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Effects of virtual reality-based interventions in reducing anxiety in individuals with eating disorders: a systematic review

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Abstract. Eating Disorders (EDs) are complex psychiatric conditions, and anxiety, including body dissatisfaction, fear of weight gain, and generalised anxiety, has been identified as both a symptom and a contributing factor to their onset and maintenance. Traditional exposure-based therapies effectively target these anxieties but face persistent challenges such as high dropout rates, limited accessibility, and dependence on extensive clinical expertise. By offering immersive, controlled, and scalable environments that provide safe exposure and cognitive restructuring, Virtual Reality (VR) presents a possible alternative. This systematic review, conducted followed PRISMA guidelines, examined studies published up to August 2025 investigating VR-based interventions for anxiety-related outcomes in individuals with EDs. Twelve studies met inclusion criteria, encompassing randomised controlled trials, pre-post designs, and single-case experimental designs. A comprehensive risk of bias assessment was conducted using validated tools appropriate to each study type. Overall, VR interventions demonstrated consistent reductions in anxiety-related constructs, including body dissatisfaction, general anxiety, fear of weight gain, and body uneasiness, particularly in the short term. Integrative, life-like virtual environments tended to produce more sustained improvements compared with simple, mirror-based or single-stimulus settings. Moreover, the degree of therapist involvement and the interactivity of VR experiences influenced both therapeutic efficacy and scalability. Despite promising results, significant heterogeneity existed across participant characteristics, virtual settings, intervention duration, and methodological quality. Evidence for long-term maintenance of treatment gains remains limited. This review supports the effectiveness of VR-based interventions as adjuncts or alternatives to conventional therapy for EDs. This study calls for more refined investigations and improved VR intervention designs to enhance long-term efficacy, maintain positive user experience during interactive tasks, and balance therapist involvement with scalability in the future.

Keywords: eating disorder, anxiety, virtual reality, effectiveness

1. Introduction

Eating Disorders (EDs) are a group of psychiatric conditions characterised by persistent eating-related disturbances that seriously harm physical and mental health, frequently with distorted attitudes towards food and body shape [1]. The global prevalence of Eating Disorders (EDs) has risen significantly in recent decades, with variation by different types, including Bulimia Nervosa (BN), Binge-Eating Disorder (BED), Anorexia Nervosa (AN), eating disorder not otherwise specified (EDNOS/OSFED), pica and rumination disorder and Avoidant/Restrictive Food Intake Disorder (ARFID) and [1, 2]. EDs have become a global health concern, underlining the need for clarifying mechanisms and developing treatment approaches.

Recent studies have identified anxiety as a core symptom and contributing factor in EDs. Such anxiety includes generalised anxiety, body-shape/weight-related anxieties (e.g., body dissatisfaction), social anxiety, and other types. These anxieties play a vital role in the development and maintenance of EDs. For example, Schaumberg et al. found that symptoms of generalised anxiety at age 10 may predict diagnoses of AN, BN, and disordered eating by age 16 [3]. In addition, body dissatisfaction, fear of weight gain, and overvaluation of shape/weight serve as both triggers and maintaining factors for restrictive eating behaviours [4, 5].

Several therapeutic interventions have been established to target these anxieties. For example, exposure-based interventions have been refined for EDs to address fear and avoidance behaviours related to food, body image, and weight, such as in vivo food exposure and mirror exposure [6-8]. By directly exposing individuals to the threatening stimulus, these techniques have demonstrated short-term efficacy [9]. However, dropout rates in ED treatments are consistently high, with estimates ranging from

20% to over 50% in inpatient care [10]. Furthermore, the successful delivery of threatening stimuli requires significant clinical expertise, making implementation challenging in large-scale and routine practice [11].

