

RESEARCH ARTICLE

A randomized clinical trial of a gamified app for the treatment of perfectionism

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Email: abramovitch@txstate.edu**Abstract**

Objectives: Perfectionism is a common transdiagnostic problem that may lead to substantial distress and functional impairments. Cognitive behavioural therapy (CBT) is an effective treatment for perfectionism. However, the existing significant barriers to access and utilization of mental health services, including among college students, demand the development of low-intensity accessible interventions. The aim of the present study was to evaluate the effectiveness of a low-intensity CBT-based self-help gamified app developed specifically for perfectionism in a sample of college students.

Methods: Participants completed assessments of perfectionism, related symptoms, emotional burden and functional impairments at pretreatment, posttreatment and at one-month follow-up.

Results: Compared with the waitlist condition ($n=35$), the app condition ($n=35$) demonstrated a significant and greater reduction in perfectionism, obsessive-compulsive symptoms, functional impairments and subjective ratings of emotional burden.

Conclusions: Results suggest that a brief, daily app-based game-like intervention targeting maladaptive perfectionistic beliefs may be a viable, low-cost alternative to traditional CBT treatments for vulnerable populations on college campuses.

KEYWORDS

app, internet-based treatment, low-intensity treatment, perfectionism, randomized clinical trial

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INTRODUCTION

Previously thought of as a personality disposition (Stoeber et al., 2015, p.1), perfectionism may be more accurately conceptualized as a transdiagnostic process involving a set of dysfunctional cognitions and behaviours (Egan et al., 2011), where individuals perceive their self-worth as exceedingly dependent on meeting those high standards. Notably, although a number of subtypes of perfectionism have been suggested (for a recent review, see Smith et al., 2022), in clinical settings it is common to utilize and operationalize the overarching term Clinical Perfectionism, defined as “Overdependence of self-evaluation on the determined pursuit (and achievement) of self-imposed personally demanding standards of performance in at least one salient domain, despite the occurrence of adverse consequences” (Shafran et al., 2002, p. 779). Clinical Perfectionism may negatively affect all aspects of one's life, particularly in the vocational and academic domains (Stoeber et al., 2016). In addition, it may increase the risk for and be involved in the maintenance of multiple disorders, including anxiety disorders, depression, obsessive-compulsive-related disorders and eating disorders (Egan et al., 2011).

Importantly, there is growing evidence that the prevalence of perfectionism has been on the rise, particularly among college students, for the past three decades (Curran & Hill, 2019), and several factors contributing to this trend have been identified, including unrealistic expectations for academic and professional achievement, increasing societal pressure and a preoccupation with receiving validation from peers (Curran & Hill, 2019). Therefore, college students may be a primary at-risk population for clinical perfectionism. Furthermore, perfectionism among students has been shown to be associated with decreased overall psychological health and well-being, life satisfaction, self-esteem (Park & Jeong, 2015), as well as higher levels of stress, anxiety and depression (Chang et al., 2020; Holden et al., 2021; Robinson & Abramovitch, 2020).

Cognitive behavioural therapy (CBT) is an effective treatment for perfectionism (Abdollahi et al., 2019; Egan, Hattaway, & Kane, 2014; Riley et al., 2007; Shafran et al., 2017) that reduces negative dysfunctional cognitions (DiBartolo et al., 2001), evaluative concerns, and comorbid depression and anxiety symptoms (Lloyd et al., 2014). However, utilization of and access to mental health services, including CBT, among college students is inadequate. For example, a recent report indicated that only one-third of students who require care were seen by mental health-care professionals (Lipson et al., 2019). Although such reports indicate that there was a minor improvement in utilization and access to mental health care among students in the past decade, the impact of the COVID-19 pandemic clearly indicates a significant worsening across mental health and subjective wellbeing outcomes among students (Charles et al., 2021; Fruehwirth et al., 2021; Wang et al., 2020). Primary factors that may account for underutilization of these services include counselling centres being overwhelmed and understaffed, shame and stigma, and problems with the dissemination of information to students about mental health and available treatments (Duffy et al., 2019). Furthermore, extending beyond these well-recognized barriers, the case of perfectionism is somewhat more complex since it is perceived as socially desirable among students, and many individuals may continue to embrace it despite the negative consequences (Stoeber & Hotham, 2013).

To address the problem of access to mental health services, there has been a recent surge of studies examining multiple forms of low-intensity interventions that require little to no direct contact with mental health-care providers. Indeed, the primary purpose of low-intensity treatments is to increase access to mental health services and ultimately enhance the public's overall mental health and well-being (Bennett-Levy et al., 2010), all while being accessible, brief and requiring less adjunct therapeutic input (Shafran et al., 2021). Low-intensity treatments are also cost-effective interventions that increase service flexibility and capacity and promote access to evidence-based treatments (Bennett-Levy et al., 2010). In light of the consistent increase in prevalence of perfectionism (Curran & Hill, 2019), there has been a growing interest in the development and use of low-intensity CBT-based interventions for perfectionism including self-help and web-based computerized approaches (Shafran et al., 2016). Both guided (Rozenal et al., 2017; Shafran et al., 2017) and un-guided (Grieve et al., 2022; Shu et al., 2019; Valentine et al., 2018; Wade et al., 2019) web-based interventions have

demonstrated efficacy in reducing perfectionism in college students, and meta-analyses have revealed no differences between face-to-face and internet-delivered CBT for perfectionism (Galloway et al., 2022; Suh et al., 2019)

While web-based interventions have increased accessibility to mental health resources, the availability of additional low-intensity treatments such as gamified CBT-based applications (i.e., apps) for students could offer increased access to mental health services at no to minimal cost to students. Gamified CBT-based apps may benefit individuals who may not be comfortable sharing their feelings or who are biased towards psychotherapy (Kajitani et al., 2020). Finally, being a low-intensity intervention, these apps do not require the involvement of mental health-care professionals. As the need for mental health resources and counselling services continues to grow across college campuses and providers continue to become increasingly overwhelmed (Center for Collegiate Mental Health, 2018), there is an urgent need for easily accessible, effective means for treating perfectionism that are cost-effective and can be made readily available to students. The aim of the present study, therefore, was to evaluate the effectiveness of a low-intensity CBT-based self-help gamified app developed specifically for perfectionism.

