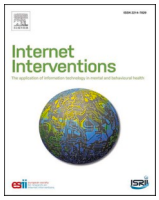
Internet Interventions 39 (2025) 100803

Contents lists available at ScienceDirect

Internet Interventions

journal homepage: www.elsevier.com/locate/invent



Long-term outcomes of smartphone-delivered cognitive behavior therapy for body dysmorphic disorder: A one-year naturalistic follow-up

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ARTICLE INFO

Keywords:
Body dysmorphic disorder
Cognitive-behavior therapy
Follow-up
Smartphone
Apps
Digital

ABSTRACT

Background: Body dysmorphic disorder (BDD) is an often chronic and impairing psychiatric condition. Research shows that smartphone-delivered cognitive behavior therapy (CBT) with coaching may be a scalable and effective treatment for BDD. However, evidence for long-term gain maintenance is limited.
Objectives: The aim of the current study was to examine the long-term outcomes of a smartphone-based CBT for BDD.
Method: Adults with a primary diagnosis of BDD who completed a 12-week course of smartphone-delivered CBT with coach support were evaluated 3- and 12-months posttreatment. Symptom severity, remission and responder status were assessed with the clinician-rated Yale-Brown Obsessive-Compulsive Scale modified for BDD (BDD-YBOCS). Secondary outcomes were also evaluated and included BDD-related insight, depression, functioning and quality of life. Data were analyzed using four different approaches to missing data, with maximum likelihood estimation as the main approach.
Results: There was significant attrition from posttreatment ($n = 57$) to 3-month ($n = 49$) and 12-month ($n = 33$) follow-up. The mean BDD-YBOCS severity score remained stable during the follow-up period [Estimated Mean (SE) at posttreatment, 3-months, and 12-months = 18.7(1.1), 18.9(1.2) and 18.8(1.3), respectively]. The proportion of participants responding to treatment and in remission remained relatively unchanged as well (63 % responders and 46 % remitters at posttreatment, 54 % and 35 % at 3-month follow-up, and 61 % and 37 % at 12-month follow-up, respectively). Posttreatment gains in BDD-related insight, functioning, and quality of life were maintained; there were small increases in depression (ES = 0.36) from posttreatment to 12-month follow-up.
Conclusions: Improvements after coach-supported smartphone-based CBT for BDD are maintained one year after treatment.

1. Introduction

Body dysmorphic disorder (BDD) is characterized by a distressing or impairing preoccupation with perceived flaw(s) in appearance that are not observable or appear slight to others (APA, 2022). BDD is often a severe condition associated with a marked impairment in functioning, poor insight, and suicidality (Snorrason et al., 2019, 2020; Toh et al., 2017). Naturalistic cohort studies have shown that BDD commonly has a chronic, unremitting course if untreated (Phillips et al., 2013).

Several controlled clinical trials have shown that therapist-delivered CBT and cognitive therapy is effective in reducing symptoms of BDD in adults and adolescents (e.g., Enander et al., 2016; Greenberg et al., 2016; Mataix-Cols et al., 2015; Ritter et al., 2022; Veale et al., 2015; Wilhelm et al., 2019), with moderate to large effect sizes (e.g., Harrison et al., 2016). In the largest controlled trial conducted to date, Wilhelm et al. (2019) found that a therapist-delivered CBT was more effective than supportive therapy (see Wilhelm et al., 2019; Weingarden et al., 2021). At posttreatment, 68 % of participants in the CBT group (vs. 42 % in the supportive therapy group) were in full or partial remission, defined as a score of ≤16 on a 0–48 point severity scale – i.e., the Yale-Brown Obsessive-Compulsive Scale modified for BDD (BDD-YBOCS). Moreover, 84 % in the CBT group had experienced treatment response

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https://doi.org/10.1016/j.invent.2025.100803
Received 3 September 2024; Received in revised form 14 December 2024; Accepted 21 January 2025
Available online 22 January 2025

(vs. 58 % in the supportive therapy group), which was defined as at least 30 % reduction in BDD-YBOCS scores from baseline. These findings suggest that many individuals with BDD receive meaningful benefit from CBT when delivered by a trained therapist.

However, most people with BDD do not have access to therapist-delivered CBT (Wilhelm et al., 2020a, 2020b). A major barrier to dissemination is the high cost of clinician-delivered treatment, and limited availability of trained clinicians. A growing literature has shown that smartphone-delivered CBT implemented with a support from a coach may be a scalable and effective treatment option for a range of psychiatric disorders (Bernstein et al., 2022). In a recent waitlist-controlled trial, Wilhelm et al. (2022) examined the efficacy of a 12-week CBT for BDD delivered via a smartphone app with light-touch support from bachelor-level coaches. At posttreatment, 65 % were classified as treatment responders and 52 % were in full or partial remission, compared to 8 % and 14 % in the waiting list condition. These results suggest that smartphone-delivered CBT with support from a non-clinician can achieve meaningful improvement in symptoms for many people with BDD.

