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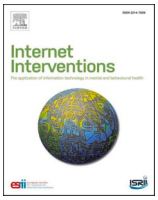

Feasibility and clinical outcomes of tailored digital CBT-E guided self-help for youth with binge-eating symptoms: A pilot randomized controlled trial

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ABSTRACT

Binge eating in adolescents and young adults is a clinically significant concern due to its risk of progression to full-syndrome eating disorders and functional impairment. Digital guided self-help (GSH) based on enhanced cognitive behavioral therapy (CBT-E) is a scalable intervention, but implementing individualized approaches within digital platforms remains challenging. This pilot randomized controlled trial used a 2-arm waitlist-controlled crossover design to evaluate the feasibility and preliminary efficacy of *PlanEat*, a developmentally and symptom-tailored digital CBT-E–based GSH program. Participants aged 13–22 years ($N = 64$) reporting binge-eating symptoms were randomized to intervention or waitlist control. Assessments were conducted at baseline, post-intervention, and 16-week follow-up, and analyzed using linear mixed-effects models. In intention-to-treat analyses, feasibility was supported by high usability and acceptable retention. At post-intervention, the intervention group showed significantly greater reductions in eating disorder symptoms than the waitlist group, with improvements in self-esteem and psychosocial functioning. These effects were maintained at follow-up. The waitlist group showed nonsignificant changes following crossover. This pilot study supports the feasibility and preliminary effectiveness of a developmentally and symptomatically tailored digital CBT-E intervention. A fully powered trial with extended follow-up is warranted.

Trial Registration: ClinicalTrials.gov Identifier: NCT05615090

1. Introduction

Binge eating is a clinically significant pattern of disordered eating, characterized by episodes of consuming an unusually large amount of food with a perceived loss of control (American Psychiatric Association, 2013). Individuals who engage in binge eating frequently experience intense guilt, shame, and emotional distress following episodes, and these behaviors are often triggered by negative affect and maintained by maladaptive coping strategies (Fairburn, 2008). Increasing evidence indicates that binge eating represents a transdiagnostic process observed across binge eating disorder (BED), bulimia nervosa, and other specified eating disorders, reflecting shared vulnerabilities such as emotion dysregulation, impulsivity, and heightened preoccupation with body image (Giel et al., 2017). Binge eating also contributes to broader psychiatric and physical health concerns, including depression, anxiety, and increased risk for obesity (Hudson et al., 2007).

Recognizing binge eating as a spectrum condition underscores the need for early intervention before maladaptive patterns become entrenched. Many individuals experience recurrent binge eating without meeting full BED criteria (Miskovic-Wheatley et al., 2023; Derks et al., 2022). Subclinical presentations often include clinically significant emotional and behavioral features that impair functioning and increase risk for progression to full-syndrome eating disorders (Stice et al., 2013; Biberdzic et al., 2021). Crucially, adolescence and young adulthood represent a high-risk period for the onset of binge eating, with prevalence rates rising sharply during these developmental stages (Marzilli et al., 2018). Yet treatment systems remain oriented toward fully diagnosed cases, contributing to limited support for individuals in at-risk

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stages (Regan et al., 2017; Egbert and Schram, 2025). Given that this population is often underserved by conventional healthcare infrastructures, addressing these disparities is essential for advancing health equity in mental health care. Such gaps highlight the need for scalable interventions that can effectively bridge the access gap and extend evidence-based care to underserved and at-risk youth populations.

Cognitive-behavioral therapy (CBT) and its enhanced, transdiagnostic variant (CBT-E) are first-line treatments for binge-eating disorder and related conditions (Fairburn et al., 2003). Evidence has also demonstrated that CBT-E is effective in adolescent populations, with several studies reporting favorable clinical outcomes (Dalle Grave et al., 2013). However, only a minority of individuals who could benefit receive CBT-E, with barriers including limited clinician availability, cost, geographic inaccessibility, and shame or stigma associated with seeking help (Fischer et al., 2014; Munsch et al., 2012; Schlegl et al., 2015). Digital therapeutics provide structured, evidence-based interventions that reduce practical and psychological barriers to care (Hong et al., 2021). In particular, guided self-help (GSH) approaches based on CBT-E are designed to enable individuals to engage in treatment with minimal specialist input, and multiple studies have demonstrated their feasibility and acceptability (Palmer et al., 2002; Hay et al., 2009). Digital interventions further offer the potential to extend access to individuals who are underserved by existing healthcare systems (Aardoom et al., 2016).

A growing body of research indicates that digital GSH interventions for eating disorders are associated with significant reductions in binge-eating behaviors compared with control conditions (Melioli et al., 2016). In adolescent and young adult populations, several digital interventions grounded in cognitive-behavioral principles have been developed and evaluated. For example, The StudentBodies2–BED program or internet-based cognitive-behavioral interventions targeting perfectionism (ICBT-P) have demonstrated reductions in eating disorder symptoms among adolescents (Shu et al., 2019; Jones et al., 2008). Extending these approaches, several smartphone-based applications grounded in cognitive-behavioral principles have been developed to manage eating disorder–related symptoms, primarily through self-monitoring and skills-based components (Lindgreen et al., 2018; Tuncer and Tuncer, 2025). Taken together, these findings suggest that digital CBT-based approaches may offer a feasible and potentially effective means of targeting specific maintaining mechanisms of eating disorders in younger populations.

While these component-focused interventions have demonstrated promising efficacy, most have not implemented the full transdiagnostic CBT-E model. Achieving this requires careful consideration of at least two key factors with direct implications for the design and implementation of digital CBT-E interventions in youth populations. First, Reviews of existing digital CBT-E implementations have consistently noted limited individual tailoring, as these approaches largely prioritized scalability over symptom-level personalization (Barakat et al., 2019). Yet within Fairburn's transdiagnostic framework, diagnostic categories are de-emphasized in favor of symptom profiles and maintenance processes, with modular interventions flexibly applied according to individual needs (Fairburn et al., 2003). From this perspective, symptom-level personalization constitutes a core component of the CBT-E model and is widely regarded as integral to its therapeutic effectiveness (Fairburn, 2008). However, early digital implementations of CBT-E largely prioritized scalability and feasibility, relying on standardized content structures (Murphy et al., 2025). This rigid standardization constrained the incorporation of individualized case formulation and symptom-based tailoring, underscoring the need for personalization strategies better suited to digital delivery contexts.

Second, when applying CBT-E to younger populations, modifications that take developmental characteristics into account have been recommended. A structured adaptation of CBT-E for adolescents has been proposed, with prior studies highlighting the need to adapt key aspects such as motivational instability, parental involvement, heightened emotional reactivity, and relatively immature self-regulatory capacity (Dalle Grave and Calugi, 2020). These characteristics may hinder sustained engagement when adult-oriented models are applied without modification (Liverpool et al., 2020). However, such adaptations have largely been discussed in face-to-face contexts, and additional considerations are required in digital settings, particularly in guided self-help (GSH) formats. In these contexts, where therapeutic support is limited and engagement depends heavily on intrinsic motivation and self-regulation, developmental vulnerabilities may more directly contribute to disengagement (Linardon et al., 2020). Accordingly, it is important to incorporate design features that structurally support self-regulation and sustained engagement. To date, although some efforts have incorporated developmental considerations into digital CBT-E interventions, these have largely remained at the level of discrete components, such as perfectionism and body image distortion. In contrast, CBT-E addresses multiple core maintaining mechanisms, including self-monitoring, the establishment of regular eating patterns, and emotion-related processes, and organizes them within a coherent and interactive framework in which these components are systematically linked. However, such integrated structures have not yet been sufficiently implemented in forms suited to self-guided digital contexts.

We developed *PlanEat*, a developmentally and symptomatically tailored digital CBT-E-based GSH program. This pilot study aimed to evaluate its feasibility and preliminary efficacy. The findings will guide program refinement and the selection of key indicators for a future fully powered randomized controlled trial, facilitating a more definitive test of treatment efficacy.

2. Methods

This study protocol was developed in accordance with the SPIRIT 2013 Statement (Standard Protocol Items: Recommendations for Interventional Trials) (Chan et al., 2025). The trial was prospectively registered at ClinicalTrials.gov (Identifier: NCT05615090) and was conducted and reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Eldridge et al., 2016).

2.1. Ethical consideration

This study was approved by the Institutional Review Board of Yonsei University College of Medicine (IRB No. 3-2022-0342) and conducted at the Department of Psychiatry, Gangnam Severance Hospital. Written informed consent was obtained from all participants, with additional parental or caregiver consent for minors. Compensation was prorated according to completed study visits to accommodate varying levels of engagement. Specifically, Specifically, participants received 20,000 KRW (approximately USD 15) if they completed only the first visit, 50,000 KRW (approximately USD 38) if they completed up to the second visit, and 100,000 KRW (approximately USD 75) upon completion of all three visits. Participation was voluntary, and participants could withdraw at any time without penalty. The study involved low-risk, noninvasive digital intervention, and all procedures were conducted in accordance with institutional ethical standards.

