Treating Binge Eating Disorder With Physical Exercise: A Systematic Review and Meta-analysis

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ABSTRACT

Objective: This review aimed to collect evidence about the effectiveness of exercise programs for managing binge eating disorder (BED) (recurrent binge eating episodes).

Methods: Meta-analysis was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol. Articles were searched in PubMed, Scopus, Web of Science, and Cochrane Library. Randomized controlled trials were eligible for inclusion if they reported the effect of an exercise-based program on BED symptoms in adults. Outcomes were changes in binge eating symptom severity, measured through validated assessment instruments, after an exercise-based intervention. Study results were pooled using the Bayesian model averaging for random and fixed effects meta-analysis.

Results: Of 2,757 studies, 5 trials were included, with 264 participants. The mean age was 44.7 ± 8.1 years for the intervention group and 46.6 ± 8.5 years for the control group. All participants were female. A significant improvement was observed between groups (standardized mean difference, 0.94; 95% credibility interval, −1.46 to −0.31). Patients obtained significant improvements either following supervised exercise programs or home-based exercise prescriptions.

Implications for Research and Practice: These findings suggest that physical exercise, within a multidisciplinary clinical and psychotherapeutic approach, may be an effective intervention for managing BED symptoms. Further comparative studies are needed to clarify which exercise modality is associated with greater clinical benefits.

Key Words: binge eating disorder, physical exercise, eating disorders, quality of life (*J Nutr Educ Behav.* 2023;55:523−530.)

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INTRODUCTION

Binge eating disorder (BED) is a psychiatric disorder characterized by recurrent binge eating episodes followed by the compensatory behaviors of bulimia nervosa.[1] It is the most common eating disorder. According to the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition, criteria, it is characterized by ≥ 1 binge eating episode/wk for 3 months or longer.[2] The mean age at onset is between 20−25 years,[3] and is more prevalent in women than men, with lifetime prevalences of 3.5% and 2.0%, respectively.[4] Binge eating disorder is also strongly associated with physical and psychiatric comorbidities, particularly an increased risk of developing cardiovascular and metabolic diseases.[5] People with eating disorders often present with high blood pressure, increased cholesterol levels, and decreased high-density lipoproteins. In addition, BED is associated with a much higher prevalence of diabetes and tobacco consumption.[6−8] Not surprisingly, obesity is quite common among BED patients, with a prevalence of up to 65%.[4] Individuals with obesity and BED display higher weight, more prevalent psychopathology,[9−11] and are more sedentary than those with obesity but not BED.[12]

Despite its prevalence and clinical severity, BED is often overlooked and undertreated.[13] Cognitive behavior therapy (CBT) is among the most effective BED treatments,[14] but not all patients respond adequately. Evidence

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about the efficacy of drug treatment is also limited.[15] In this scenario, exercise prescription may play an important role, alone or associated with other treatment regimens.[16] Exercise has an established role in managing obesity, particularly if associated with diet and behavior modifications.[17] Increasing daily energy expenditure through exercise programs effectively treats obesity in terms of weight loss.[18] Current guidelines recommend at least 150 min/wk of moderate-intensity aerobic exercise (eg, brisk walking) combined, if possible, with 1–3 weekly resistance training sessions to increase muscle strength.[19,20] Long-term positive effects of exercise will also entail improvements in social and mental well-being, higher quality of life, and reductions in hospitalization and all-cause mortality.[18] In this regard, the effectiveness of exercise should be evaluated not only by considering weight loss and short-term health-related benefits but also by long-term efficacy and adherence rates.[21] Because "the optimal exercise prescription is likely that which can be maintained long-term,"[22] the effectiveness of exercise programs should be carefully weighted considering the phenomenon of nonadherence, which may depend on barriers, some of which could be specific to individuals with BED. These may include social anxiety, limited access to facilities, feelings of shame, lack of time and social support, and exercise program costs.[23,24]

Given these premises, we aimed to evaluate the effectiveness of exercise-based interventions, alone or combined with CBT, on the symptoms of BED. It is important to evaluate the impact of different forms of exercise on treating the disorder and identify potential gaps. Previous research attempted to examine this relationship,[25,26] but because of the significant degree of heterogeneity in study designs and protocols, no one article was included in the meta-analysis. Therefore, we sought to undertake a systematic review and a meta-analysis, pooling published literature results.

