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Cognitive Training via a Mobile Application to Reduce Obsessive-Compulsive-Related Distress and Cognitions During the COVID-19 Outbreaks: A Randomized Controlled Trial Using a Subclinical Cohort

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Obsessive-compulsive disorder (OCD) is a persistent psychiatric disorder causing significant impairment in functioning. The COVID-19 pandemic has exacerbated OCD-related symptoms and interrupted access to treatment. Recent research suggests mHealth apps are promising tools for coping with OCD symptoms. This randomized controlled trial evaluated the effects of a CBT-based mobile application designed to reduce OCD symptoms and cognitions in community participants considered at high risk of developing OCD symptoms. Following initial screening ($n = 924$), fifty-five community participants scoring 2 standard deviations above the OCI-R mean were randomized into two groups. In the immediate-app use group (iApp; $n = 25$), participants started using the application at base-

line (T0), 4 min a day, for 12 days (T0–T1). Participants in the delayed-app group (dApp; $n = 20$) started using the mobile application at T1 (crossover) and used the app for the following 12 consecutive days (T1–T2). Intention to treat analyses indicated that using the app for 12 consecutive days was associated with large effect-size reductions (Cohen's d ranging from .87 to 2.73) in OCD symptoms and maladaptive cognitions in the iApp group (from T0 to T1) and dApp group (from T1 to T2). These reductions were maintained at follow-up. Our findings underscore the usefulness of brief, low-intensity, portable interventions in reducing OCD symptoms and cognitions during the pandemic.

Keywords: OCD; pandemic; COVID-19; mHealth; GG OCD

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THE SPREAD OF THE NEW coronavirus (COVID-19) was declared a pandemic in December 2019. The pandemic is associated with increased economic, social, and political uncertainty across the world (e.g., [Godinic et al., 2020](#); [Jaspal et al., 2020](#)). In addition, governments worldwide have launched

public campaigns emphasizing COVID-19-related risk of infection, the need for strict personal hygiene and social distancing (Derksen et al., 2020). For individuals with preexisting fear of infection and difficulty tolerating uncertainty, the COVID-19 pandemic may, therefore, be particularly challenging (Jassi et al., 2020).

Obsessive-compulsive disorder (OCD) is a heterogeneous disorder with diverse symptom presentations (e.g., harm obsession, scrupulosity, and relationship obsessions; e.g., Clark, 2019; Doron et al., 2014). Fear of infection, germs, contamination, and cleaning compulsions are some of the most frequently reported OCD symptoms (Abramowitz et al., 2010; Cordeiro et al., 2015). Recent empirical evidence suggests that the onset of the COVID-19 pandemic has been a significant stressor for individuals with OCD and has been associated with increased severity of obsessions and compulsions, particularly for those with preexisting contamination symptoms (Alonso et al., 2021; Benatti et al., 2020; Guzick et al., 2021; Jelinek et al., 2021; Tanir et al., 2020). For instance, several studies have shown increased frequency of obsessions, time spent on compulsive behaviors, higher reported distress and lower perceived controllability over OCD symptoms in OCD patients during the pandemic (Alonso et al., 2021; Jelinek et al., 2021).

CBT models are considered the gold-standard treatment for OCD symptoms (McKay et al., 2015). One of the main foci of CBT interventions for OCD is to decrease symptoms by challenging maladaptive beliefs and associated behaviors (Abramowitz, 2006; Doron & Derby, 2017). These models suggest that commonly occurring intrusive thoughts (e.g., “this is infected or dirty”) are triggered by external (e.g., seeing a door handle, seeing people with masks) or internal stimuli (a sudden cough, thoughts about becoming sick). Such intrusive thoughts are then catastrophically appraised (e.g., “I’ll be infected”) based on preexisting maladaptive beliefs (e.g., overestimation of threat and personal responsibility or intolerance for uncertainty) resulting in significant distress. Counterproductive strategies (i.e., compulsive behaviors) such as repeated handwashing are then used to mitigate this distress.

CBT interventions for OCD use diverse strategies for reducing OCD-related beliefs, including psychoeducation regarding their role in the persistence of OCD symptoms, cognitive reconstructing, behavioral experiments and Cognitive Bias Modification (CBM). For instance, exposure and response prevention (ERP) exercises (Abramowitz & Jacoby, 2014a, 2014b) are often used to discon-

firm individual’s expected catastrophic outcomes, thereby helping reduce adherence to maladaptive beliefs. Such strategies assist in generating alternative interpretations of events, thoughts, and emotions, allowing clients to reassess their unhelpful views and to decrease their compulsive behaviors (e.g., Abramowitz, 2006; Teachman et al., 2014).

Nevertheless, and despite its shown efficacy, many individuals with OCD are unable or unwilling to pursue CBT treatment. Prepandemic barriers to treatment include high treatment costs, fear of stigma, and difficulty accessing trained therapists (Marques et al., 2010; O’Neill & Feusner, 2015), as well as difficulty tolerating ERP and perceiving CBT treatments as demanding (Kozak, 1999). Indeed, findings indicate relatively high dropout and refusal rates for CBT treatment of OCD (Ong et al., 2016).

The onset of the pandemic brought about additional difficulties accessing mental healthcare services (Boldrini et al., 2020). For instance, lockdowns and quarantines often included restrictions on traveling to mental healthcare institutions and face-to-face treatment. Fear of infection and economic difficulties have also reduced treatment seeking during the pandemic (Wind et al., 2020). In addition, applying exposure therapies has become increasingly difficult due to various health and hygiene restrictions imposed during the pandemic. Online and mobile self-help interventions may help relieve excessive contamination fears by offering alternative, more tolerable interventions than traditional ERP (Jalal et al., 2020; Wind et al., 2020).

A large body of evidence, including randomized controlled trials (RCTs), supports the efficacy of computerized CBT and internet-based CBT in the treatment of OCD (Andersson et al., 2012; Wootton, 2016). Studies conducted before the pandemic indicated that online CBT interventions for OCD were as effective as face-to-face CBT treatments (Wootton, 2016). Following the onset of the pandemic, many authors stressed the urgency to develop novel, effective, and easy-to-use technological interventions for the treatment of OCD (Jalal et al., 2020).

Few mobile apps have been developed for OCD, most of which have limited empirical support (Van Ameringen et al., 2017). More recent studies, however, suggest CBT-based mHealth apps may provide feasible and effective tools for OCD and related disorders and symptoms (e.g., Cerea et al., 2020; Hwang et al., 2021; Roncero et al., 2018). For instance, a recent study indicated that an app-based digital CBT treatment program was as effective as a traditional face-to-face CBT in

the treatment of OCD symptoms during the pandemic (Hwang et al., 2021).

GGtude is a CBT-based mobile application platform that provides various modules to cope with maladaptive beliefs that are associated with different psychological difficulties (e.g., OCD, depression, low self-esteem, body image distress). A growing body of evidence including five RCTs has indicated that using the GGtude platform is associated with significant reductions in maladaptive beliefs and psychopathological symptoms (Aboody et al., 2020; Ben-Zeev et al., 2021; Cerea et al., 2020; Cerea et al., 2021; Giraldo-O'Meara & Doron, 2020; Roncero et al., 2018, 2019).