In general, low-intensity app-based CBT has been found to be efficacious for a number of disorders and psychological problems, with small to medium effect sizes in the general population (for a review, see Linardon et al., 2019) and small to large effect sizes among college students (Oliveira et al., 2021). One of the apps offered on the GGtude platform, OCD.app, Anxiety, Mood and Sleep (henceforth GG OCD; GGtude, 2021), is among the few available apps that have demonstrated efficacy in multiple randomized control trials (RCTs; Aboody et al., 2020; Akin-Sari et al., 2022; Ben-Zeev et al., 2021; Cerea et al., 2020; Cerea et al., 2021; Pascual-Vera et al., 2018; Roncero et al., 2019), and has been shown to be effective in reducing the severity of a host of psychological problems, including disorders such as obsessive-compulsive disorder (OCD) and more severe conditions, including schizophrenia and bipolar disorder (Ben-Zeev et al., 2021).

The GG OCD platform focuses on the cognitive aspect of CBT and is aimed at reducing maladaptive beliefs by identifying dysfunctional automatic thoughts (Knapp & Beck, 2008). A unique aspect of this app compared to traditional and web-based CBT interventions is that the app is gamified and does not include traditional CBT elements (e.g., psychoeducation, thought records, exposure exercises). Rather than completing formal behavioural exercises, users engage in a comprehensive programme consisting of brief daily exercises lasting 3–5 min that allows users to discard maladaptive cognitions (by swiping them up/pushing away from themselves) and embrace more adaptive statements (by swiping down/pulling them towards themselves). Indeed, studies indicate that engaging with the app for 3–5 min per day for 2 weeks results in significant reductions in maladaptive OCD beliefs with medium to large effect sizes between the app and control group ($d = .42-.84$; Roncero et al., 2019). Based on the available evidence from previous low-intensity interventions for perfectionism and RCTs exemplifying the efficacy of the GG OCD app in targeting different symptoms related to perfectionism, we hypothesized that compared with a wait list condition, participants using the app for a few minutes a day for two weeks would exhibit a greater reduction in symptoms of perfectionism and present with lower associated symptoms of anxiety, stress and problems related to everyday functioning.

MATERIALS AND METHODS

Participants

Participants were recruited from the body of students at a large public university in the southeastern United States in two stages (See Figure 1). First, a random sample of undergraduate students ($n = 8937$) were contacted via bulk email, inviting participants to complete the Concerns Over Mistakes (CM) subscale of the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) voluntarily and indicate if they were interested in being invited to participate in a related paid study. From the total

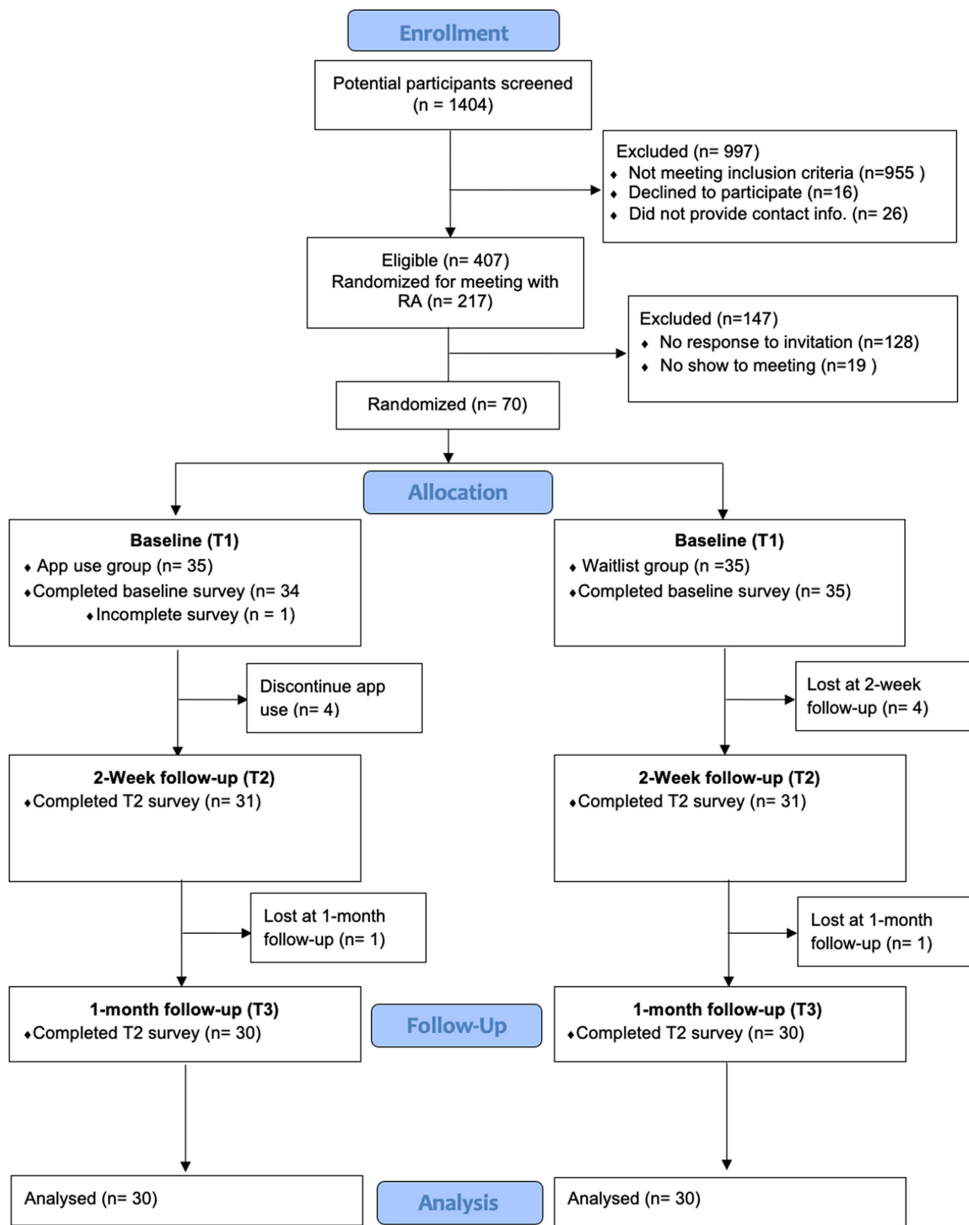


FIGURE 1 CONSORT flow diagram.

sample, 1404 students who provided their informed consent agreed to be invited to participate in the paid study. Of those students, 407 met the screening criteria, set at $1SD$ above the FMPS-CM mean ($M=28.43$, $SD=6.67$). This CM cut-off criterion has been utilized in other perfectionism studies, including clinical trials (Egan, van Noort, et al., 2014; Rozental et al., 2017). To minimize ‘no-shows’ and to ascertain that the desired sample size for each group was met, eligible participants were contacted in batches. Participants were then randomly assigned to the App ($n=35$) and Control ($n=35$) groups using a research randomization tool (Urbaniak & Plous, 2013). Inclusion criteria included basic English proficiency, age 18–65 and having a smart mobile device with the iOS or Android operating system. Demographic information for the study samples is presented in Table 1.

