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Examining the Effectiveness of Mixed Reality-Based Exposure and Response Prevention Therapy on Disgust, Anger, and Anxiety in Individuals with Obsessive-Compulsive Disorder

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ABSTRACT

Objective: The aim of this study was to investigate the effectiveness of exposure and response inhibition therapy based on mixed reality on reducing these emotions in people with obsessive-compulsive disorder.

Methods: This study was conducted in a quasi-experimental manner with a pretest-posttest design with a control group and a six-month follow-up. 40 participants diagnosed with obsessive-compulsive disorder using the Yale-Brown Obsessive-Compulsive Scale were selected and randomly assigned to two intervention and control groups. The intervention group underwent exposure and response inhibition therapy based on mixed reality for 12 sessions. Data were collected using the Haidt Disgust Sensitivity Questionnaire, the Spielberger Anger Questionnaire, and the Beck Anxiety Inventory. Data analysis was performed using repeated measures analysis of variance and Bonferroni post hoc test.

Results: he results showed that mixed reality therapy led to a significant reduction in disgust, anger, and anxiety scores in the intervention group compared to the control group at the post-test and follow-up stages ($p < 0.001$). The stage, group, and interaction effects in the analysis of variance were significant for all three emotions, and the effect size (η^2) was reported to be 0.951 for disgust, 0.972 for anger, and 0.946 for anxiety, respectively. The difference between post-test and follow-up was small but stable, indicating the relative persistence of the treatment effects.

Conclusions: Mixed reality technology, as an interactive, safe, and controllable platform for exposure to arousing stimuli, was able to significantly increase the effectiveness of exposure and response inhibition therapy in reducing harmful emotions in OCD patients. Using this new technology allows for more effective emotion regulation, reduced avoidance behaviors, and improved quality of life.

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Introduction

In recent decades, obsessive-compulsive disorder (OCD) has emerged as one of the most complex and chronic psychological disorders within the spectrum of neurotic conditions, drawing considerable attention from researchers and clinicians (Angelakis et al., 2015; Del Casale et al., 2019). Characterized by intrusive obsessive thoughts and repetitive compulsive behaviors—such as excessive washing, checking, or organizing—OCD significantly impacts individuals' social and occupational functioning and overall quality of life (Abramowitz & Blakey, 2017; Javdan & Shahri, 2023). The prevalence of OCD in the general population is estimated to range between 1% and 3%, while the likelihood of occurrence among first-degree relatives increases up to 10% (Izadi & Abedi, 2013).

The significance of addressing this disorder becomes more apparent in light of its role in long-term disability, reduced quality of life, and elevated suicide risk (Pardo et al., 2022; Saha et al., 2022). Furthermore, the COVID-19 pandemic has exacerbated OCD symptoms, particularly within the contamination subtype, with post-infection OCD-like symptoms reported in up to 71% of affected individuals (Linde et al., 2022).

Among the key psychopathological components of OCD, negative emotions play a crucial role in the maintenance and intensification of obsessive-compulsive behaviors. Three central emotions—disgust, anger, and anxiety—have been identified, each uniquely contributing to the reinforcement of compulsive cycles. Disgust, an evolutionarily grounded emotion for disease avoidance, becomes a heightened affective response in OCD, especially in the contamination subtype. It manifests through extreme avoidance behaviors and excessive rituals (D'Mello & Kumar, 2022; Jones et al., 2020). Notably, self-disgust—a powerful dimension of this emotion—significantly reinforces feelings of guilt, shame, and chronic self-criticism, which may correlate with suicidal ideation and behavior (Rubin et al., 2022; XIAO et al., 2023).

In individuals with OCD, disgust extends beyond personal experience and directly correlates with excessive behaviors such as compulsive cleaning, avoidance, and elaborate rituals aimed at neutralizing perceived internal or external contamination (Moradi Motlagh et al., 2019; Ólafsson et al., 2020).

Anger, although often considered a secondary emotion in OCD, frequently presents either as suppressed or externalized. Empirical evidence suggests that individuals with OCD experience

elevated levels of unexpressed anger, often stemming from failures to control obsessions or fulfill compulsive rituals (Cludius et al., 2021). A significant relationship has been found between anger suppression and symptom severity in OCD, highlighting the role of emotional dysregulation in this disorder (Liu et al., 2017; Zhang et al., 2019).