However, no study to date has examined long-term outcomes after coach-supported smartphone-based CBT for BDD. Previous studies have demonstrated good long-term gain maintenance after therapist-

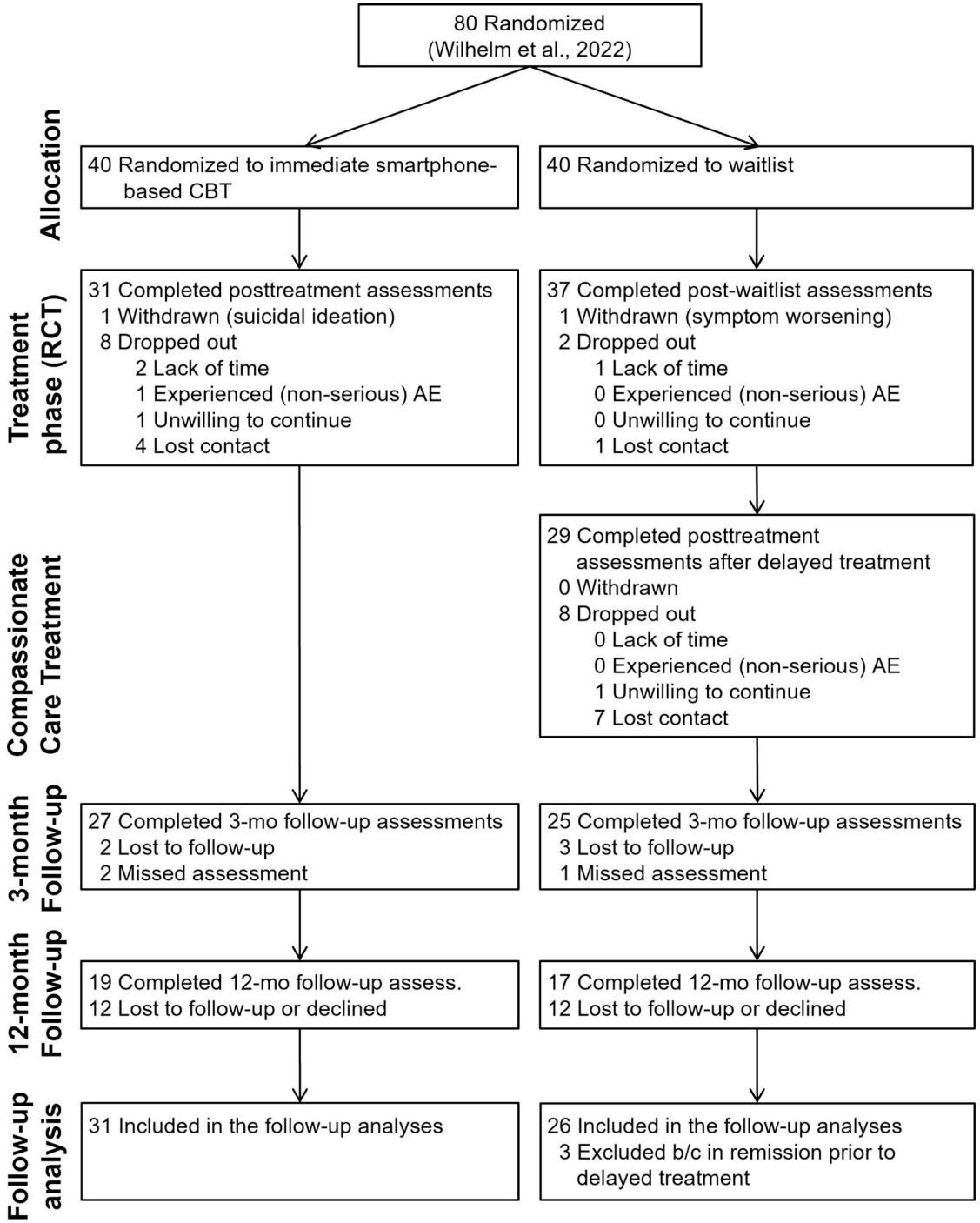

Fig. 1. Flow of participants with body dysmorphic disorder through a waitlist-controlled trial and follow-up. Participants in the waitlist were offered CBT at the end of the waitlist period. Participants in both groups were asked to complete follow-up assessments 3 and 12 months after completing CBT. Numbers for each follow-up time-point account for all participants who completed posttreatment assessments.

supported CBT for BDD delivered in-person as well as via the internet (Enander et al., 2019; Krebs et al., 2017; McKay, 1999; Rautio et al., 2023; Veale et al., 2015). For example, Enander et al. (2019) found good long-term gain maintenance of primary and secondary outcomes after CBT for BDD delivered over the internet with light touch support from a therapist. In the current study, we conducted a one-year naturalistic follow-up of participants in the Wilhelm et al. (2022) trial, which included smartphone-based CBT with light touch support from bachelor-level coaches. The original trial randomized adults with BDD to 12-week smartphone-based CBT (immediate treatment) or a 12-week waitlist with an opportunity to complete the smartphone-based CBT afterwards (delayed treatment). In the current study, we conducted follow-up assessments at 3 and 12 months after completion of the smartphone-based CBT intervention in both groups. Given previous studies demonstrating good long-term gain maintenance after therapist-supported CBT for BDD (e.g., Enander et al., 2019), we expected gain maintenance in primary and secondary outcomes over the one-year follow-up after coach guided smartphone-based CBT.