TABLE 1 Demographic characteristics for the control and app groups.

	Control	App			Entire sample
	Mean/% (n)/(SD)	Mean/% (n)/(SD)	<i>F</i> / <i>X</i> ²	<i>p</i>	Mean/% (n)/[SD]
Age (years)	18.85 [1.03]	18.71 [.92]	.37	.54	18.78 [.97]
Ethnicity					
Hispanic	42.90% (15)	40.00% (14)	1.45	.68	41.40% (29)
Non-Hispanic	51.40% (18)	45.70% (16)			48.60% (34)
Multiple ethnicities	2.90% (1)	8.60% (3)			5.70% (4)
Other	2.90% (1)	5.70% (2)			4.30% (3)
Race					
White	42.90% (15)	57.10% (20)	3.42	.49	50.00% (35)
Black	34.30% (12)	31.40% (11)			32.90% (23)
Hispanic or Latino	14.30% (5)	2.90% (1)			8.60% (6)
Asian	5.70% (2)	5.72% (2)			5.70% (4)
Hawaiian/Pacific Islander	2.90% (1)	2.90% (1)			2.90% (2)
Sex					
% Female	85.70% (30)	85.70% (30)	.00	1.00	85.70% (60)
Gender					
Female	80.00% (28)	68.60% (24)	2.30	.32	74.30% (52)
Male	14.30% (5)	14.30% (5)			14.30% (10)
Other	5.70% (2)	17.10% (6)			11.40% (8)
Relationship status					
Single	60.00% (21)	60.00% (21)	.00	1.00	60.00% (42)
Dating/Serious relationship	40.00% (14)	40.00% (14)			40.00%
Grade level					
Freshman	62.90% (22)	57.1% (20)	.25	.88	60.00%
Sophomore	34.30% (12)	40.00% (14)			37.10%
Junior	2.90% (1)	2.90% (1)			2.90%
GPA	3.24 [.62]	3.21 [.62]	.03	.86	3.22 [.62]

Abbreviations: GP, grade point average; GPA, grade point average; SD, standard deviation.

Procedures

Participants scheduled an online video call and individually met with the second author. In the call with the App group, participants were informed about the GG OCD app, asked to download it, and then received step-by-step instructions on how to use the app. They were then asked to complete three app levels a day (approximately 3–5 min a day) for 14 days. To monitor compliance regarding app use, participants in the App group were asked to share a screenshot of their current level daily with the experimenter (via email or text message), given that the app does not collect any personal information. In the video calls with the Control group, participants were informed that they were participating in a study that would assess common symptoms experienced by college students, and (similar to the App group), they were asked to complete the online questionnaire battery at three different time points. Following the video meeting, participants received an email with a link to the secured Qualtrics online platform to complete the pre-treatment (baseline; T1) evaluation and the demographic questionnaire and sign an

informed consent form. Emails with the corresponding survey links were sent to participants 14 days after T1 (i.e., post-treatment; T2), and again 30 days after T2 (follow-up; T3). At the end of the study, participants were debriefed about the study, and waitlist participants were informed about and sent a link to the App (for free use). All participants who completed the T3 survey were compensated for their time with a \$10 Amazon e-gift card, and in addition, they were entered into a raffle to win one of three \$100 Amazon e-gift cards. The study was approved by the institutional review board in accordance with the declaration of Helsinki.

Intervention

OCD.app—Anxiety, mood and sleep (Figure 2; GG Tude, 2021) consists of short training gamified exercises intended to help users cope with psychological challenges by increasing accessibility to self-statements that facilitate adaptive interpretations of thoughts, emotions and events associated with anxiety, mood and sleep problems (Roncero et al., 2019). The perfectionism section of the app contains 9 categories (*Beating self-criticism, Dealing with perfectionism, Reducing vulnerabilities, Fear of mistakes, Perfectionism and worry, Perfectionism and self-criticism, and Feeling safe I, II and III*), which contain concepts related to the category and related maladaptive beliefs (3–6 statements per belief). Levels are comprised of several statements that are either consistent with their maladaptive belief or challenge this belief. For example, “*Being perfect doesn't guarantee success*” versus “*Always focus on your flaws.*” Users respond to these statements by either embracing them (i.e., pulling the phrase downward towards the bottom of the screen) or rejecting them (i.e., pushing the phrase away and upward). Following the completion of each level, users either receive a memory-evaluation screen that asks them to recall statements that recently appeared in the level completed (see Figure 2) or an encouraging message.

Measures

Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990)

The FMPS is a 35-item self-report multidimensional measure of perfectionism. Traditionally, the FMPS consists of six subscales: Concern over Mistakes (CM; 9-items), Doubts about Actions (D; 4-items) Parental Expectations (PE; 5-items), Parental Concerns (PE; 4-items), Personal Standards (PS; 7-items) and Organization (O; 6-items). Items are rated on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), with a total score ranging from 29 to 145. The FMPS demonstrated good to excellent internal consistency across subscales in student samples ($\alpha = .77-.90$; Dorevitch et al., 2020). In the present study, the FMPS-CM was the primary outcome measure, which has been utilized in several clinical trials of perfectionism (Egan, van Noort, et al., 2014; Rozental et al., 2017; Shafran et al., 2017). In the present study, The FMPS-CM demonstrated good internal consistency ($\alpha = .83$).

Depression Anxiety Stress Scale-21 (DASS-21; Osman et al., 2012)

The DASS-21 is a 21-item self-report questionnaire that consists of three subscales that contain seven items each. Responses are scored on a 4-point Likert scale from 0 (*did not apply to me at all*) to 3 (*applied to me most of the time*), with higher scores indicating more severe symptoms. The scale possesses good to excellent internal consistency in the general population ($\alpha = .91, .80$ and $.84$ for depression, anxiety and stress, respectively; Sinclair et al., 2011). In the present study, the DASS-21 demonstrated good internal consistency ($\alpha = .88, .84$ and $.78$ for depression, anxiety and stress, respectively).

