European Archives of Psychiatry and Clinical Neuroscience (2020) 270:139–152
https://doi.org/10.1007/s00406-018-0974-3

ORIGINAL PAPER

# Smartphone applications for depression: a systematic literature review and a survey of health care professionals' attitudes towards their use in clinical practice

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Received: 30 July 2018 / Accepted: 19 December 2018 / Published online: 3 January 2019


**Abstract**
Smartphone applications ("apps") may contribute to closing the treatment gap for depression by reaching large populations at relatively low costs. The general public seems open towards the use of apps for mental disorders but less is known about the attitudes of health care professionals. Therefore, the aim of this study was to examine the available evidence on the effectiveness of apps for depression and to explore the attitudes of health care professionals towards their use in practice. A systematic literature search was performed aimed at studies utilizing smartphone applications for depression. In addition, a survey was conducted to explore health care professionals' attitudes towards using these treatment apps in clinical practice. Twelve articles were identified in the systematic literature review. All included trials reported a decline in depressive symptoms after the intervention periods. In the survey, 72 health care professionals participated. Significant differences were found between the level of technology experience and how much the health care professional would consider the use of mobile applications in clinical practice. Survey participants reported openness towards therapeutic app use but very little knowledge and experience in the field. Apps appear to be a promising self-management tool for reducing depressive symptoms. Despite some concerns, health care professionals' attitudes towards the use of smartphone applications in clinical practice are quite positive. The provision of information on the potential benefits of e-health interventions as well as the training of professionals in the application of new technologies may increase health care professionals' awareness and knowledge about mobile apps for the treatment of mental disorders.

**Keywords** e-Mental health · Depression · Smartphone applications · Mobile health · mHealth · Apps

## Introduction

Depression is one of the most common mental disorders with more than 300 million people affected worldwide. It is a major contributor to the overall global burden of disease and the leading cause of disability [1]. Although depression is a highly prevalent and disabling disease, only a part of affected individuals receives adequate treatment [2]. The median untreated rate for depression is estimated to be more than 50%, even though these rates vary per region in the world [3]. This treatment gap is a growing public health concern and the improvement of access to mental healthcare is one of the major issues in this field [4]. Numerous barriers to treatment have been identified to explain this shortcoming in mental health care provision. These include the lack of available facilities and trained professionals, the cost of treatment, stigma, structural barriers and lack of perceived need for treatment [3, 5]. Because the prevalence of depression is so high and not likely to decrease in the near future, it appears doubtful that the traditional ways of providing mental healthcare alone will be able to meet the demands [6]. Scaling up mental health care may need to make use of innovative treatment approaches. In this context, the interest in e-mental health interventions has grown substantially in recent years. Digital technologies have strongly advanced

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during the last decades and the current developments in this field are very promising [7]. The new technologies may enhance the provision of mental healthcare, contribute to closing the treatment gap and may lead to improved cost-effectiveness because large populations may be reached at relatively low cost [8]. Especially smartphone-based approaches and the use of mobile applications (apps) gain increasing attention due to the immense and expanding number of smartphone-users worldwide. It is estimated that in 2020 there will be more than 6 billion individuals worldwide using smartphones, representing 70% of the global population [9]. Thus, mobile interventions are considered to play a major role in future healthcare provision [8]. They can be incorporated in all stages of disease management (prevention, treatment, aftercare) and target different functions, for example symptom assessment, patient education, communication or treatment adherence [7]. Furthermore, there are treatment apps which are based on already established treatment methods, for example, cognitive behavioral therapy or behavioral activation [5].

Among the disease-specific apps, mental health applications play a considerable role and depression is one of the most commonly addressed mental health conditions [10]. Studies suggest that the general public is open towards these interventions for the treatment of mental disorders [11]. Health care professionals' attitudes towards app use in clinical practice are examined to a much lesser extent. However, there are studies that investigated health care professionals' acceptance towards general e-mental health interventions and these studies report varying degrees of openness [12–19]. Despite the fast pace of technological advances and the large number of health related apps on the market, research in this field is still in its infancy. Existing reviews on mobile interventions include groups of mental disorders or do not focus solely on treatment apps. Our aim was to examine the available evidence on the effectiveness of treatment apps for depression. In addition, we sought to explore the attitudes of health care professionals towards the use of these apps because they play a key role in the implementation of new technologies and represent the link between research and practice [15].

## Methods

### Systematic literature search

A systematic literature search was conducted in three databases: Medline (Pubmed), the Cochrane Library and Scopus (Elsevier). Studies were selected according to predefined inclusion and exclusion criteria.

