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The use of Smartphone applications in mental health care and its barriers of usage

A Literature Review

Hannah Manthey

Student number 1327097

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Supervisors:

1st Dr. Matthijs Noordzij

2nd Dr. Anneke M. Sools

Department of Positive Psychology & Technology

Faculty of Behavioural, Management and Social Science,

University of Twente

P.O. Box 217

Abstract

Technology is developing in important parts of modern life. In recent years, mental health care increasingly avails the technical possibilities provided by smartphones. This paper is focused on the use of smartphone applications, in the psychotherapeutic context. To this date, there has been no review of existing applications that are used in therapy, missing out on the possibility to increase the efficacy of psychotherapy by means of technology. This paper also examines the disorders the applications address, the behaviour change techniques implemented and reasons for therapists and patients to resist the use of applications.

The literature was collected via a search based on the keywords “Mobile Application”, “Smartphone”, “mHealth”, “Human”, “Mental Health” and “Health care”, which were acquired through a keyword analysis of existing literature reviews on the topics and the articles citing them. Ultimately 20 articles were included, which were then coded inductively and deductively using the program Atlas.ti and selecting text passages relevant to the research questions using codes that were previously established. If relevant, new codes were created, e.g. “Behaviour change technique used” or “Limitation perceived by user”.

The results indicated that most apps were aimed at depression and anxiety, using mostly monitoring and psychoeducative elements. Major limitations mentioned by patients were not owning a smartphone and being not familiar with smartphones, whereas psychotherapists named scepticism regarding the validity and the therapeutic elements used in the smartphone-based interventions. The discussion deals with the current superiority of apps treating mood disorders, the lack of innovative features and a missing focus on privacy and scientific standard in the apps.

Keywords: mHealth Smartphones Behaviour Change Techniques by Smartphones Psychotherapy

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Introduction

In our modern age, technologies rapidly develop. Today it is estimated that most people (93%) in the western countries are owners of a personal smartphone (Kuss, Kanjo, Crook-Rumsey, Kibowski, Wang & Sumich, 2018). This prevalence of devices and the opportunities that it brings with it are not only discerned and appreciated by the individual user, but also by broader public sectors. An example of such a sector is the public healthcare (Koehler, Vujovic & McMenamin, 2013). Smartphones provide a framework for the health care providers, to exchange information with the client at all time, in contrast to only during consultations. The opportunity to monitor behaviour closely throughout the day offers the possibility to get detailed information without recall bias, as it would be the case during consultation hours. This offers a chance to not only increase the amount of information exchange between health care providers and client but also implicates a time and space independent form of data collection. Furthermore, it allows the application-provider to individualize the treatment program to each user (Krijgsman& Klein Wolterink, 2012). The tailoring of treatment, thus the effort to adapt existing structures to the specific needs of each individual patients, is a commonly used technique to increase the efficiency and the efficacy of existing approaches (Lincoln, Riehle, Pillny, Helbig-Lang, Fladung, Hartmann-Riemer & Kaiser, 2017). Additionally, mental health care is challenged with another task: Given that most psychological problems are of a rather long-term nature and the antecedents and forces of each disorder are more individual than in e.g. medicine, a high amount of individual knowledge is required to provide optimal, individual treatment to each patient. Knowledge about the behaviour and the context in which it occurs is the basis for specified help in mental health care.

The main goal of the current review is to provide an overview of which mental health issues are currently treated with the help of smartphones, how effective the use of

a smartphone is and of the main aspects that need improvement. In the following sections, each facet of this goal is discussed in more detail.

The broader discussion of the actual relevance of technology in mental health care is the focus of the following section.

The relevance of technologies for mental health care

In the recent years, the mental health care sector has discovered the potential of implementing and using technologies within their field. "Mental Health Care" is described by Klaveren (2018) as a public sector focused on preventing, treating and curing, supporting participation in the social life of people with psychological disorders and helping people with serious addiction problems or who suffer from severe mental confusion. In the Netherlands the sector is split in General Practitioner Care and Mental Health Care- Support (for mild mental complaints; provided by an General Practitioner or an primary care assistant practitioner), General Mental Health Care (for Mild to moderately serious psychological problems; provided by an GZ psychologist, a psychotherapist or a nursing specialist) and Specialized Mental Health Care (for serious and complex mental problems; provided by an psychiatrist, psychologist or psychotherapist or a team of experts).

Mobile Health ("mHealth") can be defined as medical or public health practice supported by mobile devices (Heerden, Tomlinson & Swartz, 2012). To date, mHealth has been used for various purposes, depending on the setting in which it is used. Along with the continuous technological progress itself and an advancing implementation of technology in the health sector, technology also becomes more important in the mental health care. There are several purposes in the field of mental health care for which technology has been used so far. One can think of collecting data, delivering care, enhancing communication between professional and client or amongst clients, planning

and controlling medication schedules or increasing the patient's adherence to treatment (Tomlinson, Rotheram-Borus, Swartz & Tsai, 2013). A more specific purpose of using technology in mental health care is to foster new behaviour in everyday life. Given the fact that it is not possible to follow the patient around, technology could be used to warn about geolocational risks for substance abusers and send automatic feedback to therapists if a patient is going out, as it was given as a homework assignment (e.g. with social phobia) or if a patient is staying away from forbidden areas (e.g. bars, in case of alcohol dependency) (Vahabzadeh, Mezghanni, Lin, Epstein & Preston, 2010).

In some countries, especially Third World Countries, infrastructure and stigmatization are relevant aspects to be considered in providing care services. The former involves that mHealth has the advantage that potential service users are merely dependent on a connection to the internet. The latter, the high stigmatization level in third-world countries, is another matter of concern. Myths and beliefs about mental health issues are quite strong in some countries and could keep people from seeking help. MHealth could represent a solution by giving options for seeking help, privately and anonymously **(**Yuen, Goetter, Herbert & Forman; 2012**).**

From an economic standpoint, the use of mHealth technology can also lead to a reduction of medical expenses. This could in the future be relevant for insurance companies, the hospital, or the individual. It needs to be considered, that some aspects like genetic testing would raise the need for a closely monitored use of mHealth, to ensure keeping up with ethical regulations (Nill, Laczniak & Thistle, 2017).