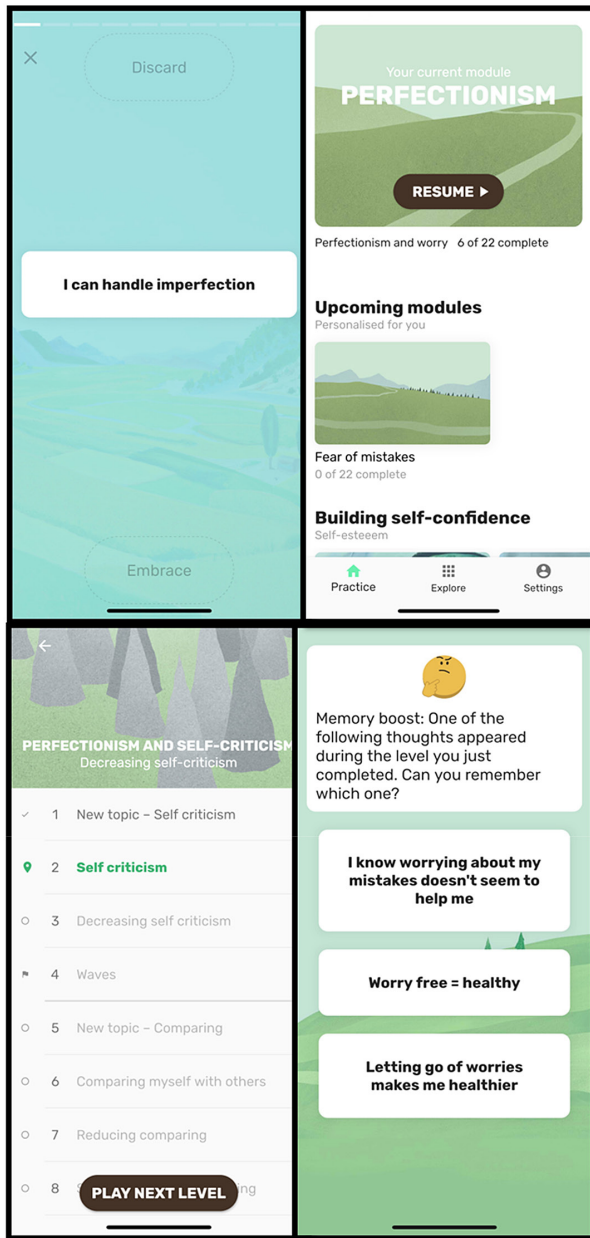


FIGURE 2 GGtude OCD.app—Anxiety, mood and sleep app, perfectionism module screenshots.

Obsessive-Compulsive Inventory 12 items (OCI-12; Abramovitch et al., 2021)

The OCI-12 is a 12-item self-report measure of obsessive-compulsive symptoms. The scale consists of four subscales: checking, ordering, washing and obsessing. Participants are asked to rank levels of distress pertaining to each statement, with responses scored on a 5-point Likert scale from 0 (*Not at all*) to 4 (*Extremely*). The OCI-12 demonstrated good psychometric properties, including test–retest reliability ($\alpha = .85$) in a clinical OCD sample and satisfactory internal consistency in OCD ($\alpha = .79$), anxiety-related disorders ($\alpha = .89$) and non-clinical controls ($\alpha = .71$; Abramovitch et al., 2021). The OCI-12 demonstrated acceptable internal consistency in the present study ($\alpha = .79$).

Barkley Functional Impairment Scale-Long Form (BFIS-LF; Barkley, 2011)

The BFIS is a 15-item self-report measure that assesses psychosocial functional impairments in 15 domains of major life activities. The 15 scale items are scored on a 10-point Likert scale, ranging between 0 (*Not at all*), and 8–9 (*Severe*). In the general population, the BFIS-LF demonstrated excellent internal consistency ($\alpha = .97$; Barkley, 2011) and good internal consistency in the present study ($\alpha = .84$). Due to a technical error, one item was omitted from the BFIS questionnaire. However, as per the measure's manual, BFIS items were designed as stand-alone items representing a domain of everyday function, and thus each of the 15 domains can be scored individually to obtain individual domain ratings, mean impairment scores, and 'percent impaired' scores (Barkley, 2011). Therefore, 14-items/domains from the BFIS-LF were analysed in the present study.

Subjective VAS functional and emotional items

To assess subjective, functional and emotional burdens exclusively related to perfectionism, two visual analogue scales (VAS) were created. The two items included were, "*To what degree has perfectionism caused an emotional burden or distress in the past week?*" and "*To what degree has perfectionism negatively impacted your level of functioning in school, work, or in terms of your relationship with other people in the past week?*" The two visual analogue scales ranged from 0 (*I do not feel that perfectionism has caused any burden or distress in the past week, or I do not feel that perfectionism has had any negative impact on my level of functioning in the past week*) to 100 (*Perfectionism has caused a very extreme degree of burden and distress in the past week, or Perfectionism has had an extreme degree of negative impact on my level of functioning in the past week*).

Covid Stress Scale (CSS; Taylor et al., 2020)

Since the study took place during the COVID-19 pandemic (during the decline in cases after the Delta variant surge), the CSS was used to control for COVID-19 distress. The CSS is a 36-item self-report questionnaire that assesses COVID-19-related fears and stress symptoms. Items are rated on a Likert scale ranging from 0 (*not at all*) to 4 (*extremely*), with a total score ranging from 0 to 144. The CSS demonstrated good to excellent internal consistency in the general population ($\alpha = .86$ – $.95$; Taylor et al., 2020) and excellent internal consistency in the present study ($\alpha = .92$).

Statistical analysis

A longitudinal design a-priori power calculation based on the primary outcome (Concern for Mistakes) was conducted with an alpha value of .05, two groups and three assessment points using the GPower program (Faul et al., 2007). A total sample of 15 participants completing the study per group provided 90% power to detect a medium effect size group difference (Cohen's $f = .25$). Therefore, the present study, which resulted in 31 participants completing the study in each group, is adequately powered.

Statistical analyses were conducted using IBM SPSS version 25 (IBM, 2017). Pearson's X^2 tests were used to analyse nominal variables, and analysis of variance (ANOVA) were performed to analyse between-group differences on continuous variables and outcome measures at baseline. To investigate the impact of the GG OCD app on all outcome measures, a series of repeated mixed two-way ANOVAs were computed with Time as the within-subject factor (T1, T2, T3) and Group as the between-subject factor (App, Control). Notably, we opted to analyse T1–T2 and T2–T3 separately since these two models relate to two different empirical questions (i.e., treatment effect and maintenance of treatment gains). Further, since individuals with more severe symptoms tend to experience a large reduction in

symptoms, these two models included covarying for baseline or end of treatment severity. Whenever the sphericity assumption was not met, Greenhouse–Geisser and Huynh Feldt corrections were used. Cohen's d was used as the effect size outcome, where d of .2, .5 and .8 corresponds to small, medium and large effect sizes, respectively (Cohen, 2013).