2.2. Participants

Participants aged 13–22 years were recruited between January 2023 and August 2024 through online and clinic-based advertisements, with follow-up completed by November 2024. Participants were eligible if they had experienced at least one binge-eating episode in the past 4 weeks. Participants were required to be able to understand the study procedures and provide informed consent. Exclusion criteria included a current or past diagnosis of anorexia nervosa, underweight status (BMI $\leq$17.5), and major psychiatric or neurodevelopmental disorders requiring specialized clinical care. Diagnostic screening and eligibility

assessments were conducted by licensed clinical psychologists.

2.3. Design, randomization, and masking

This 2-arm waitlist-controlled randomized clinical trial evaluated an 8-week mobile CBT-E program using a crossover design in which all participants ultimately received the intervention. A waitlist control was selected to evaluate preliminary intervention effects relative to the passage of time, consistent with early-stage evaluation of mHealth interventions. Participants were randomized in a 1:1 ratio to either immediate intervention or waitlist control using computer-generated permuted blocks with randomly varying block sizes of 4 and 6, implemented through a centralized system with allocation concealment until assignment (see Multimedia Appendix 1 for details). Assessments were conducted at three fixed time points: baseline (T0), 8 weeks (T1), and 16 weeks (T2). For participants randomized to the immediate intervention group, T1 corresponded to the post-intervention assessment and T2 to the follow-up assessment. For participants in the waitlist control group, T1 represented the pre-intervention assessment, and T2 corresponded to the post-intervention assessment. Owing to the waitlist design, blinding of participants and intervention personnel was not feasible; however, outcome assessments were conducted by trained evaluators blinded to group allocation, and data analysts were masked.

2.4. Sample size

This study was designed as an exploratory pilot randomized clinical trial, with the primary objectives of assessing feasibility and obtaining preliminary estimates of intervention effects rather than testing confirmatory hypotheses. Consistent with the CONSORT 2010 extension for pilot and feasibility trials (Eldridge et al., 2016), the sample size was therefore primarily determined based on feasibility considerations rather than formal power calculations. Methodological recommendations for pilot randomized trials suggest that a total sample of approximately 20–40 participants is generally sufficient to evaluate feasibility outcomes and estimate effect sizes (Whitehead et al., 2016; Julious, 2005). In line with these recommendations, these considerations support the adequacy of the planned sample size for the feasibility and exploratory objectives of the present study.

2.5. Intervention

2.5.1. Mobile-based guided self-help program (Supplementary Material 2)

2.5.1.1. Core intervention components with digital features. The *PlanEat* program comprises 23 brief daily micro-sessions. Core intervention components included psychoeducation on eating behavior and emotions, systematic self-monitoring of meals and binge-eating episodes, coping strategies for managing binge urges, mindfulness-based techniques to enhance awareness of bodily sensations and emotional responses, body image restructuring, emotion regulation strategies, and relapse prevention. A structured overview of the session domains and module-level content is presented in Table 1, while detailed descriptions of each individual session are provided in Supplementary Material 2. Digital features supporting adherence and safety included real-time meal and emotion logging, automated alerts triggered by elevated binge-eating frequency, and inactivity-based reminder notifications. Participants were also provided with information on how to access additional clinical support if significant emotional distress occurred

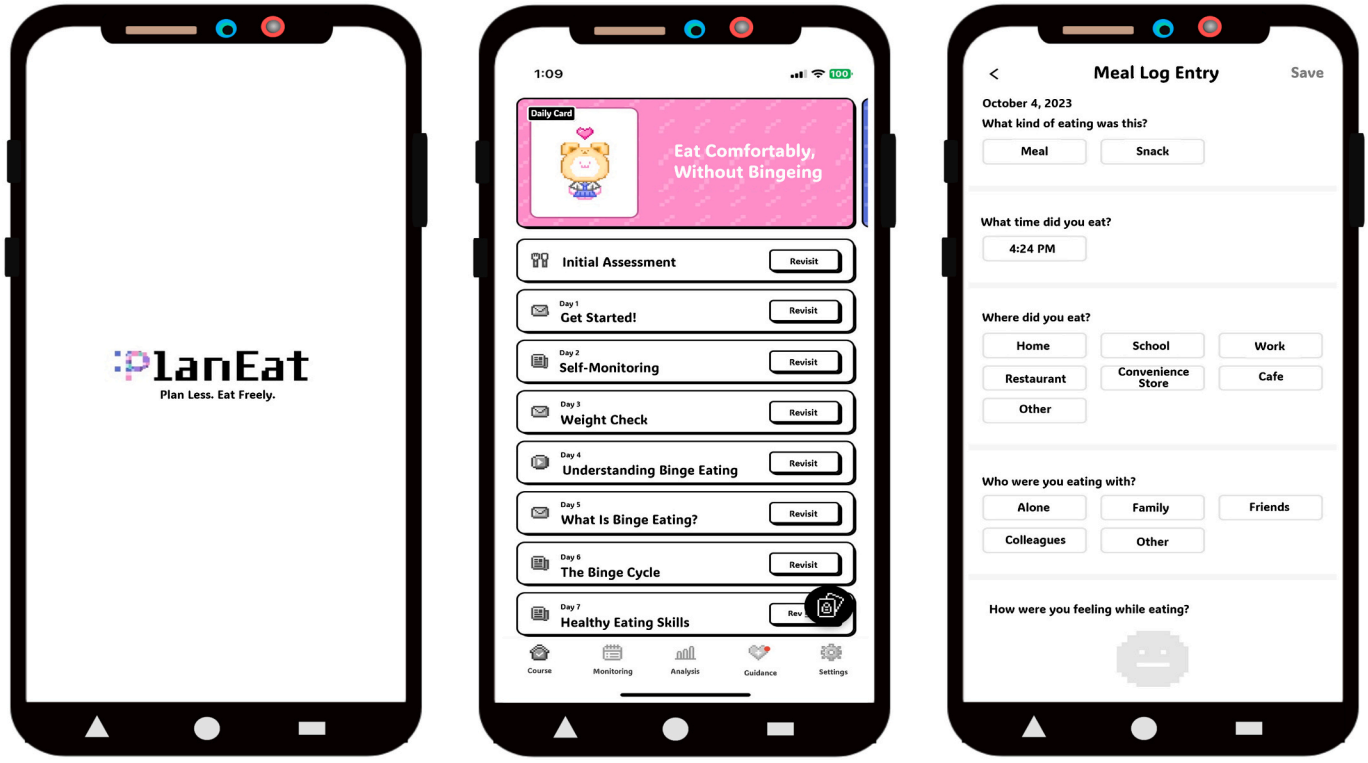

Fig. 1. Representative screenshots of the *PlanEat* digital guided self-help program.
This figure presents representative screenshots of the *PlanEat* mobile application, displayed from left to right as the landing screen, the session overview screen, and the meal log entry screen. The landing screen displays the program logo and core slogan. The session overview screen presents examples of the initial sessions from the total of 23 micro-sessions. It includes the Daily Card section, the Initial Assessment module, a Revisit button for repeated learning, and a bottom navigation menu providing access to course content, self-monitoring, progress analysis, guidance, and settings. The meal log entry screen is designed to support real-time self-monitoring and allows users to record, through structured response options, the type of eating episode, time, location, eating companions, and emotional state during eating. The interface structure and overall design of the application were preserved, and only the on-screen text was translated into English.

Table 1
Modular structure and core components of the *PlanEat* intervention.

Module	Sessions	Core components
Assessment & Psychoeducation	1–6	• Introduction to the app and treatment rationale • Baseline symptom assessment and personalized pathway classification • Training in self-monitoring of eating behaviors • Weekly weight monitoring guidance • Education on binge eating, diagnostic features, and available treatments
Behavioral Normalization	7–8	• Education on the binge–restriction cycle • Establishment of regular eating patterns (three meals and two snacks) • Guidance on meal timing, pacing, and reducing chaotic eating patterns
Motivation & Urge Coping	9–11	• Exploration of motivation for change • Identification of binge triggers; training in urge management strategies (urge surfing, delay techniques, coping cards, alternative behaviors)
Body Image Intervention	12–13	• Evaluation of body image discrepancies • Reduction of body checking and avoidance • Cognitive restructuring of distorted shape/weight beliefs
Emotional & Interpersonal Regulation	14–18	• Identification of emotional eating patterns • Emotion regulation skills (including mindfulness) • Addressing perfectionism and low self-esteem • Assertive communication skills training
Relapse Prevention	19–23	• Identification of early relapse warning signs • Development of individualized relapse prevention plans • Consolidation of core skills • Post-treatment reflection and outcome reassessment

during the intervention.