Next, to these rather general factors of health care, mHealth can also be used to offer a more complete treatment by promoting homework, thereby making the treatment more effective, which in turn might to fewer needed face-to-face sessions between therapist and patient. Also, mHealth can be applied to make optimal use of the waiting

time for a suitable therapy, by exchanging psychologists on their waiting list and their expertise on a certain psychopathology (Price, Yuen, Goetter et al. 2014).

A further relevant advantage is an increase in efficiency of the therapists. By using technology e.g. for screening the patient first, the time of the patient and professionals can be used more efficiently. Besides, mHealth can facilitate innovation and comfort by helping to shift the setting towards more primary and home care and by improving the quality of care (e.g. offering checklists and reminders) (van Gemert-Pijnen, Peters, Ossebaard, 2012).

In summary, these strategies would not only optimize the fit between patient and counsellor but also optimize the structure and efficiency of the treatment. All this would lead to lower costs in the mental health sector and more efficient therapy. This has the potential to foster satisfaction and engagement, reduce barriers (e.g., scheduling, transportation, parking and waiting time) and costs.

Another important aspect of the successful use of mHealth in any form of therapy, especially online therapy and eMental Health Interventions, is adherence (van Gemert-Pijnen et al., 2013). A possible reason for a patient to not complete a mHealth intervention is the missing direct, personal human contact. However, the fact that most people have access to their smartphones all the time, offers a chance to provide information and monitor behaviour continuously. This could possibly lead to higher adherence to the treatment plan and thereby to better health outcomes for the user and lower costs for the health sector (Berrouiguet, Baca-García, Brandt, Walter & Courtet, 2016).

Further advantages of applying technology in the mental health care sector are the opportunity to integrate technologies into everyday life, the option to monitor symptoms or to give automatically tailored feedback on time to each individual user. Another factor would be the transition from primary care (care from the general physician) to home care

(care from the patient themselves, which could be provided directly when it is needed. The technology would also allow of a personalization of the care services, based on each patient needs instead of "care as usual". (van Gemert-Pijnen, Peters, Ossebaard, 2012).

Besides, the flexibility of mobile devices plays an important role: mHealth technologies are developed for a wide range of psychological disorders: depression **(**Watts, Mackenzie, Thomas, Griskaitis, Mewton, Williams & Andrews , 2013**;** Ly, Trüschel, Jarl, Magnusson, Windahl, Johansson & Andersson; 2014), Anxiety disorders, Posttraumatic Stress Disorder, alcohol and drug-abuse, Schizophrenia or Borderline Personality Disorder (Lui, Marcus & Barry, 2017) The wide scope of different applications for a variety of mental health issues, raises the questions which aspects of the application makes it so flexible in its use? A possible reason for this is the option to obtain objective, independent data from the individual.

A current limitation is the difficulty to maintain high-quality standards in a marketplace that anyone can access. A second limitation is the level of privacy. Privacy has always been of importance in the mental health care, due to the stigma that surrounds mental health issues. Keeping sensitive and personal information on technology (with has the technical power to share this information) is a limitation, that possibly keeps patients and mental health care providers from using mHealth (Marzano, Bardill, Fields, Herd, Veale, Grey & Moran, 2015).

Another problem is the effectivity of the translation of therapy from face-to-face to a technology supported version. Recent studies showed that technology-driven interventions have lower effect sizes on the improvement of the patient and are not necessarily cheaper than face to face contact, thereby reducing the possible cost-benefit (Arnberg et al., 2014).

At last, the implied limitations of a possible application of mHealth to a certain target group need to be considered. Given that mHealth relies on the usage of a technological device, a technological understanding and the physical ability for usage as the cognitive abilities that go along with this are implied. This can be a problem for certain target groups, like the elderly who are more likely to battle with age-related issues like impaired vision, problems with manual dexterity and mobility or changes in cognition (Zarbo, Brugnera, Cipresso, Brignoli, Cricelli, Rabboni & Compare, 2017).

Finally, another problem comes with an increasing focus on technology supported mental Health care. There is a chance that the relationship between patient and professional in digital contact, can develop less intense and thereby impede one of the most effective aspects of a therapeutic relationship (Flückiger, Del Re, Wampold & Horvath, 2018).

The opportunities, the advantages of technology and limitations are further explored in the following paragraphs.

Quantified Self, Self-measurements, and possibilities for its technological implementation

In our modern society, the individual consumer not only has easier access to information that is collected about him but also does this raise the concern about privacy. There is a growing demand to know which information is collected about them. This relates to what de Groot, den Braber and Timmers (2014) called "quantified self." This concept originally coined by Wolf and Kelly describes people who are actively participating in personal experiments (2014). These personal experiments are easier to be carried out today, e.g. with the consultation of an app, who can give instructions at any given time and as often as the user wants them to hear, without getting tired.

In the field of mHealth applications, those can be reckoned among the class of quantified self- applications. They are understandable for the patient/user and the

collected data or measurements are of use for the user themselves. An application that collects data on e.g. Individual A (the patient) but can later merely be interpreted and used by another, person (Individual B, e.g. Individual A´s psychologist) is not a quantified self-application but would still be reckoned among the class of mHealth Applications.

Closely tied to the motivation to use apps is the belief in the quantification of data and the fact that data- collecting technology, should be integrated into the daily life (Gallitano, 2015).

The quantified self is therefore closely related to what is called "Self-measurement". Cornet, Mandersloot, Pool and Kogel, (2017) named three aspects that are important while measuring: personal data, the context and modern technology. They further split the available tools for self-measurement into 4 groups: wearables, carriables, domotica and implants. In this paper, we are going to focus on the first, the wearables. This includes all technology, that can be worn, and in our case, we concentrate on smartphones. This choice was made since this seems to be the largest group of used wearable technology (Torous, Friedman & Keshavan, 2014). The advantages of patients measuring the wished data for themselves include increasing self-reliance, personalisation of the treatment and monitoring of lifestyle (e.g. nutrition, exercise or sleeping patterns) (Cornet et al., 2017). These advantages combined with the advantages of smartphones as discussed earlier, lead the way to use mobile Applications to support behaviour change (about half of the used applications are designed for this aim), prevent relapses after the treatment has stopped, monitoring the medication intake and research purposes.

In the previous paragraphs, the advantages of smartphones and quantified-self technology, the implications of this technology for the general health care and the importance, possibilities to reach the individual are discussed. Despite all these

advantages, there are a few disadvantages, which must be named also. Carter, Liddle, Hall and Chenery (2015) noticed concerns like privacy issues for the user. Another issue of concern is the security of the collected data in time of hacking. In previous papers there are known cases of holding a treatment centre hostage, by threatening to delete all the electronic data, creating possible life-threatening situations (Yang, 2017) and the unsolved question of ownership.

