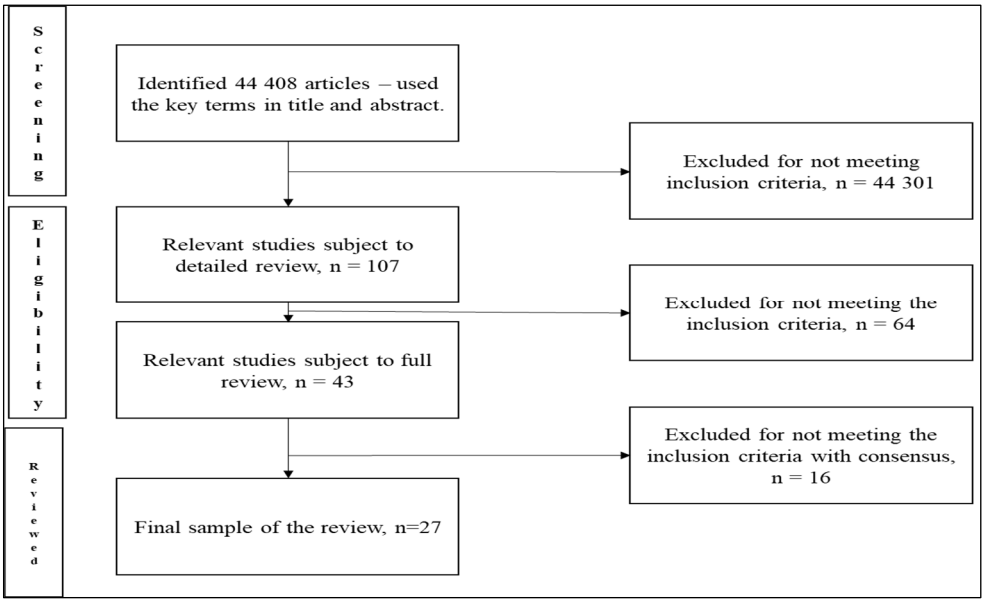

Figure 1. Search flow of the study.

In the third phase, the authors discussed 18 articles against the inclusion criteria and eventually removed 16 of them for not meeting the inclusion criteria with consensus. In this last phase, the authors reviewed six studies and designed an excel sheet and MS word document to keep record of extracted data (e.g., intervention characteristics, methodology and outcome, app engagement). After this initial pilot round of coding, the authors created the final data extraction forms. Authors randomly divided the selected articles into two groups and coded the entire article. A summary of these codes can be found in the online supplementary files (Appendixes Table 1, 2 and 3). To ensure the accuracy in data extraction, the authors exchanged the assigned articles with one another and reviewed the accuracy of data extraction.

Although studies reviewed often measured multiple outcome measures, the authors solely focused on anxiety symptoms. The present review focused on the effectiveness of interventions in reducing anxiety symptoms by looking at the statistical significance of the findings along with the effect sizes. For the usage pattern, the authors extracted the details reported in the study, including the time spent on the app, module completion, check-ins/logins and the proportion of users who completed the interventions. In terms of the therapeutic content, the authors extracted the details of the app delivered interventions as described in the studies.

Results

Overview

The intervention length described in the reviewed 27 studies ranged from 7 days to 94 days (M = 43.85, SD = 22.52). The 27 studies enrolled 3843 participants (M = 147.8, SD = 181.3), ranging from 10 to 812. After participants dropped out during the interventions, 2289 participants (M = 88.04, SD = 92.4) completed the interventions, ranging from eight to 443. Retention rate of the participants until the end of the treatment was 59% (one study lacking initial number of participants omitted from these descriptions, which had 617 participants, Bakker & Rickard, 2019).

Effectiveness

There were 27 unique studies, and 24 of them measured generalized anxiety (GA), five of them measured social anxiety (SA) and five of them measured panic attack anxiety (PA). All 27 studies had pretest and posttest assessment, 14 studies randomized the participants to treatment and waitlist/control or comparison groups. Of the studies reviewed, 11 unique studies used control or waitlist groups and seven unique studies compared the mHealth intervention to another method of treatment (e.g., mIPT or treatment as usual). Majority of the studies (N = 19, 70%) used a diagnostic procedure in identifying participants with a clinical level of anxiety above a predetermined cut-off score. Table 1 presents the findings retrieved from the reviewed studies.