Inclusion criteria:

- The study assesses treatment apps, defined as smartphone applications that contain active treatment components (e.g., based on cognitive behavioral therapy, behavioral activation).
- The smartphone application targets depression in a clinical or subclinical population.
- One main outcome measure is symptoms of depression.
- The study is written in English or German language.

Exclusion criteria:

- The app is solely used for symptom monitoring, assessment, data collection, medication/therapy adherence or prevention.
- The app is solely used for lifestyle change (e.g., diet, exercise).
- The app is a pure text-messaging or videoconferencing app.
- The app is a virtual reality or gaming app.
- The app is designed only for health care professionals.
- The study is a protocol, manual, conference abstract or opinion paper.

The search algorithm included a combination of the following terms with the asterisk indicating a truncation: intervention*, app*, blended, mhealth, e-health, e-mental health, mobil*, depression, major depressive disorder, mood disorder.

No further limits were set to the databases. The selection process followed the inclusion and exclusion criteria above as well as a quality assessment using quality checklists. These checklists contained information on study quality, study characteristics and an overall assessment.

### Survey design and development

A questionnaire was developed with the aim to explore health care professionals' attitudes toward using treatment apps in clinical practice. As operationalized in the systematic literature search, apps were defined as smartphone applications that contain active treatment components and target depression. The target group of the survey was mental health care professionals. This group was defined as professionals who are actively involved in mental health care, like psychiatrists, psychologists, (psychiatric) nurses, social workers, occupational therapists or others.

The content of the questionnaire was built based on the results of the literature search described above as well as additional searches related to acceptance of mobile technologies in mental health care. The survey contained 25 questions covering different thematic components: demographic information about the respondent (gender, age, country of residence, profession and professional experience), general

technology use (experience with technologies in general, smartphone ownership and app use) and experience and attitudes related to app use in clinical practice (awareness related to apps, expectations of treatment outcomes with apps alone and their use in a combined treatment approach, professional support and the availability of apps). Finally, a number of facilitators and barriers for the use of treatment apps were included to be rated for their relevance. All ratings were performed on five-point or four-point Likert scales. The questionnaire has been validated by a number of test-runs with mental health care professionals. They checked the questionnaire for comprehensibility (in form and content), completeness and technical functionality before the data collection started. Feedback was used to adapt the questionnaire accordingly.

### Data collection and analysis

The survey was administered with the scientific online survey platform *SurveyMonkey*. Data collection was initiated via email lists and online-platforms of these supporting organizations: *Arq Foundation* (Diemen, The Netherlands), *Mental Health Reform* (Dublin, Ireland), *Etablissement Public de Santé Mentale Lille-Métropole* (Lille, France) and *Aktionsbündnis Psychische Gesundheit* (Berlin, Germany). The organizations are active in mental health and represent a variety of professional groups in this field. They are all interested in e-mental health and were selected from existing contacts. The mentioned organizations were the ones that agreed to support the distribution of the survey. The link to the survey was sent via email (e.g., in newsletters) and put online on associated webpages. Due to the anonymous and open access character of the survey as well as the unknown number of web page visitors, it was not possible to estimate a response rate for the survey.

Data analyses were performed in IBM SPSS version 22. Descriptive and explorative analyses were conducted. A Wilcoxon–Mann–Whitney test was performed to identify gender differences in the scoring for consideration of app use as well as the scoring for concern about app use. Kruskal–Wallis tests were conducted to identify differences in age, country of residence or the amount computer experience and how much one would consider the use of apps or how much concern one has about the use of apps in clinical practice.

## Results

### Literature search

The search yielded 141 documents including ten duplicates, which were removed. After screening titles and abstracts of these 131 studies, 25 full texts were acquired. Eight additional full texts were included from cross-references of the obtained studies or from hand searches. Thirty-three studies met the eligibility criteria and were selected for full text review and quality assessment. Twenty-one studies were then excluded due to low quality or irrelevant content. Finally, twelve studies were selected for the review. The article selection process is shown in Fig. 1.

### Characteristics of included studies

All reviewed studies are summarized in Tables 1 and 2. Eligible studies included three randomized controlled trials (RCTs), two pilot-RCTs, two single arm pilot trials, one prospective cohort study, three review articles and one meta-analysis. Sample sizes of the included trials varied from 24 to 626 participants. Most trials included samples with clinical levels of depression as determined by the Patient Health Questionnaire (PHQ) or the Beck Depression Inventory (BDI) [20–23]. The remaining trials focused on sub-clinical levels of depression [6, 24, 25]. The symptom assessment was done online [21, 24] or by a (phone-) interview [6, 20, 23]. One study did not report the method of initial assessment [25]. In two studies, the diagnosis was administered by a clinician and the sample was drawn from a clinical setting [22, 26]. The remaining studies recruited their participants from the general population. From the studies that used a control condition, most of these were active control conditions providing another intervention. Two of the included RCTs used a waitlist–control condition [23, 24]. Some trials were underpowered or did not give information on the statistical power. Overall, the level of evidence of the included studies was very heterogeneous.