2.5.1.2. Developmentally informed adaptations. The intervention was designed with consideration of the developmental characteristics of adolescents and young adults. Given that the target population spanned a broad developmental range from adolescence to early adulthood, the intervention was grounded in the broad form of adult CBT-E, while incorporating developmentally informed adaptations consistent with established recommendations for adolescent CBT-E and modifying these elements for delivery within a digital self-help format (Fairburn, 2008; Dalle Grave and Calugi, 2020). Drawing on key developmental principles of adolescent CBT-E described by Riccardo Dalle Grave and colleagues (Dalle Grave and Calugi, 2020), core CBT-E concepts and therapeutic rationales were presented using concise, accessible language, supported by multimedia materials (e.g., visual aids and brief videos) to facilitate comprehension and sustained attention. Age-relevant design elements, such as program-specific avatars, were also incorporated. To address developmental differences in self-regulatory capacity, self-monitoring was implemented in a structured and guided format, including real-time tracking of eating behaviors, emotional states, and contextual factors. Motivational enhancement elements were integrated across sessions to accommodate motivational variability, and emotion regulation and impulse control strategies were emphasized using concrete and accessible techniques. The program further incorporated autonomy-supportive features, allowing participants to engage with selected exercises and coping resources based on their perceived needs, thereby promoting active and self-directed use. Self-monitoring data were analyzed and visually presented in real time to support intuitive tracking of changes over time. Among the adolescent-specific adaptations of CBT-E, parental involvement can serve a supportive role, but is typically effective when its level is carefully calibrated under therapist guidance. In a fully self-guided digital format, such calibration is difficult to achieve; therefore, parental involvement was not included. In addition, given the developmental emphasis on autonomy and independence in late adolescence, and the sensitivity of privacy-related issues, parental involvement may conflict with these needs and potentially hinder engagement and adherence (Dalle Grave et al., 2013).

2.5.1.3. Symptom-based content tailoring. To enhance therapeutic relevance and engagement, *PlanEat* incorporates a baseline symptom-driven content-tailoring system. The intervention is organized according to three primary symptom domains: body image concerns, restrained eating, and impulsive eating. These domains reflect key psychopathological features frequently linked to binge eating in adolescents and young adults. Although all participants receive a shared CBT-E–based core framework, the program adjusts the emphasis of selected sessions based on individual symptom profiles identified at baseline. This approach allows psychoeducational content and recommended exercises to be aligned with participants' predominant symptom presentations while maintaining consistency with the CBT-E framework. Baseline symptom profiles are generated using in-app assessments, including the Korean version of the Eating Disorder Diagnostic Scale (K-EDDS) and the Dutch Eating Behavior Questionnaire (DEBQ) (Bang et al., 2018a; van Strien et al., 1986). Participants are classified across the three symptom domains of body image concerns, restrained eating, and uncontrolled or impulsive eating according to predefined cutoff scores. Each domain is coded as present or absent, yielding eight possible symptom profiles. These profile combinations inform the sequencing and emphasis of intervention modules delivered within the application. The detailed decision logic used for symptom classification and content tailoring are described in the Supplementary Material 2.

2.5.2. Waitlist control

Participants assigned to the waitlist control group did not receive access to the *PlanEat* intervention during the initial 8-week period and continued treatment as usual while completing the same assessment schedule as the intervention group. Following completion of the T1 assessment, participants in the waitlist group were provided with full access to the 8-week *PlanEat* program.

2.6. Outcome measures

2.6.1. Feasibility measures

Feasibility outcomes comprised four domains: attrition, adherence, engagement, and usability. Adherence and engagement were operationalized as process measures derived from intervention usage data collected continuously throughout the intervention period. Adherence was defined as the proportion of completed intervention sessions, attrition as failure to complete the post-intervention assessment at T1 (primary efficacy endpoint), and engagement as the frequency of meal-log entries during the intervention period. Prespecified feasibility thresholds were defined as a priori to inform progression to a future definitive trial, based on feasibility recommendations and CBT-E literature. These thresholds included adherence to at least 50% of intervention sessions (Beatty and Binnion, 2016), attrition of 30% or less at T1 (Eldridge et al., 2016), and engagement defined as at least 28 meal-log entries reflecting daily self-monitoring practices (Fairburn et al., 2003). Usability was assessed as a post-intervention outcome using a 24-item composite scale adapted from established usability and technology acceptance measures, including the System Usability Scale (SUS) (Brooke, 1996), Post-Study System Usability Questionnaire (PSSUQ) (Lewis, 2002), Technology Acceptance Model (TAM) items (Davis, 1989), and the Usefulness, Satisfaction, and Ease (USE) questionnaire (Lund, 2001). Usability assessments were administered at T1 for the intervention group and at T2 for the waitlist control group, corresponding to completion of the intervention.

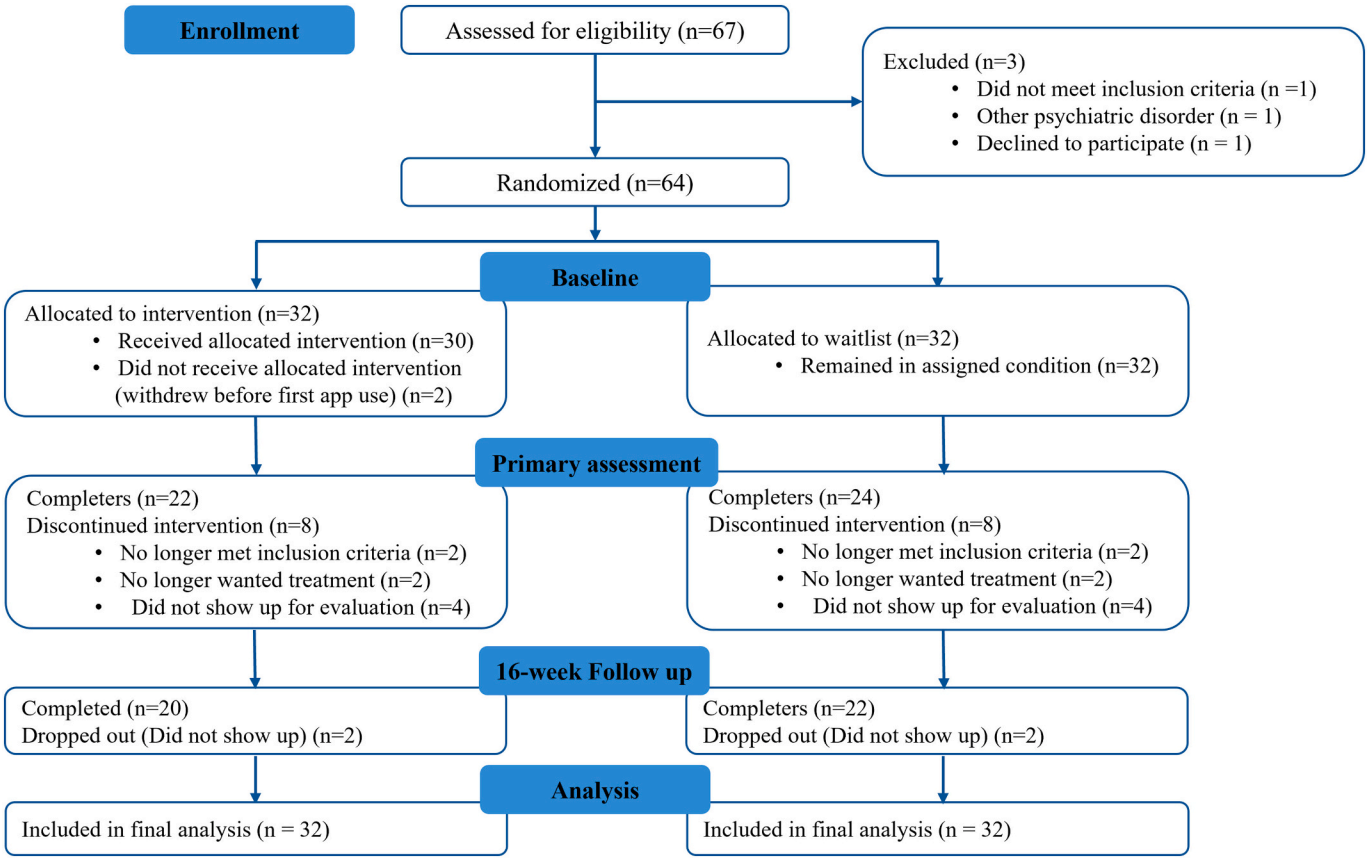

Fig. 2. Participant flow through the trial.
CONSORT diagram showing participant enrollment, randomization, allocation, and assessment time points. Included in the flow are the specific numbers of participants analyzed for clinical outcomes along with detailed reasons for discontinuation or loss to follow-up at each stage.

2.6.2. Clinical measures

The primary outcome was the change in global eating disorder psychopathology, assessed with the Eating Disorder Examination Questionnaire (EDE-Q) (Bang et al., 2018b), a widely used self-report measure capturing the core cognitive and behavioral features of eating disorders. The EDE-Q was selected as the primary outcome due to its close alignment with the central treatment targets of CBT-E.

Secondary outcomes were grouped into three domains. First, eating-related psychopathology was assessed using the EDE-Q subscales, which index restraint and eating-, shape-, and weight-related concerns; the Eating Attitudes Test–26 (EAT-26), assessing disordered eating attitudes and behaviors (Garner et al., 1982); the Yale Food Addiction Scale (YFAS), measuring addictive-like eating behaviors, with the child/adolescent version (YFAS-C) administered to adolescents and YFAS 2.0 administered to young adults (Gearhardt et al., 2016; Gearhardt et al., 2013); and the Drive for Thinness subscale of the Eating Disorder Inventory (EDI-DT), reflecting preoccupation with weight and fear of weight gain (Garner et al., 1983). Because different age-appropriate versions of the YFAS were used, YFAS symptom scores were standardized using z-scores prior to analysis to ensure comparability across participants. Second, psychological measures included the Beck Depression Inventory (BDI) for depressive symptoms (Sung et al., 2008), State-Trait Anxiety Inventory (STAI) for anxiety (Lee et al., 2008), Perceived Stress Scale (PSS) (Hong et al., 2016), and Rosenberg Self-Esteem Scale (RSES) (Bae et al., 2014). Third, functional impairment was assessed using the Clinical Impairment Assessment (CIA), which evaluates psychosocial impairment associated with eating disorder symptoms (Bang et al., 2018b). Detailed descriptions of all measures are provided in Trial Protocol (Supplementary Material 1).

