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App-guided exposure and response prevention for obsessive compulsive disorder: an open pilot trial

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ABSTRACT

Although effective treatments for obsessive–compulsive disorder (OCD) exist, there are significant barriers to receiving evidence-based care. Mobile health applications (Apps) offer a promising way of overcoming these barriers by increasing access to treatment. The current study investigated the feasibility, acceptability, and preliminary efficacy of *LiveOCDFree,* an App designed to help OCD patients conduct exposure and response prevention (ERP). Twenty-one participants with mild to moderate symptoms of OCD were enrolled in a 12-week open trial of App-guided self-help ERP. Self-report assessments of OCD, depression, anxiety, and quality of life were completed at baseline, mid-treatment, and post-treatment. App-guided ERP was a feasible and acceptable self-help intervention for individuals with OCD, with high rates of retention and satisfaction. Participants reported significant improvement in OCD and anxiety symptoms pre- to post-treatment. Findings suggest that *LiveOCDFree* is a feasible and acceptable self-help intervention for OCD. Preliminary efficacy results are encouraging and point to the potential utility of mobile Apps in expanding the reach of existing empirically supported treatments.

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Introduction

Over the past three decades significant advances have been made in the psychosocial treatment of obsessive–compulsive disorder (OCD). Indeed, randomized controlled trials have established exposure and response prevention (ERP) as a first-line treatment for OCD with 65–85% of treatment completers demonstrating clinically significant improvement and 40–70% achieving at least partial remission (Fisher & Wells, 2005; Foa et al., 2005; Simpson, Huppert, Petkova, Foa, & Liebowitz, 2006). However, despite the robust empirical support for ERP (Foa et al., 2005; Koran, Hollander, Nestadt, & Simpson, 2007; Öst, Havnen, Hansen, & Kvale, 2015) many affected individuals never receive this treatment (Fisher & Wells, 2005; Mancebo, Eisen, Sibrava, Dyck, & Rasmussen, 2011). Barriers to receiving evidence-based psychotherapies (EBP) include the inability to access qualified treatment providers, financial

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cost, concerns relating to privacy or stigma, and logistical issues (e.g. conflicts with work or childcare responsibilities, limited time, scheduling difficulties) (Mancebo et al., 2011; Marques et al., 2010). Consequently, a significant gap exists between the need for and access to EBPs for OCD.

Technology-assisted interventions have received increasing attention in the literature as a way to improve access to EBPs (Newman, Szkodny, Llera, & Przeworski, 2011). For OCD, research has mainly focused on the use of technology in the context of self-guided or minimal therapist contact ERP with promising results (see Lind, Boschen, & Morrissey, 2013 for review). Computer-based and telephone-guided interventions for OCD have demonstrated large pre-to post-treatment effects (Andersson et al., 2011, 2012; Diefenbach, Wootton, Bragdon, Moshier, & Tolin, 2015; Greist et al., 2002; Wootton et al., 2011) as well as superiority to treatment as usual (Mahoney, Mackenzie, Williams, Smith, & Andrews, 2014) and waitlist control conditions (Herbst et al., 2014). Although interventions are efficacious, they are not without limitations. These limitations include lack of portability or access to materials across the wide variety of contexts in which OCD symptoms occur (e.g. in the car, at work, while shopping) and inability to provide momentary or spontaneous symptomatic assessment, as well as limited access to the stimulus control techniques that may influence adherence to ERP (e.g. practice reminders).

