Web-Based Cognitive Behavioral Treatment for Bulimia Nervosa
A Randomized Clinical Trial

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Abstract

IMPORTANCE Despite the existence of effective treatments, many individuals with bulimia nervosa (BN) do not receive evidence-based therapies. Integrating digital interventions into routine care might reach more patients and reduce the clinical burden of BN.

OBJECTIVE To evaluate the effectiveness of a web-based cognitive behavioral self-help intervention for individuals with BN.

DESIGN, SETTING, AND PARTICIPANTS A 2-group randomized clinical trial without follow-up was conducted between February 2, 2021, and July 9, 2022, in Germany. Participants aged between 18 and 65 years who met the diagnostic criteria for BN were enrolled online via self-referral. Data analyses were conducted from October 24, 2022, to December 23, 2023.

INTERVENTIONS A web-based cognitive behavioral self-help intervention including 12 weekly modules was compared with a waiting-list control group only having access to routine care.

MAIN OUTCOMES AND MEASURES The primary outcome was the change in the number of bulimic episodes between baseline and posttreatment. Secondary outcomes included changes in global eating disorder symptoms, clinical impairment, well-being, work capacity, comorbid symptoms, self-esteem, and emotion regulation complemented by weekly measures and ecological momentary assessment. Intention-to-treat analyses were performed.

RESULTS Participants (N = 154; mean [SD] age, 29.6 [8.6] years; 149 [96.8%] female) receiving the web-based intervention demonstrated a significantly greater decrease in bulimic episodes compared with the control group (Cohen d = −0.48; 95% CI, −0.75 to −0.20; P < .001), representing a significant change in binge-eating episodes (Cohen d = −0.61; 95% CI, −0.89 to −0.33; P < .001), but not in compensatory behaviors (Cohen d = −0.25; 95% CI, −0.51 to 0.02; P = .21). The intervention was superior in improving global eating disorder symptoms (Cohen d = −0.61; 95% CI, −0.89 to −0.32; P < .001) and clinical impairment (Cohen d = −0.62; 95% CI, −0.92 to −0.33; P < .001). No significant effects were found for well-being (Cohen d = −0.08; 95% CI, −0.37 to 0.22; P > .99) and work capacity (Cohen d = −0.01; 95% CI, −0.68 to 0.66; P = .99). Exploratory analyses indicated significant changes in self-esteem and emotion regulation difficulties, but not in comorbid symptoms.

CONCLUSIONS AND RELEVANCE In this randomized clinical trial, a web-based cognitive behavioral self-help intervention effectively decreased eating disorder symptoms and illness-related burden in individuals with BN, underlining the potential of digital interventions to complement established treatments.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT04876196

Key Points

Question Can a web-based cognitive behavioral self-help intervention reduce eating disorder symptoms and address disease-related features in bulimia nervosa?

Findings In this randomized clinical trial of 154 adults with bulimia nervosa, receiving a web-based intervention led to a significantly higher reduction in binge-eating episodes, global eating disorder symptoms, and clinical impairment compared with a waiting-list control group. There were no effects on compensatory behaviors.

Meaning These findings underscore the effectiveness of web-based cognitive behavioral treatments for bulimia nervosa and suggest that these interventions can complement face-to-face therapies.
Introduction

Approximately 1% to 2% of the global population is affected by bulimia nervosa (BN) during their lifetime and experiences recurrent binge-eating episodes and inappropriate compensatory behaviors accompanied by an excessive influence of shape or weight on self-evaluations. These symptoms are associated with functional impairment, reduced well-being, increased mortality, and immense societal costs. Therefore, developing and implementing effective treatments is essential to reduce the increasing global burden of BN.

Cognitive behavioral therapy (CBT) targets key etiologic factors of BN, such as biased cognitive schemes, limited emotion regulation abilities, low self-esteem, and interpersonal problems, and has been established as an evidence-based treatment. Notwithstanding, most patients with BN do not receive adequate care. A vicious circle of illness-related characteristics and health care–related barriers leads to low treatment rates even compared with other mental disorders. Consequently, individuals with BN often spend years without receiving evidence-based care, increasing their distress.

Possibly reducing the barriers of face-to-face treatments by being more flexible, accessible, and cost-efficient, web-based interventions have been developed to complement established therapies and are increasingly integrated into routine care settings. While meta-analyses suggest that web-based interventions may reduce eating disorder symptoms, there is a scarcity of research investigating treatments tailored to BN, and previous studies are often limited regarding their generalizability to clinical practice. Therefore, more research is needed to evaluate the effectiveness of web-based interventions targeting patients diagnosed with BN, especially when applied in naturalistic settings.