"GG OCD, anxiety and depression" is a mobile app developed by GGtude to challenge maladaptive OCD-related beliefs/assumptions and to alleviate the distress associated with obsessive thoughts. Several elements of the GGtude platform have been theorized to bolster changes in users' maladaptive cognitions and associated symptoms (Aboody et al., 2020; Roncero et al., 2018, 2019). These include (1) psychoeducation to motivate users and consolidate their understanding of basic CBT principles, (2) daily categorization exercises to increase users' awareness of their inner monologue, (3) repeated exposure to self-statements challenging users' maladaptive beliefs to enhance users' accessibility and capacity to generate adaptive self-statements, and (4) concurrent priming of maladaptive beliefs and exposure to unanticipated competing appraisals to accelerate adjustive reflective processing. Based on the basic principles of CBT, the app aims to make users' adaptive cognitions about themselves, others, and the world more cognitively accessible and available than dysfunctional negative cognitions.

GG OCD targets various OCD-related beliefs including intolerance of uncertainty, fear of harm to self or others, fear of self and "not just right" feelings. Users complete a total of 35 levels, including short and daily exercises (3 min a day), and they learn to challenge maladaptive beliefs by rejecting OCD-related statements (swiping them up) and to embrace the alternative and positive statements by swiping them down (pulling them toward themselves). In each module users learn to discard the maladaptive beliefs (e.g., I need absolute certainty) that appear on the screen and to embrace the functional ones (I can withstand uncertainty). It is expected that modules targeting different OCD-related cognitions would reduce users' levels of maladaptive beliefs, leading to a decrease in various OCD symptoms such as checking, cleaning, and avoidance behaviors.

Several studies, including two RCTs (Cerea et al., 2020; Roncero et al., 2019), have shown that using the GGtude platform is associated with significant decline in OCD-related beliefs and symptoms (Cerea et al., 2020; Roncero et al., 2018, 2019). Two additional RCTs have shown that use of the GGtude platform is associated with symptom reductions in OCD-related disorders such as BDD symptoms (Aboody et al., 2020; Cerea et al., 2020). Moreover, a single case study revealed that GG OCD may also be an effective relapse prevention tool and contribute to maintaining therapeutic gains following CBT treatment for OCD (Pascual-Vera et al., 2018). Although other mobile apps for OCD exist, most include tracking or psychoeducation guides for ERP and are used in conjunction with a therapist (Boisseau et al., 2017; Hong et al., 2020). GG OCD is a user-friendly app that offers an easy, cost-effective, and accessible solution for a diverse range of people with OCD symptoms. It can be used without the therapist's direction or intervention and 3-min-a-day trainings offer a sustainable and applicable intervention.

The main goal of the current study was to evaluate the effectiveness of mobile-delivered cognitive exercises on OCD symptoms and cognitions during the COVID-19 pandemic. Although previous findings assessed the effectiveness of cognitive training exercises on OCD symptoms (e.g., Roncero et al., 2019), the effectiveness of such exercises during the pandemic has yet to be assessed. Importantly, GG OCD was developed before the pandemic and does not include content specifically developed for OCD symptoms during the COVID-19 crisis.

An additional aim of the study was to replicate previous findings supporting the effectiveness of GG OCD in a Turkish subclinical OCD sample. Although the OCD module of the GGtude platform is available in English, Spanish, Italian, and Hebrew, it was not available in Turkish nor was the effectiveness of the application assessed in a Turkish sample.

The sample used in the present study consisted of participants showing subclinical levels of OCD symptoms. A subclinical OCD sample was chosen for several reasons. Subclinical levels of OCD symptoms are more common than full OCD diagnosis, with estimates ranging from 2 to 25% (Mataix-Cols et al., 2000). The findings of this study would therefore be potentially applicable to a wider population. Subclinical levels of OCD have also been associated with significant distress and disability, including lower mood, higher rates of psychopathology, greater mental healthcare uti-

lization, more work impairment, decreased quality of life, and increased interference in functioning compared with the general population (e.g., Berg et al., 1989; Frost et al., 1988; Fullana et al., 2009; Grabe et al., 2001; Welkowitz et al., 2000). Last, subclinical OCD symptoms have been suggested to increase risk for later development of OCD (Fullana et al., 2009), making this population particularly relevant for an investigation during the current pandemic.

Since previous studies have associated intolerance of uncertainty and depression, anxiety, and stress with OCD symptoms (Kracker Imthorn et al., 2020; Rickelt et al., 2016), we also examined the association between GG OCD use and changes in these variables.

We hypothesized that compared to the delayed-use App group (dApp) at T1 the immediate-use App group (iApp; who used GG OCD immediately after the baseline measurement) would show a statistically significant decrease in OCD symptoms, obsessive beliefs, contamination-related cognitions, intolerance of uncertainty beliefs, depression, anxiety, and stress symptoms. We also expected that the dApp group would exhibit a significant decline in all measurements following crossover (between T1 and T2). All reductions in symptoms and maladaptive cognitions found in the iApp group were expected to be maintained at follow-up.

Material and Methods

PARTICIPANTS

An initial screening study was conducted to reach the participants with high levels of OCD symptoms (see Figure 1). Participants were recruited through university mailing lists and social media. The screening sample ($n = 924$) with a mean age of 25.27 ($SD = 9.67$) completed a demographic information sheet and the Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002). Inclusion criteria included speaking Turkish as a first language, being literate, being between the ages of 18–65, having an OCI-R score above 2 standard deviations from the mean, having a smartphone, and reporting of no psychiatric diagnosis. Participants who reported having been diagnosed with a mental disorder and continued to receive treatment were excluded from the sample. The inclusion criteria ensured that the participants had smart mobile devices with IOS or Android systems; they used these devices effectively and had internet access at the time of application. The mean OCI-R score of 924 participants was 23.76 ($SD = 11.77$). People who scored 2 standard devi-

ations above the mean of OCI-R ($n = 88$) were contacted by phone or e-mail. Fifty-five participants who volunteered to participate in the study were randomly assigned to the iApp ($n = 28$) and dApp ($n = 27$) groups. When OCI-R dimensions were examined, OCD symptoms in the final sample from the most common to the least common were as follows: ordering, obsessing, checking, washing, hoarding, and neutralizing. The mean OCI-R score of 55 participants was 43.65 ($SD = 7.36$). The final iApp group sample consisted of 25 participants (19 females, M age = 26.36, SD age = 11.18, range between 18–59 years old). The final dApp group sample consisted of 20 participants (12 females, M age = 22.63, SD age = 6.62, range between 18–46 years old). Table 1 shows that the groups did not differ in terms of socio-demographic variables and related measures except for age at baseline (T0).

DESIGN

The study was an RCT with a crossover design (see Figure 2). The iApp group started using GG OCD at T0 and used the app for 12 consecutive days (until T1). The participants in the dApp group were asked to start using GG OCD at T1 (after the iApp group completed using GG OCD) and use it for 12 consecutive days (until T2). Both groups completed self-report questionnaires at T0, T1, and T2.