Mobile health applications (Apps) may provide a method of overcoming these limitations while improving access to EBPs. Smartphone utilization has markedly increased over the last several years, with approximately 200 million users in the United States alone (Pew Research Center, 2015). Capitalizing on this burgeoning smartphone use, researchers have started to examine the use of mobile Apps to disseminate and implement evidence-based treatments such as prolonged exposure (Reger et al., 2013) and dialectical behavior therapy (Rizvi, Dimeff, Skutch, Carroll, & Linehan, 2011). However, research investigating Apps is still in its infancy and to date no research has examined the use of mobile health technology in ERP for OCD. Therefore, the purpose of the current study was to test the feasibility, acceptability, and preliminary efficacy of App-guided ERP program for individuals with mild to moderate OCD symptoms. It was hypothesized App-guided ERP would be a feasible and acceptable intervention for patients with mild to moderate OCD. It was also hypothesized that participants would experience statistically significant improvement in OCD symptoms following the 12-week self-help intervention. Finally, we sought to gather preliminary data investigating the relationship between perceived intervention credibility and expectancy for change and pre- to post-treatment change in OCD severity.

Method

Procedures

Participants were recruited from the community via flyers, the Internet, as well as a hospital-based outpatient specialty clinic in the northeastern United States. Potential participants were initially screened for eligibility over the phone. Eligible participants were then emailed a survey link that included informed consent, the Yale-Brown obsessive compulsive scale symptom checklist (YBOCS-SC; Goodman et al., 1989), and the beck depression inventory (BDI; Beck, Steer, & Brown, 1996). Following completion of the screening survey, a research assistant confirmed eligibility with a telephone assessment. Inclusion criteria

included: (1) Age 18 or greater, (2) United States or Canadian residency, and (3) a DSM-IV diagnosis of mild to moderate OCD established using the Structured Clinical Interview for DSM-IV Disorders (SCID-IV; First et al., 2007) and the YBOCS. Research assistants received intensive assessment training and were required to demonstrate interrater reliability with senior investigators (C.L.B. & M.C.M; intraclass correlation coefficients > .85 for YBOCS total score and SCID-IV diagnoses). Because *LiveOCDFree* is only currently available on iOS platforms, participants were required to have access to an Apple mobile device (e.g. iPhone, iPad, or iPod touch) to participate. Exclusion criteria included: (1) severe OCD symptoms (YBOCS > 23), (2) suicidal ideation, (3) psychotic, bipolar, or substance use disorder, (4) primary compulsive hoarding, and (5) past-month behavioral treatment (CBT or ERP) for anxiety or OCD.

Eligible participants were asked to complete an online baseline survey and were then provided with a code to download the App at no cost. The only instruction given to participants was to use the App for exposure practice 1 hour per day over the course of the 12-week intervention. Participants completed online assessments at mid- (6 weeks), and post-treatment (12 weeks). Those who completed all study assessments were given the option to enter to win a raffle for one of two $50 gift cards. Investigators reviewed all assessments, but only contacted participants if they indicated suicidal ideation on the BDI during the course of the intervention ($n = 1$) to assess safety. The Butler Hospital Institutional Review Board approved all study procedures.

Study app

LiveOCDFree is a mobile App designed to help individuals with OCD engage in ERP. An online user guide downloaded through the App provides the rationale for exposure-based treatment in OCD as well as guidance for how to set up a personalized ERP program, and tips for working with specific OCD symptoms. The App contains a video tutorial that explains the features of the App including how to utilize the exposure practice tool and set up an exposure hierarchy, how to set reminders for ERP practice, and how to rate overall anxiety before and after exposure practice. After creating an exposure hierarchy, users identify specific exposures to practice (e.g. touching doorknobs) without engaging in the compulsive behaviors they have identified (e.g. washing hands). Through the App, participants are also able to create loop tapes and scripts for imaginal exposure. Additionally, users are able to monitor their progress with ERP, including their success with completing ERP exercises (e.g. resistance versus giving into compulsions) and how their anxiety ratings change through the course of their ERP practice.

