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Evaluating the effectiveness of a collaborative care digital mental health intervention on obsessive-compulsive symptoms in adolescents: A retrospective study

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Abstract

Objective: Obsessive-compulsive (OC) symptoms, characterized by distressing and repetitive thoughts and behaviors, frequently onset during adolescence for individuals with obsessive-compulsive disorder or anxiety disorders. Digital mental health interventions (DMHIs) offer a promising platform to deliver mental health treatment, which may address OC symptoms. The purpose of this retrospective study was to determine the effects of a DMHI, Bend Health, on various domains of OC symptoms, including contamination, responsibility (for harm), unwanted thoughts, and symmetry, in adolescents.

Methods: OC symptoms were assessed at baseline (before beginning care) and monthly in adolescents engaged in different care programs involving coaching and/or therapy with the DMHI. Retrospective analyses were used to identify characteristics associated with OC symptoms (N = 2151) and to characterize treatment responsiveness of adolescents with elevated OC symptoms (n = 553).

Results: Adolescents with elevated OC symptoms (32.2%; n = 693 of 2151) were more likely than those with non-elevated OC symptoms to be female ($p < .001$), to have comorbid symptoms (e.g. anxiety and depression; $p < .001$), and participate in therapy ($p < .001$). Further, their caregivers had higher rates of sleep problems and burnout ($p < .05$). OC symptoms improved for 87.7% (n = 485 of 532) of adolescents during care with the DMHI, and 46.6% (n = 249 of 534) reported clinically substantive improvement. Scores decreased significantly over months in care ($t_{1187} = -8.06$, $p < .001$). Improvements were also identified for OC symptom dimensions (contamination, responsibility (for harm), unwanted thoughts, and symmetry).

Conclusions: Our results deliver compelling preliminary evidence that participation in coaching and therapy with a DMHI may mitigate a variety of OC symptoms for adolescents. Improvements were observed across different OC symptom types, demonstrating the broad applicability of the DMHI to address various presentations and complexities of OC symptoms.

Keywords

Behavioral health coaching, therapy, cognitive behavioral intervention, intrusive thoughts, anxiety, measurement-based care

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Introduction

Obsessive-compulsive disorder (OCD) affects about 1 in 200 children and adolescents, making it one of the more prevalent mental health conditions among youth.[1] Obsessive-compulsive (OC) symptoms can vary widely, often involving distressing and repetitive thoughts

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(e.g. fears of contamination, intrusive thoughts about violence or hurting others) and behaviors (e.g. compulsive counting, excessive need to clean, reordering/rearranging rituals) that differ from person to person and may contribute to broader symptoms of anxiety. The onset of OC symptoms frequently occurs during adolescence, which is a critical developmental period when individuals form identities, build social connections, and manage academic pressures.[1,2] When left untreated, OCD during these formative years can have lasting effects, with symptoms often persisting into adulthood and impacting various areas of life, such as family relationships, social interactions, and academic and/or career performance.[3] Additionally, adolescents with untreated OCD have a more difficult time breaking OC patterns and are at higher risk for developing other psychiatric disorders in adulthood, including anxiety and depression, further exacerbating challenges in daily life.[4] Considering these potential long-term impacts, early and effective intervention is critical to improve the quality of life for adolescents with OCD.

The current standard of care for adolescents with OC symptoms typically involves cognitive-behavioral therapy (CBT) with exposure response prevention (ERP; i.e. practicing coping mechanisms with small exposures to triggers), which is considered the gold standard of treatment.[5,6] Medication (especially selective serotonin reuptake inhibitors) may also be prescribed in those with moderate to severe OC symptoms or when therapy alone is insufficient.[5] However, access to specialized OCD treatment is often limited due to a shortage of trained providers, long wait times, or geographical barriers.[7,8] Digital mental health interventions (DMHIs) are a promising approach to delivering timely and effective care for adolescents with OCD.[9–11] DMHIs make support more accessible by overcoming common barriers such as geographical limitations, scheduling constraints, stigma, and limited access to specialized providers, potentially reaching adolescents who may otherwise struggle to access traditional care to manage their OC symptoms.[11,12] While DMHIs for the treatment of OCD have shown to be feasible, acceptable, and effective in reducing overall OC symptoms,[9,13–15] they face the challenge of balancing broad applicability to a large number of people with being tailored enough to address the various symptoms of OC that adolescents typically exhibit.[16,17] For example, contamination obsessions are one of the more common OC symptoms in youth and involve fears of dirt and germs, often leading to compulsive handwashing or cleaning.[18,19] Adolescents with responsibility obsessions exhibit fears of causing harm or bad outcomes, which leads to compulsive checking to ensure safety and avoiding "bad" numbers or words. Unwanted thoughts, including aggressive and intrusive thoughts that go against one's values, often prompt mental rituals and avoidance behaviors. Similarly, adolescents with symmetry obsessions, which involve the need for completeness or exactness, often partake in compulsive arranging or repeating behaviors. Adolescents may present with diverse and multiple OC symptoms, which can pose challenges for digital treatment programs.[17] While all OCD symptoms respond to ERP,[20] individual differences in symptom presentation may still influence treatment engagement and delivery within a single digital program.

The Collaborative Care Model (CoCM) offers a potential solution for addressing the complexity of adolescent OC symptoms within a DMHI. The CoCM is an evidence-based approach that integrates primary care (e.g. with a primary care provider) with behavioral care (e.g. coaching or therapy), facilitating coordinated mental healthcare through a team-based framework.[21] The CoCM has been effectively integrated into DMHIs for treating mental health disorders like depression and anxiety by providing accessible, structured, and continuous support.[21–24] Nonetheless, its potential to address the complex and varied types of OC symptoms has not yet been fully explored.

The purpose of this retrospective study was to determine the effects of a CoCM-based DMHI, Bend Health, on various types of OC symptoms, including contamination, responsibility (for harm), unwanted thoughts, and symmetry, in adolescents. We aimed to (1) evaluate characteristics of adolescents with elevated OC symptoms (e.g. demographic factors, co-occurring mental health symptoms, participation in care, and caregiver symptoms), (2) determine the effectiveness of Bend Health's CoCM DMHI in reducing the severity of overall OC symptoms, and (3) evaluate patterns of improvement across distinct OC symptoms.