PROCEDURE

Content translation of GG OCD from English to Turkish was evaluated in a pilot study. The sample of the pilot study consisted of 20 participants between the ages of 18–35 years. All expressions in the application were translated into Turkish by two clinical psychologists fluent in English. The translations were then evaluated by the research team and the developer of GG OCD. Following the feedback received, the final translation of the app was agreed upon and the app was translated. All participants were informed by the researcher about dysfunctional beliefs, self-talk, and mood via online meetings. GG OCD was then downloaded by participants and detailed information about its usage was shared. Participants were asked to report any incomprehensible sentences and of any translation errors they noticed during the 12-day use period for the application. At the end of use, participants were asked to complete a form consisting of questions regarding the app's usefulness and suitability to Turkish users and about any technical problems. As a result of the answers, possible deficiencies in the translation

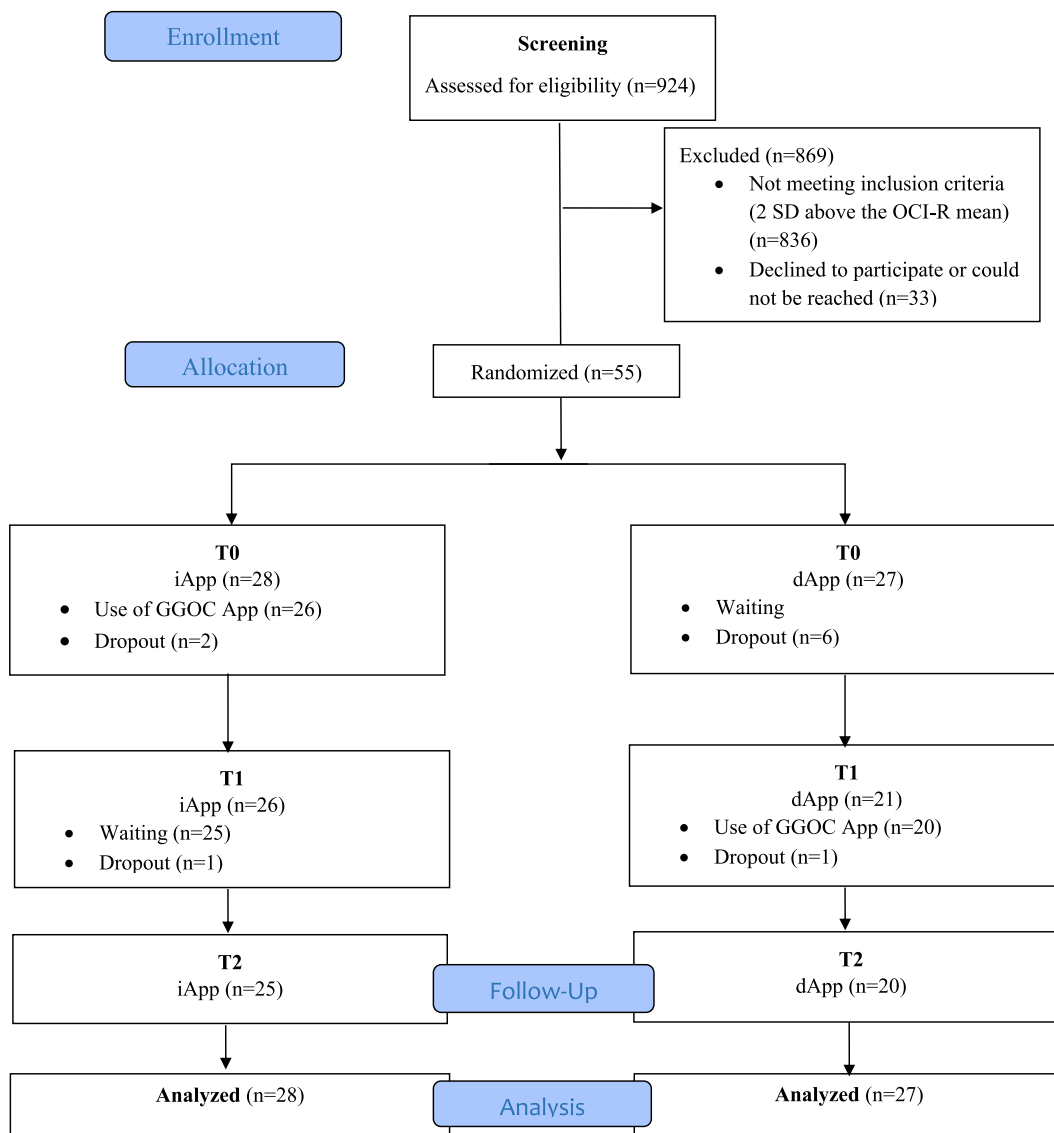


FIGURE 1 CONSORT flow diagram of participants.

process and potential technical problems were corrected before the app was used for the trial. When the pilot study was over, a small compensation fee (50 Turkish Liras) was given to the participants.

Following the screening procedure, participants were randomly assigned to the iApp ($n = 25$) and dApp ($n = 20$) groups. The simple randomization procedure was used to allocate participants to either the iApp or dApp groups. Then, participants gave their informed consent for participation and completed online self-report questionnaires including OCI-R, OBQ-44, DASS-21, IUS-12, and CCS at the baseline (T0). The study received the approval of Hacettepe University ethic's committee. The iApp group was informed about the app and asked to complete three levels per day (approximately 3 min a day) for 12 days. With the help of researchers, participants downloaded

“GG OCD, Anxiety and Depression” from the App Store or Google Play.

First-time users of the app undergo an automatic psychoeducation tutorial session explaining the effects of self-talk on mood. Users are then taught to discard maladaptive statements by dragging them upwards, out of the screen (up). Users are asked to pull functional statements towards themselves (downwards). A short training session is then undertaken.

GG OCD includes 35 levels with 3 levels targeting each particular maladaptive belief. Each level comprises several statements that are either consistent with their maladaptive belief (dysfunctional) or inconsistent with this belief (adaptive). For example, statements inconsistent with perfectionism include “Mistakes teach me how to overcome my fears” and “Imperfect is human” (see Figure 3).

Table 1
Comparisons Between the iApp and dApp Group in Sociodemographic Variables and Outcome Measures at Baseline

	iApp group M (SD)	dApp group M (SD)	$t(53)/\chi^2$	p
Gender (Female/Male)	71% F, 29% M	63% F, 37% M		
Marital Status (Married/Single)	18% M, 82% S	11% M, 89% S		
Age	26.36 (11.18)	22.63 (6.62)	-1.50	<.05
Education (years)	11.54 (1.90)	11.78 (1.85)	.47	.77
OCI-R	2.41 (.40)	2.44 (.42)	.30	.87
OBQ-44	4.32 (.54)	4.43 (.68)	.65	.46
DASS-D	1.73 (.77)	1.53 (.75)	-.98	.83
DASS-A	1.37 (.68)	1.62 (.75)	1.31	.44
DASS-S	1.76 (.57)	1.70 (.69)	-.33	.34
IUS-12	3.72 (.53)	3.91 (.59)	1.24	.55
CCS	66.65 (17.08)	69.37 (15.49)	.62	.27

Note. OCI-R: Obsessive Compulsive Inventory-Revised; OBQ-44: The Obsessive Beliefs Questionnaire-44; IUS-12: Intolerance of Uncertainty Scale Short Form; DASS-D: The Depression, Anxiety, Stress Scale-21, Depression Subscale; DASS-A: The Depression, Anxiety, Stress Scale-21, Anxiety Subscale; DASS-S: The Depression, Anxiety, Stress Scale-21, Stress Subscale; CCS: Contamination Cognitions Scale. M: mean, SD= standard deviation.