Table 1. Study Findings about the Effectiveness of the Intervention According to the Methodology of the Reviewed Studies

Generalized Anxiety Disorder (N = 24)					
Design	**Int L *M* (*SD*)**	**Att *M* (*SD*)**	***N* (%)**	**Effect Size Range**	**Significant Results (%)**
Not RCT	44.07 (32.83)	29 (26)			
Pre-post			14 (100)	-.34 – 1.20	11 (78.6)
Control			2 (100)	.001 – .45	1 (50.0)
Comparison			0	--	--
RCT	43.70 (26.12)	24 (18)			
Pre-post			10 (100)	.04 – .74	7 (70.0)
Control			8 (100)	.13 – .81	3 (37.5)
Comparison			5 (100)	-17. – .46	0

Generalized Anxiety Disorder (*N* = 24)					
Design	**Int L *M* (*SD*)**	**Att *M* (*SD*)**	***N* (%)**	**Effect Size Range**	**Significant Results (%)**
Social Anxiety Disorder (*N* = 5)					
Not RCT	28	8			
Pre-post			1 (100)	1.08	1 (100)
Control			0	--	--
Comparison			0	--	--
RCT	67.25 (21.44)	22 (16)			
Pre-post			4(100)	.68 – 1.84	4 (100)
Control			3(100)	.70 – .89	3 (100)
Comparison			4(100)	-.23 – .64	2 (50)
Panic Attack Disorder (*N* = 5)					
Not RCT	49.0 (9.90)	16 (6)			
Pre-post			2 (100)	.56 – 1.05	1 (50)
Control			0	--	--
Comparison			0	--	--
RCT	60.67 (29.14)	32 (16)			
Pre-post			3 (100)	.68 – .80	3 (100)
Control			2 (100)	.05 – .06	0
Comparison			2 (100)	-.25 – .14	0

Note. N = 27; RCT = Randomized Clinical Trials; Int L = Intervention Length Mean and Standard Deviation; Att = Attrition Mean and Standard Deviation.

For GA, a quarter of 24 studies did not find significant difference between pretest and posttest assessment. The significance of the mHealth interventions in reducing anxiety symptoms compared to a waitlist or control group (*N* = 10) dropped to 40% (*N* = 4). For SA, all five studies reported significant improvement from pretest to posttest assessments and compared to control group at posttest. For PA, 80% of the studies reported significant improvement from pretest to posttest assessments. There were two studies who compared the efficacy of interventions to a control or comparison group, and none of them produced significant difference at post assessment. This success rate showed a decreasing trend when the research design added a control/waitlist group, and the success rate dropped even more when there is an active treatment comparison group.

The number of comparisons to a control/waitlist or active treatment group(s) were limited. Within these limited number of comparisons, it is difficult to support the superiority of smartphone delivered interventions over other mediums of interventions. When the mHealth interventions on a smartphone platform compared to an app or internet delivered self-help (Boettcher et al., 2018), a placebo control app (Flett, Hayne, Riordan, Thompson, & Conner, 2019), an app delivered stress management training (Christoforou, Sáez Fonseca, & Tsakanikos, 2017), delivery of

similar content on computer (Stolz et al., 2018) or an app delivered attention control training (Ham et al., 2019), these comparisons were nonsignificant except for a significant difference in SA in favor of the app delivered CBT against self-help (Boettcher et al., 2018) and mobile interpersonal psychotherapy (Dagöö et al., 2014). These results indicate that mHealth applications for treating anxiety symptoms is better than not receiving any adequate help, yet this efficacy does not prove to be superior over control groups. Visually examining the effect sizes may help make sense of the efficacy of the mHealth interventions. Figure 2 presents the effect sizes for GA, SA and PA. The results from pretest to posttest assessments provide mostly medium to large effect sizes while the effect sizes tend to shrink with the addition of control groups.