The latter aspect relates to the fact that there is an ongoing discussion if the collected data belongs to the company that provided the means to collect these data or to the individual who produces the data. Finally, the increasing use of technology could relate to a decrease in control of the healthcare professionals, which again could lead to an increasing independence of the patient. While this is not held for all healthcare providers, there is a chance that a general fear and negative attitude toward technology, prohibits the implementation and use of technology (Sharma, Meurk, Bell, Ford & Gartner, 2018). In summary, it can be stated, that there is a wide variety of reasons to use wearable technology, to support mental health care, but there are also reasons against implementing this technology.

In the previous paragraphs the relevance and possibilities of using Smartphones in the modern Mental Health Care are explored. Given that many articles focus on merely one specific (sort of) disorder, in the context of smartphones (Affective disorders (Dogan, Sander, Wagner, Hegerl & Kohls; 2017) or Alcohol and Substance Abuse (Kazemi, Borsari, Levine, Li, Lamberson & Matta, 2017), the goal of the current review is to evaluate the current state of practice. This paper aims to explore if the usage of smartphones is limited to certain disorders or if it is equally applied to disorders from all axis of the DSM, and therefore to discover a possible underrepresentation.

In the previous sections, several aspects have been discussed regarding the usage of technology, especially smartphones, in the mental health care. Since an important part of mental Health care is represented by psychotherapy, we are going to focus on technology usage in this setting. Previous research has shown that the paradigm of Cognitive Behaviour Therapy (CBT) is the one used most. Within this paradigm, behavioural Interventions, like self-monitoring or exposure are central to treating psychological disorders (Farmer & Chapman, 2016). Given this dominance in the practice, this paper is taking a closer look if an how this dominance is also shown in the design of technology-supported Interventions, with the aim to treat mental illnesses. The last aspect we like to shed a light on are the by patients and healthcare professionals perceived drawbacks that hinder the usage of smartphones in the mental health care, to give an indication where current applications fall short, so that these issues can be considered for future developments and implementations to improve the uptake and usage of technology in this specific setting.

This paper aims to create an overview of the use of mHealth as provided with smartphones, in mental health care. In addition, it is aimed to give an impression how the excitement of current research on quantified self (Amft, 2018; Hamari, Hassan & Dias, 2018; Katz & Marshall, 2018) is translated from only providing mental health care in the practice of psychotherapy to the empowerment of patients in everyday life through use of smartphones. We are therefore focusing on answering the following research questions (RQ):

RQ I:

Which psychological disorders are presented in the current scientific literature, that are treated with the help of smartphones in the mental health care?

RQ II:

Which behavioural interventions are implemented through smartphones, to support psychological treatment, in the mental health care system?

RQ III:

What are identified drawbacks of smartphone use in the mental health care system, in the current scientific literature?

Method

Keyword Selection

To systematically identify articles relevant to our research questions, a keyword analysis has been conducted to identify the keywords most relevant. In the beginning, it was chosen to start with the main term, "smartphones in mental health care", and look for review articles on the topic. Via the search engine *Scopus*, three review articles concerning mHealth in mental Health care were found. These articles have been selected as the base for the keyword analysis to get an insight into the most represented keywords, to make sure all relevant literature is included. By screening the literature citing the three baseline articles it is made sure we get a specific but up to date selection of articles. The first is "Mobile healthcare applications: system design review, critical issues and challenges" written by Baig, Gholam Hosseini and Connolly (2015), reviewing several applications and pointing out problems of the smartphone use in the mental health care,e.g. privacy issues, resistance against the use and the financial implications of providing mHealth Care. The second "There is an app for that! The current state of mobile applications (apps) for DSM-5 obsessive-compulsive disorder, posttraumatic stress disorder, anxiety and mood disorders" published in June 2017 and written by van Ameringen, Turna, Khalesi, Pullia and Patterson. This literature review, analyses mental Health Apps Articles on the treated DSM 5 disorder, based on different behavioural change techniques and their benefits and downsides. The third is titled "Mental Health Smartphone App: Review and Evidence-Based Recommendations for Future Developments" by Bakker, Kazantzis, Rickwood and Rickard (2016). This article is a literature review aimed at creating a guideline for future developments of mHealth Apps. The results pointed out that there is a need for more applications aimed at preventing

mental problems, while there is a general need to validate the efficiency of existing applications. The keywords for each article are presented in detail in table 1 in Appendix A.

All three studies have been cited several times. To broaden the dataset, all the keywords from the citing articles the three articles above have been listed and ranked per frequency. This method included in total 131 documents and 272 keywords in total. An overview of relative and absolute frequency per keyword is given in table number 2. The table only shows keywords named three times or more, an extensive table of all keywords can be found in Appendix A.

Table 2. *Results Keywords Analysis*

Keyword	**Number of Science Article: Total (percentage)**
Mobile Application	25 (9.19)
Smartphone (including Keywords)	23 (8.45)
mHealth	22 (8.1)
Depression*	21 (7.7)
Human(s)	17 (6.25)
Mental Health	15 (5.5)
Health care	14 (5.1)

*considering the aim is to search literature about various psychological problems, this item is excluded

Exclusion Criteria

To get an overview of the current state of use and function regarding smartphones in the mental health care, a literature review with the above-described keywords was conducted via *Scopus*, to select relevant articles. Therefore, the following keywords were used as subject parameters *Mobile Application* and *Smartphone* and *mHealth* and *Mental Health* and *Health care* This resulted in 39 Documents. It was an additional specification to only consider journal articles or reviews.

The chosen keywords are presented in Table 2. To be sure that the literature included represents the current state of research only articles published between 2013 and now (2018), were included. The short time frame was also chosen to get a good overview of the current state of research since the developments in smartphone technologies are fast

moving. Additionally, all articles needed to be available in the English language. Articles were selected via the search engine "*Scopus*" reviewed at the title and abstract level and were then excluded if a study (a) was published in a book; (c) was a conference paper or notes (d) did not include the keywords "mHealth", "Smartphones" and "Mental Health" ; (e) was published before 2014 (since technology is developing so fast, to prevent reviewing technology that is maybe nowadays outdated) or (g) was written in a language other than English. For all exclusion criteria and the articles fulfilling the criteria see Figure 1.