2. Method

2.1. Participants

A total of 80 adults with a primary diagnosis of BDD living in the U.S. enrolled in the original waitlist-controlled trial (see Wilhelm et al., 2022). Thereof, 20 (25 %) dropped out prior to completion of the end-of-treatment assessment, and three (4 %) were in remission following the waitlist period and thus not symptomatic when beginning the smartphone-based CBT. The current analyses included the 57 (71 %) participants who completed the end-of-treatment assessment following smartphone-based CBT (either in the immediate treatment group or after waitlist) and were not in remission at the start of delayed CBT after the waitlist (Fig. 1). In this sample, 50 (88 %) were assigned female sex at birth and seven (12 %) male sex. One participant assigned female sex at birth identified as a non-binary or transgender person. Most of the sample endorsed Non-Hispanic/Latinx ethnicity and White race ($n = 37$, 65 %). Other racial/ethnic categories endorsed were Hispanic/Latinx ($n = 4$, 7 %%), Asian/Asian American ($n = 9$, 16 %), and mixed race/ethnicity ($n = 7$, 12 %). The average age in the sample was 27.7 years (SD = 10.5) and 19 (33 %) participants were taking a stable dose of psychiatric medication at baseline (i.e., no medication or dosage change in the 8 weeks prior to eligibility screening). During the follow-up period, 21 % of participants sought psychosocial treatment, and 25 % started or changed the dose of psychiatric medications (see details in section 3.5).

2.2. Measures

2.2.1. Yale brown obsessive compulsive scale modified for BDD (BDD-YBOCS)

The BDD-YBOCS is a 12-item semi-structured clinician-administered interview designed to assess BDD symptom severity in the past week. Items are rated on a 5-point scale (0–4) and summed for a total score, ranging from 0 to 48, with higher scores indicating more severe BDD symptoms. Previous research has shown that this instrument has acceptable psychometric properties (Phillips et al., 2014; Snorrason et al., 2024). In the current sample, the BDD-YBOCS total score had acceptable internal consistency (α range: 0.64 at baseline to 0.92 at 3-month follow-up).

2.2.2. Brown assessment of beliefs scale (BABS)

The BABS is a 7-item semi-structured clinician-administered interview designed to assess insight/conviction of dysfunctional beliefs across a range of disorders. When administered to individuals with BDD, the interview focuses on BDD-related beliefs (e.g., "I look hideous"). The first six items are summed for a total insight score (ranging from 0 to 24; higher scores indicate poorer insight). The seventh item assesses ideas of reference and is not included in the total score. The BABS has been shown to have acceptable psychometric properties among BDD patients (Phillips et al., 2013), and the internal consistency of the 6-item total score in the current study was adequate (α range: 0.75 at baseline to 0.92 at 3-month follow-up).

2.2.3. Quick inventory of depressive symptomatology- self report (QIDS-SR)

The QIDS-SR is a 16-item questionnaire designed to measure the severity of major depressive disorder symptoms. The items cover the nine DSM symptom criteria that define major depressive episodes. Items refer to the past week and are rated on a 0–3 scale. A total score is obtained by converting the responses to the 16 items into the nine DSM symptom criteria. Thus, the total score ranges from 0 to 27, with higher scores indicating more severe depressive symptoms. The QIDS-SR has been shown to have good psychometric properties (e.g., Rush et al., 2006). In the current sample, the scale had acceptable internal consistency (α range: 0.68 at baseline to 0.78 at 3-month follow-up).

2.2.4. Sheehan disability scale (SDS)

The SDS is a 3-item self-report measure of functional impairment in occupational, social, and family domains. The items are rated on a Likert scale ranging from 0 (not at all) to 10 (extremely), with a total score ranging from 0 to 30, with higher scores indicating greater disability. The scale had acceptable internal consistency in the present sample (α range: 0.65 at week 6 to 0.85 at 3-month follow-up) and has been shown to have good psychometric properties (Sheehan et al., 1996).

2.2.5. Quality of life enjoyment and satisfaction questionnaire – short form (Q-LES-Q-SF)

The Q-LES-Q is a widely used self-report measure of subjective quality of life indicated by satisfactions with various life domains (e.g., physical health, mood, relationships etc.). The instrument includes 16 items that are rated on a 5-point scale. The scoring of the Q-LES-Q-SF involves summing the first 14 items to yield a total score. The total score ranges from 14 to 70 and is expressed as a percentage (range 0–100) based on the maximum total score of the items completed. Higher scores correspond with greater ratings of quality of life. The Q-LES-Q-SF has been shown to have good psychometric properties (Endicott et al., 1993). In the current study, the internal consistency of the total score was high (α range: 0.85 at baseline to 0.92 at 3-month follow-up).

2.2.6. Client satisfaction questionnaire (CSQ-8; Attkisson and Zwick, 1982)

The CSQ-8 is an 8-item self-report scale designed as a brief global measure of client satisfaction. The items are rated on a 1–4 Likert scale and are summed for a total score ranging from 8 to 32, with higher scores indicating greater satisfaction. The internal consistency of the CSQ-8 in the current sample at end-of-treatment was excellent ($\alpha = 0.94$).

2.3. Intervention

The 12-week smartphone-based CBT program was supported by Perspectives digital service (https://koahealth.com), which consisted of a user-facing smartphone CBT app and a coach-facing online dashboard (Wilhelm et al., 2020a, Wilhelm et al., 2022). The smartphone app included psychoeducation material and interactive exercises based on CBT principles (e.g., cognitive restructuring, exposure and response prevention, mindfulness, and attentional/mirror retraining). Each participant was assigned a bachelors-level coach who monitored progress on the dashboard and provided support and coaching via secure, asynchronous in-app messaging and up to two brief phone calls. The coaches received training and group supervision from licensed psychologists. Participants had access to the smartphone app (without

coach support) during the 3-month follow-up period.