Methods

Participants and study design

Adolescent members (ages 13 to 17 at the start of care) were eligible for the study if they met the following criteria: (1) had a complete baseline assessment for OC symptoms before beginning care with the CoCM DMHI, (2) initiated care between 1 January 2023 and 1 November 2024, and (3) participated in at least one coaching or therapy session with the CoCM DMHI before 9 December 2024. As such, 2151 adolescents were eligible for inclusion in the study.

Ethical considerations

All adolescent Bend Health members and their caregivers complete informed consent to care prior to enrolling in services. The informed consent includes information about Bend Health's telehealth services, including their privacy policies. This study was classified as exempt by the Biomedical Research Alliance of New York Institutional Review Board (Study ID 23-12-034-1374) as a retrospective analysis (i.e. all data was collected as part of care) and, therefore, requirements of written informed consent for participation in this study were waived. All study data

were de-identified prior to analyses and stored on a HIPAA-compliant online drive using industry-standard encryption. Participants did not receive additional compensation for this study.

Treatment

Bend Health is a DMHI, in which the CoCM is used to integrate primary care with behavioral care for members with referral from an external provider. See Figure 1 for the flow of enrollment at Bend. During online enrollment, caregivers respond to questions about their adolescent's demographics and medical history. Caregivers and adolescents also respond to mental health assessments; details on these measures are in the "Measures" section. Adolescents and their caregiver/s then attend a synchronous video-based intake session with a behavioral care manager (BCM), who oversees care coordination, and determines their care program and treatment targets based on acuity and complexity of mental health symptoms, coverage of benefits, and treatment goals. Adolescents are assigned a behavioral health coach (herein referred to as "coach") to deliver care, and those requiring a higher level of care may also be assigned a licensed therapist. Prescribers may manage medication during care if a medication consultation is recommended (e.g. by a referring provider).

Coaches and therapists meet with adolescents in synchronous video-based sessions to deliver care that is aligned with a pre-determined care program designed to target a particular symptom domain (e.g. OCD, anxiety, or depression). Coaches are trained in behavioral health strategies including CBT, behavioral activation, motivational interviewing, caregiver training, and mindfulness-based practices. Therapists are equipped to provide diagnostic clarity and address more serious and complex behavioral and mental health challenges (e.g. trauma). While the frequency of sessions differs based on each member's treatment goals, desired services, and coverage, two coaching sessions per month are scheduled for most members. For those with a therapist on their care team, one therapy session per month is the standard frequency. Coaching and therapy sessions are typically 30 min in duration. Notably, for higher acuity cases, the frequency of coaching and therapy sessions may be increased, and therapy sessions may be extended to 45 min.

Care programs include module-based content designed to target a particular symptom or behavior in an age-appropriate manner over approximately 12 weeks. Each module includes informational content (e.g. introducing a new tool) as well as skills or homework for the adolescent to engage with outside of the session. Modules also contain content-specific instructions and support strategies for caregivers to employ. The OCD care program is intended to teach adolescents about their OC symptoms and to empower them to adopt techniques to minimize their more challenging symptoms. The program is largely founded on ERP, in which the adolescent practices employing tools to prevent an obsessive or compulsive response (e.g. ritual) through small exposures to triggers. The anxiety care program may be assigned to adolescents with anxiety or anxiety-related symptoms (including OC symptoms). The aim of this program is to help adolescents identify thoughts that contribute to their anxiety, and teach them how to address these thoughts and feelings of anxiety using skills from CBT (e.g. positive reframing). Once a care program is complete, the adolescent may remain in care if they have remaining concerns to address, at which time they will be assigned a new care program to guide treatment.

Content from the care programs is available between coaching and therapy sessions within an online learning resource center or in informational resources sent directly to the adolescent and caregiver. This additional content includes readings, guided exercises, and activities for adolescents and their caregivers to reinforce skills and techniques delivered in care sessions. To ensure safety, a caregiver must be in the same area as their adolescent child during all synchronous video-based sessions (e.g. within the same house) and may be encouraged to attend sessions with their adolescent. Caregivers and adolescents are prompted to complete mental health screeners and assessments once per month during care. Results from these assessments are reviewed by BCMs, who may adjust care plans and type accordingly. Treatment with Bend Health has also been described previously.[18,19]

Measures

At enrollment (in the online portal), caregivers report their child's date of birth (to calculate age), sex at birth (female, male, non-binary), gender identity (female, male, transgender, other), and race/ethnicity. Details about the race/ethnicity response options, as well as analytic approach for reporting these demographic characteristics, are located in the supplement. At enrollment and approximately once per month during care, caregivers and adolescents respond to screener questions and full validated questionnaires in the online portal. Screeners are intended to flag potential mental health challenges, including symptoms of OCD, anxiety, depression, attention-deficit hyperactivity disorder (ADHD), and sleep problems. If symptoms are flagged by responses to the screeners, caregivers and adolescents complete a full validated assessment. Adolescents respond to screeners and validated assessments for OCD, anxiety, depression, and sleep problems. Caregivers respond to screeners and validated assessments for their adolescent's ADHD (inattention and hyperactivity symptoms) and opposition/defiance symptoms, and their own (caregiver) sleep problems, stress, and burnout. Assessments are intended to be completed asynchronously (outside of sessions with providers). However, a coach or therapist may prompt the completion of assessments in-session if

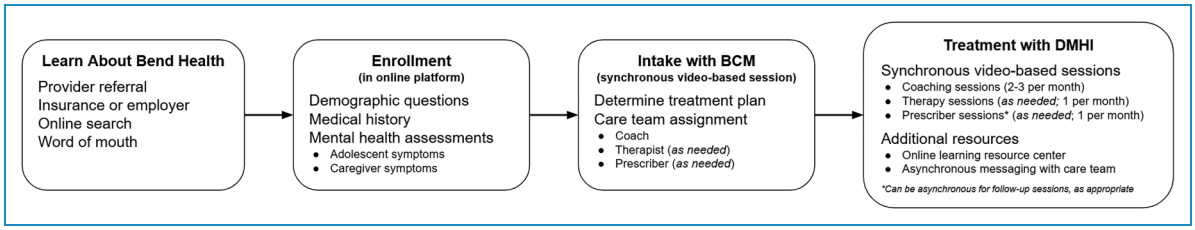

Figure 1. Flowchart of the enrollment process at Bend Health.

assessments are overdue. Details on minor methods changes to mental health screening protocols during retrospective data collection can be found in the supplement.