The push notifications are used to remind users to use the app each day. Users are expected to complete all levels of the app in 12 days (3 levels per day). After completing three levels a day, a screen instructing the user to stop using the app for the day is presented.

In the current study, users were asked to share a screenshot of their current level every day in order to ascertain consistent use of the app. Participants were compensated for their time. The overall dropout rate in both iApp and dApp groups was 18% during GG OCD use.

MEASURES

All measures besides the demographic information form were completed at three time points: baseline (T0), at the end of 12 days (T1), and again after 12 days (T2).

Demographic Information Form

The demographic information form consists of items related to gender, age, educational and marital status, physical and mental health condition, quarantine period, and time spent on mobile devices daily.

The Obsessive-Compulsive Inventory (OCI-R; Foa et al., 2002)

OCI-R is a self-report questionnaire measuring OCD symptoms. The OCI-R involves 18 items with a 5-point Likert scale from 0 (not at all) to 4 (extremely). The scale was translated and adapted into Turkish (Yorulmaz et al., 2015). Studies have shown that the original form of the scale and its Turkish adaptation have satisfactory validity and reliability levels (Foa et al., 2002; Yorulmaz et al., 2015). In this study, the internal consistency coefficient was adequate ($\alpha = .89$).

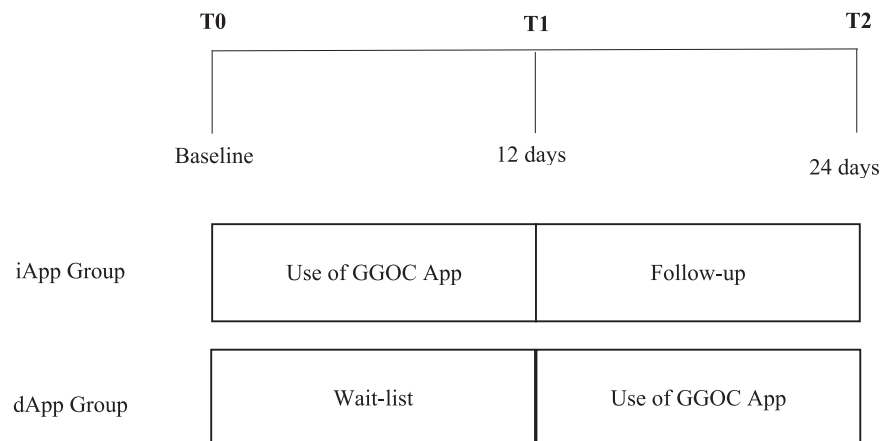


FIGURE 2 Study design.

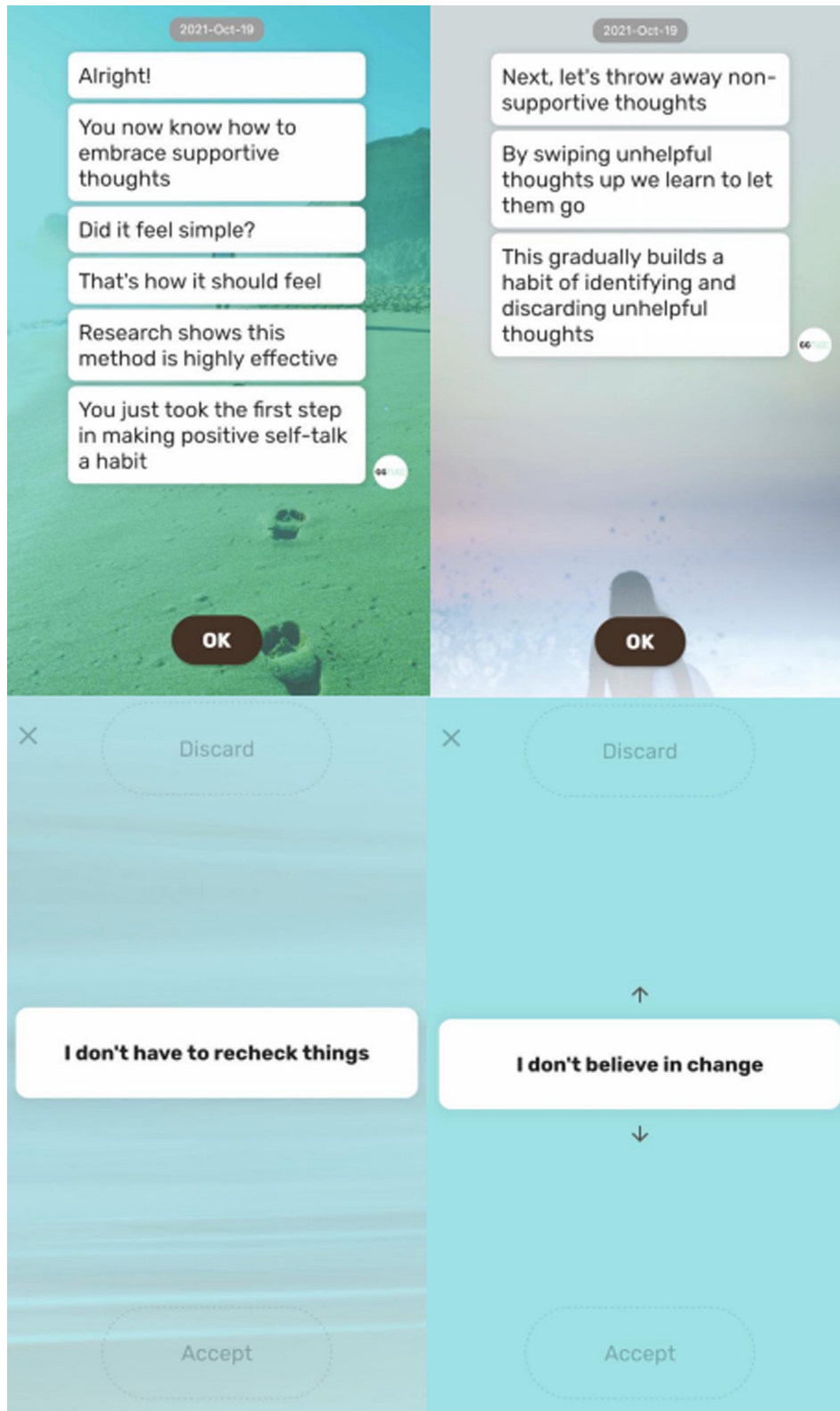


FIGURE 3 GGOC Screenshots.