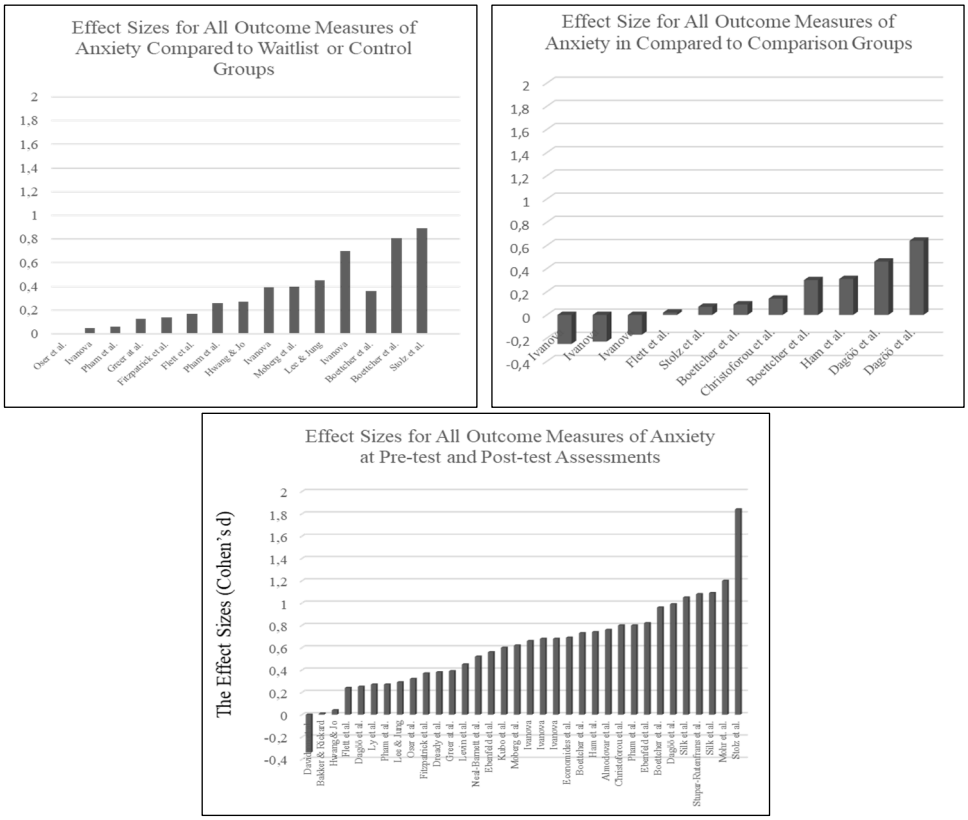

Figure 2. The effect sizes for GA, SA and PA

The Content of mHealth Interventions

The content of the interventions were assessed across eight categories. Table 2 presents the review findings. The vast majority of the studies (N = 26, 81%) used

mHealth content originated from cognitive and/or behavioral approaches like relaxation training, cognitive restructuring, problem solving strategies, mindfulness, exposure exercises (e.g., CBT Mobile App Intervention; Greer et al., 2019) as well as cognitive exercises (e.g., GET.ON; Ebenfeld et al., 2020). Eleven studies (41%) used interactive components like in-vivo exposure exercises, simulations and/or games. Delivery of the interventions also varied across studies: six studies (22%) had a design that the mHealth interventions were adjusted to the users' needs. Eight studies (30%) delivered the interventions in a structured delivery of interventions and enforced users to complete one to proceed to the next one. While the majority of the studies (N = 16, 59%) included neither professional support nor in-person treatment, one study (4%) used mHealth apps as a supportive tool in an ongoing treatment and 11 studies (29%) provided limited professional support during mHealth interventions.

Table 2. Frequencies of the mHealth App Treatment Contents Used in the Reviewed Studies

mHealth App Content	Content Included		Content Not Included	
	N	**%**	***N***	**%**
Cognitive or behavioral strategies and theories	26	96	1	4
Interactive activities, gamified exercises and exposure exercises	11	41	16	59
User adaptive in a way tailoring the activities to the users' needs	6	22	21	78
Professional support by licensed therapist or students in clinical training	11	41	16	59
Allowing users to support one another	2	7	25	93
Embedded in ongoing therapy/counseling	1	4	26	96
Reinforced app engagement with prompts or incentives	10	37	17	63
Structured treatment content in progressing the app delivered interventions	8	30	19	70

Note. N = 27.

Engagement with mHealth Interventions

Several indicators were used to gauge the engagement with and/or adherence to the interventions delivered by the smartphone apps. Table 3 presents the findings. Since there is a considerable variation across studies regarding app engagement and a limited number of studies reported the full usage data, the authors interpreted the statistics presented in Table 3 with caution. While 20 studies (74%) tracked the app usage, few studies reported how much time the users spent on the app, the completion rate of the modules or units or the frequency of logins throughout the

treatment. Four studies reported the actual time spent on the app, which indicated an average of 63.76 minutes per treatment week (*SD* = 62.17).