Obsessive-compulsive symptoms

First, to screen for elevated OC symptoms, adolescents respond to four questions derived from the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) Cross-Cutting Measure.[25] These questions ask them to report on their symptoms in the past 2 weeks, including intrusive thoughts about harm or danger, compulsive behaviors (e.g. checking things frequently), worrying about contamination, and the need to do things in a certain way. Responses are made on a 5-item Likert-type scale, ranging from "Not at all" (score = 0) to "Nearly every day" (score = 4). If the adolescent scores two or higher ("Several days" or more frequently) on any screener question, they are prompted to complete the full Dimensional Obsessive-Compulsive Scale (DOCS).[26] Otherwise, they do not take the DOCS (screen-out). The DOCS includes 20 items covering the OC symptom dimensions: contamination (items 1–5), responsibility (for harm; items 6–10), unwanted thoughts (items 11–15), and symmetry (items 16–20). For each dimension, adolescents report the following with regard to the particular problem: (1) how much time they spend thinking about the problem, (2) avoidance behaviors and thoughts, (3) how anxious or distressed they become if they have thoughts about the problem, (4) how much their daily routine is disrupted to address the problem, and (5) how difficult it is to disregard thoughts about the problem and refrain from behaviors in response to the problem. Responses are made on 5-item Likert-type scales, with responses ranging from low severity symptoms (no time/anxiety/disruption; score = 0) to severe symptoms (extreme time/anxiety/disruption; score = 4). The DOCS has an 86% accuracy for distinguishing those with diagnosed OCD from non-clinical individuals, and 77% accuracy for distinguishing those with OCD from individuals with other anxiety disorders.[26] While the DOCS was developed for use in adult populations, there is sufficient psychometric support for its use in treatment-seeking adolescents.[27]

Comorbid adolescent mental health symptoms

Adolescent anxiety and depressive symptoms are screened with the Generalized Anxiety Disorder 2-item (GAD-2) and Patient Health Questionnaire 2-item (PHQ-2), which consist of the first two items on the Generalized Anxiety Disorder 7-item (GAD-7) and Patient Health Questionnaire 9-item, adolescent version (PHQ-9A), respectively.[28,29] The GAD-2 and PHQ-2 ask adolescents to report how much or how often they have been bothered by a particular problem in the last 2 weeks. Responses are made on a 4-item Likert-type scale ranging from "Not at all" (score = 0) to "Nearly every day" (score = 3). The GAD-2 and PHQ-2 have been validated as screeners.[30,31] If the sum of scores is two or greater on the GAD-2 or PHQ-2, the adolescent is prompted to complete the remaining items on the GAD-7 and PHQ-9A, respectively. The final item on the PHQ-9A asks about suicidal ideation and is not presented to adolescents because assessments are delivered asynchronously and a member of the care team is unable to immediately intervene if a safety issue arises. Notably, while the GAD-7 was developed for use in adults, it has been validated for use in adolescents.[32] Sleep symptoms are screened with the single sleep item from the DSM-5 Cross-Cutting Measure.[25] A response of two or greater prompts the short form of the Patient-Reported Outcomes Measurement Information System (PROMIS) sleep disturbance assessment,[33] which consists of eight items about various sleep problems and behaviors. Responses are made on 5-item Likert-type scales, ranging from low severity sleep problems (score = 1) to high severity sleep problems (score = 5). Four items on the PROMIS sleep assessment have reversed scales—i.e. because they measure satisfaction with sleep.

The single-item screener for ADHD symptoms is derived from the DSM-5 Cross-Cutting Measure.[25] The single-item screener for opposition/defiance asks caregivers to report how often, in the past 2 weeks, their child/teen has problematic behaviors in relation to others. Responses to this item are made on the same scale as all screeners derived from the DSM-5 Cross-Cutting Measure. A response of one or greater (Rare, less than a day or two, or more frequently) to either of these questions prompts the caregiver to complete the validated Swanson, Nolan, and Pelham Teacher and Parent Rating Scale (SNAP-IV).[34] The SNAP-IV consists of 26 items, covering the following symptoms: inattention (items 1–9), hyperactivity (items 10–18), and opposition/defiance (items 19–26). Each question asks the caregiver to report how much or often their child exhibits

certain behaviors or symptoms in the past month. For example, failing to give close attention, talking excessively, and arguing with adults. Responses are made on a 4-item Likert-type scale, ranging from "Not at all" (score = 0) to "Very much" (score = 3).

Caregiver mental health symptoms

Caregiver sleep problems are screened by the question "During the past two (2) weeks, how much (or how often) have you had problems sleeping—that is, trouble falling asleep, staying asleep, or waking up too early?" Responses are made on a 5-item Likert-type scale ranging from "Not at all" (score = 0) to "Nearly every day" (score = 4). Caregivers are prompted to complete the insomnia severity index (ISI) if they score two or greater (several days or more frequently) on the screener.[35] The ISI includes seven items, in which caregivers rate the severity of their sleep problems in the past 2 weeks. Stress is screened using two questions from the Parental Stress Scale (PSS). Caregivers are asked how much they agree or disagree with statements regarding their satisfaction and dissatisfaction with caregiving responsibilities and their relationship with their child.[36] Caregivers complete the full 26-item PSS if they indicate agreement (score ≥ 3) with either screener question regarding dissatisfaction with parenting. Responses are made on 5-item Likert-type scales, with ranges determined based on whether the question is based on dissatisfaction or satisfaction with parenting (reversed scale). Burnout is assessed by the single-item burnout question, which asks caregivers to rate their level of burnout in the past month.[37] Responses are made on a 5-item Likert-type scale ranging from "I enjoy my work. I have no symptoms of burnout" (score = 1) to "I feel completely burned out…" (score = 5).