2.7. Statistical analysis

All statistical analyses were conducted using R (version 4.5.0). Two-tailed tests were applied with a significance level set at $\alpha = 0.05$. Baseline demographic and clinical characteristics were summarized using descriptive statistics and compared between groups using Wilcoxon rank-sum tests for continuous variables and Fisher exact tests for categorical variables. Feasibility outcomes, including attrition, adherence, and engagement, were summarized descriptively. Usability was reported as total composite scores, and internal consistency was evaluated using Cronbach's α. Clinical outcomes were analyzed according to an intention-to-treat (ITT) framework, including all randomized participants, using linear mixed-effects models to account for repeated measures over time and missing observations. Fixed effects included group, time, and the group × time interaction, with participant-specific random intercepts. Age, sex, and body mass index (BMI) were included as covariates, with continuous variables (age and BMI) mean-centered prior to analysis (Cohen, 2013; Electrophysiology TFOTESOCTNA, 1996). Models were estimated using restricted maximum likelihood without data imputation. Bonferroni-adjusted post hoc comparisons were conducted. Effect sizes were reported as partial η^2 for model effects and Cohen's d for between-group differences. Analyses of the group × time interaction centered on the intervention period (T0–T1), the pre-specified primary efficacy contrast comparing the intervention and waitlist control groups. Maintenance effects for the intervention group and delayed effects for the waitlist group were evaluated for clinical outcomes, based on the same linear mixed-effects modeling approach.

Table 2
Baseline demographic and clinical characteristics by group.

Characteristic	Intervention $N = 32$	Waitlist N = 32	*p*-Value
Demographics			
Sex			.35
Female	25 (78%)	27 (87%)	
Male	7 (22%)	4 (13%)	
Age	19.59 (2.17)	20.91 (1.28)	.01
Body mass index (kg/m^2)			.15
Normal (18.5–23, reference)	17 (53%)	21 (66%)	
Obesity (≥25)	12 (38%)	5 (16%)	
Overweight (23–25)	3 (9.4%)	5 (16%)	
Underweight (<18.5)	0 (0%)	1 (3.1%)	
Clinical Characteristics (Baseline)			
Global EDE-Q	2.99 (1.14)	3.30 (1.03)	.28
YFAS	0.11 (1.00)	0.00 (1.12)	.53
EAT-26	24.94 (12.89)	26.72 (13.46)	.71
EDI-DT	28.22 (7.67)	29.59 (5.53)	.55
BDI	16.13 (10.51)	15.31 (10.43)	.79
STAI	90.94 (28.66)	94.84 (22.36)	.63
PSS	31.38 (7.07)	29.35 (7.27)	.23

Note. Data are presented as No. (%) or Mean (SD). *P* values were calculated using the Fisher exact test for categorical variables and the Wilcoxon rank-sum test for continuous variables. Clinical cutoff scores were as follows: EDE-Q ≥ 2.8; EAT-26 ≥ 20; EDI-DT ≥ 15; BDI ≥ 21; PSS ≥ 27; STAI (State) ≥ 45; STAI (Trait) ≥ 44. Cutoff values for YFAS are not universally established. Because two age-appropriate versions of the YFAS were used in this sample, scores were standardized using z-scores to enable comparability across participants. Sample size reflects participants with available baseline data (T0). Abbreviations. EDE-Q = Eating Disorder Examination Questionnaire; YFAS = Yale Food Addiction Scale; EAT-26 = Eating Attitudes Test - 26; EDI-DT = Eating Disorder Inventory - Drive for Thinness; BDI = Beck Depression Inventory; STAI = State - Trait Anxiety Inventory; PSS = Perceived Stress Scale.

Table 3
Attrition, adherence, and engagement outcomes during the intervention phase by group.

Outcome	Intervention	Waitlist
Attrition, No./Total (%)	10/32 (26.67)	8/32 (25.00)
Adherence, mean (SD)	76.50 (23.90)	56.32 (40.30)
Met adherence criterion, No./Total (%)	18/22(81.82)	15/24(62.50)
Engagement, mean (SD)	79.32 (80.45)	84.83 (70.14)
Met engagement criterion, No./Total (%)	17/22 (77.27)	16/24 (66.67)

Note. Values are percentage (%) unless otherwise indicated. Attrition reflects the proportion of participants who did not complete the T1 assessment in each group. Adherence and engagement are reported as mean (SD) percentages of completed sessions and meal logs, respectively. Adherence and engagement measures reflect assessments conducted immediately following completion of the intervention phase for each group (T1 for the intervention group and T2 for the waitlist group).

3. Results

Of 67 participants assessed for eligibility, 64 were randomized to the intervention ($n = 32$) or waitlist control group (n = 32) (Fig. 2). In the intervention group, 30 participants received the allocated intervention, and 22 completed the primary assessment (T1). In the waitlist group, all participants remained in the assigned condition, and 24 completed the primary assessment. At the 16-week follow-up, 20 participants in the intervention group and 22 in the waitlist group completed assessments. A total of 32 intervention participants and 32 waitlist participants were included in the analysis.

3.1. Sample description

Table 2 summarizes baseline characteristics. The sample was predominantly female, with comparable sex distributions between groups (78% vs 87% female). The intervention group was slightly younger than the waitlist group (19.59 vs 20.91 years, $p = .01$), while BMI category distributions were similar, with over half of participants in the normal BMI range. No significant between-group differences were observed in baseline eating-related or psychological measures, indicating comparable clinical profiles. Overall, both groups exhibited elevated levels of eating disorder psychopathology and associated psychological symptoms, consistent with a clinically at-risk population.

Table 4
Linear mixed-effects model results for group × time interaction effects on clinical outcomes across groups during T0–T1.

Measure	β (SE) [CI]	P value	Partial η^2
Global EDE-Q	0.64 (0.28) [0.09–1.19]	0.023	0.059
EDE-Q Restraint	0.24 (0.39) [−0.52–1.00]	0.534	0.012
EDE-Q Eating Concern	0.48 (0.30) [−0.11–1.07]	0.114	0.034
EDE-Q Shape Concern	1.01 (0.32) [0.38–1.64]	0.002	0.114
EDE-Q Weight Concern	0.84 (0.37) [0.11–1.57]	0.024	0.061
YFAS	0.52 (0.20) [0.13–0.91]	0.010	0.075
EAT-26	3.42 (3.46) [−3.36–10.20]	0.326	0.018
EDI-DT	4.76 (1.57) [1.68–7.84]	0.003	0.094
BDI	3.59 (1.88) [−0.09–7.27]	0.059	0.055
STAI	7.84 (6.92) [−5.72–21.40]	0.260	0.054
RSES	−2.59 (1.29) [−5.12 to −0.06]	0.047	0.045
PSS	3.28 (2.23) [−1.09–7.65]	0.144	0.040
CIA	7.38 (2.50) [2.48–12.28]	0.004	0.093

Note. Estimates correspond to the group × time interaction effect at primary assessment (T1) from linear mixed-effects models with participant-level random intercepts. Models were adjusted for age, sex, and BMI, with age and BMI mean-centered. β (SE) represents unstandardized coefficients and standard errors; 95% confidence intervals are shown in brackets. Partial η^2 reflects effect-size estimates. Statistical significance was defined as $P < .05$ (two-tailed). Abbreviations. EDE-Q = Eating Disorder Examination Questionnaire; YFAS = Yale Food Addiction Scale; EAT-26 = Eating Attitudes Test-26; EDI-DT = Eating Disorder Inventory-Drive for Thinness subscale; BDI = Beck Depression Inventory; STAI = State-Trait Anxiety Inventory; RSES = Rosenberg Self-Esteem Scale; PSS = Perceived Stress Scale; CIA = Clinical Impairment Assessment.