METHODS

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses amendment to the Quality of Reporting of Meta-analyses statement, we developed a systematic review and meta-analysis.[27,28] The protocol for this study was previously published on an international prospective register for systematic reviews (Prospective Register of Systematic Reviews) with trial registration no. CRD42021266429.

Search Strategy and Selection Procedure

A systematic literature search was conducted in December 2022 on Medline (via PubMed), Scopus, Web of Science, and Cochrane CENTRAL for Randomized Controlled Trials (RCTs) online database. A combination of terms related to the disease and physical activity: ("binge eating disorder" OR "binge eating") AND ("exercise" OR "physical activity") have been entered in the search fields. The search strategy was adapted for each database, as necessary. A detailed description of the search strategy is reported in Supplementary Table 1. Only papers published in English, in peer-reviewed journals, and related to human trials were included in the analysis. The inclusion criteria were (1) randomized controlled trials on adults aged ≥ 18 years with BED diagnosis; (2) a main intervention strategy on the basis of exercise; (3) a detailed description of the exercise-based intervention; and (4) outcomes related to the impact of exercise on BED symptoms, assessed through self- and clinician-rated assessment instruments.

Following the definition of the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition, the severity of BED symptoms was based on the frequency of binge eating as follows: mild (1–3 episodes/wk), moderate (4–7 episodes/wk), severe (8–13 episodes/wk), and extreme (≥ 14 episodes/wk).[29] As types of intervention, we considered any form of aerobic exercise or resistance training, home-based or performed during supervised sessions. Counseling services were also considered eligible criteria, as several studies did not report a supervised exercise intervention but a home-based exercise prescription.

The exclusion criteria were (1) inappropriate study design (case report, cross-sectional, study protocol, reviews, or meta-analysis) and (2) lack of data on the outcome of interest. We did not restrict the inclusion of studies on the basis of the publication date or the type of outcome measure. Two independent reviewers analyzed the records. A third independent reviewer was involved in discussing in case of disagreement and making the final decision. All the authors agreed on the final number and type of studies included.

Data Extraction and Outcome

Data extraction was based on a database of authors, journals, year of publication, population characteristics, type of intervention, and outcomes of interest. The primary outcome was the effect of exercise-based interventions on BED symptoms evaluated through specific and validated assessment instruments.

Validity and Quality Assessment

The quality of studies and risk of bias were assessed using the Revise Cochrane risk-of-bias tool for randomized trials (RoB 2).[30] The tool includes 5 domains of bias risk: randomization process, deviations from the intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. A critical assessment of the risk of bias level (high, low, some concerns) was made for each item. The meta-analysis was not restricted to studies with high methodological quality. We performed sensitivity analyses if we encountered low or very low-quality studies.

Statistical Analysis

We conducted a meta-analysis on the efficacy of exercise-based interventions on BED symptoms, measured by symptom scores differences between the intervention and control groups. To this end, we computed the standardized mean differences (SMDs) as the difference in means between groups divided by the pooled SD, with their 95% credibility intervals (CIs).[31] When no