Therapeutic approaches of apps used in the trials included cognitive behavioral therapy (CBT), acceptance and commitment therapy, behavioral activation (BA), mindfulness-based treatment and behavioral strategies like targeting emotional regulation or cognitive reframing. Interventions were supported by clinicians in most trials. Two trials had only minimal clinician support and one intervention was conducted without any support by a clinician. Details are given in Table 1.

Eligible studies also included three review articles and one meta-analysis. The meta-analysis focused on smartphone-apps for depressive symptoms [27]. The other review articles focused on a broader scope of mobile interventions and mental disorders but they included relevant evidence on depression [5, 11, 28]. For the purpose of completeness these studies are included and presented separately (Table 2).

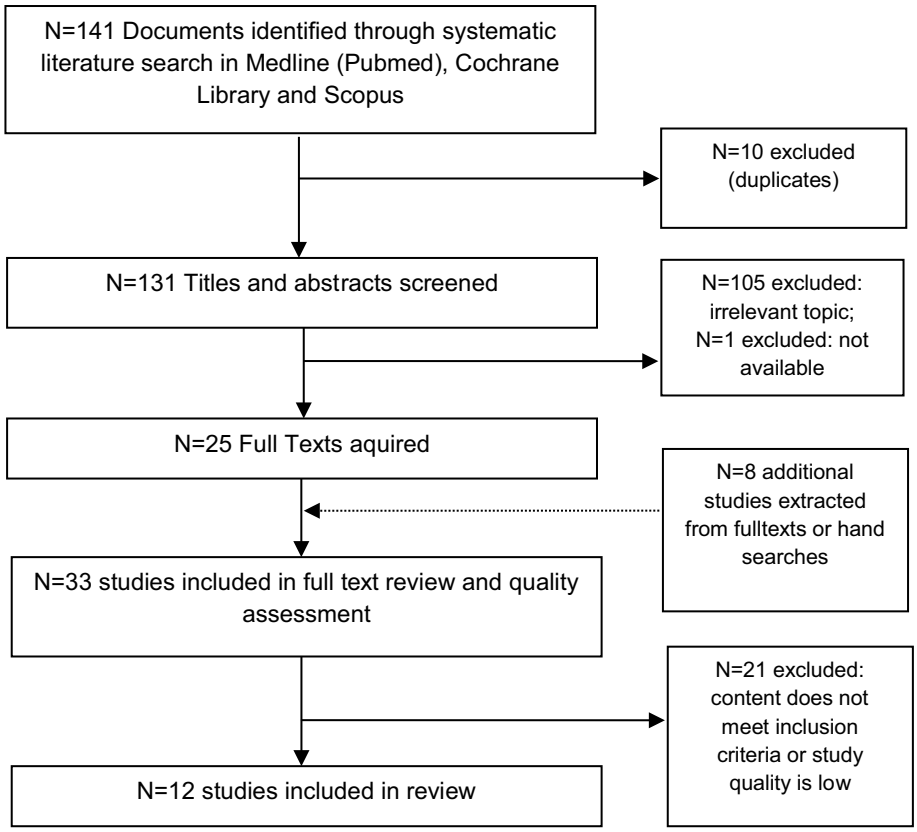


**Fig. 1** Flow of studies retrieved in the systematic literature search

## Intervention effects, adherence and user satisfaction

The maximum length of an intervention in the included trials was 12 weeks [22, 25]. Other trials conducted interventions of 8 weeks [6, 20, 23, 26] and 4 weeks [21]. Adherence rates to the respective interventions as conducted in each study varied between 70% up to 94% [20, 22, 23, 25, 26]. Two studies had lower rates between 22% and 35% of participants adhering during the intervention period [21, 24]. Furthermore, high participant satisfaction as well as acceptability of the mobile interventions was reported [22, 23, 25]. In the study by Watts et al. [23], all participants were either very satisfied or somewhat satisfied with the intervention. In another study by Schmädeke and Bischoff [22], one-third of an eligible participant group declined to engage in the intervention which the authors evaluated as an acceptance problem. However, participants who engaged in the study reported high satisfaction with the intervention [22]. All included trials reported a decline in the PHQ-9 or BDI-scores after the intervention periods. Effect sizes were not reported in all trials but when reported they ranged from medium to large effects, depending on the comparison. Details on the main outcomes of the interventions are outlined in Table 1.