Virtual reality-based interventions demonstrate potential to address these issues. A computer-generated environment called Virtual Reality (VR) transports viewers to interactive and simulated scenarios. [12]. By offering realistic virtual experiences without exposing users to the hazardous stimuli in reality, VR-based interventions have demonstrated high arousal and patients' acceptability compared to traditional interventions [13]. Moreover, VR is scalable, as it can be distributed across devices at minimal additional expense, thereby facilitating broader clinical implementation [14]. Beyond these advantages, VR also enables flexible modulation of an individual's sense of self [15]. By generating controlled perceptual illusions, VR provides opportunities to correct distorted self-perceptions.

These advantages have led to its use in several innovative approaches. Previous systematic reviews about VR interventions in EDs have provided only a limited disorder-specific focus, with anxiety-related outcomes remaining unreviewed [16]. The present review aims to systematically evaluate the effects of VR-based interventions in reducing anxiety-related outcomes in individuals with EDs.

2. Methods

2.1. Search strategy

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]. A comprehensive literature search of PubMed, Ovid, Web of Science, and Scopus was carried out in August 2025. The PICOS framework was used to build the search strategy [18], where the population (P) was defined as individuals with a diagnosis of any type of ED, without age restriction. The intervention (I) was any type of VR–based approach, compared (C) with any type of comparator condition or no comparator. The outcomes (O) of interest were any types of anxiety-related outcomes. All study designs (S) were considered for inclusion.

Specifically, the search strategy combined terms from three domains: VR, EDs, and anxiety, using Boolean "AND" operators. All retrieved records were exported into Zotero for reference management and further organised in Microsoft Excel, where duplicate entries were removed prior to screening.

2.2. Eligibility criteria

Studies were included if they involved participants of any age with a diagnosis of an ED. Eligible interventions comprised any type of VR-based treatment. No restrictions were placed on the type of comparator or control group, nor on study designs. Studies were required to report at least one anxiety-related outcome. Grey literature was excluded.

2.3. Study screening and selection

This review used the PRISMA workflow to screen and select eligible studies (see Figure 1 [19]). Using database searches, 719 records in all were first found. After removal of duplicates and grey literature, 343 records remained for title and abstract screening. Based on the eligibility criteria, 299 records were excluded, leaving 44 articles for full-text assessment. In addition, five further studies, which were reported within systematic reviews identified during the initial screening, were also retrieved and assessed at this stage. During the full-text assessment, studies that did not use VR equipment or environments, did not involve participants with a diagnosed eating disorder, or evaluated VR instead of a VR-based therapy intervention were disqualified. Ultimately, 12 articles were included in this review.

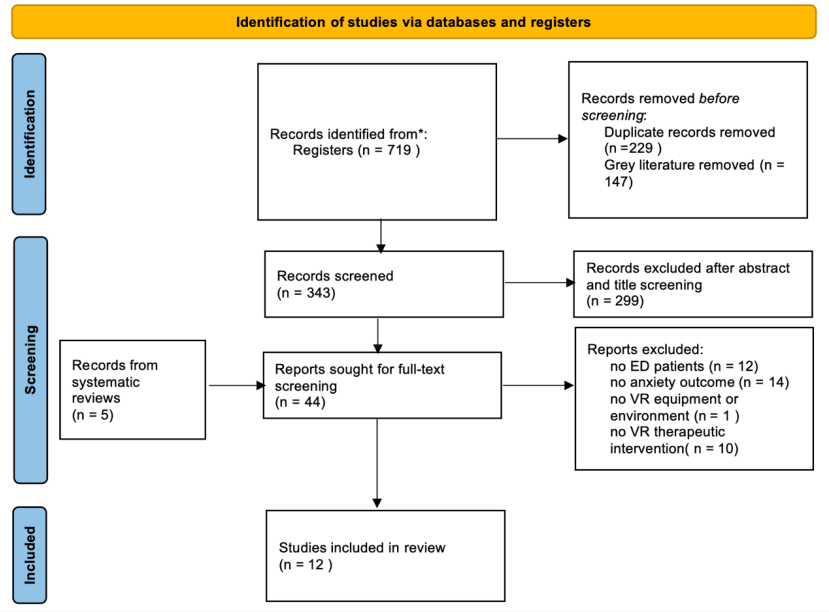

Figure 1. PRISMA workflow

Note. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses [17]; ED = Eating disorder; VR = Virtual Reality.