Table 3. Indicators of Adherence to Interventions Provided Through mHealth Apps

Indicator of Adherence to mHealth App	*N* (%)	*M*	*SD*
Info about Users' Experience	20 (74)	--	--
Usage Data	20 (74)	--	--
Total App Use in Minutes per Week	4 (15)	63.76	62.17
Frequency of the App Use per Treatment Day	5 (18)	1.46	1.35
Percentage of the App Use Days throughout the Treatment	4 (15)	56.5	30,91
Percentage of Modules Completed Across Participants	3 (11)	43	18,08
Percentage of Participants Completing Interventions	6 (22)	78	10.23

Note. [a] values represent percentages of modules completed or participants completed all activities.

Majority of the studies, which tracked the app usage, usually reported the statistics for a portion of the participants. For example, Christoforou et al. (2017) tested the efficacy of *Agoraphobia Free* and reported that 25 out of 71 participants completed 80% or more of the activities. Boettcher et al. (2018) used *Challenger* and reported that some participants completed from none to more than 50 out of 440 possible challenges (*M* = 11, *SD* = 13.7). Ebenfeld et al. (2020) tested the efficacy of *GET.ON Panic* and reported that participants spent an average of 51.88 days on the app during the treatment. Kubo et al. (2018) tested the efficacy of *Headspace* and reported that 12 of 20 participants, who completed the study, practiced meditation 70% of the days throughout treatment. While these statistics helpful to have an idea about the app engagement, it is not enough to tell the actual time spent on the app or the completion of the intervention across all participants.

There were also variations in quantifying the app use and engagement. For example, Economides et al. (2019) tested the efficacy of *MERU Health Ascend* and defined participants as *engaged* if they used the app for longer than three minutes or Pham at al. (2016) accepted a minimum of one minute engagement with the app *Flowy* during the study as a "proactive" usage. Other studies referred to the number of check-ins or sessions completed (Fitzpatrick, Darcy, & Vierhile, 2017; Levin, Hildebrandt, Lillis, & Hayes, 2012; Mohr et al., 2017) and/or the number of activities, techniques or active days (Dagöö et al., 2014; Deady et al., 2018; Oser, Wallace, Solano, & Szigethy, 2019; Stupar-Rutenfrans, Ketelaars, & Van Gisbergen, 2017). Some studies referred to medians and did not use mean and standard deviations (Almodovar, Surve, Axon, Cooper, & Nahata, 2018; Moberg, Niles, & Beermann, 2019). In addition, the variations across users were quite dispersed with high standard deviations and ranges. For example, Economides et al. (2019) reported that the engaged participants used the app for an average of 31.3 days (*SD* = 13.5, min = 3, max = 56) during the treatment. Levin and colleagues (2017) tested the

efficacy of *ACT Daily* and estimated the app use by averaging the overall number of check-ins by a total of 14-day of intervention period (M = 32.54, SD = 14.30, range = 7–51). Therefore, wide ranges and large standard deviations as well as the variations in reporting the actual usage made it difficult to use the averages to create a representation of an average user or a usage pattern.

Discussion

This systematic review examined participants' engagement with the app intervention and statistical efficacy and content of these interventions in reducing anxiety symptoms. The effectiveness of mHealth interventions was examined in generalized (GA), social (SA) and panic attack (PA) anxiety. Firth et al. (2017) aggregated effectiveness of randomized control trials (RCT) in treating anxiety symptoms and showed that mHealth apps had medium effect both in pretest-posttest assessments and in comparison to control groups. In the present study, mHealth interventions appeared to be influential on anxiety symptoms from pretest to posttest, yet it becomes fuzzy when comparing the benefit of mHealth interventions to comparison groups or control waitlist groups.