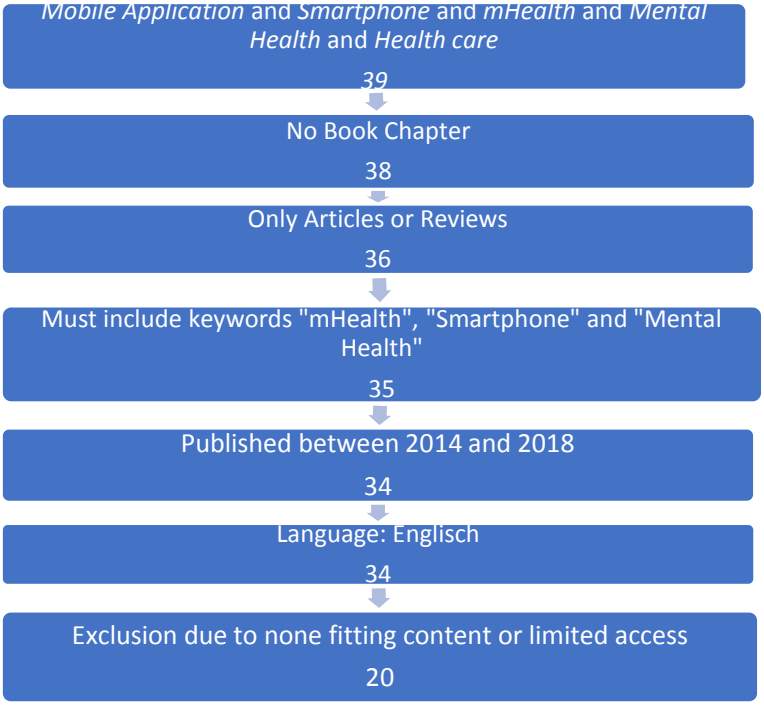

Figure 1. Overview of applied exclusion criteria and specifying the included articles

After applying all exclusion criteria in total 34 Articles were left. Next, based on the title and the summary of the found articles, the author discriminated between relevant and irrelevant articles (Was the article truly about mHealth in relation to the mental health sector? Was the problem treated of mainly psychological nature e.g. psychological disorders? And were smartphones the main method of Intervention delivery which the

articles focused on?). Also, one article, which could not be fully accessed was excluded. Ultimately 20 Articles were considered and analysed in the current literature review.

Due to the limited scope of this review, a reliability analysis of this approach was not feasible, but it was tried to increase the reliability of the results by choosing certain criteria to include and exclude literature, these criteria were established in a discussion with a fellow student to minimize bias. Although this review partly follows the criteria to increase reliability proposed by the Cochrane collaboration, future research could improve their reliability by strictly following the steps proposed by the *Cochrane Handbook*, especially "assessing risk of bias" and "[…] undertaking a meta-analysis of the literature*" (*Higgins, J. P. T. Higgins JPT, Green, 2009). Due to time limited and the restricted form of this research, it was beyond the scope of this paper to implement all the steps, mentioned in the handbook.

Results

Data Description

The articles included in the analysis were mostly published in 2017 (55%), with the second largest part been published in 2016 (15%) and 2015 (15%). The literature was published in different countries, mainly in the United States (11 Article), Australia (5) and the United Kingdom (4). Of the included papers in the current study, 15 papers were articles (75%) and consequently, 5 (25%) were Reviews.

Research Question I

The first Research Question aimed at exploring which psychological disorders are currently treated with the help of smartphones. The most mentioned disorder treated with the help of smartphones is Depression, summarizing Major Depressive Disorder (MDD) and Depressive Symptoms (Van Ameringen, Turna, Khalesi, Pullia and Patterson, 2017; Batra et al.,, 2017; Clough & Casey, 2015; Firth et al.,, 2016; Grist, Porter and Stallard, 2017; Kaipainen, Välkkynen and Kilkku, 2017; Lattie et al.,2016;

Rathbone & Prescott, 2017; Swendeman, Comulada, Ramanathan, Lazar and Estrin, 2015; and Yoo, Kim, J.C.; Kim, K.W. and Park, 2017), additionally Niendam et al. (2018) dealt with Major Depressive Disorder with Psychotic features. Schizophrenia (Batra et al., 2017; Erbes et al.,2014; Firth et al., 2016; Grist et al., 2017; Kuzman et al.,2017; Niendam et al., 2018 and Rathbone & Prescott, 2017) and Anxiety Disorders (Clough & Casey, 2015, Grist et al., 2017; Lattie et al., 2016 and Swendeman et al., 2015) were mentioned the second most, each were discussed in seven different articles.

The third most common which was dealt with in articles was the Bipolar disorder, Articles with this subject were written by van Ameringen et al. (2017); Batra et al., (2017), Firth et al. (2017); Grist et al., (2017) and Nicholas, Larsen, Proudfoot and Christensen (2017). Hereby we also like to mention the article by Niendam et al. (2018) dealing with Bipolar Disorder with Psychotic features. Apps concerning psychotic Disorders (including Suicidality) or Apps dealing with Stress, were the fourth most, mentioned in total 4 times by Batra et al. (2017), Grist (2017), Kuzman et al. (2017) and Niendam et al. (2018); respectively van Anmering et al. (2017), Clough & Casey (2015), Grist et al. (2017) and Rathbone and Prescott (2017). Mental disorders that are mentioned twice, in the literature are presented in table 3.

Table 3. *Mental Disorders Mentioned twice in the review*

Mental Disorder	**Articles**
OCD	Van Ameringen et al. (2017); Grist et al. (2017)
PTSD	Van Ameringen et al. (2017); Erbes et al. (2014)
Schizoaffective disorder	Batra et al. (2017); Niendam et al. (2018)
Substance Abuse	Erbes et al. (2014); Swendeman et al. (2015)
Mental Health Condition	Firth et al. (2016), Rathbone & Prescott (2017)
Insomnia	Grist et al. (2017); Yoo et al. (2017)
Serious Mental Illnesses	Glick, Druss, Pina, Lally & Conde (2016); Niendam et al. (2018)
Fatigue & Reduced Energy	Swendemann et al. (2015), Yoo et al. (2017)

Additionally, 13 Mental Disorders and related problems were only mentioned in one of the articles, included in the current review. These include SAD and Panic Disorder (van Ameringen et al. 2017), High Functioning Autism Spectrum Disorder and Chronic Pain (Clough & Casey, 2015), Borderline Personality Disorder (Erbes et al. 2014), Memory Complaints (Firth et al., 2017) , Self-harm, Suicide Prevention, Conduct Disorder, Eating Disorders and Body Image Issues (Grist et al., 2017), Prevention of Disorders (Kaipainen et al., 2017), Schizophreniform Disorder and Psychosis not otherwise Specified (Niendam et al., 2018) and at least Multiple ACEs (Sockolow et al., 2017).