Addressing this research gap, this randomized clinical trial aimed to evaluate the effectiveness of a 12-week, web-based cognitive behavioral self-help intervention for patients with BN in reducing the number of binge-eating episodes and compensatory behaviors. To generalize our results to key eating disorder-related mechanisms and account for the high clinical burden of BN, our secondary aim was to explore changes in global eating disorder symptoms, clinical impairment, well-being, work capacity, comorbidities, emotion regulation, and self-esteem. Moreover, including weekly and everyday measurements may increase the temporal resolution and ecological validity of our results.

Methods

Study Design

This randomized clinical trial comparing a web-based cognitive behavioral self-help intervention and a waiting-list control group received ethical approval by the institutional review board at Heidelberg University. The study design has been published, and the trial protocol is available in Supplement 1. The study included a baseline (study entrance), a midtreatment (6 weeks after baseline), and a posttreatment (12 weeks after baseline) assessment. No follow-up assessment was conducted. Study data were collected from February 2, 2021, to July 9, 2022. All participants provided written informed consent online and received monetary compensation (10€ [$10.89]) for each assessment. International data privacy regulations and European Union legislation were considered to ensure participant confidentiality and safety. This report followed the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline.

Participants

The study was coordinated at Heidelberg University, with recruitment, data assessment, and treatment conducted entirely online. German-speaking individuals with eating disorder symptoms were recruited through self-referral by distributing advertisement material online and in inpatient and outpatient treatment centers, resembling enrollment to online therapy in the German health
After the initial screening, trained clinical interviewers administered video-based interviews, including the Eating Disorders Examination Interview and the Diagnostic Interview for Psychological Disorders. Each decision on study eligibility was discussed within the research team, supervised by 2 licensed clinical psychologists (C.T. and L.P.). Interrater reliability based on 19 interviews was almost perfect ($\kappa = 0.90$). Noneligible individuals were encouraged to seek professional help, and those diagnosed with binge eating disorder were directed to a parallel study.

Eligible participants needed to (1) meet the diagnostic criteria for BN according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, (2) be aged between 18 and 65 years, (3) have adequate language skills (German C1), and (4) have a smartphone with internet access. Exclusion criteria were (1) a body mass index below 18.5 (calculated as weight in kilograms divided by height in meters squared), (2) current psychotherapy or pharmacotherapy for eating disorders, (3) lifetime bipolar or psychotic disorder, (4) acute substance dependence, (5) current severe depressive episodes, and (6) acute suicidality. Inclusion and exclusion criteria were selected to represent clinical practice while ensuring participants' safety.

Randomization and Blinding
After completing the baseline assessment, participants were randomized to the intervention or control group by an independent and blinded researcher in a 1:1 ratio using a computer-based algorithm. The interviewers were thus blinded to treatment allocation (allocation sequence concealment). Immediately after randomization, participants either received access to the intervention or were informed of the waiting period of 12 weeks via email. All data assessments were initiated automatically to ensure unbiased data collection.

Intervention
Patients in the intervention group received access to a web-based 12-week CBT self-help intervention specialized for treating BN (Selfapy). The program introduces a diathesis-stress model and then targets key eating disorder mechanisms, allowing participants to work individually on their symptoms. During the treatment, interactive evidence-based CBT techniques complemented by stress management and mindfulness-based exercises are introduced in 6 mandatory and 6 additional weekly modules. After receiving 3 reminders to register for the program, only minimal guidance was provided, including technical support and security monitoring. For a detailed description of the intervention, refer to the trial protocol in Supplement 1 and eFigure 1 in Supplement 2. Additional treatment uptake during the study period was allowed and assessed mid- and posttreatment.

Control Group
Participants in the control group did not receive any treatment as part of the study but were allowed to seek professional help, including pharmacologic and psychological therapies. All health care service uptakes were captured at each assessment. After the study period, individuals in the control group received the web-based intervention.

Outcomes
The primary outcome was the change in bulimic episodes during the study period, determined by the total number of binge-eating episodes and compensatory behaviors within the preceding 28 days of each assessment, using the Eating Disorder Examination Questionnaire. Additional symptom measures were global eating disorder symptoms (Eating Disorders Examination Questionnaire) and weekly bulimic episodes (Weekly Binges Questionnaire). Furthermore, eating disorder–related daily difficulties (Clinical Impairment Assessment Questionnaire), well-being (World Health Organization Well-Being Index), and work capacity (IMTA [institute for Medical Technology Assessment] Productivity Cost Questionnaire) were assessed as secondary outcomes.

Possible changes in depressive (Patient Health Questionnaire-9) and anxiety (General Anxiety Disorder Scale-7) symptoms, self-esteem (Rosenberg Self-Esteem Scale), and emotion regulation...
Difficulties in Emotion Regulation Scale\textsuperscript{50}, Heidelberg Form for Emotion Regulation Strategies\textsuperscript{51}) were included as exploratory outcomes.