2.4. Risk of bias assessment

Eligible articles included Randomised Controlled Trials (RCTs), within-subject pre–post designs (pre-post designs), and Single-Case Experimental Designs (SCEDs). For RCTs, the Revised Cochrane Risk-of-Bias tool for randomised trials (RoB 2) was used to evaluate methodological quality and risk of bias [20]. The National Institutes of Health (NIH) Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group was applied for pre-post intervention studies [21]. The Risk of Bias in N-of-1 Trials Scale (RoBiNT Scale) was used to single-case experimental designs [22].

3. Results

Table 1. Summary of characteristics and methodological features

Article	Country	Study Design	Participants (n)	Sample (N)	Age M (SD)	VR Equipment	Virtual Environment	VR Sessions
Riva et al., 1999 [23]	Italy	SCED	1 AN patient	1	22	An immersive VR system with a head-mounted display	Different zones, each one individually used by the therapist during a session with the patient	Five sessions lasting approximately eight weeks
Perpiñá et al., 1999 [24]	Spain	RCT	7 AN patients, 6 BN patients	18	Control group: 16.60 (1.30); VR group: 18.38 (2.90)	A PC, a head-mounted display and a 2D mouse	Six settings: learning and accommodation, food area, exhibition room, two mirrors, a doorframe with several coloured strips, different body areas	Six 1-hour weekly sessions
Riva et al., 2000 [25]	Italy	Pre–post design	25 BED patients; 14 EDNOS patients	57	18-45 (M, SD not mentioned)	A head-mounted display and an input device	Different zones, each one individually used by the therapist during a session with the patient	Five sessions during biweekly meetings

Table 1. Continued

Riva et al., 2002 [26]	Italy	RCT	20 BED patients	20	30.50 (6.72)	A head-mounted display and an input device	Seven 3-D healing experiences	Seven 50-min sessions
Marco et al., 2013 [27]	Spain	RCT	17 BN patients, 12 EDNOS patients and 5 AN patients	34	21.82 (5.75)	A PC, a head-mounted display and a 2D mouse	Five virtual environments: Virtual scale and kitchen; Photograph area; Mirror area; a doorframe with several coloured strips; different versions of one's body	Eight 1-hour weekly sessions
Cesa et al., 2013 [28]	Italy	RCT	66 BED patients	90	31.79 (7.90)	Not mentioned	Two sections for body image comparison and fourteen virtual environments—such as homes and supermarkets—present crucial scenarios linked to maintenance/relapse mechanisms	Ten 60-minute biweekly sessions
Ferrer-García et al., 2017 [29]	Spain and Italy	RCT	64 BN or BED patients	65	BN patients: 18.06 (0.77); BED: 24.55 (1.82)	A 15.6-inch stereoscopic screen; polarized glasses and earbuds	The four virtual locations (kitchen, dining room, bedroom, and bakery-café) and the ten foods are combined to create the first individualized exposure hierarchy	Three weeks of six individual 60-minute sessions given by skilled clinical psychologists every two weeks
Porras-Garcia et al., 2020 [30]	Spain	SCED	1 AN patient	1	15	A head-mounted display with two controllers and three body trackers	A plain space with a big mirror on the wall	1-hour sessions per week
Porras-Garcia et al., 2021 [31]	Spain	RCT	35 AN patients	35	18.63 (6.78)	Head-mounted displays, two controllers and three additional body trackers; two base stations	A plain space with a big mirror on the wall	Five 1-hour weekly sessions
Behrens et al., 2023 [32]	Germany	pre–post design	20 AN patients	24	30.1 (11.9)	A headset and controllers, along with three trackers; a VR base station	Two virtual full-body stereoscopic mirrors in a U-shaped changing cabin	Five sessions (a 90-minute preparation session and four 50-minute exposure sessions)
Natali et al., 2024 [33]	Italy; the UK	RCT	145 AN patients	228	21.75 (6.68)	A headset with two controllers	A kitchen where dishes with varying calorie contents were kept	One session lasted 8–10 minutes.
Brizzi et al., 2025 [34]	Italy	SCED	1 AN patient	1	24	No specific description	A room with a virtual mirror	Two weekly 1-hour sessions for a total of six meetings