The Obsessive Beliefs Questionnaire-44 (OBQ-44; Obsessive Compulsive Cognitions Working Group [OCCWG], 2005)

It is a self-assessment tool measuring cognitions related to OCD. The OBQ-44 consists of 44 items on a 7-point Likert scale from 1 (disagree very much) to 7 (agree very much). The Turkish adaptation study of the scale was conducted by [Boysan et al. \(2009\)](#). It was indicated that the Turkish version of OBQ-44 is a valid and reliable measurement tool. In this study, the Cronbach's Alpha coefficient of the scale was .86.

The Depression, Anxiety, Stress Scale-21 (DASS-21; Lovibond & Lovibond, 1995)

DASS-21 is a self-report questionnaire including negative emotional symptoms (depression, anxiety, and stress). The scale consists of 21 items with a 4-point Likert scale from 0 (never) to 3 (always). Each of the depression, anxiety, and stress subscales include 7 items. Translation and adaptation of the scale to Turkish was conducted by [Yildirim et al. \(2018\)](#). In this study, Cronbach's Alpha values of Depression, Anxiety and Stress subscales were found to be .89, .78, and .82, respectively.

Intolerance of Uncertainty Scale-Short Form (IUS-12; Carleton, Norton, et al., 2007, Carleton, Sharpe, et al., 2007)

IUS-12 consists of 12 items and is scored on a 5-point Likert scale ranging from 1 (not at all characteristic of me) to 5 (entirely characteristic of me). In the Turkish adaptation study conducted by [Saricam et al. \(2014\)](#), the scale's internal consistency was determined as .88. In this study, the internal consistency coefficient of the scale was found as .89 ([Saricam et al., 2014](#)).

Contamination Cognitions Scale (CCS; Deacon & Olatunji, 2007)

CCS includes 13 items and aims to assess the possibility and severity of contamination and perceived threat level. The Turkish adaptation study of the scale was conducted by [Inozu and Eremsoy \(2013\)](#) and indicated that the Turkish version of CCS is a valid and reliable measurement. In this study, the Cronbach's Alpha coefficient of the scale was .93.

STATISTICAL ANALYSIS

The Statistical Package for the Social Sciences (SPSS) was used to conduct statistical analysis. Means and standard deviations were reported using descriptive statistics, and t-tests were run to analyze differences between groups in socio-demographic variables and outcome measures (OCI-R, OBQ-44, DASS-21, IUS-12, and CCS).

Before testing the efficacy of the app, an intention-to-treat analysis was run. Missing data due to subject dropouts were completed using Multivariate Imputation with Chained Equations ([Groothuis-Oudshoorn & Van Buuren, 2011; \[MICE\]](#)). Multiple imputation methods follow three steps: (a) Imputing—repeating over several iterations (i) as opposed to a single imputation; (b) Analyzing—after each iteration the dataset completed is analyzed, leading to a distribution of i statistics, 1 per dataset; (c) Pooling—the i results are pooled into one estimate. Multiple imputation therefore also has the added benefit of examining the variance in estimates over iterations, reflecting the degree of uncertainty over which value to impute ([Lall, 2016](#)).

To investigate the impact of GG OCD on all outcome measures other than DASS-21, a 2 (Group: iApp, dApp) × 2 (Time: T0, T1) repeated measures analysis of variance (ANOVA) was conducted. The effect of the application on DASS-21 Subscales was examined using a 2 (Group: iApp, dApp) × 2 (Time: T0, T1) multiple analysis of variance (MANOVA). The Bonferroni correction was used to address multiple comparisons. To examine the differences across three time points for each group separately, additional two repeated measures ANOVA was conducted.

Results

Baseline (T0) correlations between all dependent variables are given in [Table 2](#). A Pearson's r data analysis revealed a moderately positive correlation between OBQ-44 and DASS-A. The results indicated that IUS-12 had moderately positive associations with DASS-A and CCS. In addition, DASS-D, DASS-A and DASS-S were found to be strongly

Table 2
Correlation Matrix for All Dependent Variables at Baseline (T0)

	1.	2.	3.	4.	5.	6.	7.
1. OCI-R							
2. OBQ-44	.25						
3. DASS-D	-.14	.18					
4. DASS-A	.14	.32*	.49**				
5. DASS-S	.07	.24	.73**	.50**			
6. IUS-12	.22	.26	.20	.34*	.26		
7. CCS	.11	.23	.03	.07	.09	.29*	

Note. OCI-R: Obsessive Compulsive Inventory-Revised; OBQ-44: The Obsessive Beliefs Questionnaire-44; IUS-12: Intolerance of Uncertainty Scale Short Form; DASS-D: The Depression, Anxiety, Stress Scale-21, Depression Subscale; DASS-A: The Depression, Anxiety, Stress Scale-21, Anxiety Subscale; DASS-S: The Depression, Anxiety, Stress Scale-21, Stress Subscale; CCS: Contamination Cognitions Scale.

* $p < .05$.

** $p < .01$.

and positively correlated with one another (see Table 2). To reduce type 1 error rate, 2 (group: iApp, dApp) \times 2 (time: T0, T1) multiple analysis of variance (MANOVA) was implemented for DASS-21 subscales (Depression, Anxiety and Stress). In order to examine the efficacy of GG OCD on OCI-R, OBQ-44, IUS-12 and CCS scores, 2 (group: iApp, dApp) \times 2 (time: T0, T1) analysis of variance (ANOVA) and Bonferroni post-hoc comparisons were conducted. Means, standard deviations, values of main and interaction effects for all of the dependent variables across two time points are displayed in Table 3. In addition, GG OCD effects in each group separately were analyzed using 1 \times 3 (time: T0, T1, T2) repeated measures ANOVA (MANOVA for DASS-21 subscales). Related to both analyses, Bonferroni post-hoc comparisons were conducted when significant differences emerged.

BETWEEN-GROUP DIFFERENCES (IAPP GROUP VERSUS DAPP GROUP)

OCI-R

The effect of GG OCD on OCI-R scores was analyzed using a 2 \times 2 repeated measures ANOVA. The results indicated that the assumption of Mauchly's sphericity was not met for time variable, $\chi^2(2) = .00$, $p < .05$. Therefore, Greenhouse-Geisser correction was used to analyze the main effect of time on OCI-R scores. The findings showed that the main effect of time on OCI-R scores was statistically significant, $F[1, 53] = 39.65$, $p < .001$, $\eta_p^2 = .43$. This effect was qualified by a significant time \times group interaction effect, $F[1, 53] = 11.37$, $p < .01$, $\eta_p^2 = .18$. The main effect of group across time was also statistically significant, $F[1, 53] = 4.41$, $p < .05$, $\eta_p^2 = .08$. The findings of Bonferroni post-hoc comparisons revealed that in the iApp group, T1 scores were significantly lower than the scores at the T0 (for M and SD , see Table 3). With respect to the dApp group, there was no significant difference between T0 and T1 scores. When we examined the group differences across time points, the results revealed that while there was no statistically significant difference between the iApp and dApp groups at T0, which supported the equality of the groups at the baseline assessment, the groups differed significantly at T1. The iApp group scored significantly lower on the OCI-R than the dApp group at T1 (see Figure 4).