The comparison groups usually included another mHealth app with different content or web-based applications. The effectiveness rate drops considerably when the improvement in GA symptoms compared to the improvement in the waitlist/control groups or comparison groups. Boettcher et al. (2018), for example, conducted an RCT, contextualizing interventions in cognitive behavioral and interpersonal skill development with in-vivo exposure components, in order to treat social and generalized anxiety symptoms. They randomized participants into three groups: one group practiced self-help program then received mHealth interventions (sequential), another group received the self-help program and mHealth interventions simultaneously (parallel), and the third waitlist group with no interventions. Parallel group showed large effect while sequential group showed moderate effect of improvement, and both groups showed significantly better improvement than waitlist group. The effect of interventions was slightly lower for GA symptoms. In another study, Christoforou and colleagues (2017) used the app, *Agoraphobia Free,* including gamified exposure exercises for panic and agarophobia symptoms. They compared the results to another mHealth app (*Stress Free)*, which used interventions of relaxation and CBT skills for stress reduction. It showed that both mHealth apps were effective. *Agoraphobia Free* app provided a significant medium effect of improvement on the symptoms, yet this improvement was not significantly different from the influence of *Stress Free* app. It was common in other studies that findings favored cognitive-behavioral approach (e.g., superior results of mCBT interventions to mIPT interventions, Dagöö et al., 2014).

Variations in treatment design across studies make it difficult to make inferences. In some studies, applications were used along with an ongoing face-to-face therapy or as a part of an intervention program, making it hard to attribute the improvements in anxiety scores to app delivered interventions per se. For example, participants in Levin et al. (2017) were traditional counseling clients receiving acceptance-commitment therapy (ACT) during the mHealth interventions; therefore, researchers indicated a need for a control group since the improvement in anxiety is not necessarily due to the use of "an app". Similarly, another study included a web-based psychoeducation followed by use of the app, *VIARY* (Ly, Dahl, Carlbring, & Andersson, 2012). Researchers indicated the difficulty of evaluating if the findings are attributable to the smartphone application itself, to the psychoeducation itself, or to the whole intervention. Moreover, in a study on the effectiveness of *Headspace* (a self-paced program providing guided mindfulness meditation instructions), researchers indicated that observed improvements in cancer patients' anxiety may simply represent natural improvements after cancer treatment (Kubo et al., 2018). This situation raises the need for more research designs with comparison groups and larger sample sizes to investigate the efficacy of smartphone-based interventions for sufficient justification.

Surprisingly, majority of the mHealth interventions included cognitive behavioral interventions, including cognitive restructuring, exposure exercises, mindfulness training and coping techniques. Studies, which did not use cognitive behavioral interventions, neither used another evidence-based theoretical model. Thus, it is difficult to compare studies regarding the theoretical framework. In addition, the mHealth interventions provided a mixture of techniques, usually including cognitive restructuring exercises, mindfulness training, problem solving skills and exposure activities; again, it is difficult to determine how the specific mHealth interventions are helpful in reducing anxiety symptoms. Therefore, the assessment of mHealth interventions was somewhat assessment of mobile delivery of CBT oriented interventions.

Problems with app engagement is another issue undermining the belief in the effectiveness of the mHealth interventions. Description of engagement with mHealth interventions seems necessary to make progress in technology use in mental health services. Active engagement of clients in sessions is a legit concern in psychotherapy, so is in mHealth interventions. To have a clear picture of the connection between mHealth interventions and observed improvement in anxiety symptoms, the users' engagement effectively with the content needs to be accurate. We, therefore, initially examined the usage data and patterns. Almost half of the studies reported usage information either by reporting self-report of users about their engagement with app delivered interventions and/or by reporting the usage data that they tracked through the app. First, a limited number of studies reported the amount of the usage time per login or per day, frequency of engaging in the app or completion rate. Second, the existing information indicated considerably limited amount of usage time or completion rate. However, it is difficult to draw exhaustive

conclusions from these statistics because there is high standard deviations and discrepancy between the users. Third, there was a wide variation in what studies recommend about the app use. While a study offered only one mHealth app and asked to use this app at least once per day (Levin et al., 2017), another study asked participants to use the app as much as they would like (Ly et al., 2012). Fourth, the prevalent tendency in the reviewed studies was to not enforce a specific app use routine (Moberg et al., 2019; Mohr et al., 2017; Oser et al., 2019). This lack of structure in the app delivered interventions appears to have valid concerns like achieving naturalistic usage patterns for assessment (Pham et al., 2016) or fear of being too demanding and lowering the participants' app use motivation (Ly et al., 2012).