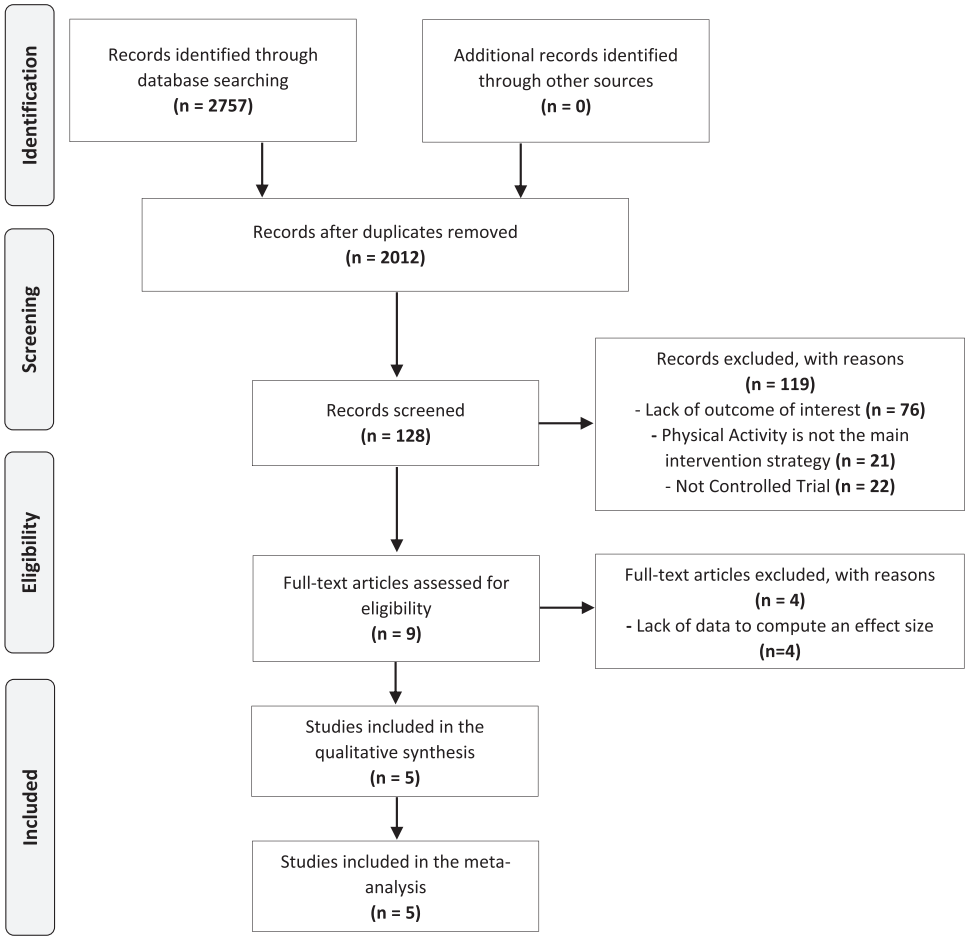

Figure 1. Outline of the search strategy: impact of exercise on binge eating disorder.

standard deviations were available, attempts were made to obtain the missing data from the trial authors by email.

Given we expected a limited number of studies and uncertainty regarding the distribution of the true effect size in the population, a robust Bayesian model averaging approach has been used. Bayesian model-averaged meta-analysis first estimates the plausibility, given the data, that the true effect is nonzero and that there is significant between-study variability. Thus, rather than deciding *a priori* whether to use a fixed-effect or a random-effect model,[32] the analysis combines the results of both these approaches while estimating the uncertainty regarding between-study heterogeneity (τ parameter, which expressed the SD of the effect size).[33] The evidence for a model relative to another model is quantified using the Bayes factor (ie, the ratio between (1) the probability of observing data given 1 hypothesis and (2) the probability of observing data given the alternative (null) hypothesis). In addition to the main meta-analysis, we performed sensitivity analyses to exclude studies with notable methodological differences. Meta-analyses were conducted using the metaBMA R package, with default skeptical priors for both the effect size and heterogeneity parameters.[34] The risk of publication bias was assessed through Egger's and Begg's test.[35,36]

RESULTS

Search Results and Study Characteristics

A total of 2,757 records were identified through database searching. After the first evaluation, 745 duplicates and 1,884 ineligible records were removed; therefore, 128 were screened. Of these, the full text of 9 articles was assessed for eligibility. Four studies were excluded because there was a lack of data to compute an effect size. After the selection procedure, 5 studies were included in the meta-analysis.[37–41] The study selection procedure is reported in Figure 1.

Of the 5 RCTs included, 2 were conducted in Australia,[37,39] 1 in the US,[40] 1 in Italy,[41] and 1 in Switzerland.[38] Characteristics of the studies included in the meta-analysis are described in the Table. They include 264 female patients with BED diagnosis, respectively allocated into intervention groups (119 women) or control groups (145 women). The mean age for the intervention arm was 44.7 ± 8.1 years, whereas, for the control, it was 46.6 ± 8.5 years.