## Survey

### Participants

Out of 72 individuals who filled out the survey questionnaire, 15 had to be excluded from the analyses because they did not belong to the target group of health care professionals. Included professionals were medical practitioner/psychologists/psychotherapists ($n=33$), other therapeutic professions like, e.g., occupational therapists ($n=13$), nurses ($n=7$) and social workers ($n=5$). From the included individuals, 31.6% ($n=18$) were male and 64.9% ($n=37$) were female. Two participants did not report their gender. The mean age was 43 years (SD = 12.3) with an age range of 21–74 years. Participants came from France ($n=2$), the Netherlands ($n=4$), Ireland ($n=14$) and Germany ($n=37$). Participants had a mean professional experience of 14.8 years (SD = 12.2, range 1–42 years).

## App use and technology experience

The vast majority of participants (93%, $n=51$) owned a smartphone and stated to have "a lot" (29.8%, $n=17$) or "quite a lot" (52.6%, $n=30$) experience with computer technologies. The remaining 17.5% ($n=10$) of the

**Table 1** List of included studies and details on design and main outcomes

| References | Type of study | Study sample | Design | Clinician support | Relevant primary outcome measure | Main findings |
|---|---|---|---|---|---|---|
| Arean et al. [24] | RCT | 626 Participants with mild-to-moderate symptoms of depression as determined by a PHQ-9 score ≥ 5, or if their score on item 10 was ≥ 2; recruitment through web-based advertising sources | 12 Weeks "EVO" (cognitive control app) vs."iPST" (problem solving therapy app) vs. "Health Tips" (Information Control) | Minimal participant contact through email or SMS; sending of reminders if the participants had 3 consecutive days of missing data | PHQ-9 | Differential treatment effects were present in participants with a baseline PHQ-9 score of more than 10. The cognitive training and problem-solving apps resulted in greater effects on mood than the information control app in participants with baseline PHQ-9 score > 10 ($\chi 2 = 6.46$, $p = 0.04$) |
| Lappalainen et al. [25] | Pilot RCT | 24 Male participants with self-reported stress and mood problems; recruitment through local newspaper advertising; no BDI cut-off for inclusion reported | 12 Weeks "P4Well" (CBT and acceptance & commitment therapy-based intervention) and 3 group meetings vs. waitlist control | 3 Psychologist-assisted group meetings | BDI | Depressive symptoms decreased more in the intervention group compared to the control group. There was a slightly significant group by time-interaction effect for the BDI ($p = 0.072$). In the treatment group the mean BDI score decreased with more than eight scores (CI 4.92–11.99) compared to four scores (CI 0.62–7.38) in the control group. A medium effect size ($d = 0.57$) was found between groups in favor of the intervention group. Post- and follow-up BDI were significantly lower than pre-intervention in the intervention group (BDI: $d = 1.11$, $p < 0.001$) |

**Table 1** (continued)

| References | Type of study | Study sample | Design | Clinician support | Relevant primary outcome measure | Main findings |
|---|---|---|---|---|---|---|
| Ly et al. [20] | RCT | 81 Participants diagnosed with MDD as defined by the Statistical Manual of Mental Disorders (DSM-IV); assessed by a diagnostic interview; patients scoring ≥ 5 on the PHQ-9 were included; recruitment via mass media and newspaper advertising | 8 Weeks behavioral activation (BA) versus mindfulness-based guided self-help treatment administered through a smartphone application | Minimal therapist contact via text messaging and email (max. 20 min per participant per week) | BDI-II, PHQ-9 | Significant improvements of BDI were found in both treatment conditions. BA treatment was more effective among participants with higher initial severity of depression from pretreatment to the 6-month follow-up (PHQ-9: F (1, 362.1) = 5.2, $p < 0.05$). The mindfulness treatment worked better for participants with lower initial severity of depression from pretreatment to the 6-month follow-up (PHQ-9: F (1, 69.3) = 7.7, $p < 0.01$); BDI-II: (F(1, 53.60) = 6.25, $p < 0.05$) |
| Mantani et al. [26] | RCT | 164 Patients with major depression as defined by DSM-V and antidepressant-resistant as indicated by a BDI-II score ≥ 10; PHQ-9 scores were assessed by telephone; recruitment among patients in 20 psychiatric clinics and hospitals | 8 Weeks medication switch alone vs. medication switch plus smartphone CBT app "Kokoro" (inlcuding self-monitoring, behavioral activation, and cognitive restructuring) | Weekly congratulations emails to participants on their progress; telephone interviews to assess PHQ-9 in weeks 0, 1, 5, 9, and 17 | PHQ-9, BDI-II (secondary outcome measure) | Added smartphone CBT was more effective than treatment by medication change alone. Of the total sample, patients allocated to the CBT app scored 2.48 points (95% CI 1.23–3.72, $p < 0.001$, standard mean difference 0.4) lower on PHQ-9 and 4.1 points (95% CI 1.5–6.6, $p = 0.002$) lower on BDI-II than those who were not. Of the per-protocol sample, the intervention group scored 1.72 points (95% CI 0.25–3.18, $p = 0.02$ lower on PHQ-9 and 3.2 points (95% CI −0.01–6.3, $p = 0.05$) on BDI-II |