Prior to data analyses, an intention to treat analysis was applied. When considering all variables in the study across the two samples, there was 12% missing data, and all missing data were due to participant dropouts. The results of Little's Missing Completely at Random test ($X^2 [72] = 77.528, p = .31$; Little & Rubin, 2019), suggest that the missing data in the present study were missing completely at random, which does not require multiple imputation procedures (Little & Rubin, 2019). However, to avoid the limitations of simple single imputations such as Last Observation Carried Forward, we opted to use a more conservative approach and employed a stochastic regression imputation procedure. Stochastic regression adds additional error variance to the predicted values and thus avoids the known problem of underestimation of variance typical of conventional single imputation methods such as Unconditional Mean Imputation and Simple Regression Imputation (Little & Rubin, 2019). The primary outcome measure for this study was the FMPS Concerns Over Mistakes (FMPS-CM) subscale. Secondary outcome measures included severity of symptoms of anxiety, depression and stress (DASS-21), obsessive-compulsive symptoms (OCI-12), subjective perception of functional and emotional burden of perfectionism (via two VAS scales) and everyday function via the BFIS. To examine whether the change in the primary outcome measure could be considered reliable and not a consequence of an error in measurement, we calculated the Reliable Change Index (RCI; Jacobson et al., 1984; Jacobson & Truax, 1991). The results of this computation indicated that the reliable change criterion (RCCrit) in the present study is 5.97 points. Therefore, a change greater than 5.97 points on the FMPS-CM subscale should be regarded as a reliable, clinically significant change.

RESULTS

Demographic characteristics and clinical indices at baseline

Table 1 presents demographic information for the entire study sample and separately for the Control and App groups. No significant group differences were found for age, ethnicity, race, sex, gender, relationship status, grade level and GPA (p 's = .32–1.00). Further, no significant differences were found between the groups on all clinical or functional variables at baseline (see Table 2).

Primary outcome from baseline (T1) to post-treatment (T2)

To examine changes in primary outcomes during the treatment period (T1–T2), two repeated measures ANOVAs were conducted within the App group. Significant reductions in symptoms between T1 and T2 were found on the FMPS-CM ($p < .001, d = -1.19$). Numerically, there was a reduction of 7.14 points within the App group on the CM, which is larger than the Reliable Change Criterion, which was calculated at 5.97 points. Within the Control group, no significant change between T1 and T2 was found on the CM (Table 3). To examine changes across time and between treatment groups during the treatment trial (T1–T2), a series of two-way mixed repeated measures ANOVAs were conducted, examining the main (time, group) and interaction effects of Group \times Time. In terms of the primary outcome, results revealed a significant main effect of time ($F[1, 68] = 17.80, p < .001$) and group ($F[1, 68] = 5.16, p = .26$) on the FMPS-CM, as well as a significant Group \times Time interaction ($F[1, 68] = 20.13, p < .001$), where the App group reported significantly reduced scores on FMPS-CM post-treatment over and above the Control group, with a large effect size ($\eta^2 = .24$; see Figure 3).

TABLE 2 Clinical and functional outcome indices at baseline (T1).

	Control		App		<i>F</i> (1,69)	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>		
Perfectionism indices						
FMPS-CM	35.34	4.92	36.48	5.29	.87	.35
VAS-Emotional	58.26	28.21	57.46	22.97	.02	.90
VAS-Functional	52.49	27.23	48.78	23.60	.37	.54
Clinical indices						
DASS-Dep	10.77	5.84	9.02	4.85	1.96	.17
DASS-Anx	9.77	5.30	8.55	4.45	1.08	.30
DASS-Stress	11.34	4.62	11.29	3.78	.00	.96
OCI-12 total score	19.00	7.17	20.45	8.31	.61	.44
Functional indices						
BFIS mean	5.28	1.80	5.54	1.59	.40	.53
CSS	33.60	15.88	40.34	22.53	2.10	.15

Abbreviations: CSS, Covid Stress Scale; DASS-21 Anx, DASS-21 anxiety subscale; DASS-21 Dep, Depression, anxiety, stress scale-21 items depression subscale; DASS-21 Stress, DASS-21 stress subscale; FMPS-CM, Frost Multidimensional Perfectionism Scale concern over mistakes scale; OCI-12 Total, The Obsessive-Compulsive Inventory-Scale 12 items total score; VAS Emotional, Perfectionism-related emotional burden; VAS-Functional, Visual analogue scale – Perfectionism-related functional impairments item.

Secondary clinical outcomes from baseline (T1) to post-treatment (T2)

Within the App group, results of a series of ANOVAs indicated a significant reduction in symptoms between T1 and T2 were found on the VAS Perfectionism-related emotional burden (VAS-Emotional; $p < .001$, $d = -.82$), DASS-Stress ($p = .02$, $d = -.52$) and on the CSS ($p < .001$, $d = -.96$). No significant differences were found within the App group on the OCI-12 Total Score ($d = -.42$), DASS-Anxiety ($d = -.40$) and DASS-Depression ($d = -.21$). Within the Control group, no significant changes between T1 and T2 were found across all outcome measures.

To examine changes across time and between the treatment groups during the treatment trial (T1–T2) on secondary clinical outcome measures, a series of two-way mixed repeated measures ANOVAs were conducted, examining the main and interaction effects (group \times time). On the VAS-Emotional outcome, there were significant main effects of time ($F[1.80, 122.89] = 7.24$, $p = .01$) and group ($F[1, 68] = 5.06$, $p = .03$), but no significant Group \times Time interaction effect was found ($F[1.80, 122.89] = 1.87$, $p = .16$, $\eta^2 = .10$), see Figure 4a. Similarly, the DASS-Anxiety subscale indicated a significant main effect of time ($F[1.78, 121.28] = 5.28$, $p = .01$) and group ($F[1, 68] = 4.55$, $p = .04$), but no significant Group \times Time interaction was found ($F[1.78, 121.28] = .87$, $p = .41$, $\eta^2 = .07$), see Figure 4b. A significant main effect of group was found for the DASS-Depression subscale ($F[1, 68] = 4.44$, $p = .04$) but no significant main effect of time ($F[1.90, 129.73] = 1.00$, $p = .36$) and Group \times Time interaction ($F[1.90, 129.73] = .21$, $p = .80$, $\eta^2 = .05$), were found see Figure 4c. There was a significant main effect of time ($F[2, 136] = 3.53$, $p = .03$) but no significant main effect of group ($F[1, 68] = 1.67$, $p = .20$) and Group \times Time interaction ($F[2, 136] = 1.38$, $p = .25$, $\eta^2 = .04$) were found on the DASS-Stress subscale; see Figure 4d. In terms of the OCI-12 Total score no significant main group effect was found ($F[1, 68] = 1.47$, $p = .23$), but there was a significant main effect of time ($F[1.72, 112.81] = 6.25$, $p < .001$), and Group \times Time interaction ($F[1.72, 112.81] = 4.95$, $p = .01$) where the App group exhibited a greater reduction on this outcome measure with a medium effect size ($\eta^2 = .07$) see Figure 4e. Further, in evaluating change over time in stress related to COVID-19, a significant main effect of time was observed ($F[1.42, 98.07] = 31.91$, $p < .001$) with a non-significant main effect for group ($F[1, 68] = .11$, $p = .74$). However, there was a significant Group \times Time interaction (CSS: $F[1.48,$

TABLE 3 Primary and secondary outcome measures over time.