2.4. Procedure

The original trial and the current study were approved by the Mass General Brigham Institutional Review Board and registered with ClinicalTrials.gov (Identifier: NCT04034693). Study data were collected from 09/17/2019 to 08/08/2022. Study data were collected and managed using REDCap electronic data capture tools (Harris et al., 2019) hosted at Massachusetts General Hospital. The research team was based in Boston, Massachusetts, but participants were recruited across the U.S (e.g., through online advertisement on social media, patient advocacy websites etc.). Assessments were conducted via HIPAA-compliant videoconferencing or telephone. Participants signed informed consent prior to undergoing study procedures. The 12-month follow-up was not part of the initial design. Thus, participants were contacted during or after participation in the trial and invited to participate in the 12-month follow-up assessment, in addition to the originally planned 3-month follow-up. To schedule follow-up assessments, research coordinators reached out via email initially; participants who did not respond were followed up with a minimum of three times by phone, email, or both. The semi-structured interviews were administered by clinicians who were blinded to the participants' study condition during the treatment phase, then unblinded during the follow-up phase. At each assessment point, the clinicians inquired about adverse events and the use of psychiatric medications or psychosocial interventions since the last visit. Further details about the intervention and study design are available in Wilhelm et al. (2022).

2.5. Data analyses

All analyses were performed in SAS version 9.4 (SAS Institute Inc). Data from the immediate and delayed CBT groups were collapsed into one sample. We examined change in the five continuous outcome measures across five time points. We used separate generalized linear mixed models (GLMM) to examine the effects of time (categorical; baseline, mid-treatment, end-of-treatment, 3-month follow-up, and 12-month follow-up), treatment group (immediate vs. delayed smartphone-based CBT) and their interaction on each of the outcomes (primary: BDD-YBOCS; secondary: BABS, QIDS-SR, SDS, and Q-LES-Q-SF). Repeated measures over time were modeled with an unstructured covariance matrix, and each model was adjusted for the stratification variable (psychotropic medication use at baseline). We used post-hoc comparisons to test two main hypotheses: (1) symptom scores at 3-month follow-up are not significantly different from posttreatment scores; (2) symptom scores at 12-month follow-up are not significantly different from posttreatment scores. In addition, we examined if symptom scores at 12-month follow-up were significantly different from baseline. To examine the sensitivity of the results to different missing data approaches, we analyzed the results in four ways: (1) maximum likelihood estimation (main models), (2) completers only, (3) last observation carried forward (LOCF), and (4) with multiple imputation. The completers-only analysis used data from 33 participants who completed the 12-month follow-up assessment; all other scenarios used the analytic sample of end-of-treatment assessment completers ($n = 57$) who had not been in remission at the start of treatment. Details about the multiple imputation process are described in the Supplementary materials. The results from the maximum likelihood analyses are presented as the main results throughout, with additional insights drawn from other modeling approaches in the text and presented in full in supplementary tables. Effect sizes (ES) for the treatment effect in these within-subjects analyses were calculated based on Feingold (2009) using model estimated pre- and post-marginal means (EMM) and using the analysis sample baseline standard deviation for each outcome; confidence intervals for effect sizes were estimated using the SAS macro by Hess and Kromrey (2003). Additionally, we examined changes in responder and remission status. Consistent with previous literature (de la Cruz et al., 2021), full or partial remission was defined as a score of 16 or lower on the BDD-YBOCS, and treatment response was defined as at least 30 % reduction in BDD-YBOCS from baseline.

We examined predictors of attrition by the 12-month follow-up assessment via a stepwise logistic regression model, modeling the probability of attrition as the outcome and evaluating the following predictors: (a) age, (b) male sex at birth (vs. female), (c) racial or ethnic minority (i.e., non-White race or Hispanic ethnicity vs. White, non-Hispanic), (d) baseline psychotropic medication use (yes vs. no), (e) immediate vs. delayed treatment, (f) active in study when offered 12-month follow-up vs. not, (g) start or increase in medication or therapy (including planned changes; vs. no change), (h) baseline BDD-YBOCS scores, (i) week 12 BDD-YBOCS scores, (j) week 12 responder status, (k) week 12 remission status, (l) week 12 BABS scores, (m) week 12 QIDS scores, (n) week 12 QLESQ-SF percentage scores, (o) week 12 SDS scores, and (p) week 12 CSQ-8 scores. All continuous predictors were standardized prior to entry in the model. We specified a significance level of 0.30 to allow a variable into the model and a significance level of 0.35 for a variable to stay in the model. Most predictors were weakly or moderately correlated ($|r| < 0.7$), except for posttreatment BDD-YBOCS scores, which were moderate to strongly correlated with posttreatment BABS total scores ($r = 0.70$), SDS total scores ($r = 0.75$), responder status ($r = -0.73$), and remission status ($r = -0.80$), as well as posttreatment QIDS-SR scores, which were strongly correlated with posttreatment Q-LES-Q-SF scores ($r = -0.71$) and SDS scores ($r = 0.71$).

3. Results

3.1. Participant flow

Fig. 1 shows the flow of participants through the trial. Eighty participants provided data at baseline and were randomized to smartphone-based CBT ($n = 40$) or waitlist ($n = 40$).

Of those on the waitlist, 37 accepted the smartphone-based CBT afterwards (i.e., delayed treatment group), thus a total of 77 participants initiated the smartphone-based CBT. Of the 77 who started treatment, three participants in the delayed CBT group were already in remission but still started delayed treatment (and completed posttreatment and follow-up assessments) and 17 dropped out or were withdrawn prior to the posttreatment assessment; both of these groups of participants were excluded from analysis. Thus, of the 77 who started treatment, 52 (68 %) completed the 3-month follow-up, and 36 (47 %) the 12-month follow-up (Fig. 1). Further, the intent-to-follow-up sample was 57 participants (see exclusions above), of whom 49 (86 %) completed the 3-month follow-up and 33 (58 %) completed the 12-month follow-up; 3 participants missed the 3-month follow-up but completed the 12-month follow-up (Fig. 1).