Note. N = sample size; M = mean; SD = Standard Deviation; RCT = randomised controlled trial; SCED = single-case experimental design; pre-post design = within-subject pre–post design; BN = bulimia nervosa; BED = binge-eating disorder; AN = anorexia nervosa; EDNOS = Eating Disorder Not Otherwise Specified; VR = Virtual Reality

3.1. Difference in settings

Table 1 presents the basic information and settings of the included studies. VR environments can be categorised into the integrative ones with life-like scenarios and simple ones with symptom-focused settings. Seven studies integrated multiple scenarios related to food or body shape-related daily life, while one study specifically focused on a kitchen scene [33], and four studies used only a simple room with mirrors [30].

3.2. VR intervention

All 12 studies were designed to expose individuals with EDs to disorder-relevant stimuli that elicit anxiety responses (see Table 2).

Table 2. Summary of VR intervention details, anxiety-related outcomes, and main findings

Article	Interventions	Comparator	Therapist Involvement	Anxiety Outcomes	Anxiety Measurements	Findings
Riva et al., 1999 [23]	Integrated VR exposure to negative stimuli (e.g., body image distortion and temptation cues) with CBT	No comparator	Implementation, administration	Body Dissatisfaction	Italian version of the Body Satisfaction Scale (BSS)；the Figure Rating Scale (FRS); the Contour Drawing Rating Scale (CDRS)	Significant reduction in body dissatisfaction
Perpiñá et al., 1999 [24]	Exposed to body- and eating- related environments	Standard Body Image Treatment	Not mentioned	Body Dissatisfaction	Eating Disorder Inventory - Body Dissatisfaction (EDI-BD); Situational Inventory of Body-Image Dysphoria (SIBID); Body Areas Satisfaction Scale (BASS)	Significant reduction in body dissatisfaction after treatment, with significantly greater satisfaction shown in the VR group
Riva et al., 2000 [25]	Integrated VR experiences targeting body image, eating control, social environments in a cognitive-behavioural approach	No comparator	Implementation	Body Dissatisfaction	Italian version of the Body Satisfaction Scale (BSS)；the Figure Rating Scale (FRS); the Contour Drawing Rating Scale (CDRS)	Significant reduction in body dissatisfaction in both samples
Riva et al., 2002 [26]	Integrated VR experiences targeting body image, eating control, social environments in a cognitive-behavioural approach plus diet and physical training	Psycho-nutritional sessions plus diet and physical training	Implementation	Body Dissatisfaction; General anxiety	Figure Rating Scale (FRS); Contour Drawing Rating Scale (CDRS); Italian version of the Body Satisfaction Scale (BSS); Italian version of the State-trait Anxiety Inventory (STAI)	Significant pre–post reductions in body dissatisfaction and general anxiety in VR group, with significant group differences in general anxiety
Marco et al., 2013 [27]	VR and CBT expose patients to social settings associated with body image issues and teach them adaptive coping mechanisms	Standard CBT for Eating Disorders Treatment	No specific description	Body Dissatisfaction	Body Attitude Test (BAT); Body Areas Satisfaction Scale (BASS); Situational Inventory of Body-Image Dysphoria (SIBID)	Significantly greater reductions in body dissatisfaction shown in VR group than the control group, with improvements maintained at one-year follow-up
Cesa et al., 2013 [28]	CBT plus exposure to negative body image situations from first- and third-person perspectives	CBT; only inpatient program	Implementation, administration	Body Dissatisfaction	The Italian version of the Body Satisfaction Scale (BSS); Contour Drawing Rating Scale (CDRS)	Significant improvement in body satisfaction in all the groups, with no difference across them