These questionnaires were complemented by a smartphone-based 5-day ecological momentary assessment protocol at baseline and posttreatment. In these recurrent assessments, daily eating disorder symptoms, such as binge-eating tendency, the current urge to compensate, and shape and weight concerns, were assessed on an 11-point Likert scale.

Other Measures
In addition to measures of change, the Attitudes Toward Psychological Online Interventions Scale,\textsuperscript{52} the Patient Questionnaire on Therapy Expectation and Evaluation,\textsuperscript{53} and the Client Sociodemographic and Service Receipt Inventory—European Version\textsuperscript{54} were used. Adverse effects and their impact were quantified using the Negative Effects Questionnaire.\textsuperscript{55}

Statistical Analysis
An a priori power analysis assuming a medium effect of Cohen $d = 0.50$ based on meta-analytic evidence for self-help interventions for eating disorders,\textsuperscript{18,56} an intraclass correlation of 0.40, a power of 0.80, and an $\alpha$ level of 0.05 indicated a required sample size of greater than or equal to 152.\textsuperscript{57,58} Data analyses were conducted from October 24, 2022, to December 23, 2023. Following our analysis plan, linear mixed models with restricted maximum likelihood estimation were run in line with the intention-to-treat principle. A random intercept and fixed effects for time (baseline, midtreatment, posttreatment), treatment (control, intervention), and their interaction were added stepwise to model continuous symptom change while considering the repeated measures design.\textsuperscript{59} The treatment effect was derived from the treatment $\times$ time interaction and standardized as Cohen $d$ effect size.\textsuperscript{60} For the secondary analyses, error rates were adjusted using the unweighted Bonferroni-Holm correction, and for the analysis of the weekly and ecological momentary assessment data, the models were modified to include the higher number of measurements. Complementing these analyses, a minimal clinically important difference (MCID = baseline SD $\sqrt{(1-r)}$) score was calculated to evaluate the clinical significance of within-group changes.\textsuperscript{61}

Enhancing the robustness of our results, missing values were addressed by conducting a sensitivity analysis using multiple imputations by chained equations. Given its questionable accuracy, the registered last observation carried forward analysis was emphasized less and is only reported in eTable 1 in Supplement 2.\textsuperscript{62} Moderator analyses were run for baseline symptom severity (Eating Disorder Examination global score), illness duration, age, previous treatments, new treatment uptake, patient expectancies, adherence, satisfaction, and attitudes toward online therapy by adding the moderators as a covariate to the mixed models. All statistical tests were conducted using R Statistics (R Foundation for Statistical Computing)\textsuperscript{63} and the lme4 package, version 1.1.27.1 (R Project for Statistical Computing).\textsuperscript{64} A 2-tailed 5% level of statistical significance was used.

Results
Participants
A total of 1757 individuals were screened, of whom 154 were equally randomized (mean [SD] age, 29.6 [8.6] years; 149 [96.8%] female; 3 [2.0%] male; 2 [1.3%] nonbinary) to the 2 study arms. Baseline participant characteristics are reported in Table 1. Participants in both groups reported similar demographic characteristics and clinical outcomes at baseline, except for the years since illness onset, which were higher in the control group, and global eating disorder symptoms and emotion regulation difficulties, which were slightly higher in the intervention group (eTable 2 and eTable 3 in Supplement 2). The CONSORT flow diagram summarizes the study flow (Figure 1). The clinical assessments were completed by 136 participants (88.3%) at midtreatment and 129 (83.8%) at posttreatment.
Changes in Primary Outcomes

There was a moderately higher decrease in bulimic episodes in the intervention group compared with the control group (Cohen $d = -0.48$; 95% CI, $-0.75$ to $-0.20$; $P < .001$) (Table 2 and Figure 2). A clinically meaningful decrease in bulimic episodes was found in the intervention group ($b = -16.27$; 95% CI, $-19.59$ to $-12.95$; MCID =12.53), but not in the control group ($b = -4.58$; 95% CI, $-9.90$ to $0.74$; MCID =12.53). Separate analyses on binge-eating episodes and compensatory behaviors revealed a moderate effect for binge-eating episodes (Cohen $d = -0.61$; 95% CI, $-0.89$ to $-0.33$; $P < .001$) with a substantial clinical symptom reduction in the intervention group ($b = -7.45$; 95% CI, $-9.41$ to $-5.49$; MCID =4.75), but not in the control group ($b = -0.14$; 95% CI, $-3.36$ to $3.07$; MCID =4.75) (eFigure 2 in Supplement 2). For compensatory behaviors, there was no significant effect