Data analysis

Measure calculations

OC symptom scores were calculated from the sum of all DOCS responses (range: 0–80). A cutoff score of 18 identified adolescents with elevated OC symptoms, as this cutoff score has been shown to have a sensitivity of 78% and a specificity of 78% in identifying individuals with OCD.[26] Dimension scores for the DOCS were calculated as the sum of all responses for each dimension (range: 0–20). For all other mental health assessments, moderate to severe symptoms were considered "elevated" and low to mild symptoms (or screening-out of the full assessment) were considered "non-elevated." Anxiety scores were calculated from the sum of all GAD-7, and a cutoff score of 10 identified elevated anxiety symptoms.[28] Depression scores were calculated as the average of the eight PHQ-9A scores multiplied by nine and rounded to the nearest whole number (to account for the single omitted item). A cutoff score of 10 identified elevated depressive symptoms.[29] Inattention, hyperactivity, and opposition/defiance scores were calculated as the sum of responses from each respective dimension on the SNAP-IV assessment.[34] A cutoff score of 18 identified elevated inattention and hyperactivity symptoms, and a cutoff score of 14 identified elevated opposition/defiance symptoms Sleep scores were calculated from the sum of all PROMIS sleep assessment responses, and a cutoff score of 22 identified elevated sleep problems (i.e. moderate to severe).[33] Caregiver sleep problems and stress scores were calculated as the sum of scores from the ISI and PSS, respectively. A cutoff score of 15 on the ISI identified elevated sleep problems,[35] and a cutoff score of 37 on the PSS identified elevated stress.[36] Elevated burnout was defined as a score of four or greater on the single item.[37] Average sessions per month (for coaching, therapy, and coaching and therapy) were calculated as the number of sessions at last assessment (per type) divided by months in care at last assessment rounded to the nearest whole number. For those in care for less than 1 month, their months in care value was set equal to one to account for extreme frequencies produced by short durations in care.

Statistical approach

Member characteristics and baseline symptoms: Data on mental health and session attendance up to 9 December were considered for analysis. The final assessment before beginning care (first BCM evaluation) was considered the baseline assessment. Adolescents with elevated OC symptoms at baseline (i.e. a DOCS score ≥18) were categorized into the "elevated OC symptoms" group. Those that screened-out of the full assessment or had non-elevated OC symptoms were categorized in the "non-elevated OC symptoms" group. The following characteristics were described for each group and compared between-groups: age, sex, gender conformity, ethnicity, rates of elevated mental health symptoms in adolescents and caregivers at baseline, participation in therapy, and care program (i.e. treatment target). Age at baseline was compared between-groups with t-test, and Chi-Square tests were used to compare all other characteristics. Descriptive statistics were used to describe OC symptoms and symptom dimension severity at baseline. All adolescents eligible for the study were included in baseline descriptions of OC symptoms and between-groups comparisons of demographic characteristics, engagement in therapy, and care program assignment (n = 2151). Adolescents and caregivers with missing mental health assessments were not included in reports and comparisons of mental health symptoms. For adolescent symptoms, the following counts of individuals were missing an assessment: n = 1 for anxiety, n = 4 for inattention, n = 6 for hyperactivity, and n = 84 for opposition/defiance. For caregiver symptoms, n = 3

were missing a sleep assessment, n = 3 were missing a stress assessment, and n = 2 were missing a burnout assessment.

Change in symptoms: For adolescents with elevated OC symptoms at baseline, change in OC symptoms during care with the DMHI was evaluated. Data from those with no follow-up assessments after the first coaching or therapy session were excluded and, given that 39 adolescents did not remain in care with the DMHI continuously, assessment data after a break in coaching or therapy of greater than 60 days was excluded. The following exclusions were applied to the sample of 693 adolescents with elevated OC symptoms: n = 135 excluded due to missing follow-up OCD assessment and n = 5 additional excluded due to a break in continuous care. An additional three assessments were excluded due to data collection errors (0.15% of eligible assessments). Ultimately, change in OC symptoms was reported for n = 553 (79.80% of full sample at baseline).

Participation in care—i.e. months in care, frequency of coaching and therapy sessions, and adherence to care—were described for adolescents included in analyses of change in OC symptoms. "Improvement" in OC symptoms was determined as either a decrease in score from baseline or screening-out of the full assessment. "Clinically substantive improvement" in OC symptoms was determined as at least a 50% decrease in score from baseline, a metric which has been used by others in assessments of treatment responsiveness.[31,32] Only full assessments were considered in this analysis. The number of adolescents with improvement and clinically substantive improvement, as well as the timing of first reported improvements (average months in care and cumulative coaching and therapy sessions), were described. Maximal change was calculated as the largest absolute negative value, which is the largest decrease from baseline score (i.e. −50% change indicates 50% decrease in score at follow-up). To test for statistically significant improvements in OC symptoms during care, the maximal change in full assessment score was calculated for each adolescent. Change scores were compared to zero using two-way Wilcox Signed-Rank tests ($p < .05$ on Shapiro test).

To assess OC symptoms over time in care, OC symptom scores from complete DOCS assessments over the first 12 months in care were analyzed in a linear mixed-effects model with a fixed effect of months in care. Inter-individual differences in response to treatment were addressed as a random effect of subject on the slope of months in care. Participation in either the OCD or anxiety care programs (Binary: 1–yes, 0–no), participation in therapy (Binary: 1–yes, 0–no), and average number of coaching and therapy per month were included as fixed effects to account for differences in treatment, and sex (female or non-female) and age at baseline were included as demographic covariates.[23,24,38] To assess whether comorbid elevated mental health symptoms significantly influenced OC symptom severity during care, we compared alternative models—i.e. that included baseline mental health severity (elevated or non-elevated) as a predictor—to the original model (including only the fixed effects and covariate specified above) using the Likelihood Ratio Test. Specifically, baseline severity of anxiety ($X_1 = 10.44$, $p = .001$), depression ($X_1 = 10.37$, $p = .001$), inattention ($X_1 = 2.63$, $p = .10$), opposition/defiance ($X_1 = 3.03$, $p = .08$), and sleep problems ($X_1 = 6.33$, $p = .01$) were tested. Baseline severity of hyperactivity was not considered as a potential predictor given the low percent of elevated hyperactivity identified in the sample. The final model included baseline anxiety, depression, and sleep problems. One adolescent was missing data for opposition/defiance, so they were excluded. Model estimates and t-tests were reported to determine whether each predictor significantly predicted OC symptom severity during care.