In summary, it can be said that most applications were targeted at the support and/or treatment of disorders from the mood disorder spectrum, like depression (most common) and bipolar disorder (ranked third), but also on schizophrenia (ranked second). Disorders from other clusters were also prevalent but were mostly mentioned once or twice. In general, there seems to be a relatively broad range of different mental disorders represented.

Research question II

Paradigms cited

At first, an overview over the most cited paradigms is given. By far the most mentioned was Cognitive Behavioural Therapy, as a basis for the structure of behavioural Interventions implemented in the App. It was mentioned a total of seven times, across the 20 articles (Batra et al., 2017; Firth et al., 2016; Grist et al., 2017; Lattie et al., 2016; Nicholas et al., 2017; Rathbone & Prescott, 2017 and van Ameringen et al., 2017).

The second most mentioned paradigms were Positive Psychotherapy and Positive Psychology (Lattie, van Ameringen et al.) and Dialectic Behavioural Therapy (Grist et al., 2017; Erbes et al. 2014). Additionally, the following paradigms were mentioned Adherence Intervention (Batra et al., Acceptance and Commitment Therapy (Kaipainen), IPSRT (Nicholas et al., 2015), Family-focused Therapy (Nicholas et al., 2015), Problem-

solving Therapy (Rathbone & Prescott, 2017), Psychosocial Behavioural Therapy (Batra et al. 2017), Mindfulness Behavioural Therapy (Firth et al., 2017) and Light Therapy Services (Yoo et al., 2017).

Change techniques in themselves

Besides the general paradigms, also the individual behavioural change techniques (behavioural interventions) of the apps, were analysed. By far the most used were techniques to monitor and track certain behaviours, e.g. by keeping a diary on the smartphone. This was also mentioned across a wide range of psychological disorders and was used by van Ameringen et al. (2017), Batra et al. (2017), Bry et al. (2018), Clough and Casey (2015), Erbes et al. (2014), Firth et al. (2017), Grist et al. (2017), Kuzman et al. (2017), Nicholas et al. (2015), Niendam et al. (2018) and Yoo et al. (2017).

The second most was "Psychoeducation" being mentioned eleven times by van Ameringen et al. (2017), Batra et al. (2017), Clough and Casey (2015), Erbes et al. (2014), Glick et al. (2016), Grist et al. (2017), Kuzman et al. (2017), Nicholas et al. (2015) and Sockolow, Schug, Zhu, Smith, Senathirajah and Bloom (2017). Psychoeducation is used to inform the user about the background of certain problems, mostly to prepare them for the next behaviour change techniques.

The third rank is taken by what we called "Assessment", which means a sort of screening questionnaire, the user could fill in to get an indication if there could be some sort of disorder present, and how strong it is present. This feature was used six times by Batra et al. (2017), Erbes et al. (2014), Grist et al. (2017), Kuzman et al. (2017), Nicholas et al. (2015) and van Ameringen et al. (2017).

The next two techniques mentioned were Media use (incl. Audio feedback) and sending reminders via the App to support the treatment. Both were mentioned 5 times by Clough and Casey (2015), Kaipainen et al. (2017), Stoll et al. (2017), van Ameringen et

al. (2017) and Yoo et al. (2017), respectively Batra et al. (2017), Clough & Casey (2015), Firth et al. (2016), Glick et al. (2016) and van Ameringen et al. (2017).

The next most prominent features were "Supervision with the therapist" (Batra et al. (2017), Firth et al., (2016), Glick et al. (2016) and Niendam et al., 2018)) and "Relaxation training (incl. Breathing training)" (Bry et al. 2018, Erbes et al. 2014, Stoll et al. 2017 and van Ameringen et al. 2017) both mentioned four times.

The following techniques were all mentioned three times: "Text to support the treatment or reinforce" (Glick et al., 2016; Niendam et al. 2018 and van Ameringen et al. 2017), "Exposure" inclusive components like making an appropriate gradation hierarchy and visualisation by Bry et al. (2018), Gist et al. (2017) and van Ameringen et al. (2017) and at least "Social support", mentioned by Kaipainen et al. (2017), Nicholas et al. (2017) and Yoo et al. (2017). For a better overview, techniques that were only mentioned twice are presented in table 4, see Appendix A.

The following paragraph addresses the techniques that were only mentioned once. Van Ameringen et al. (2017) discussed Music Therapy, Positive affirmations, Behaviour training, Exercise-based Therapy and Diet and activity suggestions. Batra et al. (2017) mentioned Self-management, Behaviour activation and Modelling. Bry et al. (2018) dealt with a Hierarchy of feared situations, Problems solving in general, Self-evaluation thoughts and behaviour thought challenging and approach behaviour reinforcement. At third, Clough and Casey (2015) mentioned "Ecological Monetary Assessment", while Kaipainen et al. (2017) added Cognitive diffusion, Value Clarification, and the Principles of Acceptance and Commitment Therapy. Nicholas et al. (2017) mentioned someone who formed a therapeutic alliance with the application itself, while Niendam et al. (2018) described a Dashboard and the offer to put the user in

touch with professionals. The last three techniques were Cognitive control (Rathbone & Prescott, 2017), Storytelling (Sockolow et al., 2017) and Planning (Stoll et al., 2017).

In summary, it can be said that as expected Cognitive Behavioural Therapy is the most used paradigm, which also provided one of the most used behavioural Interventions: Self-monitoring, while surprisingly other prominent CBT features like Exposure or Homework were less prevalent.

In summary, the most mentioned techniques across all articles were based on Cognitive Behavioural Therapy, with the most prominent being classic techniques like Monitoring and tracking, psychoeducation, and some form of assessment. Although this three were clearly dominant, there were overall 38 different techniques mentioned in total.

Research Question III

The answer to the third research question "What are identified drawbacks of smartphone use in the mental health care system, in the current scientific literature?", is going to be split in two: first identifying drawbacks on the therapeutic side, and second looking at drawbacks from the patient's point of view.