Table 1. Participants’ Demographic and Clinical Characteristics at Baseline

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
<th>Control group (n=77)</th>
<th>Intervention group (n=77)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>22.0 (6.8)</td>
<td>23.0 (6.0)</td>
<td>21.0 (7.0)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>149 (96.8)</td>
<td>75 (97.4)</td>
<td>74 (96.1)</td>
</tr>
<tr>
<td>Male</td>
<td>3 (2.0)</td>
<td>1 (1.3)</td>
<td>2 (2.6)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>2 (1.3)</td>
<td>1 (1.3)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>148 (96.1)</td>
<td>74 (96.1)</td>
<td>74 (96.1)</td>
</tr>
<tr>
<td>Other (including dual citizenship)</td>
<td>6 (3.9)</td>
<td>3 (3.9)</td>
<td>3 (3.9)</td>
</tr>
<tr>
<td>Relationship statusa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>109 (70.8)</td>
<td>49 (63.6)</td>
<td>60 (77.9)</td>
</tr>
<tr>
<td>Romantic relationship</td>
<td>44 (28.6)</td>
<td>28 (36.4)</td>
<td>16 (20.8)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University degree</td>
<td>79 (51.3)</td>
<td>44 (57.1)</td>
<td>35 (45.5)</td>
</tr>
<tr>
<td>Professional qualification</td>
<td>26 (16.9)</td>
<td>7 (9.1)</td>
<td>19 (24.7)</td>
</tr>
<tr>
<td>High school diploma</td>
<td>42 (27.3)</td>
<td>24 (31.2)</td>
<td>18 (23.4)</td>
</tr>
<tr>
<td>Secondary school diploma</td>
<td>3 (2.0)</td>
<td>1 (1.3)</td>
<td>2 (2.6)</td>
</tr>
<tr>
<td>In school</td>
<td>4 (2.6)</td>
<td>1 (1.3)</td>
<td>3 (3.9)</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In professional occupation</td>
<td>77 (50.0)</td>
<td>39 (50.6)</td>
<td>38 (49.4)</td>
</tr>
<tr>
<td>In training (studies, apprentice)</td>
<td>49 (31.8)</td>
<td>25 (32.5)</td>
<td>24 (31.2)</td>
</tr>
<tr>
<td>In training and in occupation</td>
<td>20 (13.0)</td>
<td>10 (13.0)</td>
<td>10 (13.0)</td>
</tr>
<tr>
<td>No professional occupation</td>
<td>8 (5.2)</td>
<td>3 (3.9)</td>
<td>5 (6.5)</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>24.2 (5.0)</td>
<td>24.3 (5.3)</td>
<td>24.0 (4.7)</td>
</tr>
<tr>
<td>Time since illness onset, mean (SD), y</td>
<td>5.3 (8.0)</td>
<td>6.9 (9.1)</td>
<td>3.7 (6.2)</td>
</tr>
<tr>
<td>Comorbiditiesb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affective disorders (F30-F39)</td>
<td>36 (23.4)</td>
<td>17 (22.1)</td>
<td>19 (24.7)</td>
</tr>
<tr>
<td>Neurotic, stress-related, and somatoform disorders (F40-F48)</td>
<td>21 (13.6)</td>
<td>8 (10.4)</td>
<td>13 (16.9)</td>
</tr>
<tr>
<td>Borderline personality disorder (F60.31)</td>
<td>4 (2.6)</td>
<td>2 (2.6)</td>
<td>2 (2.6)</td>
</tr>
<tr>
<td>Past treatment, lifetime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychotherapy</td>
<td>85 (55.2)</td>
<td>44 (57.1)</td>
<td>41 (53.3)</td>
</tr>
<tr>
<td>Psychotropic medication</td>
<td>22 (14.9)</td>
<td>14 (18.2)</td>
<td>8 (10.4)</td>
</tr>
<tr>
<td>Inpatient treatment</td>
<td>44 (28.6)</td>
<td>22 (28.6)</td>
<td>22 (28.6)</td>
</tr>
<tr>
<td>No treatment</td>
<td>63 (40.9)</td>
<td>29 (37.7)</td>
<td>34 (44.2)</td>
</tr>
<tr>
<td>Treatment past 12 wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychotherapy</td>
<td>10 (6.5)</td>
<td>7 (9.1)</td>
<td>3 (3.9)</td>
</tr>
<tr>
<td>Psychotropic medication</td>
<td>5 (3.3)</td>
<td>1 (1.3)</td>
<td>4 (5.2)</td>
</tr>
<tr>
<td>Inpatient treatment</td>
<td>1 (0.6)</td>
<td>0 (0.0)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>No treatment</td>
<td>139 (90.3)</td>
<td>69 (89.6)</td>
<td>70 (90.9)</td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

a One double mention.
(Cohen $d = -0.25$; 95% CI, $-0.51$ to $0.02$; $P = .21$) and neither a clinically meaningful change in the intervention group ($b = -8.82$; 95% CI, $-11.29$ to $-6.34$; MCID $=9.16$) nor in the control group ($b = -4.43$; 95% CI, $-7.45$ to $-1.42$; MCID $=9.16$) was found (eFigure 3 in Supplement 2). Underlining the robustness of our findings, these results were replicated in our sensitivity analysis (Table 2).