For OC symptom dimensions, adolescents in the elevated OC symptom group were considered to have elevated scores on a dimension if their score was greater than or equal to the group median at baseline. To test for statistically significant improvements in OC symptoms for each dimension during care among adolescents with elevated symptoms, the maximal change in dimension score was calculated for each adolescent and then change scores were compared to zero using two-way Wilcox Signed-Rank tests ($p < .05$ on Shapiro tests). To determine whether OC symptom dimension scores decreased over the course of care, a multi-variate linear mixed-effects model was used to determine change in score over the first 12 months in care. The model included the interaction of dimension (contamination, responsibility [for harm], unwanted thoughts, and symmetry) with months in care. A random effect of subject on the intercept, as well as slope of months in care, was included to account for inter-individual differences, and sex and age at baseline were included as demographic covariates. Model estimates and accompanying t-tests for the interaction of each dimension with months in care reported to determine whether dimension scores significantly decreased each month. For all analyses, $p < .05$ was considered statistically significant, and $p < .10$ was reported as approaching statistical significance.

Results

Member characteristics and baseline symptoms

A total of 2151 adolescents screened for OC symptoms at baseline, an average of 12.48 ± 19.67 days before beginning care with the DMHI. Of these, 67.8% (n = 1458) had non-elevated OC symptoms, 40.4% (n = 869) screened-out of the full assessment, and 27.4% (n = 589) screened-in to the full assessment and had non-elevated symptoms. The remaining 32.2% (n = 693) screened-in to the full assessment and had elevated symptoms (score ≥ 18). Comprehensive demographics and mental health outcomes

for adolescents with non-elevated OC symptoms versus adolescents with elevated OC symptoms are reported in Table 1. In brief, adolescents with elevated OC symptoms were more likely to be female and gender non-conforming than adolescents with non-elevated OC symptoms, and their reported racial/ethnic identities also differed. Adolescents with elevated OC symptoms had higher rates of comorbid anxiety, depressive, and opposition/defiance symptoms, as well as sleep problems, and their caregivers reported higher rates of burnout and sleep problems. Participation in therapy was higher among adolescents with elevated OC symptoms versus those with non-elevated OC symptoms.

Adolescents with elevated OC symptoms at baseline (N = 693) scored a median of 28 (IQR: 22–36) on the DOCS. They scored a median of 4 (IQR: 1–7) on the contamination dimension, 8 (IQR: 5–11) on the responsibility (for harm) dimension, 11 (IQR: 8–14) on the unacceptable thoughts dimension, and 7 (IQR: 4–10) on the symmetry dimension.

Change in symptoms

Adolescents with elevated OC symptoms and at least one follow-up assessment during continuous care with the DMHI (n = 553) were in care a median of 3.70 (IQR: 2.10–6.50) months in care. Their final assessment was completed after a median of 3.33 (IQR: 1.70–6.13) months in care, and after a median of 7 (IQR: 7–7) coaching and therapy sessions. In terms of the type of care, 52.1% (n = 228) were in coaching and therapy. For those in each type of care, adolescents had an average of 1.75 ± 0.66 coaching sessions per month and 0.94 ± 0.42 therapy sessions per month. Adolescents had 2.21 ± 0.85 coaching or therapy sessions per month (approximately 66 provider-facing minutes). Ultimately, 99.6% (n = 551) had an average of at least one therapy or coaching session per month and 67.3% (n = 371) had an average of at least two coaching or therapy sessions per month. Nearly two in three adolescents participated in the anxiety care program (64.4%; n = 356) and 7.6% (n = 42) participated in the OCD care program. Thus, 66.7% were in care for anxiety or OCD.

During care, 87.7% (n = 485 of 553) reported OC symptom improvement. The first decrease in symptoms was reported after an average of 1.09 ± 1.07 months in care, and after an average of 2.84 ± 2.37 coaching and therapy sessions. When considering only full assessments, 46.6% (n = 249 of 534) reported clinically substantive improvement in OC symptoms, first reported after an average of 2.17 ± 2.24 months in care and 5.22 ± 5.03 coaching and therapy sessions.

Adolescents reported statistically significant decreases in their OC symptoms during care, as scores on the full assessment decreased by a median of 42.9% (IQR: −73.91–15; $Z = -14.69$, $p < .001$). OC symptom severity decreased significantly over months in care ($t_{1187} = -8.06$, $p < .001$; estimate: -1.06 ± 0.13 points per month); see Figure S1. Adolescents in the OCD or anxiety care program had more severe symptoms than those in other care programs ($t_{525} = 2.64$, $p = .009$), and there was a marginal association between being in therapy and more severe OC symptoms ($t_{525} = 1.82$, $p = .07$; estimate: 2.30 ± 1.26). Females had higher OCD scores than non-females ($t_{525} = 3.27$, $p = .001$; estimate: 4.55 ± 1.31), and each additional year in age was associated with more severe OC symptoms ($t_{525} = 2.17$, $p = .03$; estimate: 0.95 ± 0.44). Having comorbid (elevated) anxiety symptoms at baseline associated with more severe symptoms ($t_{525} = 2.15$, $p = .03$; estimate: 3.00 ± 1.39), and the association for elevated depressive symptoms at baseline approached significance ($t_{525} = 1.79$, $p = .07$; estimate: 2.54 ± 1.42). OC symptom severity during care was not predicted by baseline severity of sleep problems ($t_{525} = 1.21$, $p = .23$). Notably, the association between coaching and therapy session frequency and OC symptom severity approached statistical significance ($t_{525} = -1.74$, $p = .082$), such that having more frequent sessions predicted less severe symptoms throughout care.