Anxiety remains a foundational component in the psychopathology of OCD. Typically, anxiety arises in response to obsessive thoughts and is reinforced through compulsive behaviors intended to alleviate distress (Bennett et al., 2021). Research indicates that anxiety in individuals with OCD is associated with an increase in intrusive thoughts, emotional distress, and a decline in life quality (Fakhri et al.; Homayuni, 2023). Beyond psychological effects, chronic anxiety has been linked to physical health conditions such as diabetes, obesity, cardiovascular, and gastrointestinal disorders (Rowe et al., 2023).

Despite the efficacy of traditional treatments such as Exposure and Response Prevention (ERP) in managing OCD, challenges such as patients' fear of confronting real-life anxiety-inducing stimuli, high dropout rates, and the need for direct clinical supervision limit their practical effectiveness (Lohse et al., 2023; Miegel et al., 2023). Pharmacological interventions, though beneficial in alleviating certain symptoms, face limitations including side effects, medication resistance, and a lack of deep cognitive-emotional transformation (Hirschtritt et al., 2017).

In response to these challenges, innovative psychotherapy technologies—particularly Virtual Reality (VR) and Mixed Reality (MR)-based therapies—have emerged as promising alternatives to traditional exposure approaches. MR therapy, by integrating virtual environments with real-world elements, provides a more immersive, safe, and controllable experience for exposure. This method not only enables gradual exposure to anxiety-provoking stimuli but also reduces psychological stress associated with real-life confrontation (Efe, 2022; Lopez-Espada & Linares-Palomino, 2023).

Preliminary findings suggest that MR-based ERP can effectively reduce OCD symptoms, especially in contamination-related subtypes, without significant adverse effects (Miegel et al., 2023). The sense of presence in a therapeutic environment, patient engagement with stimuli, and the adaptability of MR to create personalized scenarios position it as a potentially powerful tool for treating complex emotions such as disgust, anger, and anxiety (Dehghan et al., 2022; Rahman et al., 2023).

However, most existing studies have primarily focused on overall symptom reduction in OCD, with limited research specifically targeting emotional dimensions such as disgust, anger, and anxiety, particularly within MR-based interventions. Among these emotions, disgust remains underexplored due to its clinical and theoretical complexity and has rarely been a focal point in ERP treatments (Novara et al., 2021; Thayer et al., 2021).

To address the existing gaps in OCD treatment, the present study investigates the efficacy of MR-based ERP therapy with a specific focus on key emotions—disgust, anger, and anxiety. The innovation of this study lies in its use of mixed reality as an interactive and safe platform for gradually exposing patients to emotionally charged stimuli. This approach is designed to enhance emotion regulation and achieve sustained symptom reduction in individuals with OCD.

Material and Methods

This study employed a quasi-experimental design using a pre-test–post-test with independent groups and a six-month follow-up period. The aim was to examine the effectiveness of mixed reality-based exposure and response prevention (ERP) therapy on three key emotions in individuals with obsessive-compulsive disorder (OCD): disgust, anger, and anxiety. Participants were randomly assigned to experimental and control groups. The experimental group received the therapeutic intervention, while the control group received no treatment. Evaluations were conducted at three time points: pre-test, post-test, and six-month follow-up.

The sample consisted of 40 individuals, selected via convenience sampling in two phases. Initially, clients from psychological service centers were assessed using the Yale-Brown Obsessive Compulsive Scale (Y-BOCS) (Goodman et al., 1989). Those who scored two standard deviations above the clinical cut-off score of 16 were selected as eligible participants. These individuals were then randomly assigned to either the experimental group (mixed reality-based ERP therapy) or the control group, with 20 participants in each group.

According to Delavar (2013), a minimum of 15 participants per group is sufficient in experimental research, thus the sample size was deemed adequate. Due to constraints in full randomization, convenience sampling was used. Inclusion criteria were: no severe psychological disorders (based on interviews and self-report), no alcohol or substance dependency, absence of chronic physical illness, not currently taking psychiatric medication, diagnosis of contamination-related OCD

(based on DSM-5 and OCD questionnaires), at least six months of OCD symptom history, age between 20–25 years, and willingness to participate. Exclusion criteria included: missing more than three sessions, comorbid psychological or physical disorders, undergoing other forms of therapy simultaneously, or withdrawal from the study.