	App (n = 35)			Waitlist (n = 35)		
	Pre (T1)	Post (T2)	FU (T3)	d T1-T2	d T1-T3	d T1-T3
FMPS-CM	36.48 (5.29)	29.34 (6.61)	29.42 (6.48)	-1.19	-1.19	.01
VAS-Functional	48.78 (23.60)	37.22 (22.84)	36.91 (22.74)	-.49	-.51	-.25
VAS-Emotional	57.46 (22.96)	39.69 (20.02)	39.03 (19.92)	-.82	-.85	-.25
DASS-21 Dep	9.02 (4.53)	7.96 (4.98)	8.38 (5.68)	-.21	-.12	-.14
DASS-21 Anx	8.55 (4.45)	6.75 (4.50)	6.17 (4.24)	-.40	-.54	-.21
DASS-21 Stress	11.29 (3.78)	9.18 (4.25)	9.52 (4.96)	-.52	-.40	-.19
OCI-12	20.44 (8.30)	16.76 (9.05)	14.03 (8.25)	-.42	-.77	-.00
CSS	40.34 (22.52)	23.20 (11.21)	18.44 (12.12)	-.96	-1.21	-.43

Abbreviations: CSS, Covid Stress Scale; DASS-21 Anx, DASS anxiety subscale; DASS-21 Dep, DASS depression subscale; DASS-21 Stress, DASS stress subscale; DASS-21, Depression Anxiety and Stress Scale 21 items; FMPS-CM, Frost Multidimensional Perfectionism Scale concern over mistakes and doubts about actions subscale; OCI-12 Total, The Obsessive-Compulsive Inventory-Scale 12 Items; VAS Emotional, Perfectionism-related emotional burden; VAS-Functional – Visual analogue scale, perfectionism-related functional impairments item.

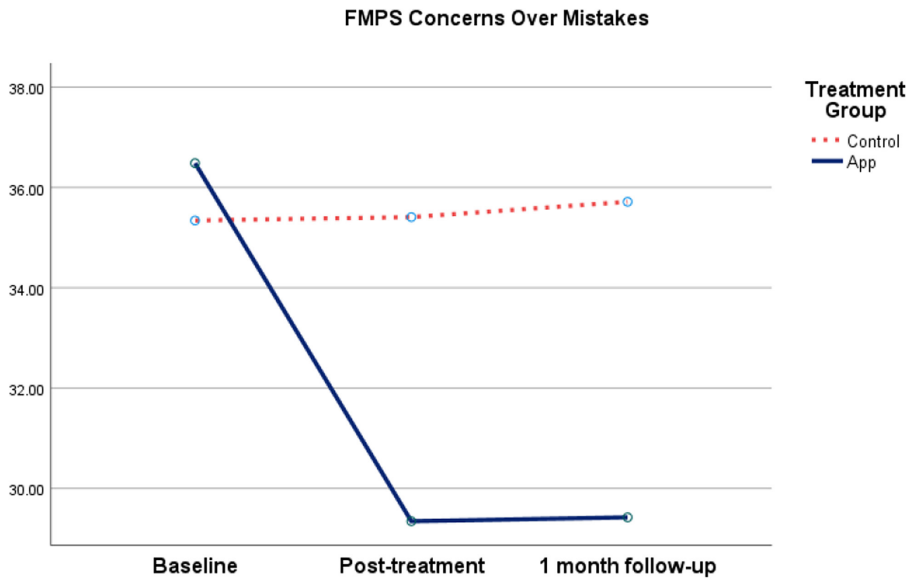


FIGURE 3 Primary clinical outcome: concern for mistakes, at baseline, post-treatment and one-month follow-up.

101.10] = 5.40, $p = .01$), where the App group reported a significantly greater reduction in COVID-19 stress symptoms, associated with a medium effect size ($\eta^2 = .07$); see [Figure 4f](#).

Secondary functional indices from baseline (T1) to post-treatment (T2)

To examine changes in functional outcomes during the treatment period (T1–T2), a series of repeated measures ANOVAs were conducted within the App group on the BFIS, and the VAS-Functional outcomes. Within the App group, significant reductions in symptoms between T1 and T2 were found on the BFIS Mean of 14 items ($p < .001$, $d = -.48$) and on the VAS-Functional ($p = .03$, $d = -.49$) and specifically for the following domain items: Home-family ($p < .001$, $d = .61$), Home-chores ($p < .001$, $d = .80$), Money-management ($p = .01$, $d = .51$), Daily responsibilities ($p = .06$, $d = .65$) and Health maintenance ($p = .02$, $d = .66$). No significant differences were found within the App group on Work ($d = .35$), Social strangers ($d = .43$), Social friends ($d = .40$), Community activities ($d = .03$), Education ($d = .14$), Marriage/dating ($d = .28$), Driving ($d = .36$), Sexual relations ($d = .09$) and Self-care routines ($d = .41$, see [Table S1](#)).

Results from a series of two-way mixed repeated measures ANOVAs indicated a significant Group \times Time interaction ($F[1.63, 91.55] = 3.34$, $p = .05$), where the App group reported a significant improvement in terms of overall functional impairments (BFIS), with a small effect size ($\eta^2 = .04$), see [Figure 5a](#). BFIS domain analyses revealed significant Group \times Time interactions for Home-chores ($F[2, 112] = 5.60$, $p < .001$), Community activities ($F[2, 112] = 4.95$, $p = .01$), Daily responsibilities ($F[2, 112] = 4.19$, $p = .02$) and Health maintenance ($F[2, 112] = 1.54$, $p = .22$) where the App groups demonstrated significant improvement on these outcomes over and above the control group. Finally, no significant interaction effect was found for the VAS-Functional item $F[1.68, 94.40] = .88$, $p = .41$, $\eta^2 = .00$), see [Figure 5b](#).