OBQ-44

The effect of GG OCD to reduce OBQ-44 scores was investigated by a 2 \times 2 repeated measures ANOVA. Mauchly's Test of Sphericity indicated

that the assumption of sphericity had been violated, $\chi^2(2) = .00$, $p < .05$. To examine the main effect of time on OBQ-44 scores, Greenhouse-Geisser correction was used. According to the results, the main effect of time, $F[1, 53] = 10.09$, $p < .01$, $\eta_p^2 = .16$, and Time \times Group interaction effect, $F[1, 53] = 14.39$, $p < .001$, $\eta_p^2 = .21$, on OBQ-44 scores were statistically significant. There was also a significant main effect of group, $F[1, 53] = 9.78$, $p < .01$, $\eta_p^2 = .16$. Results for the Bonferroni post-hoc comparisons showed that for the iApp group T0 scores were significantly greater than T1 scores (for M and SD , see Table 3). In the dApp group, the difference between T0 and T1 OBQ-44 scores was not significant. Time \times Group interactions showed that there was statistically significant difference between the groups at T1. The iApp group had significantly lower OBQ-44 scores compared to the dApp group at T1 (see Figure 4).

DASS-21

A 2 \times 2 mixed design MANOVA was conducted to examine the efficacy of GG OCD on DASS-21 subscales including Depression, Anxiety and Stress. Mauchly's Test of Sphericity showed that the sphericity assumption was not met, $\chi^2(2) = .00$, $p < .05$. Therefore, Greenhouse-Geisser correction was applied to report the results. The findings revealed that time and group main effect and Time \times Group interaction effect were not statistically significant for all subscales (see Figure 4).

IUS-12

In order to examine the impact of GG OCD on IUS-12 scores, a 2 \times 2 repeated measures ANOVA was implemented. Mauchly's Test of Sphericity demonstrated that the sphericity assumption was not met, $\chi^2(2) = .00$, $p < .05$. Hence, Greenhouse-Geisser correction was used to analyze the main effect of time on IUS-12 scores. The results showed significant effect for time, $F[1, 53] = 27.16$, $p < .001$, $\eta_p^2 = .34$, and Time \times Group interaction, $F[1, 53] = 6.03$, $p < .05$, $\eta_p^2 = .10$. There was also a significant main effect for group, $F[1, 53] = 7.50$, $p < .01$, $\eta_p^2 = .12$. The findings of Bonferroni post-hoc analysis for the significant interaction effect demonstrated that related to the iApp group, IUS-12 scores at T0 were significantly greater than scores at T1 (for M and SD , see Table 3). In the dApp group, the difference between T0 and T1 was not significant. When we compare the groups across different time points, the groups differed significantly at T1. Following usage of the application, the iApp group had significantly lower IUS-20 scores than the dApp group at T1 (see Figure 4).

Table 3
Comparisons Across T0 and T1 for iApp and dApp Groups

	T0		T1		Time		Group			Time × Group			
	M (SD)		M (SD)		$F_{(1,53)}$	p	Cohen's d	$F_{(1,53)}$	p	Cohen's d	$F_{(1,53)}$	p	Cohen's d
iApp	dApp	iApp	dApp										
OCI-R	2.41 (.40)	2.44 (.42)	1.80 (.67)	2.26 (.44)	39.65	<.001	1.74	4.41	<.05	.59	11.37	<.01	.94
OBQ-44	4.32 (.54)	4.43 (.68)	3.61 (.75)	4.50 (.81)	10.09	<.01	.87	9.78	<.01	.87	14.39	<.00	1.03
DASS-D	1.73 (.77)	1.53 (.75)	1.70 (.76)	1.69 (.76)	.003	.956	–	.027	.871	–	3.94	.05	–
DASS-A	1.37 (.68)	1.62 (.75)	1.37 (.60)	1.70 (.71)	.203	.654	–	3.03	.087	–	.203	.65	–
DASS-S	1.76 (.57)	1.70(.69)	1.82 (.59)	1.94 (.70)	3.52	.066	–	.05	.823	–	1.26	.27	–
IUS-12	3.72 (.53)	3.91 (.59)	3.20 (.51)	3.72 (.55)	27.16	<.001	1.44	7.50	<.01	.74	6.03	<.05	.67
CCS	66.65 (17.08)	69.37 (15.49)	59.18 (18.64)	68.75 (15.05)	4.62	<.05	.59	2.27	.138	–	3.31	.08	–

Note. OCI-R: Obsessive Compulsive Inventory-Revised; OBQ-44: The Obsessive Beliefs Questionnaire-44; DASS-D: The Depression, Anxiety, Stress Scale-21, Depression Subscale; DASS-A: The Depression, Anxiety, Stress Scale-21, Anxiety Subscale; DASS-S: The Depression, Anxiety, Stress Scale-21, Stress Subscale; IUS-12: Intolerance of Uncertainty Scale Short Form; CCS: Contamination Cognitions Scale. M: mean, SD: standard deviation.

CCS

The effect of GG OCD on CCS scores was tested using a 2×2 repeated measures ANOVA. Mauchly's Test of Sphericity showed that the assumption of sphericity had been violated, $\chi^2(2) = .00$, $p < .05$. For this reason, Greenhouse-Geisser correction was applied to report the results. The findings revealed that the main effect of time, $F[1, 53] = 4.62$, $p < .05$, $\eta_p^2 = .08$, was statistically significant. However, Time × Group interaction effect and main effect of group were not significant (see Figure 4).

Within-Group and Follow-Up Effects for iApp Group

In the iApp group, pre-post decline in OCD symptoms, obsessive beliefs, intolerance of uncertainty levels, contamination cognitions and negative emotional symptoms (depression, anxiety, and stress) as well as retention of these effects in the follow-up period were expected. For this reason, pre-to-final changes were investigated with a repeated-measures ANOVA between T0, T1 and T2. To reduce type 1 error rate, MANOVA was implemented only for DASS-21 subscales. Mauchly's test of sphericity indicated that the assumption of sphericity was met for all measures except from CCS. Therefore, Greenhouse-Geisser correction was used to analyze the main effect of time on CCS scores.

In the iApp group, the main effects of time were statistically significant for OCI-R ($Wilks' \lambda = .36$, $F[2, 26] = 23.61$, $p < .001$, $\eta_p^2 = .65$), OBQ-44 ($Wilks' \lambda = .56$, $F[2, 26] = 10.10$, $p < .01$, $\eta_p^2 = .44$), IUS-12 ($Wilks' \lambda = .49$, $F[2, 26] = 13.56$, $p < .001$, $\eta_p^2 = .51$) and CCS ($F[2, 26] = 5.28$, $p < .05$, $\eta_p^2 = .16$). On the other hand, the main effects of time were not significant in

terms of DASS-21 subscales. Bonferroni post-hoc comparisons demonstrated significant reductions from T0 to T1 and from T0 to T2 for OCI-R, OBQ-44 and IUS-12. There were also significant reductions from T0 to T2 for CCS. No significant differences (p 's $> .05$) emerged from T1 to T2 in terms of all of the outcome measures (see Table 4).