3.2. Predictors of attrition

The final stepwise regression model predicting attrition at 12-month follow-up fit reasonably well (area under the curve = 0.76) and retained three predictors: older age, treatment changes, and response status at week 12 (Table 1). Of these predictors, only age was significant, indicating that a one standard deviation increase in age (i.e., 10.5 years) was associated with a 2–3 fold increase in the odds of attrition by the 12-month follow-up assessment (OR[95 % CI] = 2.77 [1.24, 6.19]; $p = .013$). We found no evidence of a lack of fit in the selected model (Hosmer and Lemeshow goodness-of-fit test: $p = .62$). Screening all predictors in univariate logistic regression models yielded similar results (Table 1).

3.3. Primary and secondary outcomes

Table 2 shows estimated means of primary and secondary outcomes

Table 1
Predictors of attrition at the 12-month follow-up assessment.

				Univariate logistic regression models				Stepwise selection logistic regression model			
Predictors	Prevalence (%)	M	(SD)	OR	[95 % CI]		p	OR	[95 % CL]		p
Age, years, 1 SD change		27.7	(10.5)	2.28	[1.14,	4.55]	0.0196	2.77	[1.24,	6.19]	0.0133
Male sex at birth, Y/N	12			0.51	[0.09,	2.88]	0.45				
Racial or ethnic minority, Y/N	35			0.63	[0.21,	1.95]	0.43				
Baseline psychotropic medication use, Y/N	33			1.00	[0.33,	3.05]	1.00				
Immediate (vs. delayed) treatment, Y/N	54			0.74	[0.26,	2.12]	0.57				
Active in study when offered 12-month follow-up, Y/N	30			0.67	[0.21,	2.16]	0.50				
Start or increase medication or therapy (incl. planned), Y/N	16			0.34	[0.06,	1.80]	0.20	0.09	[0.01,	1.03]	0.0526
Baseline BDD-YBOCS scores, 1 SD change		29.3	(4.5)	1.42	[0.82,	2.48]	0.21				
Baseline CEQ credibility scores, 1 SD change		19.0	(3.7)	0.80	[0.47,	1.37]	0.42				
Week 12 BDD-YBOCS scores, 1 SD change		18.3	(7.7)	1.30	[0.76,	2.23]	0.34				
Week 12 responder status, Y/N	63			0.51	[0.17,	1.53]	0.23	0.45	[0.12,	1.61]	0.2176
Week 12 remission status, Y/N	46			0.76	[0.26,	2.19]	0.61				
Week 12 BABS scores, 1 SD change		9.1	(5.6)	1.11	[0.65,	1.89]	0.71				
Week 12 QIDS-SR scores, 1 SD change		7.7	(4.2)	1.42	[0.80,	2.54]	0.24				
Week 12 Q-LES-Q-SF percentage scores, 1 SD change		63.4	(15.7)	0.99	[0.56,	1.75]	0.98				
Week 12 SDS scores, 1 SD change		8.5	(6.4)	1.44	[0.81,	2.56]	0.22				
Week 12 CSQ-8 scores, 1 SD change		25.5	(5.4)	0.95	[0.54,	1.67]	0.85				

Notes: M = mean; SD = standard deviation; OR = odds ratio; CI = confidence interval; Y/N = yes or no, where predictor is modeled as yes = 1, no = 0; smartphone-based CBT = smartphone-based cognitive behavioral therapy; BDD-YBOCS = Yale Brown Obsessive Compulsive Scale Modified for BDD (range: 0–48, where higher scores indicate more severe BDD symptoms); CEQ credibility (range: 3–27, where higher scores indicate greater perceived treatment credibility); BABS = Brown Assessment of Beliefs Scale (range: 0–24, where higher scores indicate poorer insight); QIDS-SR = Quick Inventory of Depressive Symptomatology- Self Report (range: 0–27, where higher scores indicate more severe depressive symptoms); Q-LES-Q-SF = Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form (range: 0–100, where higher scores indicate higher quality of life); SDS = Sheehan Disability Scale (range: 0–30, where higher scores indicate greater functional impairment); CSQ-8 = Client Satisfaction Questionnaire (range: 8–32; higher scores indicate greater client satisfaction).

Table 2
Estimated means and mean differences (compared to posttreatment) in primary and secondary outcomes in smartphone-based cognitive behavior therapy for body dysmorphic disorder pre- and posttreatment and during the 12-month follow-up.