Instruments

Several validated psychometric tools were used to measure the variables:

Yale-Brown Obsessive Compulsive Scale (Y-BOCS): A semi-structured interview with 10 items (five assessing obsessions and five assessing compulsions) developed by Goodman et al. (1989). In Iran, it has demonstrated high inter-rater reliability (0.98), internal consistency (0.89), and test-retest reliability (0.84) (Izadi & Abedi, 2013).

Disgust Sensitivity Questionnaire (DSQ): Developed by Haidt et al. (1994) and validated in Iran with four subscales. The Persian version has shown a reliability coefficient of 0.90 (Karsazi & Nasiri, 2016).

Spielberger State-Trait Anger Expression Inventory (STAXI): A 57-item scale developed by Spielberger (1999) to measure anger as a state and trait. In Iranian studies, it has demonstrated a Cronbach's alpha of 0.91 (Asghari Moghadam et al., 2011).

Beck Anxiety Inventory (BAI): A 21-item questionnaire developed by Beck et al. (1988) to assess the severity of anxiety symptoms. The Persian version has shown good reliability (0.83) and internal consistency (0.92) (Hossein Kaviani & Mousavi, 2008).

Mixed Reality Equipment

The Meta Quest 3 mixed reality headset was utilized as the main therapeutic tool. This advanced device enabled immersive exposure to virtual stimuli relevant to contamination-related OCD within a realistic, safe, and controlled environment. The aim was to provide participants with gradual and guided exposure to emotionally charged stimuli—disgust, anger, and anxiety—within a clinically supervised context, allowing opportunities to practice emotion regulation strategies.

Therapeutic scenarios were custom-developed by the researcher using the Unity game engine. These scenarios simulated real-life emotional triggers such as:

- Disgust: contact with contaminated objects,
- Anger: being prevented from performing cleaning rituals,
- Anxiety: being placed in unpredictable or uncontrollable situations.

All therapeutic content was culturally adapted to the Iranian context to maximize relevance and efficacy.

Therapeutic Intervention Protocol

A novel mixed reality-based ERP therapy protocol was developed by the researcher, with a focus on emotional regulation of disgust, anger, and anxiety. The intervention consisted of 12 weekly sessions, each lasting 30 to 45 minutes. Participants were also required to complete daily homework assignments in their real-life environments to facilitate transfer of skills to natural settings. Early sessions included psychoeducation covering:

- Introduction to OCD, particularly the contamination subtype,
- The role of emotions in maintaining OCD symptoms,
- Principles of cognitive-behavioral therapy (CBT),
- The logic of ERP,
- Familiarization with mixed reality therapy and the Meta Quest 3 headset.

Practical training on headset use was also provided to reduce technological anxiety and increase psychological readiness.

Starting from Session 3, participants engaged in gradual exposure to emotionally provocative stimuli, based on individual emotional hierarchies. Exposures began with low-intensity triggers and progressed to more intense situations. In the mixed reality environment, digital elements representing contamination, frustration, or anxiety were overlaid onto real-world objects within the therapy room, offering a safe and structured context for emotional confrontation.

Each session included:

- Review of previous homework,
- Emotional state assessment,
- Mixed reality exposure session,
- Prevention of avoidance or compulsive behaviors under therapist supervision.

The ultimate goal was to enhance emotional tolerance and acceptance, while reducing emotional reactivity to triggers. A summary of the therapeutic protocol is presented in Table 1.