Within-Group Effects for dApp Group

In the dApp group, following the usage of GG OCD application (T2), a significant decrease in OCD symptoms, obsessive beliefs, intolerance of uncertainty levels, contamination cognitions and negative emotional symptoms (depression, anxiety, and stress) was expected. Hence, changes across three time points for dApp group were examined with a repeated-measures ANOVA. MANOVA was performed only for DASS-21 subscales. Mauchly's test of sphericity revealed that the assumption of sphericity was not met for OCI-R, IUS-12 and CCS. Thus, Greenhouse-Geisser correction was applied to examine the main effect of time on OCI-R, IUS-12 and CCS scores.

Repeated measures ANOVA for dApp group revealed that the main effects of time were statistically significant for OCI-R ($F[2, 25] = 19.59$, $p < .001$, $\eta_p^2 = .43$), OBQ-44 ($Wilks' \lambda = .49$, $F[2, 25] = 13.04$, $p < .001$, $\eta_p^2 = .51$), IUS-12 ($F[2, 25] = 8.36$, $p < .01$, $\eta_p^2 = .24$) and CCS ($F[2, 25] = 5.28$, $p < .05$, $\eta_p^2 = .17$). With respect to DASS-21 subscales, the main effect of time was not statistically significant. Bonferroni post-hoc comparisons showed significant declines from T1 to T2 and from T0 to T2 for OCI-R and OBQ-44. There were significant declines from T0 to T2 for IUS-12 and CCS. From T0 to T1, there were no significant differences for all of the dependent variables



FIGURE 4 Graphs of the measures across T0, T1, and T2 for iApp and dApp groups.

(p 's > .05) except from OCI-R. Results are displayed in Table 5.

Discussion

Mobile health apps have unique advantages particularly relevant during the COVID-19 pandemic, including availability anytime anywhere, low cost, and anonymity. This study examined the efficacy of a mobile application called “GG OCD, Anxiety

and Depression” (GG OCD) in a Turkish sample with people at high risk for OCD.

Previous studies have shown the usefulness of short, daily cognitive exercises delivered via the GGtude platform on various symptoms (e.g., Aboody et al., 2020; Ben-Zeev et al., 2021; Cerea et al., 2020; Giraldo-O’Meara & Doron, 2020; Roncero et al., 2018). However, this is the first study to examine the usefulness of targeting

OCD symptoms and cognitions during the COVID-19 pandemic with a Turkish sample of individuals at high risk for OCD.

As expected, short, daily cognitive exercises delivered using GG OCD were associated with improved OCD symptom and cognition measures and these effects persisted at follow-up. More specifically, interaction effects revealed significantly fewer OCD symptoms, obsessive beliefs, and intolerance of uncertainty immediately after intervention (T1) in the iApp group compared to the dApp group. These results were maintained at follow-up. Furthermore, once participants in the dApp group started using GG OCD (following crossover), they reported similar large effect-size reductions in their OCD symptoms and cognitions. Thus, the effects found in iApp group were replicated in the dApp group.

These promising results support the efficacy of GG OCD in reducing obsessive-compulsive symptoms, dysfunctional obsessive beliefs, and intolerance of uncertainty. The results are consistent with those of Roncero et al. (2018, 2019) and Cerea et al. (2020) that showed using GGRO (an app on the GGtude platform targeting relationship OCD maladaptive beliefs) was associated with significant reductions in OCD-related cognitions and relationship OCD symptoms (ROCD; Doron et al., 2016).

GG OCD targets maladaptive beliefs associated with various OCD symptom dimensions (e.g., contamination, “just right” feelings, fear of harm, scrupulosity). This may explain the larger reductions in the OCI-R scores found in the current study compared with previous studies (Cerea et al., 2020; Roncero et al., 2018, 2019). Daily cognitive exercises including identification and categorization of self-statements, repeated presentation of adaptive self-statements to the user, and psychoeducation may have promoted retrieval of adaptive beliefs over maladaptive ones, thereby reducing the severity of OCD symptoms.

Cognitive-behavioral models of OCD state that dysfunctional obsessive beliefs including overestimation of threat and responsibility, the importance of thoughts, intolerance of uncertainty, and perfectionism are closely associated with OCD symptoms (e.g., Moulding et al., 2011; Tallis, 1996). Obsessive beliefs are also believed to be crucial factors in understanding the reactions of people to the pandemic. As noted by Taylor (2019), people who tend to overestimate the threat exaggerate the likelihood and severity of the Ebola virus, SARS, and Swine flu and see themselves vulnerable to the perceived threat.

Intolerance of uncertainty (IU) contributes to anxiety and psychological distress (Ouellet et al., 2019) and may be an important underlying mechanism associated with OCD symptoms and anxiety (Gillett et al., 2018). The significant large-effect size decrease in intolerance of uncertainty scores found in our study suggest GG OCD may also be effective in reducing IU in a period of global health crisis, uncertainty, and a perceived sense of uncontrollability (Flett & Zangeneh, 2020). Tools such as the GG OCD may, therefore, be useful for increasing tolerance for uncertainty in times of increase uncertainty, particularly for individuals with heightened OCD symptoms.

In our study, we did not detect any significant decline in DASS scores in either groups. The app used in this study (GG OCD) was designed to target maladaptive beliefs associated with OCD symptoms, rather than depression or general anxiety symptoms. Targeting maladaptive beliefs more relevant to depression (e.g., hopelessness, helplessness, self as a burden) for a longer time period may be more useful in reducing depression and anxiety symptoms. Indeed, a recent fully remote RCT using the GGtude CORE app targeting serious mental illness cognitions found significant medium-large effect size reductions in depression symptoms following 30 days of use (Ben-Zeev et al., 2021).

Although our results indicated large effect-size reductions in OCD-related cognitions (as measured by the OBQ) and intolerance of uncertainty beliefs, statistically significant reduction in contamination-related cognitions (as measured by the CSS) was not found. These results were puzzling and unexpected. One possibility is that cognitions related to contamination have not significantly changed following the intervention. However, a closer look at the findings shows Time x Group interaction on the CSS were close to significant ($p = .08$), with large effect-size reductions found in the iApp group between T0-T1 (Cohen's $d = .87$) and replicated in the dApp group (Cohen's $d = .91$). Thus, the lack of significant findings may be attributed to our limited sample size.