	N	Est. Mean (SE)		Est. Mean Diff. to Posttreatment [95 % CI]			*p*-value	ES [95 % CI]		
BDD-YBOCS										
Pretreatment	57	29.6	(0.6)	–			–	–		
Posttreatment	57	18.7	(1.1)	–			–	–		
3-months	49	18.9	(1.2)	0.2	[−1.4,	1.9]	0.76	0.06	[−0.3,	0.4]
12-months	33	18.8	(1.3)	0.1	[−2.3,	2.5]	0.94	0.02	[−0.4,	0.4]
BABS										
Pretreatment	57	14.6	(0.5)	–			–	–		
Posttreatment	56	9.5	(0.8)	–			–	–		
3-months	49	9.1	(0.8)	−0.4	[−1.6,	0.7]	0.47	−0.11	[−0.5,	0.3]
12-months	33	9.2	(0.9)	−0.3	[−1.8,	1.1]	0.65	−0.08	[−0.5,	0.4]
QIDS-SR										
Pretreatment	57	11.5	(0.6)	–			–	–		
Posttreatment	51	8.2	(0.6)	–			–	–		
3-months	46	8.3	(0.7)	0.1	[−1.1,	1.4]	0.81	0.03	[−0.4,	0.4]
12-months	31	9.7	(0.8)	1.6	[0.1,	3.0]	0.04	0.36	[−0.1,	0.8]
SDS										
Pretreatment	57	15.6	(0.9)	–			–	–		
Posttreatment	51	8.7	(0.9)	–			–	–		
3-months	46	7.6	(1.0)	−1.1	[−2.9,	0.7]	0.24	−0.16	[−0.6,	0.2]
12-months	32	7.3	(1.2)	−1.4	[−3.9,	1.1]	0.26	−0.22	[−0.7,	0.2]
Q-LES-Q-SF										
Pretreatment	57	52.8	(2.1)	–			–	–		
Posttreatment	51	63.4	(2.2)	–			–	–		
3-months	46	65.0	(2.3)	1.6	[−2.3,	5.5]	0.42	0.10	[−0.3,	0.5]
12-months	32	61.8	(2.8)	−1.6	[−7.0,	3.9]	0.56	−0.10	[−0.5,	0.3]

Notes: SE = standard error; CI = confidence interval; BDD-YBOCS = Yale Brown Obsessive Compulsive Scale Modified for BDD (range: 0–48, where higher scores indicate more severe BDD symptoms); BABS = Brown Assessment of Beliefs Scale (range: 0–24, where higher scores indicate poorer insight); SDS = Sheehan Disability Scale (range: 0–30, where higher scores indicate greater functional impairment); QIDS-SR = Quick Inventory of Depressive Symptomatology- Self Report (range: 0–27, where higher scores indicate more severe depressive symptoms); Q-LES-Q-SF = Quality of Life Enjoyment and Satisfaction Questionnaire – Short Form (range: 0–100, where higher scores indicate higher quality of life). Estimated marginal means and mean differences are based on the GLMM model of the follow-up sample (n = 57) that used maximum likelihood estimation to address missing data. Mean differences presented are post-hoc comparisons between the 3-month follow-up or 12-month follow-up vs. posttreatment means; presented with significance test and associated effect size.

across assessment points and Fig. 2 provides a visual depiction of the BDD-YBOCS severity score trajectory. Consistent with findings for the immediate treatment group in the main outcome paper (Wilhelm et al., 2022), there was a significant improvement in all measures from pre- to posttreatment in this intent-to-follow-up sample that combined the immediate and delayed treatment groups (all $p < .0001$; results not shown). Furthermore, there were no significant changes between posttreatment and 3-month, or 12-month follow-up for BDD severity, BDD-

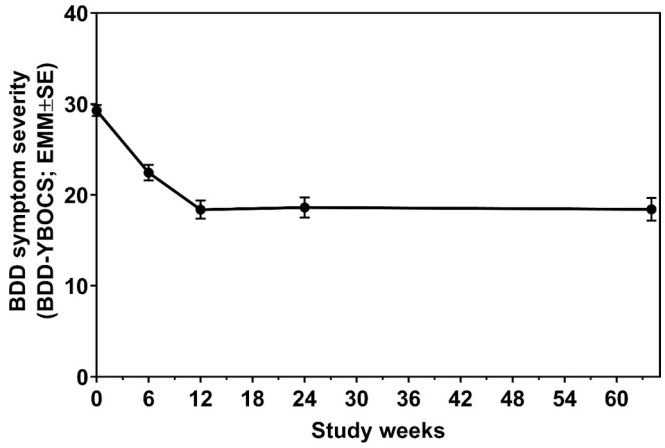

Fig. 2. Body dysmorphic disorder symptom severity (as measured by BDD-YBOCS) over time among participants who completed the posttreatment assessment at week 12. Participants received smartphone-based CBT either immediately after randomization (immediate treatment) or after a 12-week waitlist period (delayed treatment). Data shown are estimated marginal means from a model using maximum likelihood estimation in the intent-to-follow-up sample.

related insight, functional impairment, and quality of life (all $p > .20$, all $|ES| < 0.25$; Table 2). The only exception was depression severity, where depression scores were slightly higher at 12-month follow-up (EMM (SE): 9.7 (0.8)) compared to posttreatment (8.2 (0.6); estimated difference [95 % CI]: 1.6 [0.1, 3.0]; $p = .038$, ES = 0.36). The results were similar in the completers-only, LOCF, and multiple imputation models; however, the increase in depression scores from posttreatment to 12-month follow-up was not detectable in the LOCF model (Supplementary Table 1). Compared to pretreatment, improvements in BDD severity (ES = −2.40), BDD-related insight (ES = -1.39), and functional impairment (ES = −1.29) were still significant (all $p < .0001$) with strong effect sizes at follow-up, and improvements in depression severity (ES = −0.42, $p = .033$) and quality of life (ES = 0.59, $p = .001$) were still significant with moderate effect sizes (Supplementary Table 2).

3.4. Treatment response and remission status

In the sample, 63 % (36/57) of participants were considered treatment responders at posttreatment, and 46 % (26/57) were in remission. Then, depending on the missing data approach used, 52–67 % were treatment responders at the 3-month follow-up and 53–67 % were treatment responders at the 12-month follow-up (Table 3). The remission rates were 35–40 % and 37–48 % for 3-month and 12-month follow-ups, respectively. Using the completers-only data provided the highest treatment response and remission estimates at 3-month follow-up, and multiple imputation provided the highest treatment response and remission estimates at 12-month follow-up; other missing data approaches switched as to which provided the most conservative estimates (Table 3).