### Changes in Secondary Outcomes

Medium differences in the changes from baseline to posttreatment favoring the intervention group were found for global eating disorder symptoms (Cohen $d = -0.61$; 95% CI, $-0.89$ to $-0.32$; $P < .001$) and clinical impairment (Cohen $d = -0.62$; 95% CI, $-0.92$ to $-0.33$; $P < .001$). In contrast, no meaningful effects were detected for well-being (Cohen $d = -0.08$; 95% CI, $-0.37$ to $0.22$; $P > .99$) and the restoration of work capacity (Cohen $d = -0.01$; 95% CI, $-0.68$ to $0.66$; $P = .99$). The same pattern of results occurred in the sensitivity analysis (Table 2). Concerning the weekly symptom measurements, bulimic behaviors decreased more substantially in the intervention group compared with the control group ($b = -0.15$; 95% CI, $-0.24$ to $-0.06$; Cohen $d = -0.29$; 95% CI, $-0.46$ to $-0.11$; $P = .005$) (eFigure 4 in Supplement 2).

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**Figure 1. Participant Flow Diagram**

1757 Patients screened for eligibility

- 1361 Excluded
  - 750 Discontinuation of screening
  - 241 Psychotherapy for ED
  - 103 BMI <18.5
  - 194 Current suicidal ideation
  - 47 No bulimic episodes
  - 12 Age criterion not met
  - 8 Language criterion not met
  - 4 No permanent internet access
  - 2 No informed consent

- 396 Structured diagnostic interviews

154 Randomized

- 77 Randomized to web-based intervention
  - 76 Received treatment
  - 1 Did not access the intervention
  - 65 Completed midtreatment assessments
  - 12 Could not be reached
  - 60 Completed posttreatment assessments
  - 17 Could not be reached
  - 77 Included in primary analysis

- 77 Randomized to waitlist control group
  - 71 Completed midtreatment assessments
  - 6 Could not be reached
  - 69 Completed posttreatment assessments
  - 8 Could not be reached
  - 77 Included in primary analysis