Scores on all OC symptom dimensions decreased significantly during care (see Table 2). Contamination scores decreased over months in care ($t_{3166} = -10.07$, $p < .001$; estimate: -0.47 ± 0.05 points/month), as did responsibility (for harm) scores ($t_{3166} = -9.19$, $p < .001$; estimate: -0.43 ± 0.05 points/month) and symmetry scores ($t_{3166} = -8.15$, $p < .001$; estimate: -0.39 ± 0.05 points/month). Unwanted thoughts scores were not predicted by duration in care ($t_{3166} = 0.18$, $p = .85$). Females had more severe symptoms during care than non-females (estimate: 1.42 ± 0.37; $t_{504} = 3.80$, $p < .001$), and each additional year in age was associated with more severe symptoms (estimate: 0.39 ± 0.13; $t_{504} = 2.98$, $p = .003$).

Discussion

The purpose of this retrospective study was to determine the effects of a CoCM-based DMHI, Bend Health, on various types of OC symptoms, including contamination, responsibility (for harm), unwanted thoughts, and symmetry, in adolescents. At baseline, one third of adolescents had elevated OC symptoms. Adolescents with elevated OC symptoms were more likely to be female or gender non-conforming, and female sex predicted more severe OC symptoms throughout care. Adolescents with elevated OC symptoms had higher rates of co-occurring anxiety, depression, oppositional/defiance behaviors, and sleep problems compared to their peers with non-elevated OC symptoms and had higher rates of engagement in therapy. Caregivers of adolescents with elevated OC symptoms reported greater sleep problems and burnout than caregivers of adolescents without elevated OC symptoms. During treatment, adolescents with elevated OC symptoms showed significant improvement, with reductions in symptom severity also reported

Table 1. Demographics, baseline mental health outcomes, participation in therapy, and care program assignment for adolescents with non-elevated symptoms of OCD compared to adolescents with elevated OD symptoms. Between-groups comparisons were used to identify differences between these groups.

	Non-elevated (67.8%; n = 1458)	Elevated (32.2%; n = 693)	Between-groups comparison
Age (in years): M ± SD	14.81 ± 1.35	14.89 ± 1.33	$t_{1382.9} = 1.35$, $p = .18$
Female sex: % (n)	55.5% (n = 809)	72.2% (n = 500)	$X^2_1 = 54.5$, $p < .001$
Gender non-conforming: % (n)	4.0% (n = 58)	8.2% (n = 57)	$X^2_1 = 15.91$, $p = .001$
Ethnicity: % (n)			$X^2_6 = 19.33$, $p = .004$
White	49.4% (n = 720)	54.5% (n = 378)	
Hispanic/Latino	5.6% (n = 81)	8.5% (n = 59)	
Black/African Descent	6.6% (n = 96)	5.8% (n = 40)	
Asian	7.8% (n = 114)	4.9% (n = 34)	
Indigenous Peoples of the Americas	0.1% (n = 2)	0.0% (n = 0)	
Native Hawaiian/Pacific Islander	0.1% (n = 1)	0.1% (n = 1)	
Other or multi-racial	30.5% (n = 444)	26.1% (n = 181)	
Elevated adolescent mental health outcomes: % (n of n)			
Anxiety	30.3% (n = 442 of 1457)	76.0% (n = 527 of 693)	$X^2_1 = 383.44$, $p < .001$
Depression	36.4% (n = 531 of 1458)	74.7% (n = 518 of 693)	$X^2_1 = 267.52$, $p < .001$
Inattention	25.1% (n = 365 of 1456)	26.8% (n = 185 of 691)	$X^2_1 = 0.52$, $p = .47$
Hyperactivity	4.7% (n = 68 of 1455)	6.7% (n = 46 of 690)	$X^2_1 = 3.05$, $p = .081$
Opposition/Defiance	15.9% (n = 221 of 1393)	20.6% (n = 139 of 674)	$X^2_1 = 7.02$, $p = .008$
Sleep problems	36.6% (n = 534 of 1458)	64.2% (n = 445 of 693)	$X^2_1 = 142.32$, $p < .001$
Elevated caregiver mental health outcomes: % (n of n)			
Sleep problems	10.4% (n = 152 of 1458)	14.6% (n = 101 of 690)	$X^2_1 = 7.37$, $p = .007$
Stress	23.3% (n = 339 of 1458)	24.8% (n = 171 of 690)	$X^2_1 = 0.47$, $p = .49$
Burnout	9.9% (n = 144 of 1458)	13.6% (n = 94 of 691)	$X^2_1 = 5.73$, $p = .017$
Participation in therapy: % (n)	32.7% (n = 470)	51.8% (n = 352)	$X^2_1 = 70.47$, $p < .001$
Care program: % (n)			
OCD	1.0% (n = 15)	7.2% (n = 50)	$X^2_1 = 59.25$, $p < .001$
Anxiety	52.4% (n = 764)	62.2% (n = 431)	$X^2_1 = 17.85$, $p < .001$

(continued)

Table 1. Continued.

	Non-elevated (67.8%; n = 1458)	Elevated (32.2%; n = 693)	Between-groups comparison
Depression	18.4% (n = 269)	30.6% (n = 212)	$X^2_1 = 39.19$, $p < .001$
ADHD	23.8% (n = 347)	13.9% (n = 96)	$X^2_1 = 27.81$, $p < .001$
Stress	10.8% (n = 157)	6.1% (n = 42)	$X^2_1 = 11.85$, $p < .001$

Note: Demographic outcomes, engagement in therapy, and care program assignment reported for all study participants. Mental health outcomes reported only for study participants with available data (see methods).
OCD: obsessive-compulsive disorder.

Table 2. Percent change in OC symptom dimensions during care with the DMHI for adolescents with elevated symptoms of that type at baseline. Sample size, maximum score decrease during care, and Wilcox Signed-Rank test of maximum score decrease (against 0) are reported for all dimensions.

Dimension	Sample size: n	Maximum score decrease (% of baseline): Median (IQR)	Wilcox Signed-Rank z=, p=
Contamination	300	−50.0% (IQR: −94.2%–16.7%)	$Z = -10.65$, $p < .001$
Responsibility (for harm)	298	−57.1% (IQR: −92.2%–27.8%)	$Z = -12.45$, $p < .001$
Unwanted thoughts	301	−50.0% (IQR: −73.3%–18.2%)	$Z = -12.05$, $p < .001$
Symmetry	275	−55.6% (IQR: −87.5%–22.2%)	$Z = -11.32$, $p < .001$

OC: obsessive-compulsive; DMHI: digital mental health intervention.

for OC symptom dimensions. Adolescents enrolled in the OCD or anxiety care programs and those receiving therapy had more severe symptoms throughout care, and while the association between session frequency and symptom severity approached significance, findings suggest that more frequent sessions may be linked to lower symptom severity.