3.2. Feasibility outcomes

During the intervention phase, attrition rates were comparable between groups (26.67% in the intervention group and 25.0% in the waitlist group). Adherence was moderate overall and numerically higher among participants receiving the intervention immediately than among those receiving it after the waitlist period, with a greater proportion meeting the predefined adherence criterion (81.8% vs 62.5%). Engagement levels were comparable between groups, and the majority of participants met the predefined engagement criterion; however, substantial interindividual variability was observed in engagement levels within both groups. Given this heterogeneity in self-monitoring behavior, we conducted exploratory Spearman correlations to examine whether engagement level was associated with differential treatment response within the intervention group (Supplementary Material 3: Table S1). A nominally significant negative association was observed between engagement and change in food addiction symptoms (YFAS; rs = −0.64, $p = .019$), suggesting that higher engagement may be associated with greater reductions in food addiction symptomatology. Associations with other clinical indices were in a consistent negative direction but did not reach statistical significance (rs = −0.34 to −0.44, all $p > .05$). Group-specific feasibility outcomes are summarized in Table 3. The 24-item composite usability scale demonstrated high internal consistency (Cronbach's α = 0.85). Overall usability ratings were favorable (mean, 55.21; SD, 6.29), with consistently positive item-level responses across ease of use, perceived usefulness, and satisfaction. Brief qualitative feedback indicated that while overall user experience was positive, some participants perceived specific components, such as meal logging and mindfulness technique (e.g. meditation), as burdensome,

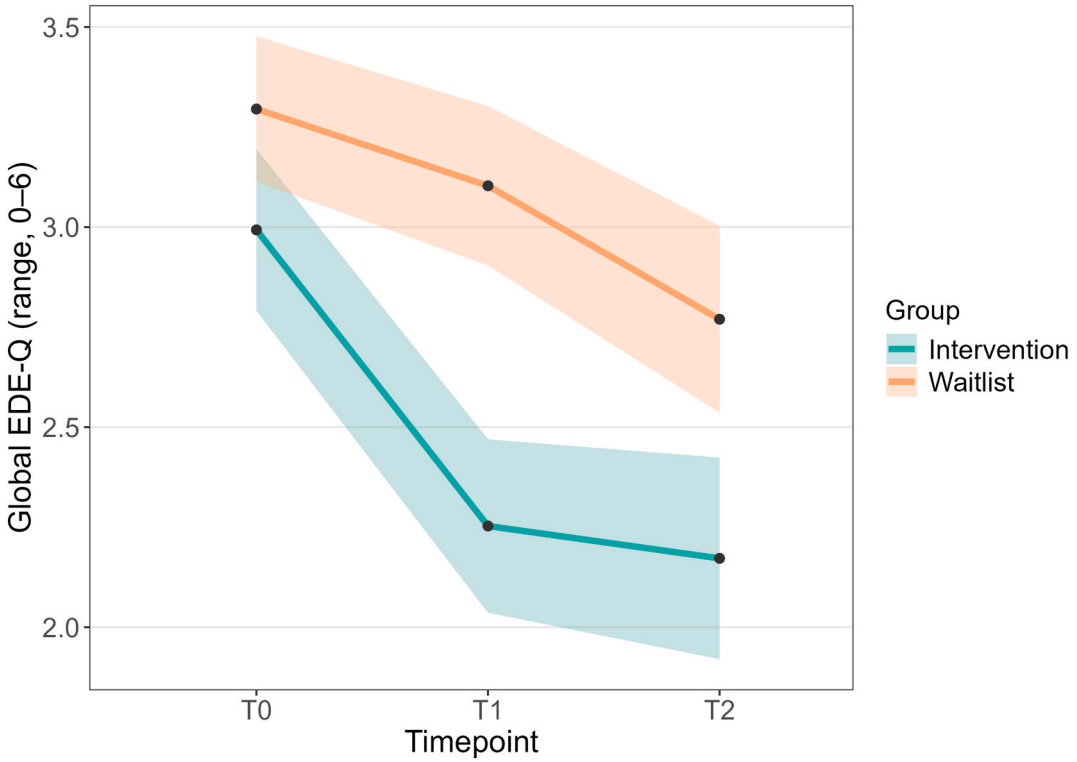

Fig. 3. Change in global Eating Disorder Examination Questionnaire scores.
Group-level mean Global EDE-Q scores are shown for the intervention and waitlist groups at baseline (T0), primary assessment (T1), and 16-week follow-up (T2). Shaded areas represent standard errors. Lower scores indicate reduced eating disorder psychopathology.

and reported variability in engagement with self-monitoring activities. Response details of usability ratings and summaries of qualitative interviews are provided in Supplementary Material 3.

3.3. Clinical outcome

3.3.1. Clinical outcome during the primary efficacy evaluation period (T0–T1)

The primary outcome, global eating disorder psychopathology assessed using the EDE-Q, demonstrated a significant Group × Time interaction during the primary efficacy evaluation period (T0–T1) (β = 0.64, SE = 0.28, P = .023, partial η^2 = 0.059), indicating greater symptom reduction in the immediate intervention group compared with the waitlist control group (Table 4). Mean scores decreased in the immediate intervention group from 2.99 (SD = 1.14) at baseline to 2.25 (SD = 1.23) at the end-of-intervention assessment (T1), whereas the control group showed only modest change over the same period (3.30 [SD = 1.03] to 3.10 [SD = 1.13]). Notably, only the immediate intervention group showed a reduction in mean scores below the established clinical cutoff (≥2.8) during the primary efficacy evaluation period (Fig. 3).

Consistent with the primary outcome, secondary clinical outcomes demonstrated a coherent pattern supporting intervention effects. In the domain of eating-related psychopathology, significant Group × Time interactions were observed during the primary efficacy evaluation period for EDE-Q Shape Concern and Weight Concern, with greater reductions in the immediate intervention group compared with the waitlist control group (Shape Concern: β = 1.05, SE = 0.32, P = .002, partial η^2 = 0.122; Weight Concern: β = 0.88, SE = 0.37, P = .020, partial η^2 = 0.067). Drive for thinness (EDI-DT) also showed a significantly greater reduction in the immediate intervention group (β = 4.61, SE = 1.61, P = .005, partial η^2 = 0.089). In addition, addictive-like eating behaviors assessed using the YFAS exhibited a significant Group × Time interaction, indicating greater symptom attenuation in the immediate intervention group relative to the waitlist group (β = 0.55, SE = 0.20, P = .008, partial η^2 = 0.089). Significant changes were also observed in the psychological state domain. The immediate intervention group demonstrated a greater improvement in self-esteem (RSES) compared with the waitlist control group (β = −2.98, SE = 0.21, P = .016, partial η^2 = 0.068). In the functional impairment domain, psychosocial impairment related to eating disorder symptoms, as measured by the Clinical Impairment (CIA), decreased more substantially in the immediate intervention group than in the waitlist group (β = 7.33, SE = 2.54, P = .005, partial η^2 = 0.092). Detailed descriptive statistics, full fixed-effect model estimates, post hoc comparisons, and results from the completer analysis are provided in Supplementary Material 4.

3.3.2. Maintenance and delayed effects across groups (T1–T2)

During the T1–T2 interval, no statistically significant changes were observed in the intervention group across global eating disorder psychopathology (EDE-Q), related eating pathology measures, or psychosocial impairment. Among psychological outcomes, anxiety (STAI) showed a further significant reduction from T1 to T2 (estimate = 16.57, SE = 5.30, p = .007), whereas no additional significant changes were observed in depressive symptoms (BDI), perceived stress (PSS), or self-esteem (RSES). (Supplementary Material, Table S4). During the delayed intervention period (T1–T2), no statistically significant changes were observed across clinical outcomes in the waitlist group. However, nonsignificant trends toward improvement were observed in EDE-Q restraint (estimate = 0.64, SE = 0.28, p = .06) and EAT-26 (estimate = 5.25, SE = 2.45, p = .09) (Supplementary Material, Table S5).

4. Discussion

To our knowledge, this is one of the first randomized trials of a developmentally and symptomatically tailored digital CBT-E self-help program. The program demonstrated acceptable feasibility, with satisfactory completion, engagement, and usability despite high attrition

typically observed in adolescent digital interventions. A prior user-centered internet-delivered CBT-E study in adults reported approximately 73.2% adherence, providing a useful benchmark for interpreting the present findings (Wiberg et al., 2022). Given that treatment completion is generally lower in adolescents, the level of adherence observed in this study may be considered acceptable within the context of digital CBT-E self-help interventions. The use of brief micro-sessions, a developmentally aligned structure, and multimodal interactive content may have supported engagement (Radovic et al., 2018). In addition, *PlanEat* is distinguished by its symptom-tailored algorithm based on clinically informed profiling, rather than user-choice-based personalization, allowing for more precise CBT-E-consistent tailoring (Wanniarachchi et al., 2025). In this context, *PlanEat* extends prior work by applying a developmentally adapted, mobile-based approach.

However, exploratory interview findings indicated that some components, such as meal logging and meditation, as well as self-monitoring tasks, were perceived as burdensome by a subset of participants, and substantial interindividual variability in engagement was observed. These findings suggest that applying a uniform structure and intensity across both core content and supportive task demands may have limitations, highlighting the need for more flexible personalization strategies. In a follow-up exploratory analysis accounting for variability in engagement, a significant negative correlation was observed between engagement and change in food addiction symptoms (YFAS). This suggests that engagement may be associated with symptom change and supports its potential relevance to treatment response in digital self-help interventions, consistent with prior studies reporting associations between engagement-related indicators and treatment outcomes (McClure et al., 2024). However, given the small sample and exploratory nature of the analysis, further validation is needed.