Participants diagnosed with binge eating disorder were referred to another study. BMI indicates body mass index (calculated as weight in kilograms divided by height in meters squared); ED, eating disorder.
Table 2. Treatment Effects for Primary and Secondary Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group</th>
<th>Baseline assessment</th>
<th>Midtreatment assessment</th>
<th>Posttreatment assessment</th>
<th>Within-group effect, b (95% CI)</th>
<th>Treatment effect ( a )</th>
<th>Mixed models</th>
<th>Cohen d (95% CI)</th>
<th>P value</th>
<th>Sensitivity analysis ( b )</th>
<th>b (95% CI)</th>
<th>Cohen d (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulimic episodes</td>
<td>Control</td>
<td>34.90 (24.91)</td>
<td>29.66 (40.69)</td>
<td>29.58 (32.52)</td>
<td>-4.58 (-9.90 to 0.74)</td>
<td>-5.58 (-8.80 to -2.37)</td>
<td>.001</td>
<td>-0.48 (-0.75 to -0.20)</td>
<td>&lt;.001</td>
<td>-5.11 (-8.44 to -1.78)</td>
<td>-0.44 (-0.75 to -0.13)</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>34.00 (21.67)</td>
<td>26.22 (23.91)</td>
<td>16.93 (19.91)</td>
<td>-16.27 (-19.59 to -12.95)</td>
<td>-3.50 (-5.11 to -1.88)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.33)</td>
<td>-0.001</td>
<td>-3.49 (-5.28 to -1.71)</td>
<td>-0.60 (-0.92 to -0.29)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Binge-eating episodes</td>
<td>Control</td>
<td>15.18 (10.07)</td>
<td>12.72 (14.03)</td>
<td>14.61 (16.15)</td>
<td>-0.14 (-3.36 to 3.07)</td>
<td>-7.45 (-9.41 to -5.49)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.33)</td>
<td>&lt;.001</td>
<td>-3.49 (-5.28 to -1.71)</td>
<td>-0.60 (-0.92 to -0.29)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>16.64 (12.85)</td>
<td>12.43 (11.43)</td>
<td>8.43 (9.46)</td>
<td>-7.45 (-9.41 to -5.49)</td>
<td>-3.50 (-5.11 to -1.88)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.33)</td>
<td>&lt;.001</td>
<td>-3.49 (-5.28 to -1.71)</td>
<td>-0.60 (-0.92 to -0.29)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Compensatory behaviors</td>
<td>Control</td>
<td>19.71 (18.00)</td>
<td>16.94 (29.36)</td>
<td>14.97 (20.13)</td>
<td>-4.43 (-7.45 to -1.42)</td>
<td>-8.82 (-11.29 to -6.34)</td>
<td>&gt;.99</td>
<td>-0.25 (-0.51 to 0.02)</td>
<td>.21</td>
<td>-1.85 (-4.19 to 0.50)</td>
<td>-0.22 (-0.50 to 0.06)</td>
<td>.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>17.36 (15.97)</td>
<td>13.78 (16.72)</td>
<td>8.50 (13.98)</td>
<td>-8.82 (-11.29 to -6.34)</td>
<td>-2.09 (-4.37 to 0.19)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.33)</td>
<td>&lt;.001</td>
<td>-3.49 (-5.28 to -1.71)</td>
<td>-0.60 (-0.92 to -0.29)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Global eating disorder symptoms</td>
<td>Control</td>
<td>4.04 (1.12)</td>
<td>3.75 (1.23)</td>
<td>3.65 (1.14)</td>
<td>-0.38 (-0.57 to -0.20)</td>
<td>-0.29 (-0.43 to -0.15)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.32)</td>
<td>&lt;.001</td>
<td>-2.77 (-4.19 to -1.34)</td>
<td>-0.63 (-0.96 to -0.31)</td>
<td>.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>4.35 (0.77)</td>
<td>3.73 (1.01)</td>
<td>3.31 (1.24)</td>
<td>-0.96 (-1.23 to -0.69)</td>
<td>-1.64 (-3.56 to 0.28)</td>
<td>&lt;.001</td>
<td>-0.61 (-0.89 to -0.32)</td>
<td>&lt;.001</td>
<td>-3.49 (-5.28 to -1.71)</td>
<td>-0.60 (-0.92 to -0.29)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Clinical impairment</td>
<td>Control</td>
<td>31.99 (9.40)</td>
<td>31.38 (9.65)</td>
<td>30.13 (10.18)</td>
<td>-1.64 (-3.56 to 0.28)</td>
<td>-2.72 (-4.40 to -1.15)</td>
<td>&lt;.001</td>
<td>-0.62 (-0.92 to -0.33)</td>
<td>&lt;.001</td>
<td>-2.77 (-4.19 to -1.34)</td>
<td>-0.63 (-0.96 to -0.31)</td>
<td>.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>33.74 (7.99)</td>
<td>30.05 (9.75)</td>
<td>25.62 (11.55)</td>
<td>-6.88 (-9.06 to -4.70)</td>
<td>-1.64 (-3.56 to 0.28)</td>
<td>&lt;.001</td>
<td>-0.62 (-0.92 to -0.33)</td>
<td>&lt;.001</td>
<td>-2.77 (-4.19 to -1.34)</td>
<td>-0.63 (-0.96 to -0.31)</td>
<td>.004</td>
<td></td>
</tr>
<tr>
<td>Well-being</td>
<td>Control</td>
<td>35.48 (19.33)</td>
<td>36.34 (20.03)</td>
<td>40.52 (19.56)</td>
<td>4.35 (0.22 to 8.48)</td>
<td>-0.70 (-3.45 to 2.06)</td>
<td>&gt;.99</td>
<td>0.47 (-2.98 to 3.91)</td>
<td>.05</td>
<td>-0.40 (-0.40 to 0.50)</td>
<td>0.05 (-0.40 to 0.50)</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>35.17 (17.51)</td>
<td>34.34 (17.33)</td>
<td>39.07 (20.80)</td>
<td>2.93 (-1.71 to 7.58)</td>
<td>2.93 (-1.71 to 7.58)</td>
<td>&gt;.99</td>
<td>0.47 (-2.98 to 3.91)</td>
<td>.05</td>
<td>-0.40 (-0.40 to 0.50)</td>
<td>0.05 (-0.40 to 0.50)</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td>Work capacity</td>
<td>Control</td>
<td>0.79 (0.22)</td>
<td>0.71 (0.28)</td>
<td>0.75 (0.24)</td>
<td>0.00 (-0.10 to 0.11)</td>
<td>0.00 (-0.08 to 0.08)</td>
<td>.001</td>
<td>-0.01 (-0.68 to 0.66)</td>
<td>.99</td>
<td>0.01 (-0.05 to 0.08)</td>
<td>0.11 (-0.47 to 0.69)</td>
<td>&gt;.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>0.82 (0.23)</td>
<td>0.79 (0.24)</td>
<td>0.80 (0.28)</td>
<td>0.00 (-0.17 to 0.09)</td>
<td>0.00 (-0.08 to 0.08)</td>
<td>.001</td>
<td>-0.01 (-0.68 to 0.66)</td>
<td>.99</td>
<td>0.01 (-0.05 to 0.08)</td>
<td>0.11 (-0.47 to 0.69)</td>
<td>&gt;.99</td>
<td></td>
</tr>
</tbody>
</table>

\( a \) The continuous treatment effect is the treatment × time interaction effect derived from a mixed model, including fixed effects for time (baseline, midtreatment, posttreatment), treatment (control, intervention), and their interaction. False discovery rates for secondary outcomes were adjusted using the Bonferroni-Holm correction.