Participants

Twenty-one participants were enrolled in the study (see Figure 1). Of these, 2 did not start the intervention because of technical difficulties downloading the App (e.g. version of tablet operating system not compatible with App). Of the remaining 19, 4 were lost to follow-up. Therefore, mid treatment and post-treatment data were available for 15 participants (71.4%). Participants were 76.2% female ($n = 16$) and primarily Caucasian ($n = 19$). The mean age was 36.6 (SD = 10.9) and participants ranged from 23 to 59 years old. Participants were highly

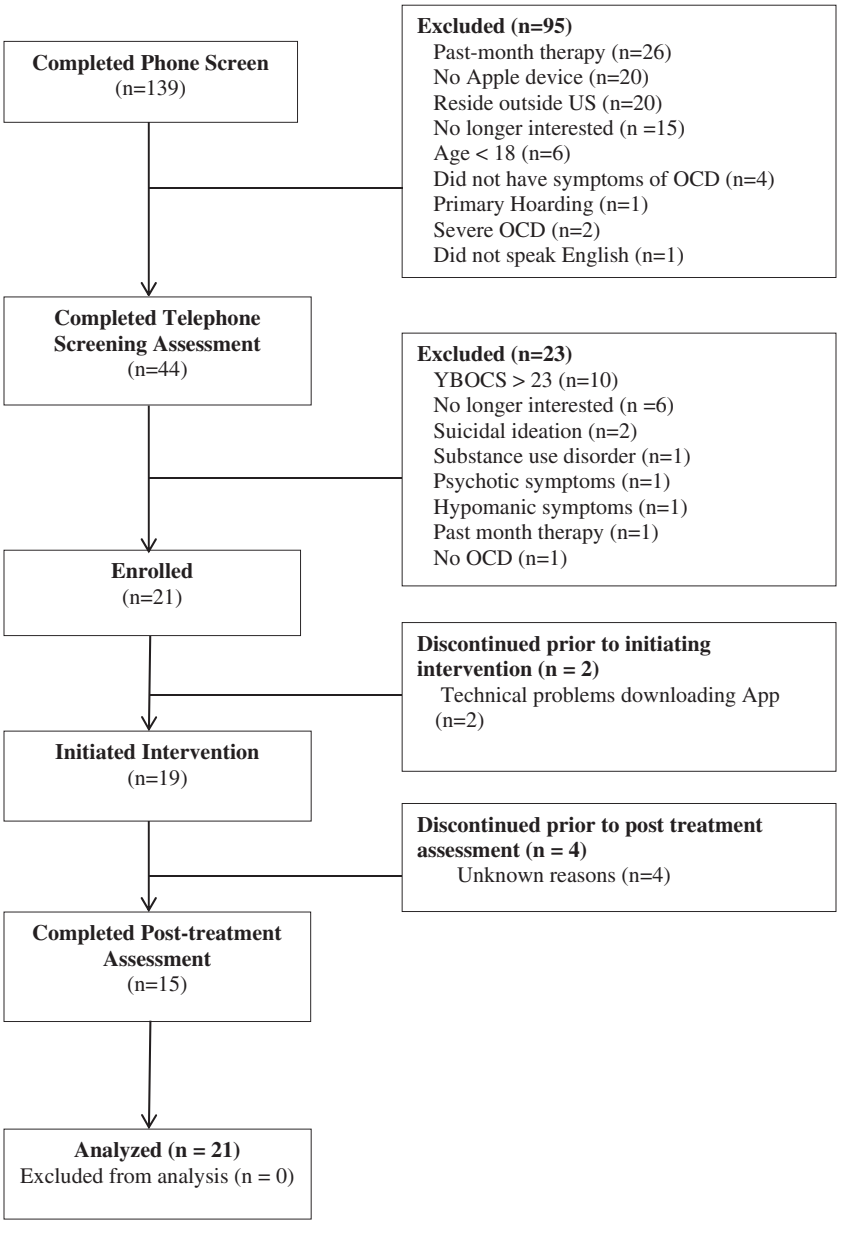

Figure 1. Flow chart of participant enrollment.

educated; 85.7% (n = 18) reported that they had graduated from a four-year college and 52.3% (n = 11) reported at least some graduate study. Eleven individuals reported taking psychotropic medication including antidepressants (n = 8), benzodiazepines (n = 4), and stimulants (n = 3). All participants reported at least 8-week medication stability prior to entering the trial and were asked not to change or initiate new treatment for the duration of the study.