Table. Characteristics of Studies Analyzing the Impact of Exercise in BED (included in the meta-analysis)

Author (Country)	Population	Groups (n)	Duration	Exercise Intervention	BED Assessment	Outcome: BED symptoms
Pendleton et al[37] (Australia)	84 subjects Mean age: 36.6 ± 6.5 Sex: female (100%) Mean BMI (kg/m^2): 36.2 ± 6.5	CBT (17) CBT and MP (23) CBT and EX (20) CBT, EX, and MP (24)[a]	16 mo	Supervised exercise sessions 2×/wk 45 ft, in addition to 1 home-based walking session	7-d recall of BE episodes	CBT, EX, and MP groups showed greater reductions of BE episodes, compared with the CBT-only group, at 4 mo ($z = -2.06$, $P = 0.04$) and 16 mo ($z = 2.6$, $P = 0.01$)
Fossati et al[38] (Switzerland)	61 subjects Mean age: 41.8 ± 2.2 Sex: female (100%) Mean BMI (kg/m^2): 35.5 ± 1.5	CBT (13) CBT and N (23) CBT and EX (25)[b]	12 wks	Exercise recommendation: 3×/wk 30 ft of chosen aerobic activity and increasing ADL	EDI-2	EDI-2 values after treatment: CBT group decrease of 12.0 ± 10.0 ($P < 0.01$); CBT and EX decrease of 14.0 ± 6.0 ($P < 0.001$)
McIver et al[39] (Australia)	50 subjects Mean age: 41.1 ± 10.4 Sex: female (100%) Mean BMI (kg/m^2): 34.1 ± 6.4	Yoga (25) Waitlist control (25)	12 wks	Yoga supervised sessions: 1×/wk 60 ft; yoga home sessions 30 ft/wk	BES	BES score after treatment: Yoga group decrease of 14.4 ± 6.4 ($P = 0.001$); control group decrease of 1.4 ± 6.0
Mama et al[40] (US)	180 subjects, 50 BED Mean age: 47.2 ± 8.4 Sex: female (100%) Mean BMI (kg/m^2): 34.7 ± 8.0	EX group (122; 35 BED) Dietary group (58; 15 BED)	6 mo	Exercise recommendations: 2×/wk 60 ft and then 1×/mo; set exercise goals and explain the benefits of being physically active	BES	BES score after treatment: BED subjects of the EX group decreased by 6.2 ± 1.3 ($P < 0.05$); BED subjects of the dietary group decreased by 4.4 ± 0.7 ($P < 0.05$)
Galasso et al[41] (Italy)	19 subjects Mean age: 45.6 ± 8.3 Sex: female (100%) BMI (kg/m^2): 38.0 ± 10.0	CAAET (10) CTRL (9)	6 mo	Supervised exercise sessions: 4×/wk 60 ft aerobic activity, 20 ft strength training, 10 ft stretching	BES	BES score after treatment: CAAET group decrease of 13.0 ± 2.0 ($P < 0.05$); CTRL group decrease of 8.0 ± 2.0 ($P < 0.05$)

ADL indicates daily living activities; BE, binge eating; BED, binge eating disorder; BES, binge eating scale; BMI, body mass index; CAAET, combined aerobic and anaerobic exercise training; CBT, cognitive-behavioral therapy; CTRL, control; EDI-2, Eating Disorder Inventory-2; EX, exercise; MP, maintenance; N, nutrition.
[a]The effect size was computed by contrasting CBT vs CBT, EX, and MP; [b]The effect size was computed by contrasting CBT vs CBT and EX.

The severity of BED symptoms was assessed by all studies with the following assessment instruments: the binge eating scale, 16 items with 4 response options[42]; the 7-day recall of binge eating episodes, binge days count[43]; and the Eating Disorder Inventory-2, 8 subscales.[44,45] Exercise-based intervention can be divided into supervised activity (SA) or counseling activity (CA), mainly on the basis of aerobic activities. One study analyzed the efficacy of yoga: participants took part in a 12-week yoga program composed of 60-minute SA sessions performed at different intensities (Pranayama, Hatha yoga, yoga Nidra) and 30-minute home-based sessions.[39] One study proposed a 6-month SA program, including 4 weekly sessions of 60 minutes of aerobic activity, such as brisk walking, 20 minutes of resistance training, and 10 minutes of static stretching.[41] In another study, participants in the exercise intervention group were involved in a 4-month SA intervention (within the 16-month program), composed of two 45-minute supervised aerobic sessions and 1 home-based walking session.[37] Finally, in 2 studies, exercise intervention was related to CA, followed by a home-based prescription on the basis of specific guidelines. One study's recommendations included increasing the number of daily living activities and 3 weekly sessions of a chosen aerobic activity for 12 weeks.[38] The other study proposed a 6-month program composed of CA sessions to set physical activity goals and explain the benefits of being physically active.[40] In almost all studies,[37,38,41] the control group attended a CBT program. In addition to CBT, periodic dietary counseling was mentioned in some trials.[40,41] Only 1 article in the control group was considered a waitlist and therefore not involved in any intervention.[39]