Adolescents with elevated OC symptoms were more likely to be female or gender non-conforming and had higher rates of co-occurring mental health issues. These findings align with prior research showing that females are more likely to present with OC symptoms during adolescence, often exhibiting greater symptom severity, higher rates of comorbid anxiety or depression, and a distinct symptom profile (e.g. a higher prevalence of obsessions about contamination).[38] These findings may be driven by gender-related differences in social expectations, stress exposure, and biological factors such as hormonal fluctuations.[38–40] The higher rates of elevated OC symptoms in gender non-conforming adolescents may reflect the unique stressors and vulnerabilities faced by this group, including experiences of stigma and discrimination, which have been linked to greater psychological distress.[41–43] Future research should explore whether tailored approaches may effectively address gender- and sex-based stressors, symptom profiles, and co-occurring mental health challenges.

The co-occurrence of anxiety, depression, oppositional/defiance behaviors, and sleep problems is well-documented in adolescents with OC symptomatology, underscoring its complex and multifaceted nature.[44–47] Elevated anxiety symptoms were approximately 46% more common in adolescents with elevated OC symptoms compared to adolescents with non-elevated OC symptoms, and adolescents with OC symptoms were more likely to have anxiety as a primary treatment target. We also identified associations between elevated anxiety and depressive symptoms and more severe OC symptoms throughout care, further reinforcing the associations identified in our sample at baseline. Anxiety frequently coexists in youth with OC symptoms due to shared underlying vulnerabilities, such as heightened emotional reactivity, difficulty tolerating uncertainty, and deficits in cognitive flexibility.[48–50] We also found that elevated depressive symptoms were associated with more severe OC symptoms during care, further reflecting the close-knit relationship between mood disorders and OCD, as others have shown.[51,52] For example, youth with major depressive disorder comorbid with OCD experience more severe depressive symptoms compared to youth with major depressive disorder but no OCD.[51] This complexity suggests a need for integrated treatment approaches that address both OC symptoms and the broader emotional and behavioral challenges that often accompany them.

Notably in our sample, adolescents with elevated OC symptoms were more likely to participate in therapy in addition to coaching, reflecting the ability of CoCM to flexibly tailor care to their complex therapeutic needs.

Adolescents enrolled in the OCD or anxiety care programs had more severe symptoms throughout care, as did those receiving therapy. Notably, the association between session frequency and symptom severity approached significance, suggesting that more frequent sessions may be linked to lower symptom severity while in care. Prior research indicates that CBT incorporating ERP is effective in treating adolescents with OCD, typically requiring 12 to 20 sessions for significant improvement.[7] Some evidence suggests that a median of 13 therapy sessions (11.5 h of treatment total) can lead to significant improvements.[53] These findings reinforce the importance of higher intensity, therapist-led interventions for adolescents with more severe OC symptoms and highlight the potential benefits of increasing session frequency for optimizing treatment outcomes.

Caregivers of adolescents with elevated OC symptoms reported significantly higher levels of sleep problems and burnout compared to caregivers of adolescents without elevated symptoms. Caregivers of youth with OCD are at heightened risk for sleep disruptions due to the demands of accommodating compulsive behaviors and managing the emotional toll of their child's distress.[2,54,55] Burnout, often driven by chronic stress and emotional exhaustion, further exacerbates these challenges, reducing caregivers' resilience and contributing to increased family strain.[56,57] Additionally, caregiver anxiety, depression, and accommodation behaviors have been identified as key mediators linking the severity of OC symptoms to family dysfunction, underscoring the need for targeted interventions that address both caregiver well-being and OCD symptom management.[58] Sleep disturbances and burnout in caregivers can significantly impair their ability to provide consistent emotional and practical support to their child, potentially perpetuating cycles of stress and family dysfunction.[59] Providing support to caregivers to mitigate sleep problems and burnout is critical for improving outcomes not only for caregivers themselves but also for the adolescents they support.

Nearly nine in 10 (87.7%) adolescents with elevated OC symptoms experienced improvements in their OC symptoms during the DMHI after an average of less than three coaching and therapy sessions. Adolescents reported a median decrease in symptom severity of 43% during care. Previous research has suggested that over 10 sessions are required for clinical improvements.[7,53] In contrast, this study found clinically substantive improvements (50% or greater reduction in symptoms) reported by approximately half of adolescents (46.6%) after fewer than six sessions. While OCD-targeted therapies (e.g. CBT-ERP) are typically delivered over 12 or more sessions,[53] our findings highlight a relatively short duration required for OC symptom improvement. However, this could be due to Bend's DMHI, which employs a variety of care programs that incorporate numerous therapeutic methods, including caregiver support and engagement with therapeutic content outside of sessions (e.g. in the learning resource center). Because of this, the "dose" of treatment in this study likely extends beyond the time spent in coaching and therapy sessions. It is also important to note that there were inter-individual differences in treatment response. Many adolescents in the study required greater than six sessions to report clinically substantive improvements. These findings emphasize the need to consider various factors – including demographics, symptom acuity, treatment type, and engagement – when evaluating the effectiveness of different interventions. Notably, OC symptoms improved over time by over one point for each month of care. This aligns with intervention studies showing that digitally-delivered care, specifically CBT, is effective for improving OC symptoms in youth.[9,10,60] The ability of the present study's DMHI to significantly improve multiple dimensions of OC symptoms is particularly noteworthy, as tailoring care to diverse OC symptoms is a known challenge for scalable OCD treatment.[16] The current study observed significant improvements across all symptom dimensions during DMHI care, with varying rates of symptom reduction. Symptom reductions in the contamination, responsibility (for harm), and symmetry dimensions were most notable, while unwanted thoughts decreased during care, but duration in care did not predict the severity of these symptoms. One reason for this pattern may be that contamination, responsibility, and symmetry dimensions respond more easily to standard treatments, while taboo obsessions—like unwanted thoughts about sex, violence, or morality—require more specialized approaches.[61] This may be because taboo obsessions often involve abstract, internally generated fears rather than external triggers, making it more difficult to design concrete exposure exercises.[61] Individuals with these symptoms may experience greater shame or reluctance to disclose their thoughts, which can hinder engagement with treatment and reduce the effectiveness of standard care.[61,62] Given these challenges, CBT techniques, such as cognitive restructuring and inference-based therapy, may be particularly beneficial in helping adolescents reframe maladaptive beliefs and reduce distress. While the DMHI integrates CBT principles, which may have contributed to overall improvements in OC symptoms, additional tailoring may be needed to optimize outcomes for unwanted thought-related symptoms, as their reduction was not associated with time in care.