During the primary efficacy evaluation period (T0–T1), immediate improvements were observed across eating disorder–related domains, including global eating disorder psychopathology, shape- and weight-related cognitions, difficulties in dietary control, and functional impairment. Notably, mean Global EDE-Q scores in the immediate intervention group declined below the established clinical cutoff by the end-of-intervention assessment, indicating that clinically meaningful change can be achieved within a relatively brief, fully self-guided digital intervention. These findings suggest that the core maintaining mechanisms targeted by CBT-E can be effectively engaged over a short time frame. In addition to symptom reduction, the observed improvement in self-esteem may reflect early reorganization of maladaptive self-evaluation structures, which are disproportionately anchored to weight and shape concerns. Within the CBT-E framework, self-evaluation is conceptualized as a central cognitive mechanism underlying eating disorder psychopathology (Fairburn, 2008). Accordingly, the present findings suggest that the intervention may have influenced higher-order cognitive targets beyond symptomatic change. Such early cognitive shifts may serve as a foundation for subsequent emotional and behavioral stabilization, and future adequately powered studies should formally examine these pathways using mediation analyses (De Jong et al., 2020; Rahmani et al., 2025). Importantly, these initial improvements were largely maintained at the 16-week follow-up assessment, with no evidence of significant deterioration or rebound across key clinical indicators. This finding suggests that changes induced by the brief digital CBT-E-based intervention may be stably maintained at least over the follow-up period.

In contrast, indices of emotional distress, including depressive and anxiety symptoms, did not show significant immediate changes during the primary efficacy evaluation period. This pattern may be understood within a process-oriented framework of cognitive-behavioral change, in which intervention effects unfold sequentially from reductions in eating disorder symptoms to reconfiguration of self-evaluative processes, ultimately leading to reductions in emotional distress (Linardon, 2018). Within this framework, emotional benefits of CBT-E-based interventions are expected to emerge only after cognitive-behavioral and self-evaluative changes have sufficiently accumulated and stabilized (Fairburn, 2008). Given that prior studies have reported significant improvements in depressive symptoms at 12 months post-treatment rather than immediately after treatment (Cassioli et al., 2023), the 8-week intervention period employed in the present study may have been sufficient to capture early changes in eating disorder psychopathology and self-evaluation, but insufficient to detect immediate changes in emotional distress. Indeed, prior studies of eating disorder and CBT-based interventions have reported that improvements in comorbid emotional symptoms often occur as secondary, temporally lagged effects following improvement in core eating disorder symptoms (De Jong et al., 2020). This interpretation is further consistent with NICE guidelines, which recognize that improvements in emotional comorbidity in eating disorders often require sustained treatment and longer-term follow-up rather than brief interventions alone (National Guideline Alliance (UK), 2017). Importantly, in the present study, anxiety symptoms (STAI) continued to decline during the follow-up period (T1–T2) despite the absence of ongoing intervention. This pattern suggests that emotional stabilization may develop gradually as earlier cognitive and behavioral changes are progressively integrated into daily functioning. Consequently, these findings underscore the importance of longitudinal assessment for capturing time-lagged intervention effects in digital CBT-E-based interventions.

Meanwhile, during the delayed intervention phase (T1–T2), no statistically significant changes were observed across overall clinical outcomes in the waitlist group, with only nonsignificant trends toward improvement in global EDE-Q and EAT-26 scores. Prior studies have commonly attributed attenuated responses following delayed access to interventions to reduced motivation and increased disengagement after prolonged waitlist periods, factors that may negatively influence intervention uptake (McClure et al., 2024). Consistent with this interpretation, adherence in the waitlist group was noticeably lower than that observed in the immediate intervention group of the present study. At a hypothesis-generating level, whether adherence accounted for between-group differences in treatment effects should be systematically examined in future studies using approaches such as exploratory predictor analyses. In the present study, the waitlist condition likely reflected a context closer to treatment as usual (TAU) rather than a pure no-treatment control. Allowing participants in the waitlist group to maintain existing treatments may have contributed, in part, to the absence of marked symptom deterioration during the delayed intervention phase. However, despite this relative stability, the magnitude of improvement observed in the waitlist group during the delayed intervention analysis was substantially smaller than that observed in the immediate intervention group. These observations suggest that the outcomes in the waitlist group likely reflect a combination of natural symptom trajectories, ongoing treatment effects, and diminished engagement due to prolonged waiting. Consequently, such patterns highlight the inherent limitations of a simple waitlist design in isolating intervention-specific effects from non-specific confounding factors. The type of control condition is known to critically shape the inferences that can be drawn from mHealth randomized controlled trials (Goldberg et al., 2023). Accordingly, the present findings should be interpreted as preliminary evidence of intervention effectiveness relative to the passage of time, rather than definitive evidence of intervention-specific effects, given the use of a waitlist control design. In this context, the present study represents an early-stage evaluation of intervention effects. Even from an ethical standpoint, the minimal improvements observed in the waitlist group further underscore the need to strengthen methodological rigor while maintaining ethical responsibility in adolescent trials. Accordingly, future adequately powered randomized controlled trials should consider incorporating comparator conditions such as enhanced TAU or attention-matched active control groups, which would allow intervention-specific effects to be more clearly distinguished from nonspecific factors related to contact frequency, motivation, and engagement (Mohr et al., 2009).

5. Limitations

This study has several limitations that warrant careful consideration. First, as a pilot randomized trial with a modest sample size, it was not adequately powered to detect subtle or small effect sizes. Second, given multiple outcomes tested for group-by-time interactions, the risk of Type I error cannot be excluded. As a pilot study, findings should be interpreted with caution. Third, the waitlist-controlled design inherently precluded participant blinding, which may introduce expectancy effects or performance bias. Furthermore, because the control group crossed over to the intervention immediately after the primary evaluation, we were unable to conduct between-group comparisons of long-term sustainability or delayed intervention effects. Fourth, although the program incorporated symptom-based tailoring, the study design did not allow us to disentangle the specific therapeutic effects of personalization from the general effects of CBT-E content. In addition, while the intervention included core components of transdiagnostic CBT-E, adolescent-specific adaptations were only partially applied, and parental involvement was not included due to the absence of therapist guidance in this program. Future research should explore ways to integrate parental or family involvement within digital intervention frameworks. Finally, our sample was predominantly composed of digitally literate females. This demographic skew may limit the generalizability of the findings to male populations, individuals with lower digital proficiency, or those with higher clinical severity, such as individuals requiring inpatient care. Additionally, gender was assessed in a binary manner (male/female), and therefore diverse gender identities were not captured. This may further limit the generalizability of the findings to individuals with diverse gender identities, including non-binary and transgender populations. Future research should incorporate more inclusive gender measures to better examine treatment responses across diverse gender groups.

6. Conclusion

The developmentally and symptomatically tailored digital CBT-E program evaluated in this study demonstrated overall favorable feasibility, with preliminary indications of improvement reflected in treatment engagement and clinical symptom reduction. These findings support the validity of the proposed study protocol and justify progression to a fully powered randomized controlled trial (RCT). Specifically, the results provide a crucial foundation for identifying key clinical indicators to precisely detect the efficacy of binge eating interventions and for further refining the study design. From a program development perspective, user-reported usability data and qualitative interview feedback highlight opportunities to further enhance intervention components and personalization strategies. Addressing these aspects in future iterations will strengthen user engagement and scalability, ultimately contributing to the increased accessibility of evidence-based digital interventions for adolescents and young adults with disordered eating.

CRediT authorship contribution statement

Hyangkyeong Oh contributed to study design, formal statistical analysis, and manuscript drafting. Ujin Lee led the conceptualization and development of the digital therapeutic intervention. Bokyung Shin contributed to study design and digital intervention conceptualization. Yunhee Kim conducted the experimental procedures and assessments. Youngchul Jung served as the principal investigator responsible for funding acquisition and project administration. Eunjoo Kim served as the principal investigator overseeing study conceptualization, supervision, and overall project leadership.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used generative AI tools to assist with language editing and improving readability. The authors take full responsibility for the content of the manuscript.

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Declaration of competing interest

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Appendix A. Supplementary data

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References

Aardoom, J.J., Dingemans, A.E., Van Furth, E.F., 2016 Apr. E-health interventions for eating disorders: emerging findings, issues, and opportunities. Curr. Psychiatry Rep. 18 (4), 42. https://doi.org/10.1007/s11920-016-0673-6.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. APA, Washington DC.

Bae, H.N., Choi, S.W., Yu, J.C., Lee, J.S., 2014. Reliability and validity of the Korean version of the Rosenberg Self-Esteem Scale in adults. Mood Emot. 12 (1), 43–49.

Bang, E.B., Han, C.L., Jeon, Y., Kim, Y.R., 2018a. The Korean version of the Eating Disorder Diagnostic Scale DSM-5 (K-EDDS DSM-5): a reliability and validity study. Anxiety Mood 14 (2), 127–134.

Bang, E.B., Han, C.L., Kim, Y., Kim, M.H., Lee, Y.H., Heo, S.Y., Kim, Y.-R., 2018b. A reliability and validity study of the Korean versions of the Eating Disorder Examination Questionnaire version 6.0 (EDE-Q version 6.0) and the Clinical Impairment Assessment Questionnaire (CIA). J. Psychosom. Med. 26 (2), 152–163. https://doi.org/10.22722/KJPM.2018.26.2.152.

Barakat, S., Maguire, S., Smith, K.E., Mason, T.B., Crosby, R.D., Touyz, S., 2019 Oct. Evaluating the role of digital intervention design in treatment outcomes and adherence to eTherapy programs for eating disorders: a systematic review and meta-analysis. Int. J. Eat. Disord. 52 (10), 1077–1094. https://doi.org/10.1002/eat.23131.