Studies varied in their rates of and approach to the analysis of dropout. In Pendleton et al,[37] 114 participants were enrolled, and 84 (73.7%) completed all assessments. Fossati et al[38] reported that 61 out of 63 enrolled (96.8%) were included in the analyses. McIver et al[39] presented 90 eligible participants, 71 (78.9%) randomized, with an attrition rate of 26% in the intervention group and 32% in the control group. Moreover, 3 people in the yoga group declined to participate during the follow-up. This was the only study in which analyses were conducted using the per-protocol and intention-to-treat approaches.[39] In the analysis of Mama et al,[40] 310 women were randomized, and 180 (58.1%) were included, with a dropout rate of 41.7% and 47.2% for the intervention and control arm, respectively. Finally, Galasso et al[41] reported that 65 participants were eligible for the study, and 41 (63.1%) were excluded. Of the 24 included, 4 (16.7%) declined to participate, and 1 (5%) withdrew their consent. Finally, 20 participants were allocated, and 19 were included in the analyses.

Primary Outcome

The Bayesian meta-analysis showed that the hypothesis for a nonzero effect of exercise on symptoms (either fixed- or random-effect) was 15 times more probable than a nonsignificant effect (Supplementary Table 2). In particular, the model leaned toward a random-effect model with a significant effect, with a posterior probability of 93.7%. The model-averaged meta-analysis showed that exercise was associated with a large effect compared with the comparator (SMD, −0.94; 95% CI, −1.46 to −0.31) (Figure 2, Supplemental Figures 1 and 2, and Supplemental Table 3). The analysis also revealed a large degree of heterogeneity: the SD of the distribution of effects between-study (τ) was 0.569 (95% CI, 0.269-1.252). Egger's test confirmed the low risk of publication bias (intercept = 0.24; 95% CI, −19.95 to 20.42; $P = 0.97$) and Begg's tests (Kendall's $\tau = -0.20$; $P = 0.62$).

Excluding the study of Pendleton et al[37] did not meaningfully change results (SMD, −0.94; 95% CI, −1.46 to −0.31; Bayes factor, 6.28; inclusion posterior probability, 86.3%; large heterogeneity τ, 0.661; 95% CI, 0.287−1.564), similarly, to excluding the study of Mama et al[40] (SMD, −1.048; 95% CI, −1.628 to −0.248; Bayes factor, 12.464; IPP, 92.6%; large heterogeneity τ, 0.562; 95% CI, 0.225−1.384).

DISCUSSION

This meta-analysis examined the effectiveness of exercise-based interventions for managing BED symptoms. The purpose was to analyze results through a quantitative method, extending previous research by Vancampfort et al[25] and Blanchet et al.[26] Pooling the results of available randomized, controlled studies suggest that exercise-based interventions are associated with a large effect size reducing the severity of BED symptoms, compared with other interventions. These meta-analytic estimates are characterized by moderate heterogeneity and methodological issues; thus, results must be interpreted cautiously.

Despite the clinical importance and high prevalence of BED, and despite the potential effectiveness and benefits of exercise, only a few studies investigated the role of exercise in treating symptoms of BED. For this reason, each study characteristic may significantly influence the observed estimates of the meta-analysis. Overall, included studies recruited samples with homogeneous clinical characteristics. Even if we did not consider any exclusion criteria related to sex, all the participants included in the analysis were female. Most were women of similar age groups, typical of when BED had a greater clinical impact. Exercise-based interventions also had similar features, with activities mainly on the basis of aerobic exercises or home-based prescriptions of low-to-moderate intensity. The typical protocol length was 3 or 6 months, with a 2−3 sessions/wk frequency. Individual study results suggest that walking activities and yoga may lead to a similar, significant reduction of binge eating episodes. Furthermore, as reported by Mama et al,[40] the recommendation to adopt an active lifestyle may represent an effective approach, although it is based on a small sample size. An active lifestyle can be considered a valuable option for patients and health professionals to develop and maintain exercise-based programs when center-based and clinically supervised sessions are not possible.