**Table 1** (continued)

| References | Type of study | Study sample | Design | Clinician support | Relevant primary outcome measure | Main findings |
|---|---|---|---|---|---|---|
| Mohr et al. [6] | Single-arm pilot trial | 99 Participants with elevated symptoms of depression or anxiety (score > 10 on PHQ-9); assessed by a phone interview and web-based questionnaire; recruitment from a variety of sources (internet, print advertisement, clinical research registries) | 8 Weeks of coaching on the use of "IntelliCare" (skills focused app selection to reduce symptoms of depression and anxiety) | Coaching via one initial phone call of 30–45 min and text messaging (1–2 texts per week) | PHQ-9, GAD-7 | Participants showed substantial reductions in the PHQ-9. Significant reductions in symptoms of depression were found in the entire sample (PHQ-9: $d = 1.4$; $p < 0.001$) |
| Schmädeke & Bischoff [22] | Prospective control group study | 92 Inpatient aftercare patients with an ICD-10 unipolar affective disorder; diagnosis administered by a clinician | 3 Months of eATROS smartphone supported cognitive behavioral rehabilitation aftercare vs. ambulant post inpatient aftercare | Support via telecoaching and emergency contacts | BDI | Patients in the intervention group were more capable to maintain the rehabilitation-induced improvement of the depressive symptoms. A medium effect was found (partial $\eta^2 = 0.07$). Patients of the intervention group were significantly less depressed than the control group at post intervention (BDI: $F = 6.76$, $p = < 0.01$) |
| Wahle et al. [21] | Single-arm pilot trial | 126 Clinically depressed participants (PHQ-9 ≥ 11) assessed by an online-screening survey; recruited from the general public through advertising | 4 Weeks of using the CBT-smartphone app "MOSS" (Mobile Sensing and Support) | No clinician support | PHQ-9 | Subjects who used the app for a prolonged timeframe showed significant reduction in self-reported symptom severity. For subjects with PHQ-9 ≥ 11 at baseline and adherence ≥ 8 weeks, the score on PHQ-9 dropped significantly ($p = 0.01$) |

**Table 1** (continued)

| References | Type of study | Study sample | Design | Clinician support | Relevant primary outcome measure | Main findings |
|---|---|---|---|---|---|---|
| Watts et al. [23] | Pilot RCT | 35 Participants diagnosed with MDD as defined by DSM-IV and assessed by the PHQ-9 and Mini International Neuropsychiatric Interview Version 5.0.0 (MINI); the interview was done by phone | 8 Weeks of app-based CBT vs. computer-based CBT ("Get Happy Program") | Clinician support via email or phone calls until lesson two of the intervention | PHQ-9, BDI-II | Significant symptom reduction was found in both groups. PHQ-9 Pre- to follow-up within group measurement for the mobile group: ($F$ [3, 73.6] = 28.4, $p \leq 0.001$); BDI-II ($F$ [2, 47.09] = 60.1, $p \leq 0.001$) |

participants described to have "a little" experience with computer technologies. Daily use of their smartphone apps was reported by 75.4% ($n = 43$) of the respondents. On average, the participants used seven apps on their smartphone on a regular basis (SD = 7.5). Less than half of the respondents (45.6%, $n = 26$) stated that they did not know apps for mental disorders. Knowledge of apps for mental disorders was reported by 42.1%;($n = 24$) of the participants. For applications that are specifically used for depression, 59.6% ($n = 34$) of the respondents stated that they did not know any of these apps and 31.6% ($n = 18$) stated that they knew apps for depression. With regard to their own use of apps in clinical practice, 70.2% ($n = 40$) of the participants replied that they had never used apps in clinical practice before. Only 21.1% ($n = 12$) stated that they had used treatment apps before.