\( b \) Sensitivity analysis with data from multiple imputations by chained equations using age, body mass index, global eating disorder symptoms, number of binge-eating episodes determined in the clinical interview, and years since illness onset as auxiliary predictors.

\( c \) The within-group effect refers to the fixed effect of time (baseline, posttreatment) derived from a mixed model using the data from the respective group.
Changes in Exploratory Secondary Outcomes

Exploratory analysis indicated a moderately higher increase in self-esteem (Cohen $d = 0.33; 95\% CI, 0.11 to 0.56; P = .003$) and a more substantial reduction in emotion regulation difficulties (Cohen $d = −0.61; 95\% CI, −0.88 to −0.34; P < .001$) in the intervention group. There were no substantial differences in the pre-post changes for comorbid symptoms (depressive symptoms: Cohen $d = −0.24; 95\% CI, −0.56 to 0.07; P = .13$; anxiety symptoms: Cohen $d = −0.09; 95\% CI, −0.39 to 0.21; P = .57$) and the repertoire of adaptive emotion regulation strategies (Cohen $d = 0.18; 95\% CI, −0.11 to 0.46; P = .22$) (Table 3). Confirming the results from the questionnaires, the ecological momentary assessment analyses demonstrated a notably higher reduction in binge-eating tendency, urges to compensate, and shape and weight concerns in daily life (all $\beta > .18$) (eTable 4 and eFigure 5 in Supplement 2).

Moderators of Change

Age, participants’ treatment expectancies, baseline global eating disorder symptoms, and attitudes toward online interventions did not moderate the treatment $\times$ time interaction (eTable 5 in Supplement 2). However, a more prolonged illness duration was associated with a higher symptom reduction (eTable 5 and eFigure 6 in Supplement 2).

Regarding previous treatment experiences, 48 of the 77 participants (62.3%) in the control group and 43 of the 77 participants (55.8%) in the intervention group had received prior psychotherapeutic or pharmacologic treatments. During the study period, 6 participants (8.0%) in

![Figure 2. Trajectories of the Number of Bulimic Episodes During the Study Period](image)

Table 3. Treatment Effects for Secondary Exploratory Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group</th>
<th>Mean (SD)</th>
<th>Within-group effect, $b$ (95% CI)$^a$</th>
<th>Treatment effect$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Baseline assessment</td>
<td>Midtreatment assessment</td>
<td>Posttreatment assessment</td>
</tr>
<tr>
<td>Depressive symptoms</td>
<td>Control</td>
<td>13.31 (5.03)</td>
<td>12.89 (5.51)</td>
<td>12.39 (5.22)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>13.43 (4.38)</td>
<td>12.23 (4.92)</td>
<td>11.02 (5.67)</td>
</tr>
<tr>
<td>Anxiety symptoms</td>
<td>Control</td>
<td>9.47 (4.19)</td>
<td>9.86 (4.72)</td>
<td>9.03 (4.91)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>10.06 (4.82)</td>
<td>9.51 (4.52)</td>
<td>8.98 (5.08)</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>Control</td>
<td>14.78 (6.80)</td>
<td>15.13 (6.25)</td>
<td>15.55 (6.46)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>13.74 (6.35)</td>
<td>14.68 (6.94)</td>
<td>16.58 (7.44)</td>
</tr>
<tr>
<td>Emotion regulation difficulties</td>
<td>Control</td>
<td>110.91 (24.02)</td>
<td>113.59 (24.24)</td>
<td>112.07 (23.41)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>118.17 (21.30)</td>
<td>113.65 (22.58)</td>
<td>101.85 (25.65)</td>
</tr>
<tr>
<td>Emotion regulation repertoire$^c$</td>
<td>Control</td>
<td>9.05 (1.98)</td>
<td>9.23 (1.87)</td>
<td>9.28 (2.12)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>8.66 (1.56)</td>
<td>8.83 (1.77)</td>
<td>9.25 (1.68)</td>
</tr>
</tbody>
</table>

$^a$ The continuous treatment effect is the treatment $\times$ time interaction effect derived from a mixed model, including fixed effects for time (baseline, midtreatment, posttreatment), treatment (control, intervention), and their interaction.

$^b$ The within-group effect refers to the fixed effect of time (baseline, posttreatment) derived from a mixed model using the data from the respective group.