However, studies also had important differences among the type of

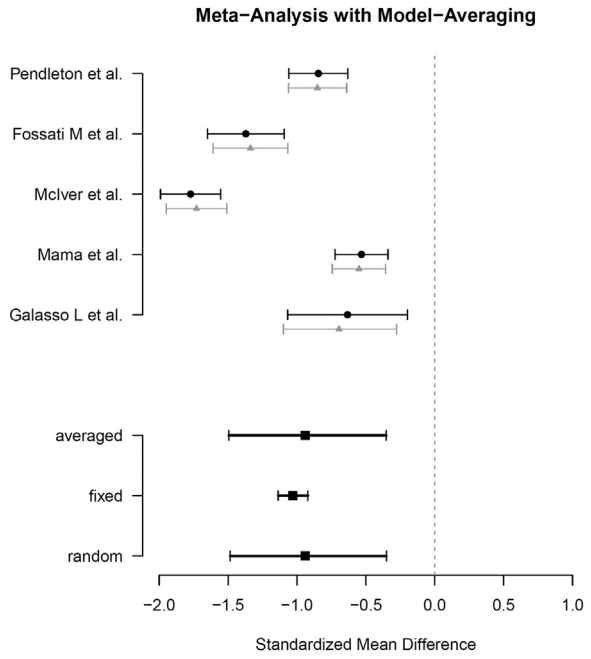

Figure 2. Model-averaged meta-analysis of exercise vs control conditions on symptoms of binge eating disorder effect sizes (standardized mean differences of binge eating scores at posttreatment) with 95% credible intervals. Studies cited in the figure include Pendleton et al,[37] Fossati et al,[38] McIver et al,[39] Mama et al,[40] and Galasso et al.[41]

intervention. Regarding SA, exercise differed for type, including yoga, walking, and strength training, whereas CA was mainly based on home-based aerobic activity prescription and maintaining an active lifestyle. Moreover, exercise was either compared with a nonactive control intervention[39–41] or used as an add-on to nutrition counseling or established psychotherapy, namely CBT.[37,38] This may be why the meta-analysis was characterized by moderate-to-large heterogeneity even after sensitivity analysis.

The effectiveness of exercise-based strategies may positively affect symptoms of BED through multiple potential mechanisms at the neurobiological, psychological and cognitive levels.[26] First, exercise reduces the severity of anxiety and depression symptoms, as demonstrated by several studies.[46,47] This might indirectly reduce the frequency of binge eating episodes that often appear as a maladaptive coping strategy for anxiety or depression.[48] In particular, aerobic exercise may effectively regulate the reward system involved in mood regulation and food addiction.[49,50] Exercise efficacy is postulated to balance the levels of neurotransmitters that affect mood (serotonin or endorphin secretion) and by exerting neuroprotective functions.[51,52] There is evidence of a direct improvement in appetite control through neurochemical mechanisms,[53] and changes in body composition that influence daily energy needs.[54] Considering the psychological and cognitive perspective, exercise may result in reduced binge eating behaviors by improving self-efficacy, self-esteem and behavioral control abilities.[55]

Overall, studies are insufficient to establish whether the association between different treatment strategies (CBT, nutritional counseling, and exercise) has greater effects than either strategy alone, but the presence of multiple, noncompeting candidate mechanisms of efficacy highlights the importance of adopting a multidisciplinary approach to the treatment of this disorder.

This meta-analysis is based on a small number of studies. However, specific tests were carried out (described in the subject and methods chapter) to rule out that publication bias largely influenced results. The symptom improvement (main outcome) estimation is largely based on subjective assessment instruments, possibly biased by patients' social desirability. Studies did not report sufficient data to estimate the effect on patient weight. Finally, even though BED is diagnosed in men, no relevant RCTs examine the impact of exercise in male samples.

IMPLICATIONS FOR FUTURE RESEARCH AND PRACTICE

Patients in the exercise-based intervention group obtained significant results from a SA program or periodic CA followed by a tailored home-based exercise prescription. Pending replication of results with methodologically robust studies, exercise may be considered a promising, possibly effective intervention for managing BED symptoms, especially within a multidisciplinary clinical and psychotherapeutic approach. This can provide practitioners with valuable insights for developing more feasible intervention models, by considering the use of counseling associated with home-based exercise, in addition to usual care or when SA programs are unavailable. Although these results are encouraging, further comparative studies are needed to clarify which exercise modality is associated with greater clinical benefits. Therefore, further RCTs on larger samples and more rigorous methodological quality are warranted.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jneb.2023.03.010.

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