Measures

Symptom severity

Yale-Brown obsessive compulsive scale and symptom checklist (*YBOCS*; Goodman et al., 1989). The Y-BOCS was utilized to assess OCD symptom severity at screening to initially determine study eligibility. Subsequently, (i.e. pre-, mid-, and post-treatment) the self-report version (Y-BOCS-SR) was used and is the primary outcome measure. YBOCS-SR has shown strong convergent validity with the original interview version (Steketee, Frost, & Bogart, 1996). Internal consistency (α) of the Y-BOCS-SR in this sample was .91.

Beck depression inventory-II (*BDI-II*; Beck et al., 1996). The BDI-II is a 21-item widely used measure of depression severity with strong psychometric properties (Beck et al., 1996). Internal consistency in the current sample was good (α = .88).

Beck anxiety inventory (*BAI*; Beck & Steer, 1993). The BAI is a 21-item self-report measure of anxiety-related symptoms with good psychometric properties (Steer, Ranieri, Beck, & Clark, 1993). Internal consistency in this sample was acceptable (α = .69).

Quality of life and functioning

Quality of life enjoyment and satisfaction questionnaire-short form (*QLESQ-SF*; Endicott, Nee, Harrison, & Blumenthal, 1993). The QLESQ-SF is a 16-item self-report measure of quality of life (QoL) enjoyment and satisfaction across multiple domains including physical health, mood, work, social and family relationships, household and leisure activities, daily functioning, sexual life, economic status and living situation, overall well-being and medications. Higher scores indicate better QoL. This widely used measure has been found to be valid, reliable, and sensitive to change (Rapaport, Clary, Fayyad, & Endicott, 2005; Stevanovic, 2011) The QLESQ-SF demonstrated good reliability in the current study (α = .94).

Acceptability and treatment satisfaction

The credibility/expectancy questionnaire (*CEQ*; Devilly & Borkovec, 2000) was administered at mid-treatment to measure the credibility of treatment rationale and expectancy for improvement. Because the CEQ uses two scales during administration, (1–9 and 0–100%), composite credibility and expectancy scores were created by first standardizing the individual items and then summing the items for the respective subscales. The CEQ has shown to be predictive of clinical outcomes in previous treatment trials (Devilly & Borkovec, 2000). Cronbach's alpha was .89 for expectancy and .93 for credibility in this sample.

Acceptability questionnaire. An acceptability questionnaire was created for this study to characterize participants' experience with the App. Participants were asked to rate the overall usability of the app (1 = *very difficult to use* to 7 = *very easy to use*). They were also asked to rate several components of the App including the tutorial, progress tracker, practice reminders, and the practice ERP tool on a seven-point Likert scale (1 = *not very helpful* to 7 = *very helpful*). Participants were also asked to indicate how useful they found the App to be overall in managing their OCD symptoms (1 = *not very useful* to 7 = *very useful*). In addition, participants were asked how likely they would be to recommend the App to a friend and the likelihood of their own continued use following study completion (1 = *very unlikely* to 7 = *very likely*). Finally, participants were asked a series of open-ended questions allowing them to comment on App quality, perceived benefits, and changes they would like to see made to delivery or App content.

Client satisfaction questionnaire (*CSQ*-8; Larsen, Attkisson, Hargreaves, & Nguyen, 1979). The CSQ-8 was administered to access participant satisfaction with the services received including the overall quality of services, their perception of whether the program met their needs, amount of help received, and the extent to which the App helped them deal more effectively with OCD symptoms. The CSQ-8 demonstrates good internal consistency, test-retest reliability, and sensitivity to treatment (Nguyen, Attkisson, & Stegner, 1983).