Additionally, the online learning resource center within the DMHI provided adolescents access to supplemental materials between coaching and therapy sessions. These supplemental materials may have reinforced therapeutic techniques, contributing to symptom improvements by allowing adolescents to engage with interventions outside of scheduled sessions. However, engagement with these

resources was not systematically tracked, limiting our ability to assess their direct impact on outcomes. While this study observed improvements across multiple OCD symptom dimensions, certain symptoms, particularly unwanted thoughts, may require additional structured interventions beyond standard digital resources and self-guided materials to maximize treatment effectiveness.

This study demonstrates the potential of DMHIs to provide personalized and adaptive treatment that can meet the unique needs of adolescents with varied OC symptom profiles, even when OC symptoms are not the primary therapeutic target. Traditional in-person OCD treatment is often hindered by the limited availability of specialized practitioners, limited access, and difficulty with adherence to treatment long-term.[63] While our results suggest that DMHIs are promising for OCD treatment, more research is needed to confirm our findings and evaluate their effectiveness on other types of OC symptoms (e.g. perfectionism). Findings from this study also highlight the importance of structured, therapist-led interventions within a DMHI, particularly for adolescents with more severe OC symptoms or co-occurring mental health issues. Given that engagement with supplemental digital content, such as guided exercises and psychoeducational resources, is not tracked, it remains unclear how these materials contribute to symptom improvement. Future research should explore whether tracking and personalizing digital resource usage could optimize outcomes and inform usage guidelines for individuals with elevated OC symptoms.

Strengths and limitations

Our study has several strengths. This is the first study, to our knowledge, to assess the effectiveness of a CoCM DMHI in improving OC symptoms. A known gap in digital OCD treatment is the lack of tailored, scalable interventions that address the unique needs of individuals with different OC symptom dimensions, as these programs are often designed to be broad and inclusive to reach a large audience.[16] Our findings demonstrate that the CoCM DMHI evaluated here can effectively address multiple dimensions of OC symptoms, highlighting its potential to combine broad accessibility with targeted and individualized support. This study leverages a large sample, with over 2000 adolescents included in the baseline analyses and over 550 included in assessing change in OC symptoms. This study also evaluates OC symptom and dimension outcomes in a well-established, commercially available DMHI that has been effective in addressing other mental health challenges in children and adolescents.[23,24]

Our findings are limited by several factors. This was a retrospective study, which prevents us from drawing causal inferences. Additionally, this study lacked a control group, making it unclear whether the DMHI was more, less, or equally effective compared to standard care for adolescents with OCD. We used the DOCS to measure OC symptoms in adolescents, which was originally developed for use in adults.[64] Nonetheless, the DOCS demonstrates strong diagnostic accuracy for distinguishing those with OCD from non-clinical individuals and individuals with other anxiety disorders.[26] However, applying an adult-derived cutoff score and language to an adolescent population may have influenced the results by potentially overestimating or underestimating symptom severity, as adolescents may interpret certain items differently or experience symptom presentations that do not fully align with adult-focused constructs. Finally, while the DMHI in this study included a care program tailored to OCD, participation in this program was relatively low. Thus, we were unable to parse-apart outcomes of those in the general anxiety care program versus the OCD care program. We also did not assess different aspects of engagement with the DMHI outside of session, including caregiver participation and engagement with therapeutic content in the learning resource center; factors which may have contributed to the "dose" of treatment received by participants. Future studies should consider using measures of OC symptoms specifically designed for adolescents.[64] Additionally, they should incorporate a wholistic view of engagement with care and also incorporate a control group and OCD-specific treatment to directly compare digital interventions for OCD to alternative (e.g. traditional or anxiety-focused) treatment approaches.

Conclusion

Given that OCD typically begins in adolescence and can have long-term consequences if left untreated, early and accessible interventions tailored to the needs of youth are essential to mitigate its impact and improve outcomes. OC symptoms—including contamination, responsibility (for harm), unwanted thoughts, and symmetry dimensions—showed significant improvement over the course of the DMHI. Notably, the results suggest that adolescent females and gender non-conforming adolescents experience greater OC symptom severity and co-occurring mental health conditions, but more research is needed to understand the underlying mechanisms and how treatment approaches can best address these differences. Our findings add to the growing body of evidence supporting the use of DMHIs in treating OCD in adolescents and show that a scalable DMHI can improve various types of OC symptoms. Future research should explore long-term outcomes and refine personalization strategies to enhance their impact across diverse populations.

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Statements and declarations

Ethical considerations

This study was deemed not human subjects research by the Biomedical Research Alliance of New York (Study ID 23-12-034-1374). As this study was determined "exempt," the requirement for written informed consent was waived by the institutional review board.

Author contributions/CRediT

All authors collaborated on study conceptualization. DLS and KM collaborated on study methodology and writing of the first draft. DLS performed data curation tasks and conducted all formal analyses and data visualizations. JH supervised DLS and KM. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: DLS, MR, and JH are employed or contracted with Bend Health Inc., which delivered the intervention used in this study. However, authors' employment status and compensation (e.g. salary) are not dependent upon the results of their research.

Data availability

Given Bend Health Inc's privacy policy and HIPAA, the data sets analyzed for the current study are not publicly available. However, aggregated and anonymized data that is not associated with individual users and does not include personal information is available from the corresponding author on reasonable request.

Supplemental material

Supplemental material for this article is available online.

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