## Attitudes

Of those, who had never used treatment apps before, 40.3% ($n = 23$) would consider their use "a lot" or "quite a lot". Another 33.3% ($n = 19$) of the respondents would use treatment apps "a little" or "very little". Only 3.5% ($n = 2$) stated that they would not use apps at all in their practice. Regarding the helpfulness for different levels of depression, the respondents were asked to rate each level according to their opinion. Most participants considered apps most helpful for individuals with sub-clinical levels of depression (68%, $n = 34$) followed by mild-to-moderate depression (52%, n = 26) and finally for severe depression (10%, $n = 5$). The majority of the respondents (64.9%, $n = 37$) found that apps should be freely available to anyone. Concerning the use of treatment apps with the support of a health care professional, 45.6% ($n = 26$) of the respondents voted against and 42.1% ($n = 24$) voted in favor of app use only with support of a health care professional. Apps were rated more helpful in a combined treatment approach than as a stand-alone intervention. The majority of the respondents (66.0%, $n = 33$) expected treatment outcomes to be "better" or "much better" when apps are added to the treatment of depression. Negative attitudes of therapists towards digital treatment, lack of therapist contact, limited security of personal data and privacy protection and limited suitability for certain patient groups were the most named barriers for therapeutic app use. Easy access to treatment, increased availability of therapy anytime and anywhere, and the reach of certain patient groups received strongest agreement as facilitators of therapeutic app use (Table 3).

Kruskal–Wallis tests showed no significant differences between age groups or the country of residence and the scoring for consideration of app use as well as the concern about app use. Significant differences were found in the levels of computer experience and how much one would

**Table 2** List of included reviews with details on study purpose, sample and relevant findings for the treatment of depression

| References | Type of study | Study purpose | Study sample | Relevant findings |
|---|---|---|---|---|
| Donker et al. [11] | Systematic review | Review on the efficacy of mental health apps for mobile devices | 227 Participants across 8 included studies using apps for depression, stress and substance use | The review found promising results for evidence-based mental health apps in reducing depressive symptoms. Included studies on depression showed a significant reduction of depressive symptoms |
| Firth et al. [27] | Meta-analysis | Review on the efficacy of smartphone-based mental health interventions for depressive symptoms | 18 RCTs included with data from 3414 participants with depression, bipolar disorder, social anxiety, insomnia, PTSD, ADHD, suicidal thoughts | Smartphone apps had a significant effect on reduction of depressive symptoms compared to control conditions ($g = 0.38$, 95% CI: 0.24–0.52, $p < 0.001$). A moderate effect was found in comparison to inactive control conditions ($g = 0.56$, 95% CI: 0.38–0.74). Only a small effect was found in comparison to active controls ($g = 0.22$, 95% CI: 0.10–0.33) |
| Menon et al. [28] | Systematic review | Review on psychotherapeutic applications of mobile phone-based technologies | 24 Articles were included with apps related to anxiety, substance use, depression, bipolar disorder, schizophrenia, psychotic disorders and attempted suicide | In general, apps were found to be feasible and acceptable. Effectiveness trials are scarce. Apps for depression lead to a reduction of depressive symptoms in the included studies |
| Van Ameringen et al. [5] | Review | Review on the current state of mobile applications for DSM-5 obsessive–compulsive disorder, posttraumatic stress disorder and mood disorders | Five studies exploring the efficacy of treatment-based smartphone apps for MDD were included | Studies show some promise in relieving symptoms of depression. MDD treatment apps have suggested efficacy in controlled settings. In naturalistic settings, effects become less pronounced |

**Table 3** Number of respondents (in %) rating facilitators and barriers for therapeutic app use

| | Strongly agree | Agree | Disagree | Strongly disagree |
|---|---|---|---|---|
| Facilitators | | | | |
| Easy access to treatment | 37.2 | 49.2 | 13.6 | 0.0 |
| Availability 24/7 | 37.2 | 49.2 | 13.6 | 0.0 |
| Availability anywhere | 44.1 | 44.1 | 11.8 | 0.0 |
| Reach certain patient groups (e.g., young individuals) | 37.3 | 52.5 | 10.2 | 0.0 |
| Barriers | | | | |
| Negative attitudes of therapists towards digital treatment | 34.0 | 46.0 | 16.0 | 4.0 |
| Lack of therapist contact | 42.0 | 44.0 | 14.0 | 0.0 |
| Limited security of personal data and privacy protection | 54.0 | 24.0 | 20.0 | 2.0 |
| Apps are not suitable for all patient groups (e.g., older individuals) | 34.0 | 42.0 | 24.0 | 0.0 |

Rating on a four-point Likert scale: 1 = "strongly agree" to 4 = "strongly disagree". $N = 59$