Data analysis

Intention-to treat analyses (ITT) using the last observation carried forward method (LOCF) and completer analyses were conducted to examine the consistency of results. Treatment outcome data were analyzed using repeated measures analysis of variance (ANOVA). Effect sizes are reported as partial eta-squared (η_p^2) for which values of .01, .06, and .14 are considered to reflect small, medium, and large effects, respectively (Cohen, 1988). Greenhouse-Geisser correction procedures were employed in cases where assumption of sphericity was violated. In addition, participants were categorized as responders, using the reliable change index (RCI; Jacobson & Truax, 1991). Thus, participants were considered responders if the their post-treatment YBOCS-SR (a) was within the non-clinical normal range defined as a score ≤14 (Farris, McLean, Van Meter, Simpson, & Foa, 2013; Lewin et al., 2011), and (b) had decreased by a reliable level (at least 1.96 times the standard deviation of the measure, taking into account the reliability of the measure itself). Consistent with prior OCD research (Mataix-Cols et al., 2016), participants were considered to have a clinically meaningful reduction in symptoms if their percent change in YBOCS score was ≥35%. Pearson's correlations were conducted using residualized pre- to post-treatment change scores to examine the associations between treatment credibility and expectancy ratings and OCD symptom change. Residualized change scores were used to control for error related to repeated measurement and individual differences between patients. Finally, descriptive statistics were conducted to report on acceptability of the App.

Results

Treatment outcome

As shown in Table 1, ITT analyses ($n = 21$) revealed a significant effect of time for YBOCS-SR, $F(2, 40) = 4.25$, $p = .020$, $\eta_p^2 = .17$, with Bonferroni corrected pairwise comparisons indicating that symptom improvement occurred from baseline to mid-treatment ($p = .04$). For secondary outcome measures, a significant main effect of time was found on the BAI [$F(1.31, 26.13) = 3.96$, $p = .047$, $\eta_p^2 = .17$], but not on the BDI [$F(1.32, 26.33) = 3.57$, $p = .059$,

Table 1. Descriptive statistics and effect size estimates for primary study variables ($n = 21$).

Measure	Pre-treatment mean (SD)	Mid-treatment mean (SD)	Post-treatment mean (SD)	p	η_p^2
YBOCS-SR	21.33 (5.19)	17.95 (5.76)	17.86 (6.17)	.020	.17
BDI	13.13 (10.33)	9.76 (8.84)	8.67 (7.62)	.059	.15
BAI	13.86 (9.14)	11.19 (8.76)	10.52 (8.94)	.047	.17
QLESQ-SF	48.81 (9.87)	50.67 (8.80)	52.62 (9.43)	.104	.11

Note: YBOCS-SR = Yale-Brown obsessive compulsive scale- self report; BDI = Beck depression inventory; BAI = Beck anxiety inventory; QLESQ-SF = Quality of life enjoyment and satisfaction questionnaire-short form.

Table 2. Descriptive statistics and effect size estimates for primary study variables in treatment completers ($n = 15$).

Measure	Pre-treatment mean (SD)	Mid-treatment mean (SD)	Post-treatment mean (SD)	p	η_p^2
YBOCS-SR	21.33 (5.56)	16.93 (6.03)	16.80 (6.55)	.019	.25
BDI	14.87 (10.58)	10.13 (9.05)	8.60 (7.32)	.058	.21
BAI	12.07 (7.01)	8.33 (4.56)	7.40 (4.41)	.044	.23
QLESQ-SF	48.13 (10.66)	50.73 (9.32)	53.47 (10.02)	.103	.19

Note: YBOCS-SR = Yale-Brown obsessive compulsive scale- self report; BDI = Beck depression inventory; BAI = Beck anxiety inventory; QLESQ-SF = Quality of life enjoyment and satisfaction questionnaire-short form.