In addition, some features of the CSS may have attributed to the lack of statistically significant findings, particularly during the pandemic. The CSS includes items asking participants to imagine contacting something (public closet valves, public door handles, elevator buttons, money, public ladder handles, etc.) without being able to wash their hands, and then rate the probability and severity of contamination. Such questions during one of the

Table 4
Comparisons Between Assessments for iApp Group

	T0 M (SD)	T1 M (SD)	T2 M (SD)	$F_{(2, 26)}$	p	Cohen's d	Post-hoc
OCI-R	2.41 (.40)	1.80 (.67)	1.87 (.56)	23.61	<.00	2.73	T0 vs T1 = $p < .00$ T0 vs T2 = $p < .00$ T1 vs T2 = $p = 1.00$
OBQ-44	4.32 (.54)	3.61 (.75)	3.74 (.77)	10.10	<.01	1.77	T0 vs T1 = $p < .00$ T0 vs T2 = $p < .01$ T1 vs T2 = $p = 1.00$
DASS-D	1.73 (.77)	1.70 (.76)	1.54 (.75)	1.54	.22	.46	T0 vs T1 = $p = .35$ T0 vs T2 = $p = .49$ T1 vs T2 = $p = 1.00$
ASS-A	1.37 (.68)	1.37 (.60)	1.36 (.57)	.01	.99	.00	T0 vs T1 = $p = 1.00$ T0 vs T2 = $p = 1.00$ T1 vs T2 = $p = 1.00$
DASS-S	1.76 (.57)	1.82 (.59)	1.82 (.63)	.18	.80	.20	T0 vs T1 = $p = 1.00$ T0 vs T2 = $p = 1.00$ T1 vs T2 = $p = 1.00$
IUS-12	3.72 (.53)	3.20 (.51)	3.36 (.70)	13.56	<.00	2.04	T0 vs T1 = $p < .00$ T0 vs T2 = $p < .05$ T1 vs T2 = $p = .61$
CCS	66.65 (17.08)	59.18 (18.64)	52.85 (21.49)	5.28	<.05	.87	T0 vs T1 = $p = .09$ T0 vs T2 = $p < .01$ T1 vs T2 = $p = .67$

Note. OCI-R: Obsessive Compulsive Inventory-Revised; OBQ-44: The Obsessive Beliefs Questionnaire-44; DASS-D: The Depression, Anxiety, Stress Scale-21, Depression Subscale; DASS-A: The Depression, Anxiety, Stress Scale-21, Anxiety Subscale; DASS-S: The Depression, Anxiety, Stress Scale-21, Stress Subscale; IUS-12: Intolerance of Uncertainty Scale Short Form; CCS: Contamination Cognitions Scale. M: mean, SD: standard deviation.

peaks of the pandemic in Turkey (October–December, 2020), when perceived risk of infection was very high, may have attenuated the reported effects of the intervention and increased response variance. Finally, GG OCD is a cognitive intervention without any behavioral components such as ERP. As indicated above, marginally significant Time \times Group interaction effects were found on the CSS. However, including behavioral components in the intervention may have strengthened the effects of the mobile intervention used.

STRENGTHS AND LIMITATIONS

Our study had a significant dropout rate (18%). Such dropout rates, however, are not unusual in studies assessing mobile applications for mental health (Ludden et al., 2015). In fact, one meta-analysis study on dropout rates in clinical trials of mobile apps for depressive symptom found the mean dropout rate to be 26.2% (Torous et al., 2020). In another meta-analysis, the mean dropout rates was found to be 33.2% when accounting for publication bias and 24.1% without accounting for publication bias (Linardon & Fuller-Tyszkiewicz, 2020). In the current study, however, dropouts

may have occurred as a small compensation fee (50 Turkish Liras) may not have been seen as a sufficient source of motivation to keep using the app.

Our study was a crossover RCT. Such study design permits evaluation of between-group effects during the intervention period and within-group changes in both groups over time. That is, crossover RCT design allows us to assess whether our within group results are replicable. This study design also indicated an association between the timing of participants' use of the app and changes on our outcome measures. Nevertheless, one limitation of our crossover design is that only participants in one group could be assessed at follow-up.

A limitation of the study was that participants were women and from the young adulthood age group. Older age groups may have more difficulty using and accessing such an app. Previous research using the GGtude platform, however, indicated high usability rates in older participants (mean age of 37.7; Ben-Zeev et al., 2021). Nevertheless, age may have different effects in terms of some variables. For example, one study showed significant age differences in DASS scores across ages (Wood et al., 2010). Future studies would benefit

Table 5
Comparisons Between Assessments for dApp Group

	T0 M (SD)	T1 M (SD)	T2 M (SD)	$F_{(2, 25)}$	p	Cohen's d	Post-hoc
OCI-R	2.44 (.42)	2.26 (.44)	1.86 (.55)	19.59	<.00	1.74	T0 vs T1 = $p < .05$ T0 vs T2 = $p < .00$ T1 vs T2 = $p < .01$
OBQ-44	4.43 (.68)	4.50 (.81)	3.63 (.77)	13.04	<.00	2.04	T0 vs T1 = $p = 1.00$ T0 vs T2 = $p < .00$ T1 vs T2 = $p < .00$
DASS-D	1.53 (.75)	1.59 (.76)	1.45 (.62)	1.76	.18	.51	T0 vs T1 = $p = .69$ T0 vs T2 = $p = 1.00$ T1 vs T2 = $p = .24$
DASS-A	1.62 (.75)	1.70 (.71)	1.49 (.79)	.821	.43	.35	T0 vs T1 = $p = 1.00$ T0 vs T2 = $p = 1.00$ T1 vs T2 = $p = .79$
DASS-S	1.70 (.69)	1.94 (.70)	1.52 (.74)	5.22	.01	.91	T0 vs T1 = $p = .23$ T0 vs T2 = $p = .37$ T1 vs T2 = $p = .02$
IUS-12	3.91 (.59)	3.72 (.55)	3.39 (.60)	8.36	<.01	1.12	T0 vs T1 = $p = .17$ T0 vs T2 = $p < .01$ T1 vs T2 = $p = .11$
CCS	69.37 (15.49)	68.75 (15.05)	61.87 (17.22)	5.28	<.05	.91	T0 vs T1 = $p = 1.00$ T0 vs T2 = $p < .05$ T1 vs T2 = $p = .08$

Note. OCI-R: Obsessive Compulsive Inventory-Revised; OBQ-44: The Obsessive Beliefs Questionnaire-44; DASS-D: The Depression, Anxiety, Stress Scale-21, Depression Subscale; DASS-A: The Depression, Anxiety, Stress Scale-21, Anxiety Subscale; DASS-S: The Depression, Anxiety, Stress Scale-21, Stress Subscale; IUS-12: Intolerance of Uncertainty Scale Short Form; CCS: Contamination Cognitions Scale. M: mean, SD: standard deviation.

from including a more balanced gender and age distribution to increase the generalizability of the findings.

Another limitation of this study is the possibility of producing systematic bias via self-report measures. Accordingly, the self-reported data should be verified through other objective measurement tools. In addition, the period of the study coincides with the positive news about the vaccination studies, which received wide coverage in the media. Thus, the findings should be revisited considering the current situation of the pandemic. Finally, although not examined in this study, future studies can examine whether change has a mediating role in the relationship between obsessive beliefs and intolerance of uncertainty to better understand the mechanisms underlying the reduction in OCD symptoms.

Conclusions

Uncertainty about the future, anxiety, disappointment caused by postponed plans, fear of being infected, sleep problems, and irritability that emerged with the pandemic have all become important factors affecting people's quality of life.

This may be particularly true for vulnerable individuals presenting with mental health difficulties. Considering current challenges in accessing traditional face-to-face therapeutic interventions, the development of alternative, low-cost, accessible mental health interventions that are available any time anywhere has become a priority. Our findings suggest that even a brief, daily cognitive intervention without behavioral elements may lead to a significant reduction in OCD symptoms and cognitions during times of uncertainty, increased stress, and anxiety.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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