We also examined the trajectories of responder/remission status between posttreatment and 12-month follow-up. The results showed that 44–52 % were sustained responders (i.e., responders at posttreatment and 12-month follow-up), 9–18 % delayed responders (i.e., non-responder at posttreatment, but responder at 12-month follow-up), 18–28 % non-responders (i.e., non-responder at both posttreatment and 12-month follow-up), and 14–19 % relapsed (i.e., responder at posttreatment but not 12-month follow-up), depending on the missing data approach (Supplementary Table 3). For remission status, 28–32 % were in sustained remission, 9–20 % had delayed remission, 34–46 % never remitted, and 14–18 % relapsed, depending on the missing data approach (Supplementary Table 3).

3.5. Adverse events and treatment seeking during follow-up

For adverse events and treatment seeking during follow-up, we limit the sample to the 52 participants of the intent-to-follow-up sample who provided data for at least one follow-up assessment. There were 20 adverse events documented for 31 % (16/52) of participants during the follow-up, none of them classified as serious. These included (a) accidents, injuries, food poisoning, COVID-19, or medical problems ($n = 17$) and (b) increase in psychiatric distress such as anxiety or depression ($n = 3$). One incident of suicidal ideation was noted in the context of medication changes during follow-up; no suicidal attempts or behaviors were documented during the follow-up. Twenty-three percent (12/52) of participants had sought psychosocial treatment during follow-up; for 8 participants, the psychosocial treatment addressed BDD rarely or not at all and for 4 participants it addressed BDD about half of the time or more. Twenty-seven percent (14/52) of participants reported changing or starting psychiatric medication during the follow-up period, predominantly for indications of depression ($n = 9$; including Bipolar II), sleep ($n = 4$), anxiety (n = 3), BDD ($n = 2$), ADHD (n = 2), as well as mood, OCD, nerve pain, migraines, or panic (each n = 1).

4. Discussion

In this study, we conducted a one-year naturalistic follow-up of individuals with BDD who had completed coach-supported, smartphone-delivered, CBT in a waitlist-controlled trial. The results showed overall good maintenance of gains during the follow-up period. Symptom severity assessed with the BDD-YBOCS remained unchanged from posttreatment to the 3- and 12-month follow-up, as did BDD-related insight, overall functioning, and quality of life. Depressive symptoms also remained relatively stable, though there was a small, but statistically significant, increase in depressive symptoms from posttreatment to 12-month follow-up.

Our findings are generally in line with previous literature documenting good long-term maintenance of gains after therapist-delivered CBT for BDD. Several previous studies have followed BDD patients after

Table 3
Percent and count of participants with body dysmorphic disorder classified as having responded and remitted after smartphone-based cognitive behavior therapy.

	Posttreatment				3-Month Follow-up				12-Month Follow-up			
	Responder		Remission		Responder		Remission		Responder		Remission	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)
Maximum likelihood[a]	63	(36)	46	(26)	54	(31)	35	(20)	61	(35)	37	(21)
Completers only[b]	70	(23)	48	(16)	67	(20)	40	(12)	64	(21)	45	(15)
LOCF	63	(36)	46	(26)	54	(31)	37	(21)	53	(30)	40	(23)
Multiple imputation[c]	63	(36)	46	(26)	52	(19)	36	(20)	67	(38)	48	(27)

Notes: LOCF = last observation carried forward.
[a] using observed data where available and predicted values for missing observations ($n = 8$ had missing scores at week 24, and $n = 24$ had missing scores at week 64).
[b] missing data for 3 participants who returned for their 12-month follow-up assessment.
[c] mean count and percentage of all multiply imputed datasets.

therapist-delivered CBT for one year or longer and demonstrated good maintenance of gains across primary and secondary measures in both adolescents and adults (Enander et al., 2019; Krebs et al., 2017; McKay, 1999; Rautio et al., 2022, 2023; Veale et al., 2015). Furthermore, Enander et al. (2019) showed good maintenance of gains during 2 year follow up among adults with BDD who received internet-delivered CBT with light touch support from a therapist (BDD-NET). The current study demonstrating comparable gain-maintenance following a coach supported smartphone-delivered CBT The estimated mean BDD-YBOCS scores were almost identical to Enander et al. (2019) at pretreatment, posttreatment and 3-month follow-up, although Enander et al. (2019) observed significant reduction in scores from 3- to 12-month follow-up, whereas the current study showed no difference across 3- and 12-month follow-up.

The reasons for the slight increase in depression scores (QIDS-SR) at the 12-month follow-up in the current study are unclear. At follow-up, the scores remained in the mild range and continued to be significantly improved compared to baseline, however, there was a significant elevation from posttreatment to 12-month follow-up (although not statistically significant in the LOCF analyses). Of note, the current study was conducted during the COVID 19 pandemic, and therefore our study participants had to cope with lockdown regulations as well as potential health threats and other stressors, which might also have affected the results. Furthermore, given that scores on other outcome measures in our sample remained unchanged it is possible that this elevation reflects a normal score variations, rather than a true effect.

In this sample, older age was associated with greater attrition during the follow-up. It appears that participants in their forties and older had lower odds of completing the follow-up assessment compared to younger participants. Age did not predict outcomes or attrition during the treatment phase of this trial (Greenberg et al., 2024) and has not been associated with attrition in other long-term follow-up studies in BDD (e.g., Enander et al., 2019). Further research is needed to replicate these findings; however, future researchers may want to provide additional support for older participants to help reduce attrition during naturalistic follow-up.