Table 2. Continued

Ferrer-García et al., 2017 [29]	Immersed in individualised virtual environments with specific food cues, instructed to interact with but not eat the food	CBT	Assistance reassurance	Body Dissatisfaction; General anxiety	Body Dissatisfaction scales of the ED Inventory-3 (EDI-3); the State–Trait Anxiety Inventory-Form Y (STAI-Y)	Significant pre-post reduction in body dissatisfaction and general anxiety, with significantly lower anxiety in VR group than the control group
Porras-Garcia et al., 2020 [30]	Exposed to a gradually increasing BMI avatar	No comparator	No specific description	Body Anxiety; Fear of Weight Gain (FGW)	Physical Appearance State and Trait Anxiety Scale - Weight Scale (PASTAS - W); Visual Analog Scales (VAS)	Significant pre–post reductions in body anxiety and FGW, with body anxiety further decreasing but FGW increasing at the 5-month follow-up
Porras-Garcia et al., 2021 [31]	Exposed to an avatar with a BMI gradually increased toward a personalised healthy target	Treatment as usual	Support	Body Dissatisfaction; Fear of Weight Gain; Body Anxiety	Eating Disorder Inventory 3 - Body Dissatisfaction (EDI-BD) and Drive for Thinness (EDI-DT) scales；Physical Appearance State and Trait Anxiety Scale (PASTAS); The Body Image Assessment Scale-Body Dimensions (BIAS-BD); Visual Analog Scales (VAS)	Significant reduction in body dissatisfaction and FGW in experimental group compared to the control group, no significant effect on body anxiety
Behrens et al., 2023 [32]	Exposed participants to individually tailored virtual body weights	No comparator	Supervision	Body Dissatisfaction; Fear of Weight Gain	Figure Rating Scale (FRS); Visual Analog Scales (VAS)	Significant within-session reductions in FWG and non-significant within-session yielded trends in body dissatisfaction, but no significant changes across sessions
Natali et al., 2024 [33]	Exposure to a virtual kitchen where patients interacted with foods under three conditions	Baseline; with a virtual pet to induce positive mood; with an avatar providing social support	No specific description	Virtual food-related anxiety；General anxiety	Visual Analogue Scale (VAS)	There were no differences between the conditions for general anxiety, but there was a significant rise in food-related anxiety in the baseline condition, a significant decrease in the positive mood condition, and no effect in the social support condition. The positive mood condition showed significantly lower post-exposure levels than baseline.
Brizzi et al., 2025 [34]	Encouraged to positively perceive and verbalise body parts	No comparator	No specific description	Body Uneasiness; Body Anxiety	Body Uneasiness Test (BUT); Physical Appearance State and Trait Anxiety Scale (PASTAS)	Overall reduction in body uneasiness and body anxiety

Note. VR = Virtual Reality; FWG = Fear of Weight Gain; CBT = Cognitive Behavioural Therapy.

3.3. Exposure to threatening stimuli

Four integrated exposures to both food and body image-related stimuli [23]; six studies exposed patients only to avatars with different body images, while two specifically focused on food-related stimuli [29, 33]. Interactive and individualised components

were frequently mentioned (e.g., verbalising perceptions of body-part illusions in Brizzi et al. [34]; tailoring avatars to patients' body shape in Porras-Garcia et al. [30]).

3.4. Difference in therapist involvement

Four studies reported a high level of involvement: in two, therapists administered the entire process [23, 28], whereas in the other two, they were responsible only for implementation [25, 26]. Three studies reported low-level involvement, with therapists providing supportive functions [29].

3.5. Anxiety synthesis

Considerable heterogeneity was observed, and reported constructs included body dissatisfaction, general anxiety, FWG, body anxiety, virtual food-related anxiety, and body uneasiness.