$\eta_p^2 = .15$], or the QLESQ [$F(1.37, 27.72) = 2.65$, $p = .10$, $\eta_p^2 = .12$]. Table 2 presents the results for treatment completers ($n = 15$). These analyses revealed a significant effect of time for YBOCS-SR, $F(2, 28) = 4.60$, $p = .019$, $\eta_p^2 = .25$, with Bonferroni-corrected pairwise comparisons indicating that symptom improvement occurred from baseline to mid-treatment ($p = .03$). Consistent with the ITT analyses, a significant main effect of time was found on the BAI [$F(1.33, 18.66) = 4.22$, $p = .044$, $\eta_p^2 = .23$], but not on the BDI [$F(1.32, 18.46) = 3.77$, $p = .058$, $\eta_p^2 = .21$], or the QLESQ [$F(1.41, 19.74) = 2.75$, $p = .10$, $\eta_p^2 = .16$]. Twenty percent of treatment completers were classified as responders using the RCI pre- to post-treatment. Six participants (40%) reported a clinically significant reduction in OCD severity (decrease of YBOCS score ≥35%) pre- to post-treatment.

Credibility and expectancy

At mid-treatment, participants rated the App as moderately credible with mean ratings for the logic behind treatment ($M = 6.14$, SD = 2.03), usefulness of the program ($M = 5.71$, SD = 2.67), and confidence in recommending the program ($M = 6.21$, SD = 2.39). Participants reported a modest expectancy for symptom improvement; participants reported that they *thought* symptoms would improve on average by 60% (SD = 25.4%) by the end of the program and *felt* as though symptoms would improve on average by 52.1% (SD = 26.9%). Treatment credibility was significantly associated with pre- to post-treatment change on the YBOCS ($r = -.56$, $p = .03$), however expectancy was not ($r = -.43$, $p = .11$).

Acceptability and satisfaction

App utilization varied with 6.7% of participants reporting using the App on average several times per day, 33.3% reporting using the App several times per week, 26.7% reporting once per week utilization, 26.7% reporting using the App less than once per week, and 6.7% reporting no utilization. Participants reported that the App was easy to use ($M = 5.40$, SD = 1.88) and taught them new information about OCD ($M = 4.21$, SD = 2.23). Specific features of the App were also rated positively with participants reporting that the tutorial ($M = 5.00$, SD = 1.73), progress tracker ($M = 4.36$, SD = 2.24), and reminders ($M = 4.67$, SD = 1.87) were helpful, and that the App was a helpful tool for practicing ERP ($M = 5.00$, SD = 1.73). On average, participants reported that they were likely to continue to use the App following study completion ($M = 5.07$, SD = 2.12). In terms of client satisfaction, 100% of participants rated the quality of services as good (54%) or excellent (46%). Eighty percent ($n = 12$) of participants reported that they received the services they wanted, 73%

(n = 11) would recommend the program to a friend, and 66% (n = 10) reported that most or almost all of their needs had been met. The majority of participants reported that the App helped them deal more effectively with OCD symptoms, with 53.3% (n = 8) reporting the services helped somewhat and 26.7% (n = 4) reporting that the services help a great deal. Most participants reported satisfaction with the program overall and 46.7% reported being satisfied with the amount of help they received.

Discussion

To our knowledge, this is the first study to evaluate the preliminary efficacy and acceptability of a mobile App in the treatment of OCD. Participants reported statistically significant improvement in OCD symptoms over the 12-week self-help ERP intervention with 40% of treatment completers reporting clinically significant improvement on the YBOCS (decrease ≥ 35%) and 20% meeting criteria for reliable change. Participants also reported significant improvement in overall anxiety, and modest, though not statistically significant, improvements in depression and QoL. These results are generally consistent with other low-intensity interventions such as Internet-guided self-help for OCD (Diefenbach et al., 2015), though less robust than gold-standard therapist-guided ERP (see Lind et al., 2013 for review). Interestingly, improvement in OCD symptoms occurred early with significant change from pre- to mid-treatment that was maintained throughout the rest of the intervention period. These results, if confirmed, could suggest that a plateau in OCD symptom improvement follows initial, early response to treatment. Future research should examine if this pattern reflects the attenuation of treatment effects seen in self-help treatments more generally, level of patient engagement with the App over time, or potentially modifiable limitations of major App components. Regardless, these findings point to the possible utility of a stepped-care approach (Tolin, Diefenbach, & Gilliam, 2011) whereby individuals without early response to App-guided ERP are referred for treatment with greater level of therapist involvement.