**Table 4** Mean values for "consideration of app use" as well as "concern about app use" regarding gender, age, country of residence, and amount of computer experience

| | Consideration of app use | | | Concern about app use | | |
|---|---|---|---|---|---|---|
| | Mean | SD | *p* | Mean | SD | *p* |
| Gender | | | 0.43 | | | 0.76 |
| Male | 3.6 | 1.2 | | 3.1 | 1.0 | |
| Female | 3.3 | 1.0 | | 3.2 | 0.9 | |
| All | 3.4 | 1.0 | | 3.2 | 1.0 | |
| Age group | | | 0.42 | | | 0.44 |
| Age 21–29 | 3.7 | 1.5 | | 3.1 | 0.4 | |
| Age 30–39 | 3.7 | 0.6 | | 3.1 | 0.8 | |
| Age 40–49 | 3.2 | 1.3 | | 3.5 | 1.0 | |
| Age 50–59 | 3.4 | 0.7 | | 2.8 | 1.2 | |
| Age 60–74 | 3.3 | 1.0 | | 2.8 | 1.1 | |
| All age groups | 3.4 | 1.0 | | 3.2 | 0.9 | |
| Country | | | 0.68 | | | 0.38 |
| IE | 3.3 | 1.3 | | 3.2 | 1.2 | |
| DE | 3.6 | 0.9 | | 3.2 | 0.8 | |
| NL/BE/FR | 2.8 | 1.3 | | 2.7 | 0.8 | |
| All countries | 3.4 | 1.0 | | 3.2 | 0.9 | |
| Computer experience | | | **0.03** | | | 0.57 |
| "A little" | 3.3 | 1.0 | | 3.4 | 0.5 | |
| "Quite a lot" | 3.2 | 0.9 | | 3.1 | 1.0 | |
| "A lot" | 4.0 | 1.2 | | 3.1 | 1.0 | |
| All levels | 3.4 | 1.0 | | 3.2 | 0.9 | |

Statistically significant value is in bold ($p < 0.05$)

*P* significance level of Wilcoxon-test (gender) or Kruskal–Wallis-test (age, country, experience)

Consideration of app use rated on a five-point Likert scale: 1 = "not at all" to 5 = "a lot";

Concern about app use rated on a five-point Likert scale: 1 = "no concern" to 5 = "a lot"

*DE* Germany, *IE* Ireland, *NL* The Netherlands, *BE* Belgium, *FR* France

Computer Experience rated on a five-point Likert scale: 1 = "none" to 5 = "a lot"

*SD* standard deviation

consider using apps in clinical practice (Table 4). The Wilcoxon Mann–Whitney test did not show gender differences in how much one would consider the use of apps in clinical practice or how much concern one had about the use of apps in clinical practice. Mean values and standard deviations for age, country of residence, gender, the amount of computer

experience and the consideration of app use as well as concern about app use are shown in Table 4.

## Discussion

App-based interventions lead to a reduction of symptoms of depression in all reviewed studies. These results appear promising and are in line with previous reviews on other e-mental health interventions [4, 5, 11, 27–31]. The adherence and user satisfaction were good in more than half of the included trials which may provide a link to their acceptability, indicated by these two factors [29]. Acceptability of an intervention among patients is an important factor for sustainability and successful implementation in practice [32]. The vast majority of the studies included some sort of clinician support during the intervention periods, which makes it difficult to completely isolate the intervention effects due to the new technologies [5]. Using apps in a combined treatment approach might be the preferred method of their application. Previous research has also shown that clinician support improves adherence and outcomes [6, 33]. Health care professionals play a vital role when it comes to the application of new and effective therapeutic approaches [32]. They are the primary advisors to patients and directly influence their attitude formation towards a treatment method [34]. When acceptability is low, the overall effectiveness of an intervention may be hampered [32].

Despite the promising findings of the reviewed studies, it needs to be pointed out that the evidence base is still limited. In addition, the quality of the evidence in the selected studies differed widely and included a number of small-scale pilot trials and single arm trials with no comparator. Some of the studies that used a control group, compared to an active control condition which was not an established treatment approach in all cases. The effects of the interventions may be smaller compared to active controls than to inactive control groups which has also been shown previously [27]. The interpretation of the results should thus be made carefully.

Overall, survey respondents' attitudes towards app use in the treatment of depression were quite positive. Similar positive attitudes of health care professionals towards technology use have also been reported in other studies [15–19]. The health care professionals in the survey reported a good understanding of technology and regular use of smartphones. But only a few participants had knowledge about app-based interventions or actual experience with them in the treatment of depression or other mental disorders. Awareness of existing therapeutic technologies seems to be quite low. One of many reasons for this might be the fact that validated and reliable apps are often not freely available because they were designed for study purposes [35]. In most countries, apps or other e-health technologies are not yet integrated into standard health care provision.

A considerable number of respondents were open towards app use and would consider using them a lot in clinical practice. Participants regarded apps as most suitable for sub-clinical levels of depression followed by mild levels of depression. That apps were considered to be more suitable for mild-to-moderate symptoms than for severe symptoms was also found in previous studies [5, 13, 27]. Our survey participants expected app use in combination with face-to-face treatment to be more effective than the stand-alone app treatment. A combined treatment approach thus appears to be the preferred treatment option by health care professionals. Guidance and professional support are supposedly key factors in the use of e-health interventions [33, 36]. As indicated above, a combined treatment approach might not only be more effective for patients but also more acceptable for professionals and by this easier to implement in practice.