Primary outcomes at 1-month follow-up

Further analyses were conducted to determine whether significant pre-post changes were maintained at 1-month follow-up (T3). No significant changes between T2 and T3 were observed on the FMPS-CM

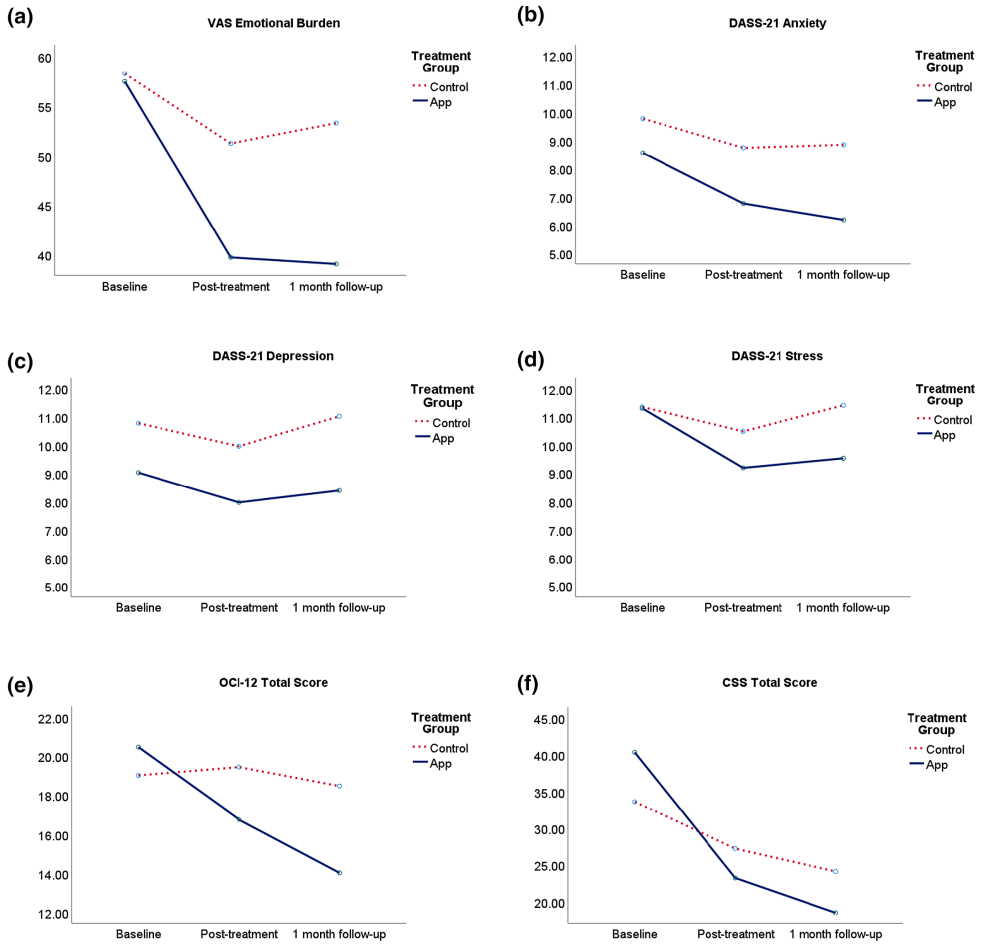


FIGURE 4 Secondary clinical outcomes at baseline, post-treatment and one-month follow-up. CSS, Covid Stress Scale; DASS-21, Depression Anxiety and Stress Scale-21; OCI-12 Total, The Obsessive-Compulsive Inventory-Scale 12 Items total score; VAS Emotional Burden, a visual analogue scale assessing emotional burden exclusively associated with perfectionism.

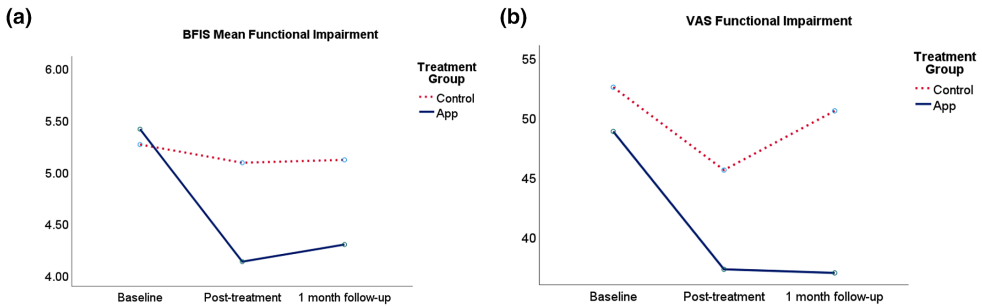


FIGURE 5 Secondary functional outcomes at baseline, post-treatment and one-month follow-up. BFIS, Barkley Functional Impairment Scale; VAS Functional Impairment, a visual analogue scale assessing functional impairments exclusively associated with perfectionism.

($p = .92$, $d = .01$, [Table 3](#)). Numerically, there was a reduction of 7.06 points within the App group on the CM at follow-up (from T1 to T3), which is larger than the Reliable Change Criterion, which was calculated at 5.97 points.

Secondary clinical outcomes at 1-month follow-up

Within the App group, there were no significant changes found between T2 and T3 on the OCI-12 total score ($d = -.31$), the VAS Emotional item ($d = -.03$) or the DASS-Anxiety ($d = -.13$), Depression ($d = .07$) and Stress ($d = -.07$) scales. A significant reduction was found on the CSS ($p = .01$, $d = -.40$), where the App group exhibited significantly lower scores at follow-up compared with post-treatment, with a small effect size ([Table 3](#) and [Figure 4e](#)). No Group \times time interactions were found on any of the secondary outcomes from t2 to t3.

Secondary functional indices at 1-month follow-up

At 1-month follow-up, no further significant changes were found for the mean BFIS ($d = .08$) and the VAS-Functional item ($d = -.01$), indicating that changes in this group were maintained at follow-up. In terms of the BFIS functional domains, a significant reduction was found, however, only for Community activities ($p = .05$, $d = .38$), indicating further improvement at follow-up compared with post-treatment within the App group. Further, a significant Group \times Time interaction was found for Community activities ($F[1, 56] = 7.93$, $p = .01$). These results indicated that the App group demonstrated a significantly greater reduction on this measure, with a medium effect size ($\eta^2 = .12$).

DISCUSSION

The aim of the present study was to evaluate the efficacy of a low-intensity gamified mobile app (GGTude, 2021) designed to improve symptoms of perfectionism and related maladaptive thinking. Compared with participants in the control group, App users exhibited significant improvements in Concerns Over Mistakes (CM) at post-treatment, with a large effect size (App Group $d = -1.19$). This effect was not found in the waitlist control group, where the effect size for CM was negligible (Waitlist Group $d = .01$). Moreover, the treatment effect on the CM outcome was determined to be a reliable change that exceeded the minimum reliable change index criterion.