The Therapists point of view

The most mentioned barrier for adoption was that the therapist believed that the applications delivered by the smartphones, had lower validity and/or guideline orientation than other treatment options (Nicholas et al., 2015, Rathbone & Prescott, 2017; van Ameringen et al., 2016). Barriers mentioned twice are for reasons of clarity represented in table 6, in the Appendix.

The following barriers were merely mentioned once: Fear of a reactive effect (repeated questioning increasing e.g. the chance of suicide) (Batra et al., 2017), Concerns about the general quality (Bry et al., 2018), Inadequate design of applications and lack of fit between the technology available and the current level of research (Clough & Casey,

2015), fear of an digital placebo effect (Firth et al. 2016), Increased responsibility, a higher need for training of the therapists and fear of increasing expectations from the patients to the therapists (Grist et al. 2017). Kaipainen et al. (2017) mentioned that it would be difficult to motivate the clients, a concern that technology would replace face-to-face treatment and that therapist would prefer the human contact over providing help via an app. Finally, Lattie et al. (2016) mentioned the decrease in engagement and Yoo et al. (2017) named that the capacities of the application would restrict by the treatment services.

In summary, it can be stated, that the most prevalent barrier for smartphone adoption in therapy for the professionals is disbelief in the scientific base for the application and the efficiency or additional value provided by such an application for the therapeutic process. Additional to these major concerns, other points were also relevant but less common.

The patient's point of view

Patients as well named several barriers the experienced regarding the adoption of more smartphone-based interventions in the current mental health care. The fact that the use of app required ownership and familiarity with smartphones, which are quite expensive, was the most frequently named barrier (Clough & Casey, 2015; Firth et al. 2016, Grist et al. 2017 and Kaipainen et al. 2017).

Also, several patients were concerned about the confidentiality in general (Bry et al. 2018, Clough& Casey, 2015; Firth et al., 2016 and Nicholas et al. 2015). For barriers that were only mentioned once by an article like "lower helpfulness" (van Anmeringen et al. 2017), see Table 5 *"One-time mentioned Barriers for Adoption of smartphone use in the GGZ from the patient's point of view"* in the Appendix.

In summary, it can be stated, that while there were several barriers mentioned by the patients, the most urgent were practical issues like the requirement to own and know how to use a smartphone.

Discussion

In the selected literature we found that regarding our first research question, the current mHealth research is mostly aimed at treating Major Depression Disorder, Schizophrenia or Bipolar Depression Disorder. Mostly, the applications offered features from the classic Cognitive Behavioural Therapy, like monitoring or tracking and psychoeducational elements to the user. More innovative elements like ecological monetary assessment or geospatial location feedback were less or not at all present (Research Question II). Additionally, with focus on the third research question, we found that the greatest barrier for using smartphones in therapy for the therapists were the belief that the apps had low validity and had no orientation on the guidelines for treating disorders, while the patients named that they did not own a smartphone and worried about data security.

Regarding the first research question, we found that the most prominent disorders in the focus of application supported treatment were depression, anxiety, schizophrenia, and bipolar disorder. This comes no surprise, given that depression is the disorder with the highest prevalence worldwide, and therefore the one with the most urgent need for treatment (14% lifetime-prevalence), next in line are anxiety disorders, which are also the second most treated (13,6% lifetime-prevalence) in the mHealth environment (Alonso et al., 2004).

The fact that bipolar disorder was the third most mentioned disorder, was a little surprising given that the main way of treating bipolar disorders is a treatment with antipsychotics or benzodiazepine, thus rather medical than behavioural treatment. On the other side, an important part of the treatment is to ensure education about the background

of the disorder and to increase medication adherence. Both tasks represent a feature that are central treatment strategies in the literature review, and which could easily be supported by technology. It is therefore likely that the applications are used to manage bipolar disorder, instead of curing it. (Goodwin & Consensus Group of the British Association for Psychopharmacology, 2009).

In contrast to previously discussed disorders, SAD and Panic Disorder (van Ameringen et al. 2017), High Functioning Autism Spectrum Disorder and several other disorders (see Results) were mentioned only once, which means there was only one app in the review specialised on treating this illness. The underrepresentation of apps for these illnesses may be a result of lower prevalence rates (thus there are not as many people in need of treatment), the complexity of the disorders and the fact that e.g. eating disorders (Feld, Woodside, Kaplan, Olmsted & Carter, 2001), psychosis (Chang et al., 2018) or patients with suicidal ideations (Britton, Williams & Conner, 2008,) often go along with poor treatment motivation in the first place. This again could translate into low adherence to the treatment-application. The market and the chance of applications to successfully help treating these illnesses, is therefore, smaller than for depression and anxiety disorders, explaining the underrepresentation of apps in the found literature.

Implication I

Mobile applications focused on treating mental disorders outside of mood disorders are underrepresented in the scientific literature. Future research or even developments are necessary.

As previously stated the most mentioned paradigm was "Cognitive Behavioural Therapy". This is no surprise, given that in modern health care, cognitive behavioural therapy is seen as "the way to go" **(**Westbrook & Kirk, 2005). Other mentioned therapy exercises like e.g. Acceptance and Commitment Therapy (Kaipainen et al., 2017) are increasingly on the rise but are scenically not (yet) seen as equally effective to CBT.

Within this framework, the most used "Behavioural change Intervention" are Monitoring/ Tracking, Psychoeducation and Assessment. These results are explainable by the fact that it is a standardized part of the anamnesis for nearly all psychological disorders to assess how often symptoms occur over a given period. This seems logic, considering an exemplary criterion to diagnose a "Major Depression Disorder": the patient must suffer from lower for most days during the last 6 months. Also, provides this technique with a possibility if the symptoms occur less as a consequence of executing a certain psychological Intervention, therefore determining the effectivity of other behaviour change techniques across a wide range of psychological disorders. An interesting aspect regarding the implementation of methods to monitor behaviour is its translation from a paper-and-pencil to an electronic version. Also, the form itself seems to be unchanged, an important point is compliance. According to Stone, Shiffman, Schwart, Broderick and Hufford (2003) compliance on electronic measuring, is about the same as with the classic paper-and-pencil version. Nevertheless, an important point is that paper-and-pencil versions are known to be more prone to retrospective biases since there is an increasing chance that the patients fill in all ratings for a day at the same time. This could be lower for the mobile version since most people tend to have their phone with them all day, and reminders to fill in could be set more easily. The innovation in this part is thus not the form, but the delivery of the behavioural interventions "monitoring" or "tracking".