$^c$ Mean use of problem-solving, acceptance, and reappraisal strategies.

the control group and 7 participants (10.6%) in the intervention group sought additional professional help (eTable 6 in Supplement 2). Previous treatments or the uptake of a new therapy did not moderate changes in bulimic behaviors (eTable 5 in Supplement 2).

**Treatment Dose, Satisfaction, and Negative Effects**

Seventy-six of 77 participants (98.7%) allocated to the intervention group started the web-based intervention and finished a mean (SD) of 7.4 (4.1) of 12 modules. Forty-seven participants (61.0%) completed the main course consisting of 6 modules, and 26 participants accessed all offered contents (33.8%). A mean (SD) satisfaction of 60.6 (23.4) was reported on a scale from 0 (no satisfaction) to 100 (complete satisfaction). Adherence based on the number of finished modules and satisfaction did not moderate symptom changes (eTable 5 in Supplement 2). Adverse effects caused by the intervention mostly concerned the intervention’s quality and the occurrence of psychological symptoms (eTable 7 in Supplement 2).

**Discussion**

A maladaptive interplay of dysfunctional self-evaluations, binge-eating episodes, and compensatory behaviors dominates the life of individuals with BN, leading to a high illness-related burden. While the effectiveness of face-to-face psychotherapies for BN has been established, web-based treatments have not been investigated to a similar extent. Targeting this imbalance in research, the present 2-armed clinical trial indicates that a web-based cognitive behavioral self-help intervention for patients with BN can lead to a substantial reduction in binge-eating episodes, global eating disorder symptoms, and clinical burden. Supporting the validity of these results, changes in symptoms were also observed when examining weekly and momentary real-time assessments.

These findings complement previous results on web-based treatments for eating disorders by obtaining a similar effect in a sample of individuals diagnosed with BN. Apart from changes in eating disorder symptoms, web-based self-help also reduced psychosocial impairments and emotion regulation difficulties, and improved self-esteem. Thus, the present intervention successfully targeted key symptoms and etiologic mechanisms of eating disorders.

Demonstrating the feasibility of the web-based intervention for BN, the dropout rates and adverse effects mirror those obtained in previous studies. Regarding the participants’ adherence, the number of completers was similar to previous studies, while the mean number of finished modules was slightly lower, probably due to 6 modules being optional. Satisfaction ratings, possibly influenced by the substantial proportion of participants reporting prior therapies, were moderate. This fits research on unguided interventions but falls below the satisfaction levels observed in programs with clinical support.

While aligning with previous results on web-based interventions, the effects are smaller than the ones reported in meta-analyses on face-to-face psychotherapies. Moreover, in contrast to established therapies, the present intervention did not lead to substantial improvements in compensatory behaviors, comorbid symptoms, and overall well-being. Mixed findings for changes in compensatory behaviors have been found for other web-based interventions for BN, indicating that more prolonged and more extensive treatments (eg, with more guidance) might be needed to establish changes in these domains. Compared with findings on guided web-based interventions, posttreatment symptom levels were still high. Reasons for this might have been the negative influences of the COVID-19 pandemic during the study period and that the effects of internet-based interventions might need more time to unfold.

**Limitations**

The current study has limitations that may affect the interpretation of the results. First, this randomized clinical trial did not include an active control group and patients in the control group were aware that they would receive treatment after the study period, possibly minimizing their
intrinsic motivation to address their symptoms independently. Second, participants enrolled in the study via self-referral, raising the possibility that the sample might not represent the overall BN population. Still, similar demographic data and baseline symptom severity were observed in previous studies on BN. Third, the web-based intervention was designed to address German participants, and the study design was adjusted to the German health care system, possibly limiting its generalizability. Fourth, the present trial did not include follow-up assessments, and the long-term stability of the treatment effects remains unclear.

Conclusions

This randomized clinical trial showed that a web-based CBT self-help intervention can effectively reduce eating disorder symptoms and the burden of BN. Therefore, considering their low threshold, integrating web-based interventions into routine care might increase access to effective treatments for BN. Likewise, the high scalability of these interventions can assist in treating hard-to-reach patient groups with or without a formal diagnosis. Building on these results, future research should test whether more extensive interventions (i.e., blended or ecological momentary interventions) can impact compensatory behaviors, comorbid symptoms, and overall well-being more effectively. Overall, web-based self-help can support patients to work on their symptoms autonomously and has the potential to complement established health care structures.

ARTICLE INFORMATION

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Critical review of the manuscript for important intellectual content: Timm, Barnow, Rubel, Lalk, Pruëssner.

Statistical analysis: Hartmann, Pruëssner.

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REFERENCES


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Web-Based Cognitive Behavioral Treatment for Bulimia Nervosa


73. Fitzsimmons-Craft EE. Thinking flexibly about who digital mental health interventions are for and how they should be evaluated and used: commentary on McClure et al (2023). Int J Eat Disord. Published online January 5, 2024. doi:10.1002/eat.24136