Beatty, L., Binnion, C., 2016 Dec. A systematic review of predictors of, and reasons for, adherence to online psychological interventions. Int. J. Behav. Med. 23 (6), 776–794. https://doi.org/10.1007/s12529-016-9556-9.

Biberdzic, M., Tang, J., Tan, J., 2021 Dec. Beyond difficulties in self-regulation: the role of identity integration and personality functioning in young women with disordered eating behaviours. J. Eat. Disord. 9 (1), 93. https://doi.org/10.1186/s40337-021-00398-5.

Brooke, J., 1996. SUS: A "Quick and Dirty" Usability Scale. Taylor & Francis, London. ISBN:0-7484-0460-0.

Cassioli, E., Rossi, E., Martelli, M., Arganini, F., Giuranno, G., Siviglia, S., Tarchi, L., Faldi, M., Castellini, G., Ricca, V., 2023. Longitudinal coupling between eating disorder psychopathology and depression in patients with anorexia nervosa and bulimia nervosa treated with enhanced cognitive behavior therapy: a one-year follow-up study. Brain Sci. 13 (4), 535. https://doi.org/10.3390/brainsci13040535. Mar 24.

Chan, A.-W., Boutron, I., Hopewell, S., Moher, D., Schulz, K.F., Collins, G.S., Tunn, R., Aggarwal, R., Berkwits, M., Berlin, J.A., Bhandari, N., Butcher, N.J., Campbell, M.K., Chidebe, R.C.W., Elbourne, D.R., Farmer, A.J., Fergusson, D.A., Golub, R.M., Goodman, S.N., Hoffmann, T.C., Ioannidis, J.P.A., Kahan, B.C., Knowles, R.L., Lamb, S.E., Lewis, S., Loder, E., Offringa, M., Ravaud, P., Richards, D.P., Rockhold, F.

W., Schriger, D.L., Siegfried, N.L., Staniszewska, S., Taylor, R.S., Thabane, L., Torgerson, D.J., Vohra, S., White, I.R., Hróbjartsson, A., 2025 June. SPIRIT 2025 statement: updated guideline for protocols of randomized trials. Nat. Med. 31 (6), 1784–1792. https://doi.org/10.1038/s41591-025-03668-w.

Dalle Grave, R., Calugi, S., 2020. Cognitive Behavior Therapy for Adolescents with Eating Disorders. Guilford Publications.

Dalle Grave, R., Calugi, S., Doll, H.A., Fairburn, C.G., 2013 Jan. Enhanced cognitive behaviour therapy for adolescents with anorexia nervosa: an alternative to family therapy? Behav. Res. Ther. 51 (1), R9–R12. https://doi.org/10.1016/j.brat.2012.09.008.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 13 (3), 319–340. https://doi.org/10.2307/249008.

De Jong, M., Spinhoven, P., Korrelboom, K., Deen, M., Van Der Meer, I., Danner, U.N., Van Der Schuur, S., Schoorl, M., Hoek, H.W., 2020 May. Effectiveness of enhanced cognitive behavior therapy for eating disorders: a randomized controlled trial. Int. J. Eat. Disord. 53 (5), 717–727. https://doi.org/10.1002/eat.23239.

Derks, I.P.M., Harris, H.A., Staats, S., Gaillard, R., Dieleman, G.C., Llewellyn, C.H., Swanson, S.A., Jansen, P.W., 2022. Subclinical binge eating symptoms in early adolescence and its preceding and concurrent factors: a population-based study. J. Eat. Disord. 10 (1), 180. https://doi.org/10.1186/s40337-022-00688-6. Nov 23.

Egbert, A., Schram, S., 2025. Early intervention for eating disorders: a call to action for inclusion of minoritized groups. Eat. Disord. 1–16. https://doi.org/10.1080/10640266.2025.2564947. Sept 30.

Eldridge, S.M., Chan, C.L., Campbell, M.J., Bond, C.M., Hopewell, S., Thabane, L., Lancaster, G.A., 2016. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ, i5239. https://doi.org/10.1136/bmj.i5239. Oct 24.

Electrophysiology TFOTESOCTNA, 1996 Mar. Heart rate variability: standards of measurement, physiological interpretation, and clinical use. Circulation 93 (5), 1043–1065. https://doi.org/10.1161/01.CIR.93.5.1043.

Fairburn, C.G., 2008. Cognitive Behavior Therapy and Eating Disorder. Guilford Press.

Fairburn, C.G., Cooper, Z., Shafran, R., 2003 May. Cognitive behaviour therapy for eating disorders: a "transdiagnostic" theory and treatment. Behav. Res. Ther. 41 (5), 509–528. https://doi.org/10.1016/S0005-7967(02)00088-8.

Fischer, S., Meyer, A.H., Dremmel, D., Schlup, B., Munsch, S., 2014 July. Short-term cognitive-behavioral therapy for binge eating disorder: long-term efficacy and predictors of long-term treatment success. Behav. Res. Ther. 58, 36–42. https://doi.org/10.1016/j.brat.2014.04.007.

Garner, D.M., Olmsted, M.P., Bohr, Y., Garfinkel, P.E., 1982. The eating attitudes test: psychometric features and clinical correlates. Psychol. Med. 12 (4), 871–878. https://doi.org/10.1017/S0033291700049163.

Garner, D.M., Olmstead, M.P., Polivy, J., 1983. Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. Int. J. Eat. Disord. 2 (2), 15–34. https://doi.org/10.1002/1098-108X(198321)2:2<15::AID-EAT2260020203>3.0.CO;2-6.

Gearhardt, A.N., Roberto, C.A., Seamans, M.J., Corbin, W.R., Brownell, K.D., 2013. Preliminary validation of the Yale Food Addiction Scale for Children. Eat. Behav. 14 (4), 508–512.

Gearhardt, A.N., Corbin, W.R., Brownell, K.D., 2016. Development of the Yale Food Addiction Scale version 2.0. Psychol. Addict. Behav. 30 (1), 113–121.

Giel, K., Teufel, M., Junne, F., Zipfel, S., Schag, K., 2017. Food-related impulsivity in obesity and binge eating disorder—a systematic update of the evidence. Nutrients 9 (11), 1170. https://doi.org/10.3390/nu9111170. Oct 27.

Goldberg, S.B., Sun, S., Carlbring, P., Torous, J., 2023. Selecting and describing control conditions in mobile health randomized controlled trials: a proposed typology. Npj Digit. Med. 6 (1), 181. https://doi.org/10.1038/s41746-023-00923-7. Sept 30.

Hay, P.P., Bacaltchuk, J., Stefano, S., Kashyap, P., 2009. Psychological treatments for bulimia nervosa and binging. Cochrane Common Mental Disorders Group, editor Cochrane Database Syst. Rev.. https://doi.org/10.1002/14651858.CD000562.pub3. Oct 7.

Hong, G.R., Kang, H.K., Oh, E., Park, Y., Kim, H.S., 2016. Reliability and validity of the Korean version of the Perceived Stress Scale-10 in older adults. Res. Gerontol. Nurs. 9 (1), 45–51.

Hong, J.S., Wasden, C., Han, D.H., 2021 Sept. Introduction of digital therapeutics. Comput. Methods Programs Biomed. 209, 106319. https://doi.org/10.1016/j.cmpb.2021.106319.

Hudson, J.I., Hiripi, E., Pope, H.G., Kessler, R.C., 2007 Feb. The prevalence and correlates of eating disorders in the National Comorbidity Survey replication. Biol. Psychiatry 61 (3), 348–358. https://doi.org/10.1016/j.biopsych.2006.03.040.

Jones, M., Luce, K.H., Osborne, M.I., Taylor, K., Cunning, D., Doyle, A.C., Wilfley, D.E., Taylor, C.B., 2008. Randomized, controlled trial of an internet-facilitated intervention for reducing binge eating and overweight in adolescents. Pediatrics 121 (3), 453–462. https://doi.org/10.1542/peds.2007-1173. Mar 1.

Julious, S.A., 2005 Oct. Sample size of 12 per group rule of thumb for a pilot study. Pharm. Stat. 4 (4), 287–291. https://doi.org/10.1002/pst.185.

Lee, Y.J., Choi, S., Lee, H.K., Kim, B., Kim, W., Lee, S.H., Bang, S.Y., 2008. Korean state–trait anxiety inventory application study in middle and high school students. J. Korean Neuropsychiatr. Assoc. 47 (5), 471–480.

Lewis, J.R., 2002. Psychometric evaluation of the Post-Study System Usability Questionnaire (PSSUQ). Int. J. Hum.-Comput. Interact. 14 (3–4), 363–366. https://doi.org/10.1080/10447318.2002.9607486.

Linardon, J., 2018. Meta-analysis of the effects of cognitive-behavioral therapy on the core eating disorder maintaining mechanisms: implications for mechanisms of therapeutic change. Cogn. Behav. Ther. 47 (2), 107–125. https://doi.org/10.1080/16506073.2018.1427785. Mar 4.