Offering psychoeducation before the actual therapy is often used to explain the therapy rational and the working mechanism of the disorder to establish trust as a starting point for the therapeutic relationship and to provide the patient with background knowledge on the disorder (Walitzer, Dermen & Connors, 1999). Another factor that explains the frequent use of psychoeducational methods in eHealth is the fact that is

essential to the treatment of all disorders, especially the ones we found in the literature review like Schizophrenia (Bäuml, Froböse, Kraemer, Rentrop, Pitschel-Walz, 2006) bipolar disorder (Zaretsky , Lancee, Miller, Harris & Parikh, 2008), Periodic explosive disorder (Bernard, Appelo, Scholing & Kok, 2003) and bipolar Depression (Lam, Hayward, Watkins, Wright & Sham, 2005). While other techniques like the practice of "exposure" for anxiety disorders are disorder-specific (McNally, 2007). It, therefore, makes sense, that psychoeducation is more prevalent as Intervention in the apps than other techniques. The lack of "exposure"-exercises in the anxiety-specific applications can be explained by the nature of anxiety disorders. Given that a central feature is "avoidance" and panic, sometimes as strongly that the patients fear to "die of anxiety", it seems reasonable that the preparation and executing of exposure tasks is easier in the presence of another person that helps the patient through the exercise.

A result that came quite surprising was that classic techniques such as giving "Homework" or giving "Notifications" via the App were only mentioned twice. In advance, both were expected to be quite prevalent considering giving and evaluating "Homework" is one of the main ways of working in the traditional CBT. It is traditionally used to reflect on and to learn and manifest learned techniques from the previous session. Most importantly previous studies showed that the results from the intervention correlated strongly with the implementation of homework (Neimeyer & Feixas, 1990). A possible explanation would be that those features would increase the workload of the psychologist even more, so there would be more resistance towards implementing the technology. We are going in on this aspect later while discussing barriers for the adoption of smartphones in the modern mental health care. We expected that "Notifications" would also be implemented quite often, in double function as a reminder, given that adherence to

technology-based Interventions is often quite problematic (van Gemert-Pijnen, Peters & Ossebaard, 2013).

Another expectation was that in the rapidly developing field of mHealth innovative features would be used more, especially since some of the classic features like e.g. notifications were expected to be less prevalent. A possible explanation gives our later discussed finding that therapists are concerned about the validity of the applications, especially those with more "innovative" features. To support the growth in these areas it would be important to establish the quality of an application and to advertise the use of the quality-proofed application with more innovative features towards the therapists. Also, the interventions themselves seem to be not innovative, the delivery via smartphones make it easier to provide the patients with access to the interventions in nearly any location and at all times (since most people have their smartphone with them for most of the day, as discussed in the introduction) and possibly increase validity due to the minimization of recall bias while reporting. As it was summarized by Skinner, Attwood, Baddeley, Evans-Reeves, Bauld and Munafò (2017) the smartphone enables "researchers to gather fine-grained information about the lifestyle behaviours of individuals, in free-living conditions, on a large scale", therefore not the way the smartphones are used, but the use of the collected data and close intertwinement with the everyday life of the user are in this case the innovative aspect.

Implication II

Future applications should include more evidence-based behaviour change techniques, to potentially increase trust and facilitate adoption by the professionals.

Regarding the barriers of Implication, which were experienced by therapists and patients, we found that a lot of therapists resist implementing technology, out of fear of the consequences that the implementation could have for their work. This aligns with

previous work from Ashcraft (2013) stating that implementing new technology changes the work-related identity, which could in the worst-case scenarios lead to an identity crisis. Considering that people tend to avoid Identity crises, it would make sense for them to resist the use of technology in the first place. Additionally, considering that Applications are still a relatively new technology, it makes sense that according to *Normalization Process Theory* there is still a fear of implementation. The Theory stated that "The production and reproduction of a practice require continuous investment by agents in ensembles of action that are carried forward in time and space." (May et al., 2009; p.2.). It is, therefore, possible that the lack of investment by previous therapists is part of the reason mHealth is underused.

The main barrier on the side of the patients was, contradictory to what was expected, lack of ownership and knowledge of a smartphone. A possible explanation is the fact that psychological problems occur often in people of older age (Linden, Kurtz, Baltes, Geiselmann, Lang, Reischies & Helmchen, 1998), children and/ or people with a lower social-economic background (Everson, Maty, Lynch & Kaplan, 2002). Furthermore, Chung et al. (2010) stated that age can be a key moderating factor in the acceptance and uptake of new technologies. A possible factor that we yet left unexplored is the severity of the condition, people who are e.g. hospitalized may have no accesses to a smartphone due to the regulations in most hospitals who do not allow the use of those phones (Jain, A.S., Asrani, Singhal, Asrani, Deshmukh & Jain, D., 2017).

A factor that was also mentioned several times was the need for personalization. Chellappa and Sin (2005) showed that privacy concerns and the scope for personalization, influence the chance of the adoption of personalized services. This links to another mentioned barrier of adoption: privacy. Research has shown that worries about privacy and data safety decrease the chances of adoption, whereas personalization increases these

chances. Considering, that these factors influence the same behaviour in different directions it was stated by Guo, Zhang, and Sun (2016), that trust could be the decisive factor.

Implication III

To increase adoption of mHealth technologies in the mental health care it is critical to address privacy and personalization of the technology in the development and adoption process and to provide access to smartphones for patients outside of the classic smartphone user group

Related to this problem is the question of data security, which is essential to keep the confidentiality about psychological dossiers and honouring a guideline that is established by the NIP (Article 73; Nederlands Instituut van Psychologen, 2015). Keeping in mind these guidelines, a suggestion would be to give the clients access to the data that the application and the psychologist stores, and to allow removal of unwanted stored information. This is currently regulated within the European Union by the Personal Data Protection Act (AVG) (Verordening (EU) 2016/679 van het Europeese Parlament en de Raad van 27 april 2016). It would also be helpful to establish an independent organization rating the quality of applications for the use in mental health care, to work against the fear of the professionals to provide low-quality care via smartphones (Al Thomari, Mummanei, Alsalamah, Moussa & Coustasse, 2015).