Overall, the results indicate that the effects of coach-supported smartphone-based CBT tend to be durable. However, it is important to note that many BDD patients who receive CBT remain symptomatic after treatment. Like previous studies, a significant proportion of the participants were classified as non-responders at posttreatment and follow-up, suggesting they received no or modest benefit from the treatment. Research has shown that some individuals with BDD may benefit from CBT with a longer duration or greater intensity (Greenberg et al., 2022). Future researchers may want to examine the efficacy of stratified or stepped-care models in which non-responders to coach supported smartphone-delivered CBT are offered more intensive interventions (Mohr et al., 2019). Additionally, even though digitally supported CBT for BDD have shown promise in efficacy trials (e.g., Enander et al., 2016; Wilhelm et al., 2022) no study to-date has directly compared these interventions with gold standard face-to-face CBT for BDD (Wilhelm et al., 2019).

Several limitations of the current study should be considered. First, there was significant attrition in the sample from posttreatment to follow-up assessments. It is therefore possible that the follow-up sample was biased toward those with favorable long-term outcomes (e.g. in terms of symptom improvement, adverse events etc.). We analyzed the treatment outcome variables using four different missing data approaches (i.e. maximum likelihood estimation, completers only, LOCF and multiple imputations). These methods help address potential biases resulting from missing data, and we found overall similar results across approaches (see also further sensitivity analyses in Supplementary Table 3). Nevertheless, attrition remains a significant limitation of the current results, and it is important to replicate the current findings with more complete follow-up samples.

Second, although using naturalistic follow-up strengthened the external validity of the study, 21 % and 25 % received psychosocial or psychopharmacological treatment during the follow-up, respectively, we therefore cannot confidently state that the smartphone-based CBT caused sustained improvement. Third, during the follow-up phase, the independent evaluators were unblinded. This may have biased the results as both participants and evaluators may have been aware of the researcher's expectation that treatment was efficacious (Spinelli et al., 2015). Fourth, even though we achieved relatively large recruitment of racial/ethnic minorities (compared to typical clinical trials in the U.S.), non-Hispanic White women were overrepresented in the sample. The study should therefore be replicated in more racially, ethnically, and socio-economically diverse samples. Additionally, the study sample differed clinically from BDD patients in treatment settings (e.g., less depression and suicidality; Jaroszewski et al., 2024) and future replications in naturalistic outpatient clinics are warranted. Finally, participants received small monetary compensation for participating in the follow-up assessments and this may have influenced their responses.

In conclusion, smartphone-delivered CBT with coach support has been shown to be an effective treatment for individuals with a range of emotional disorders, including BDD. The current findings show that treatment effects are relatively durable over a one-year follow-up. The results add to a growing literature showing that smartphone-delivered therapies are effective and scalable interventions for BDD and other psychiatric disorders.

Funding statement

During the preparation of this manuscript, Dr. Weingarden was supported in part by the National Institute of Mental Health of the National Institutes of Health under Award Number K23MH119372 (Weingarden). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Declaration of competing interest

Dr. Snorrason, Dr. Hoeppner, Dr. Vanderkruik, Dr. Bernstein, Ms. Berger-Gutierrez and Mr. Klare have received research support from Koa Health. Dr. Weingarden has received research support from Koa Health and is a presenter for the Massachusetts General Hospital Psychiatry Academy in educational programs supported through independent medical education grants from pharmaceutical companies. Additionally, Dr. Weingarden has a consulting agreement with Hello Therapeutics, Inc. Dr. Greenberg has received research support from Koa Health and is a presenter for the Massachusetts General Hospital Psychiatry Academy in educational programs supported through independent medical education grants from pharmaceutical companies. She has also received speaking honoraria from L'Oreal (SkinCeuticals) and RBC Consultants (CeraVe) and honoraria for advisory board participation from RBC Consultants (CeraVe). Dr. Bernstein has received research support from Koa Health, and is on the advisory board for AugMend Health, Inc., and is a consultant for Otsuka Pharmaceutical Development & Commercialization, Inc. Dr. Wilhelm has received royalties from Elsevier Publications, Guilford Publications, New Harbinger Publications, Springer, and Oxford University Press. Dr. Wilhelm has also received speaking honoraria from various academic institutions and foundations, including the International Obsessive Compulsive Disorder Foundation, the Tourette Association of America and the Centers for Disease Control and Prevention, and from NAMI (National Alliance on Mental Illness). In addition, she received payment from the Association for Behavioral and Cognitive Therapies for her role as Associate Editor for the Behavior Therapy journal, as well as from John Wiley & Sons, Inc. for her role as Associate Editor on the journal Depression & Anxiety. Dr. Wilhelm has also received honoraria from One-Mind for her role in PsyberGuide Scientific Advisory Board. Dr. Wilhelm is also on the Scientific Advisory Board for Koa Health, Inc. and for Noom, Inc. Dr. Wilhelm has received

research support from Koa Health, Inc. Dr. Harrison is Founder/CEO of Koa Health Limited, a digital mental health company that collaborated with Dr. Wilhelm and her team at MGH to build Perspectives. Dr. Harrison also serves on the WHO Roster of Experts for Digital Health, sits on the Board of EMPOWER (a non-profit organization promoting the training of community health workers to provide mental healthcare), is a member of the Expert Panel for implementing the Wellcome Trust's mental health strategy, and is The Royal Society Entrepreneur in Residence in Healthcare AI at Oxford University.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2025.100803.

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