3.6. Short-term and long-term effects

Most studies reported significant short-term improvements in anxiety-related outcomes after VR sessions, with greater pre–post changes observed in experimental groups. In follow-ups, one study demonstrated maintenance of these improvements at a one-year follow-up [27], whereas another observed FGW worsening at a five-month follow-up [30].

4. Risk of bias assessment

Six RCTs were assessed as having some concerns, and one as low risk, because of the description of the randomisation process and Intention-to-Treat (ITT) analysis. The two within-subject pre–post studies presented risks related to small sample sizes, repeated measurements, and the limited consideration of group-level generalisability, and both were rated as fair in quality. The three SCED studies demonstrated unsatisfactory considerations regarding some internal and external validity domains. Overall, one SCED was at low risk and two at moderate risk (see Table 3).

Table 3. Risk of bias assessment results of RCT

Article	Domain 1: Bias from Randomisation	Domain 2: Bias from Deviations	Domain 3: Bias from Missing Data	Domain 4: Bias in Measurement	Domain 5: Bias in Selection of Reported Result	Overall Risk of Bias
Perpiñá et al., 1999 [24]	Some concerns	Low risk	Low risk	Low risk	Low risk	Some concerns
Riva et al., 2002 [26]	Some concerns	Low risk	Low risk	Low risk	Low risk	Some concerns
Marco et al., 2013 [27]	Some concerns	Low risk	Low risk	Low risk	Low risk	Some concerns
Cesa et al., 2013 [28]	Some concerns	Low risk	Low risk	Low risk	Low risk	Some concerns
Ferrer-García et al., 2017 [29]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Porras-Garcia et al., 2021 [31]	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Natali et al., 2024 [33]	Some concerns	Some concerns	Low risk	Low risk	Low risk	Some concerns

Note. RCT = randomised controlled trial.

5. Discussion

5.1. Variability in VR environments and threatening stimuli

The included studies demonstrated variability in the design of VR environments and threatening stimuli. Specifically, the use of integrative VR environments with life-like scenarios and simpler VR environments has demonstrated effectiveness in the short term. However, follow-up data suggested potential distinctions in long-term outcomes: integrative environments were associated

with maintained improvements [27], whereas simple settings showed a relapse [30]. This highlights the need to clarify whether integrative settings confer more durable effects than simple ones. The variability of anxiety-provoking stimuli reflects the growing trend toward individualisation, such as avatars or virtual food, which were co-developed with patients [32], supporting their effectiveness.

5.2. Human-vr interactions

The interaction between patients and VR is one of the most important determinants of the effectiveness of VR interventions. First, such interaction plays a vital role in correcting distorted self-perceptions, allowing patients to reconcile discrepancies between their distorted internal body image and more realistic external representations. Additionally, interactive VR tasks can elicit greater arousal and engagement compared to passive exposure [35]. However, heightened interaction and immersion in VR interventions may also provoke adverse reactions in patients. One included study reported fear symptoms during VR exposure (e.g., intrusive memories [32]). Striking a balance between providing sufficient interaction to achieve therapeutic effects and maintaining safeguards to prevent adverse experiences remains a critical challenge.

The relationship between therapists and VR interventions may be a key enabler of effective VR therapy, as therapeutic alliance is a well-established contributor to treatment success [36]. However, low-therapist-involvement models enhance low-cost scalability, which increases the possibility of facilitating broader clinical implementation. These findings call for further investigation into the optimal balance between therapist involvement and scalability.

5.3. Future research

Future, more rigorous investigations are needed to investigate the relationship between intervention design and long-term efficacy. This review also underscores the need to pay closer attention to patient experience, with safeguards to minimise adverse effects. The optimal balance between human and VR interaction remains unclear; one possible direction for future trials is to compare VR designs involving different levels of therapist involvement.

6. Conclusion

The findings support the effectiveness of VR in targeting anxiety-related constructs among individuals with EDs, though significant heterogeneity exists. This study calls for more refined investigations and improved VR intervention designs to enhance long-term efficacy, maintain positive user experience during interactive tasks, and balance therapist involvement with scalability in the future.

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