Furthermore, an additional limitation was the social isolation some users experienced, this could not only increase symptoms such as social isolation but also contribute to the increasing problem of smartphone addiction (Bian & Leung, 2015) and consequently social isolation (Karimi & Neustaedter, 2012) or even increasing the chance on suicidal reactivity.

Also, we found that while there are apps using behavioural Intervention strategies to support the treatment of psychological disorders, there is a need to encourage the

establishment of more innovative techniques, thereby making use of all the new options that digital phenotyping has to offer, as it was discussed in the Introduction. An example of such a possibility would be, on the interventional level, the support of exposure tasks via the smartphone to treat anxiety disorders. A possible explanation, why they not yet are a standard part of common practice would be that as patients gain more responsibility (Lovatt & Holmes, 2017), health professionals would lose part of their authority, and patients would be made increasingly more responsible for their health, but also for their diseases. In the future, these technologies could play an increasingly independent, active role in the treatment of mental health, by analysing the collected data themselves (Briffault, Morgiève & Courtet, 2018). Also, these are obstacles for the implementation of digital phenotyping technologies, several theories, like the *Population Model of Adopters* (Berwick, 2003) have described the slow beginning of the diffusion of new technology, like the use of digital phenotyping in the Mental Healthcare. Recommendations to establish the more innovative use of technology in the health sector are named by Berwick (2003), possibilities could be to invest in the use of mHealth by financial aid, encourage psychologists to set an example and finally – to give it time.

Limitations

A limitation of the study is the generality of the results due to discrepancies in the methodology in the reviewed studies and the lack of meta-analytical data. Additionally, the statistical efficiency of each application was not considered. To increase objectivity, inclusion and exclusion criteria were established and applied while screening the studies. Nevertheless, the screening process was subjective and vulnerable to personal bias (Mallett, Hagen-Zanker, Slater & Duvendack, 2012). In the future, it is therefore recommended to extend the research by letting two researchers screen the articles and by taking the statistical efficiency of the apps into account, to get a better idea of the reasons why certain behavioural change Interventions might be less prevalent.

Another limitation results from the fact that only literature which could fully be accessed was used. This called “Full text on net bias” (Krieger, Richter & Austin, 2008) was prevalent since it was decided to use only articles which were fully available to get the chance to answer all research questions since the description in the abstracts were not detailed enough. Articles potential crucial to our research could not be bought, due to a lack of financial funding for this research. For the future, it is therefore recommended to get secure financial support before conducting the research. An additional limitation comes from the method of analysing literature itself. Since only literature could be used, there is a chance that relevant factors not yet discovered are left out. While in our case, there was no way of taking of this bias, this aspect could in the future be addressed by changing the approach and conducting and analysing interviews on the research questions in the target group (mental health practitioners and patients).

Conclusion

Despite the named limitations, it finally can be said that the research gave a first insight into where smartphones are already used in the health care system, but also showed aspects that still need improvement. At the current state psychologists and patients are in need for a more excessive training on the aims and possibilities of the use of smartphones. The current review made aware that the aim is not to replace the treatment - but to extend it.

Appendix

Table 1. *Linked Keywords per Review article*

Article	Keywords
Baig, Gholam Hosseini and Connolly (2015)	Healthcare systems, m-Health Applications, Mobile Healthcare Applications, Mobile monitoring and mobile healthcare technology, Smartphone based applications
Ameringen, Turna, Khalesi, Pullia and Patterson (2017)	(Anxiety, depression) eHealth, mHealth, mobile apps, (OCD, PTSD) Smartphones
Bakker, D., Kazantzis, N., Rickwood, D., & Rickard, N. (2016)	mobile phones mental health smartphones apps mobile apps (depression) (Anxiety) cognitive behavior therapy cognitive behavioral therapy clinical psychology

*Keywords in brackets, are excluded from the literature research due do potential limiting the area directly to much on anxiety and depression, and therefore missing the whole picture

Table 4. *Behavioural change techniques, that mentioned twice across the literature*

Behaviour change technique	*Mentioned by*
Video	Kaipainene et al. (2017), Kuzman et al. (2017)
Homework	Batra et al. (2017), Erbes et al. (2014)
Contingency Management i.e. rewards, positive reinforcement	Bry et al. (2018), Stoll et al. (2017)
Cognitive restructuring i.e. challenging, looking for evidence	Bry et al. (2018), Stoll et al. (2017)
Notifications	Niendam et al. (2018), Stoll et al. (2017)
Schedule Appointments	Niendam et al. (2018)
Skill Coaching	Niendam et al. (2018), Stoll et al. (2017)

Table 5. *One-time mentioned Barriers for Adoption of smartphone use in the GGZ from the patient´s point of view*

Barrier	***Article***
Lower helpfulness	Van Ameringen et al., 2017
Lower motivations	Van Ameringen et al., 2017
No user centred design	Batra et al., 2017
Low treatment rates in traditionally underserved groups	Bry et al., 2018
More modular approach needed in some apps	Bry et al., 20018
Feasibility lower because of low cognitive function of the target group	Firth et al., 2016
Feasibility lower because of social isolation	Firth et al., 2017
Attitude-behaviour gap	Firth et al., 2016
Preference for f2f over technology use	Grist et al., 2017
Restricted form of monitoring	Nicholas et al., 2017
App used to much data or power	Nicholas et al., 2017
Provision of poor information	Nicholas et al., 2015
Failure to consider vulnerable users	Nicholas et al., 2017
Services not receives	Nicholas et al., 2017
Discrepancies between clinician and self-rated scores	Niendam et al., 2018
App on own device instead of a special device	Stoll et al., 2017
Ease of non-response in comparison with face to face	Swendeman et al., 2015

Table 6. *Barriers to implementing smartphones in psychotherapy perceived by Mental Health Care professionals mentioned in two articles across the reviewed literature*

Barrier	*Mentioned by*
Pessimism regarding treatment efficiency	Nicholas et al., 2015 and van Ameringen et al., 2016
constant change in the availability of Applications	Bry et al., 2018 and van Ameringen et al., 2016
absence of scientific evidence regarding the efficacy of an app for certain disorders	Batra et al., 2017 and Bry et al., 2018
concerns about privacy and security regarding the data collected by the applications	Grist et al., 2017 and Nicholas et al. 2017
the fear of an increased workload resulting from the use of app in the therapeutic context	Grist et al., 2017 and Kaipainen et al. 2017
costs that go along with the use and maintenance of applications	Grist et al., 2017 and Niendam et al. 2018

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