How studies define the usage considerably varies. In a study, engagement with the app, *Pacifica*, was determined by the number of logins during 30-day of intervention (Moberg et al., 2019). In this study, login numbers ranged from 1 to 286, again indicating that the average usage is quite dispersed. In another study testing the effectiveness of IntelliCare app platform (Mohr et al., 2017), which included 13 clinical apps, each of which is targeting a specific behavioral or psychological treatment strategy, researchers defined two app use metrics: *lifetime use* and *frequency of use. "Lifetime use"* was defined as the time between the first launch and the last launch. They defined *frequency of use"* as the percentage of days the app was used and calculated as "the number of days the app or set of apps was launched divided by the number of days in the study after the app was downloaded by a participant and available for use" (p. 3). Moreover, Moberg et al. (2019) brought a new viewpoint to the issue of commitment. In their study, individuals who completed relatively more thought records demonstrated delayed improvement. Moberg and colleagues indicated that "completing thought records is a more time-intensive and cognitively demanding activity than health tracking or meditation and increased use of these activities may be a marker of greater commitment to treatment or improvement" (*p*. 12). In their study, the apparent delayed positive influence of engaging in relatively more thought activities is consistent with the knowledge that despite examining and challenging negative thoughts is difficult in the short term; it may result in more long-lasting benefits. Therefore, there are at least two qualities of engagement like amount of time spent on the app and quality of the time spent on the app. If not all app features have the same therapeutic effect on anxiety reduction, simply averaging the number of use of different features an app included may not reflect the actual therapeutic app engagement. Engagement with the app seems to be a problem almost in all of the studies.

Implications for Clinical Practice

Even though there are some questions about the efficacy of mHealth interventions compared to waitlist/control and active treatment control groups, participants of the reviewed studies mostly reported that they benefitted from

mHealth interventions. The mHealth interventions help individuals deal with their anxiety symptoms either as a stand-alone intervention or as an embedded tool in an ongoing face-to-face psychotherapy. Providers of mental health services, therefore, may consider the ways to incorporate smartphone applications in their treatment plan for clients. In addition, mHealth interventions may facilitate clients' access to mental health services and it can be an option for providers to facilitate clients' access to treatment. The present research reviewed studies including 25 mHealth apps. Many of these apps benefitted from cognitive and behavioral strategies. Particularly, some of these apps effectively incorporated simulations of anxiety provoking scenarios like public speaking. Therefore, providers may use mHealth apps to simulate an environment for their clients in order to help clients practice the skills covered in counseling sessions. Practitioners, who use CBT, may use mHealth apps as an auxiliary tool to the ongoing treatment.

Limitations and recommendations for future research

The present review has several limitations. The present research concentrated on anxiety symptoms, yet majority of studies focused on generalized anxiety symptoms while only five of the reviewed studies included social and panic attack anxiety. Therefore, the current findings limited to anxiety symptoms, and mostly to generalized anxiety. Future researchers may focus on other mental health concerns, including other forms of anxiety disorders. The authors were limited with their institutions' access to the databases. Even though the present research included a wide coverage of databases, future researchers may also screen unpublished studies as well as inquire other databases not covered in the present review. One of the striking findings in this review was the time spent on the interventions. However, limited number of studies reported the actual time that users spent on the interventions. Future researchers who are interested in the delivery of interventions through smartphone applications may consider multiple measures of app engagement, particularly the actual time spent on the app. In addition, majority of apps delivered a set of strategies and techniques, including evidence-based interventions as well as psychoeducation and other techniques. The actual efficacy of these interventions in reducing anxiety symptoms observed from pretest to posttest is somewhat unclear. Future researchers may utilize strategies to isolate strong from weak therapeutic contents, which may help to adjust the workload delivered through the mHealth app interventions.

Conflict of Interest

We hereby declare that there are no potential conflicts of interest associated with this publication. The present research did not receive any funding.

Conclusion

There are three major conclusions of this systematic review. The mHealth apps deliver evidence-based interventions and the results point to the efficacy of these interventions in reducing anxiety symptoms. However, this efficacy mostly relies on cognitive behavioral traditions and there is a need to test the efficacy of mHealth interventions compared to other forms of treatments delivered through either the smartphone platforms or traditional means. The review findings point to a high variations in the usage of mHealth interventions and it is difficult to make inferences about the usage patterns.

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