Linardon, J., Shatte, A., Messer, M., Firth, J., Fuller-Tyszkiewicz, M., 2020 Nov. E-mental health interventions for the treatment and prevention of eating disorders: an updated systematic review and meta-analysis. J. Consult. Clin. Psychol. 88 (11), 994–1007. https://doi.org/10.1037/ccp0000575.

Lindgreen, P., Lomborg, K., Clausen, L., 2018. Patient experiences using a self-monitoring app in eating disorder treatment: qualitative study. JMIR Mhealth Uhealth 6 (6), e10253. https://doi.org/10.2196/10253. June 22.

Liverpool, S., Mota, C.P., Sales, C.M.D., Čuš, A., Carletto, S., Hancheva, C., Sousa, S., Cerón, S.C., Moreno-Peral, P., Pietrabissa, G., Moltrecht, B., Ulberg, R., Ferreira, N., Edbrooke-Childs, J., 2020. Engaging children and young people in digital mental health interventions: systematic review of modes of delivery, facilitators, and barriers. J. Med. Internet Res. 22 (6), e16317. https://doi.org/10.2196/16317. June 23.

Lund, A.M., 2001. Measuring usability with the USE questionnaire. Usability Interface 8 (2), 3–6.

Marzilli, E., Cerniglia, L., Cimino, S., 2018 Jan. A narrative review of binge eating disorder in adolescence: prevalence, impact, and psychological treatment strategies. Adolesc. Health Med. Ther. 9, 17–30. https://doi.org/10.2147/AHMT.S148050.

McClure, Z., Fuller-Tyszkiewicz, M., Messer, M., Linardon, J., 2024 May. Predictors, mediators, and moderators of response to digital interventions for eating disorders: a systematic review. Int. J. Eat. Disord. 57 (5), 1034–1048. https://doi.org/10.1002/eat.24078.

Melioli, T., Bauer, S., Franko, D.L., Moessner, M., Ozer, F., Chabrol, H., Rodgers, R.F., 2016 Jan. Reducing eating disorder symptoms and risk factors using the internet: a meta-analytic review. Int. J. Eat. Disord. 49 (1), 19–31. https://doi.org/10.1002/eat.22477.

Miskovic-Wheatley, J., Bryant, E., Ong, S.H., Vatter, S., Le, A., National Eating Disorder Research Consortium, Aouad, P., Barakat, S., Boakes, R., Brennan, L., Bryant, E., Byrne, S., Caldwell, B., Calvert, S., Carroll, B., Castle, D., Caterson, I., Chelius, B., Chiem, L., Clarke, S., Conti, J., Crouch, L., Dammery, G., Dzajkovski, N., Fardouly, J., Felicia, C., Feneley, J., Firriolo, A.-M., Foroughi, N., Fuller-Tyszkiewicz, M., Fursland, A., Gonzalez-Arce, V., Gouldthorp, B., Griffin, K., Griffiths, S., Hambleton, A., Hannigan, A., Hart, M., Hart, S., Hay, P., Hickie, I., Kay-Lambkin, F., King, R., Kohn, M., Koreshe, E., Krug, I., Linardon, J., Long, R., Long, A., Madden, S., Maguire, S., Maloney, D., Marks, P., McLean, S., Meddick, T., Miskovic-Wheatley, J., Mitchison, D., O'Kearney, R., Ong, S.H., Paterson, R., Paxton, S., Pehlivan, M., Pepin, G., Phillipou, A., Piccone, J., Pinkus, R., Raykos, B., Rhodes, P., Rieger, E., Rodan, S.-C., Rockett, K., Russell, J., Russell, H., Salter, F., Sawyer, S., Shelton, B., Singh, U., Smith, S., Smith, E., Spielman, K., Squire, S., Thomson, J., Touyz, S., Utpala, R., Vartanian, L., Vatter, S., Wallis, A., Ward, W., Wells, S., Wertheim, E., Wilksch, S., Williams, M., Touyz, S., Maguire, S., 2023. Eating disorder outcomes: findings from a rapid review of over a decade of research. J. Eat. Disord. 11 (1), 85. https://doi.org/10.1186/s40337-023-00801-3. May 30.

Mohr, D.C., Spring, B., Freedland, K.E., Beckner, V., Arean, P., Hollon, S.D., Ockene, J., Kaplan, R., 2009. The selection and design of control conditions for randomized controlled trials of psychological interventions. Psychother. Psychosom. 78 (5), 275–284. https://doi.org/10.1159/000228248.

Munsch, S., Meyer, A.H., Biedert, E., 2012 Dec. Efficacy and predictors of long-term treatment success for cognitive-behavioral treatment and behavioral weight-loss-treatment in overweight individuals with binge eating disorder. Behav. Res. Ther. 50 (12), 775–785. https://doi.org/10.1016/j.brat.2012.08.009.

Murphy, R., Khera, C., Osborne, E.L., 2025. Breaking the cycle: a pilot study on autonomous digital CBTe for recurrent binge eating. Front. Digit. Health 6, 1499350. https://doi.org/10.3389/fdgth.2024.1499350. Jan 17.

National Guideline Alliance (UK), 2017. Eating disorders: recognition and treatment. National Institute for Health and Care Excellence (UK), London.

Palmer, R.L., Birchall, H., Mcgrain, L., Sullivan, V., 2002 Sept. Self-help for bulimic disorders: a randomised controlled trial comparing minimal guidance with face-to-face or telephone guidance. Br. J. Psychiatry 181 (3), 230–235. https://doi.org/10.1192/bjp.181.3.230.

Radovic, A., McCarty, C.A., Katzman, K., Richardson, L.P., 2018. Adolescents' perspectives on using technology for health: qualitative study. JMIR Pediatr. Parent 1 (1), e2. https://doi.org/10.2196/pediatrics.8677. Mar 14.

Rahmani, S., Kashani, H.F., Kohani, M., Barazandeh, A., Babaei, F.S., 2025. The Effectiveness of Enhanced Cognitive Behavioral Therapy (CBT-E) on Body Image and Self-Criticism in Overweight Adolescents Without a Formal Diagnosis of Eating Disorders. Int. J. Educ. Cogn. Sci. 6 (4), 1–9.

Regan, P., Cachelin, F.M., Minnick, A.M., 2017 Mar. Initial treatment seeking from professional health care providers for eating disorders: a review and synthesis of potential barriers to and facilitators of "first contact". Int. J. Eat. Disord. 50 (3), 190–209. https://doi.org/10.1002/eat.22683.

Schlegl, S., Bürger, C., Schmidt, L., Herbst, N., Voderholzer, U., 2015. The potential of technology-based psychological interventions for anorexia and bulimia nervosa: a systematic review and recommendations for future research. J. Med. Internet Res. 17 (3), e85. https://doi.org/10.2196/jmir.3554. Mar 31.

Shu, C.Y., Watson, H.J., Anderson, R.A., Wade, T.D., Kane, R.T., Egan, S.J., 2019 Sept. A randomized controlled trial of unguided internet cognitive behaviour therapy for perfectionism in adolescents: impact on risk for eating disorders. Behav. Res. Ther. 120, 103429. https://doi.org/10.1016/j.brat.2019.103429.

Cohen, J., 2013. Statistical power analysis for the behavioral sciences. Routledge, New York.

Stice, E., Marti, C.N., Rohde, P., 2013 May. Prevalence, incidence, impairment, and course of the proposed DSM-5 eating disorder diagnoses in an 8-year prospective community study of young women. J. Abnorm. Psychol. 122 (2), 445–457. https://doi.org/10.1037/a0030679.

Sung, H.M., Kim, J.B., Park, Y.N., Bai, D.S., Lee, S.H., Ahn, H.N., 2008. A study on the reliability and validity of Korean version of the Beck Depression Inventory-II (BDI-II). J. Korean Soc. Biol. Ther. Psychiatry 14 (3), 201–212.

Tuncer, G.Z., Tuncer, M., 2025. The effect of eHealth-based guided self help interventions for binge eating disorder: a meta-analysis of randomized controlled trials. Eat. Disord. 1–23. https://doi.org/10.1080/10640266.2025.2498247. May 5.

van Strien, T., Frijters, J.E.R., Bergers, G.P.A., Defares, P.B., 1986. The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. Int. J. Eat. Disord. 5 (2), 295–315.

Wanniarachchi, V.U., Greenhalgh, C., Choi, A., Warren, J.R., 2025. Personalization variables in digital mental health interventions for depression and anxiety in adolescents and youth: a scoping review. Front. Digit. Health (7), 1500220. https://doi.org/10.3389/fdgth.2025.1500220. May 15.

Whitehead, A.L., Julious, S.A., Cooper, C.L., Campbell, M.J., 2016 June. Estimating the sample size for a pilot randomised trial to minimise the overall trial sample size for the external pilot and main trial for a continuous outcome variable. Stat. Methods Med. Res. 25 (3), 1057–1073. https://doi.org/10.1177/0962280215588241.

Wiberg, A.-C., Ghaderi, A., Danielsson, H.B., Safarzadeh, K., Parling, T., Carlbring, P., Jansson, M., Welch, E., 2022 Dec. Internet-based cognitive behavior therapy for eating disorders – development and feasibility evaluation. Internet Interv. 30, 100570. https://doi.org/10.1016/j.invent.2022.100570.