While both face-to-face and low-intensity web-based CBT interventions for perfectionism utilize formal exercises and skills, including but not limited to thought records and behavioural exercises, the gamified app does not include traditional elements of CBT. Despite this, the present study yielded a similar effect size for perfectionism compared to some face-to-face (e.g., $d = -1.22$; Egan, van Noort, et al., 2014) and web-based CBT interventions (e.g., $d = .99$; Rozental et al., 2017; $d = 1.10$; Wade et al., 2019). Furthermore, similar to internet-based CBT interventions (Zetterberg et al., 2019), as well as traditional interventions for perfectionism, gains were maintained at one-month follow-up on the primary outcome measures (Egan, van Noort, et al., 2014; Radhu et al., 2012). Our results also revealed that several minutes a day of using the GG OCD app resulted in significant reductions in subjective ratings of emotional burden stemming directly from perfectionism, which was associated with a large effect size ($d = -.82$) and was maintained at one-month follow-up ($d = -.85$). The wait list group's effect sizes, on the other hand, were small at post-treatment, with a slight decline at follow-up ($d = -.25$ and $-.19$, respectively). These findings are important due to the unique nature of this app-based intervention, which is designed to be extremely brief (3–5 min a day) and gamified with no outside exercises (e.g., reading, thought monitoring, behavioural experiments) required.

In terms of secondary clinical indices, no significant improvements in depression, stress, or anxiety symptoms were found in the App group post-treatment. While this is in line with one previous study that found that guided iCBT for perfectionism did not significantly improve depression, stress, or anxiety symptoms post-intervention (Shafran et al., 2017), most studies demonstrated significant reductions in these symptoms at post-treatment and were maintained at follow-up (Grieve et al., 2022; Rozental et al., 2017; Shu et al., 2019; Valentine et al., 2018; Wade et al., 2019). However, it is important to note that the app focuses specifically on perfectionism and does not provide general education about the cognitive model or traditional CBT exercises. As such, it is not surprising that these symptoms were not improved to the extent frequently seen in face-to-face and web-based CBT. Interestingly, significant improvements in overall OCD symptoms were found for the app group compared with the control group at post-treatment ($d = -.42$ vs. $.00$) and at follow-up ($d = -.77$ vs. $-.05$), which is consistent with previous studies. For example, a CBT intervention for clinical perfectionism in an OCD sample demonstrated significant reductions in OCD symptoms (Sadri et al., 2017).

Finally, we were interested in examining the impact of this App-based treatment on everyday functioning. At baseline, no differences were observed between the groups with regard to everyday functioning as measured by the BFIS or the VAS item pertaining to everyday dysfunction directly attributed to perfectionism. According to the BFIS norms, both groups had elevated levels of functional impairments (overall determined as borderline impairment level; Barkley, 2011). Post-intervention, the App group demonstrated a significant reduction in functional impairment across domains associated with completing daily responsibilities, including the Home-Family, Home-Chores, Money Management, Daily Responsibilities, and Health Maintenance, with medium to large effects (d range = $-.58$, $-.80$) that largely persisted at follow-up. No significant changes were found among the control group on any of the BFIS outcomes. Given that perfectionism is a performance-based construct (Frost et al., 1990; Sirois & Molnar, 2016), it is not surprising that significant reductions were found across these domains but not on other domains (e.g., Community Activities, Sexual Relations). As research has demonstrated that clinical perfectionism interferes with functioning and consequently leads to further significant distress (Shafran & Mansell, 2001), these findings cement the beneficial impact of the GG OCD app on functional impairments that stem from perfectionism. This is of importance given that only a few studies have examined the impact of CBT for perfectionism on everyday functions. However, our findings are consistent with studies pointing to functional improvement following treatment for perfectionism (e.g., Ong et al., 2019).

Limitations

This study has several strengths, including its methodology (i.e., randomized controlled trial) and being the first study to examine the efficacy of a mobile application specifically designed to treat perfectionism. However, the present study is not free of limitations. First, the study had a plurality of female participants (85.7%), which may hinder generalizability. However, it should be noted that the percentage of female participants in the current study is similar to other RCTs for perfectionism (e.g., Grieve et al., 2022; Rozental et al., 2017). Future studies would benefit from including a more sex and/or gender-balanced sample. Second, our study did not include a traditional wait-list control group in that participants in the control group were not informed that they were participating in a clinical trial. Although control group participants were offered the app after the study had concluded, not informing control participants that they were taking part in a clinical trial may theoretically impact the study's results given the lack of expectancy effect in the control group. However, it has been demonstrated that waitlist control conditions typically display minimal changes in results, even when informed of their condition (Smits & Hofmann, 2009). Further, RCTs have reported negligible effects of classic waitlist control conditions (e.g., Riley et al., 2007; Steinert et al., 2017) and a recent meta-analysis of CBT for perfectionism demonstrated that the aggregated effect size across studies for the FMPS-CM was found to be .9 after controlling for the waitlist effect, which is similar to the results of the present study. Another limitation of this study is that one item from the BFIS was not included

due to a technical error. Therefore, only 14 out of the 15 items were presented to participants. However, as stated previously, the measure was designed for items to represent standalone domains and can be computed individually to obtain individual domain scores, including itemized norms (Barkley, 2011). Finally, the current study was conducted during COVID-19 and may have impacted results across our study. However, the utilization of a psychometrically valid COVID Stress Scale (Taylor et al., 2020) to assess the relative impact of pandemic-related stress demonstrated that it did not affect the result of this study in any meaningful way. Given that the two groups did not differ on COVID-related stress at baseline and that both groups exhibited consistent reductions at post-treatment and at follow-up, the greater reduction on this measure in the App group can be speculatively explained by the fact that the App groups demonstrated a significant reduction in perfectionism and related symptoms that may indirectly alleviate the extent of distress experienced due to the pandemic.

CONCLUSION

The current study shows that a brief (3–5 min) daily app-based game-like intervention that targets maladaptive perfectionistic beliefs and dysfunctional automatic thoughts in students is associated with significant improvements in perfectionism, as well as related symptoms (e.g., obsessive-compulsive symptoms, anxiety) and everyday functions. Overall, our findings clearly indicate that this type of low-intensity intervention may be a viable, low-cost alternative to traditional CBT treatments for vulnerable populations across college campuses.

AUTHOR CONTRIBUTIONS

Amitai Abramovitch: Conceptualization; writing – original draft; supervision; formal analysis; methodology; investigation; visualization. **Akuekege Uwadiae:** Conceptualization; writing – original draft; formal analysis; methodology; investigation; project administration. **Anthony Robinson:** Writing – original draft; visualization; methodology.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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