Importantly, our findings also suggest that App-guided ERP is an acceptable intervention for individuals with OCD in the community. Participants reported that the major intervention components including the practice ERP tool, progress tracker, practice reminders, and tutorial were moderately to very helpful. Open ended-responses supported these findings, with participants citing that the App helped keep them accountable for their own ERP practice and helped them to prevent or delay compulsive behavior. Seventy-one percent of participants completed the program and all participants rated the quality of services received as *good* or *excellent*. Over 70% of participants reported that they would recommend the App to a friend and 80% reported that the App helped them deal more effectively with OCD symptoms. Nevertheless, a minority of participants reported that they did not find the App useful and preferred "paper and pencil," "more interaction," or help with creating the hierarchy. Other themes surrounding participant responses included wanting a more detailed tutorial and improved functionality (e.g. ability to use App features simultaneously, navigation between tools, and ability to save information during practice ERP trials). Overall, these results indicate that *LiveOCDFree* holds promise for helping individuals with OCD conduct exposures without direct therapist involvement. However, some individuals may still prefer or need therapist assistance in developing the hierarchy and initiating exposures.

Despite the positive ratings about the App's features and overall ratings of satisfaction with the services received, more than half of participants were dissatisfied with the amount of help they received. In this context, it is also noteworthy that most participants used the App less frequently than the hour per day guideline provided. Thus, it appears that participants were looking for a different kind of help than provided by the basic features of the App. As this study included no formal contact with providers or study personnel outside of the initial screening assessment, it would be worthwhile to examine if minimal contact throughout the course of treatment would result in increased satisfaction and more App utilization. Research on computer-guided self-help interventions supports this notion. Brief clinician support via pro-actively scheduled phone calls has been shown to enhance treatment compliance and outcome in computer-guided self-help (Greist et al., 2002). More research is needed to establish the optimal amount of human support needed for users of App-guided self-help balancing effectiveness and accessibility.

Limitations of this study also warrant consideration. First, as with all open trials, findings must be interpreted with caution due to the pilot nature of the investigation. More specifically, findings may be due to more general effects of participating in a research study or regression to the mean. As such, the conclusions drawn are preliminary and await replication in a randomized controlled trial. Moreover, the sample was small and the generalizability to individuals with less education, those with severe OCD symptoms, and those from ethnic/racial minority groups is unknown. Relatedly, we were unable to test the impact of different symptom subtypes. In addition, *LiveOCDFree* is currently only available on Apple operating systems, limiting the potential reach of the intervention. Finally, we relied on self-report assessments of severity or improvement and did not follow participants after the intervention period. Thus, the long-term impact of this technology-based intervention is unclear. Future studies should include more comprehensive assessment including measures of App utilization via passively collected clickstream data, interviewer-rated measures of symptom change, and follow-up assessments to determine the durability of treatment effects.

Conclusions

The current findings contribute to the small but emerging literature investigating the utility of mobile Apps in the treatment of psychiatric disorders. Although further efficacy evaluation is necessary, results are promising particularly from a public health perspective. Given that nearly two-thirds of adults in the United States use smartphones (Pew Research Center, 2015), the App provides an easily accessible, informative tool for conducting ERP with potential reach to a large number of individuals with OCD who may not be able to access EBPs. Thus, although the effect of *LiveOCDFree* on OCD symptoms appears to be modest when used as a self-help tool, this study highlights the potential of mobile Apps for cost-effective dissemination of evidence-based interventions. The current study investigated *LiveOCDFree* as stand-alone intervention; however, it also would be worthwhile to study its utility with varying levels of therapist involvement and across different health care settings (e.g. primary care). Future investigations should determine the optimal balance between therapist contact, efficacy, and cost-effectiveness in technology-assisted exposure-based treatment of OCD.

Disclosure statement

Pocket Therapist, LLC provided the *LiveOCDFree* App at no cost to participants in this study. Pocket Therapist, LLC had no role in the study design, analysis or interpretation of results from this study. The authors report no conflicts of interest. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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