We found significant differences between the levels of computer experience and how much one would consider app use in clinical practice. Thus, more familiarity with technology positively influences the attitude towards apps and the expectation of their therapeutic benefits. Accordingly, prior experience with (health-) technologies is an important facilitator for acceptance of e-health interventions which has also been reported in other studies [15, 34, 37]. The acceptance and willingness to use these interventions could be improved by education and training in the field. In a study by Perle et al. (2013), the majority of included psychologists stated that they were more willing to use e-health interventions with additional training and education [38]. In another study by Titzler et al. (2018), the necessity of providing educational and training sessions to become familiar with new technologies was pointed out by participating psychotherapists who were asked about their perspectives on blended therapies including internet- and mobile-based interventions [39]. Exposure through demonstration of an intervention and the provision of information material may also positively influence attitudes as has been shown in studies on computerised cognitive behavioral treatment [40]. The distribution of evidence-based information as well as the provision of training sessions, seminars and workshops for e-health could be used to positively influence attitudes and uptake of web- and mobile-based interventions.

Studies have found that male health care professionals show higher acceptance of e-health interventions than female health care professionals [15, 34, 41]. Younger age may also positively influence acceptance of e-health interventions [15, 34, 38, 40]. Our analyses could not confirm these previously reported gender or age differences. Effects in our analyses were small-to-moderate without reaching significance level. However, a post hoc power calculation revealed that age and gender would have reached significance level in a sample of

150–200 participants, whereas the obtained sample size was sufficient to ensure the large effect for "computer experience" and "consideration of app use" as reported.

The participants in our survey considered the lack of therapist contact, negative attitudes of therapists towards digital treatment and limited data and privacy protection as the biggest drawbacks in app use. Especially the concerns about data protection are a frequently cited problem [10, 13, 39, 42, 43]. Given the enormously growing app market, it is difficult to select those apps that are reliable and effective [43]. In fact, there are no regulations or mandatory guidelines for quality or data protection to date. Many apps fail to provide accurate privacy policies [10]. This barrier is increasingly recognized by stakeholders and there are now attempts to develop guidelines and quality criteria including data protection for internet interventions [7, 10, 44].

## Limitations

This study has several limitations. The number of included studies in the review was small and the quality varied widely. The limited amount of available research may lower the generalizability of the presented results. In addition, the intervention periods were relatively short with a maximum of 3 months. The sustainability of effects and long-term adherence needs to be confirmed in studies over a longer period of time. Furthermore, only two studies recruited the sample from a clinical setting with an actual clinician-administered diagnosis. The remaining studies recruited from the general population and partly used self-assessment tools for inclusion. This may limit the meaning of the results in relation to real disease. The apps that were used in the included trials varied and it is not yet clear which components of the interventions are effective and which mode or frequency of use is most beneficial for adherence and outcomes. As the field of research on mobile interventions is relatively new, these aspects need to be addressed in future research. The review focused especially on treatment apps for depression which might have excluded other good internet interventions that have been studied. In addition, the outcomes of our study may not be applicable to other types of mobile interventions or other mental disorders.

Our survey results should be interpreted with caution. Despite all recruitment efforts, the number of responding health care professionals was small. Furthermore, the majority of our respondents were female and German, which may limit the generalizability of the results. Finally, most of the respondents did not have any experience with smartphone applications in clinical practice. Thus, participants replied from a more theoretical point of view, which needs to be taken into account in the interpretation of the results.

## Conclusion

Apps appear to be a promising self-management tool for reducing depressive symptoms and seem to be acceptable for both app users and professionals. Despite some concerns, health care professionals' attitudes towards the use of mobile interventions in clinical practice are rather positive. Therapeutic benefits of apps are seen especially in their application in combination with other treatment methods and for mild-to-moderate levels of depression. Positive attitudes are necessary for future implementation. However, health professionals lack knowledge and experience related to app use in the treatment of mental disorders. The provision of information on the potential benefits of e-health interventions as well as the training of professionals in the application of new technologies may increase health care professionals' awareness and knowledge about mobile apps for the treatment of mental disorders.

**Acknowledgements** We would like to thank the Arq Foundation (Diemen, The Netherlands), Mental Health Reform (Dublin, Ireland), Etablissement Public de Santé Mentale Lille-Métropole (Lille, France) and Aktionsbündnis Psychische Gesundheit (Berlin, Germany) for their support in distributing the survey.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical standards** The survey was approved by the ethics committee of the Medical Faculty of the Heinrich-Heine University Düsseldorf.

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