Table 1. Summary of ERP protocol

Session	Content	Aim
1	Introduction to obsessive-compulsive disorder, examining the role of emotions of disgust, anger, anxiety; Introduction to mixed reality therapy	Establishing a therapeutic relationship, understanding the role of emotions
2	Learning to use the headset and getting familiar with the technological environment	Technical and psychological preparation for exposure
3	Reviewing emotional experiences; Preparing a list of stimuli and developing a hierarchy	Identifying specific emotional situations
4	Exposure to low-intensity stimuli in a mixed environment	Starting the process of reducing emotional sensitivity
5	Gradually increasing the intensity of exposure to medium-intensity stimuli	Training to tolerate controlled anger and anxiety
6	Exposure to complex and high-intensity stimuli of disgust, anger, and anxiety	Strengthening the skill of stopping compulsive emotional responses
7	Integrating virtual exposure with real situations; Homework	Generalizing skills to real life
8	Practice emotion regulation in more complex situations; Direct supervision by the therapist	Increasing emotional self-efficacy
9	Exposure to a combination of multiple emotions simultaneously	Improving skills of regulating overlapping emotions
10	Review and analyze reactions; Review coping strategies	Consolidating effective coping patterns
11	Perform a final assessment; Complete psychometric tools	Measuring the treatment process
12	Teaching relapse prevention strategies; Conclusion	Strengthening the durability of treatment and ending the process

Results

Data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics, specifically Repeated Measures Analysis of Variance (ANOVA). All statistical analyses were conducted using SPSS version 27. Table 2 presents the means and standard deviations of disgust, anger, and anxiety scores in both the intervention and control groups across the pre-test, post-test, and six-month follow-up phases.

Table 2. Means and standard deviations of disgust, anger, and anxiety scores in both the intervention and control groups across the pre-test, post-test, and six-month follow-up phases

Variable/phase	Group	Mean	SD
Disgust / Pretest	Control	57.84	3.54
Disgust / Pretest	Intervention	59.56	6.69
Disgust / Posttest	Control	57.19	4.26
Disgust / Posttest	Intervention	41.04	6.57
Disgust / Follow-up	Control	55.90	4.23
Disgust / Follow-up	Intervention	40.55	7.13
Anger / Pretest	Control	65.19	3.02
Anger / Pretest	Intervention	64.37	4.32
Anger / Posttest	Control	63.18	2.94
Anger / Posttest	Intervention	44.54	4.81
Anger / Follow-up	Control	61.87	3.29
Anger / Follow-up	Intervention	43.70	5.26
Anxiety / Pretest	Control	40.56	7.34
Anxiety / Pretest	Intervention	41.29	5.32
Anxiety / Posttest	Control	38.45	7.25
Anxiety / Posttest	Intervention	25.38	5.84
Anxiety / Follow-up	Control	37.31	6.94
Disgust / Pretest	Intervention	23.99	6.05

In the intervention group, a significant reduction in emotional scores was observed from pre-test to post-test, and this improvement was relatively maintained at the follow-up stage. In contrast, the control group showed minimal and statistically non-significant changes across the three time points.

In accordance with the assumptions of Repeated Measures Analysis of Variance (ANOVA), Levene's test was conducted to examine the homogeneity of variances across the three phases (pre-test, post-test, and follow-up) for each of the three emotions. The results were non-significant ($p > 0.05$), indicating that the assumption of homogeneity of variances was met. Furthermore, the Shapiro–Wilk test confirmed the normality of data distribution for all measured variables. However, due to the violation of the sphericity assumption, the Greenhouse–Geisser correction was applied to adjust the degrees of freedom in the repeated measures ANOVA analyses. Table 3 presents the results of the repeated measures ANOVA for the emotions of disgust, anger, and anxiety.

Table 3. Results of the repeated measures ANOVA

Variable	Phase effect	Phase * Group effect	Group effect
Disgust	$F=743.25$, $p<.001$, $\eta^2=.951$	$F=561.18$, $p<.001$, $\eta^2=.937$	$F=32.81$, $p<.001$, $\eta^2=.463$
Anger	$F=1339.59$, $p<.001$, $\eta^2=.972$	$F=784.53$, $p<.001$, $\eta^2=.954$	$F=101.78$, $p<.001$, $\eta^2=.728$
Anxiety	$F=660.30$, $p<.001$, $\eta^2=.946$	$F=339.84$, $p<.001$, $\eta^2=.899$	$F=17.82$, $p<.001$, $\eta^2=.319$

Table 4 presents the results of the Bonferroni post hoc tests for pairwise comparisons across the different measurement phases.

Table 4. Bonferroni post hoc test results

Variable	Phase comparison	Mean difference	P
Disgust	Pretest-posttest	9.58	0.001
Disgust	Pretest-follow up	10.48	0.001
Disgust	Posttest-follow up	0.90	0.001
Anger	Pretest-posttest	10.67	0.001
Anger	Pretest-follow up	10.48	0.001
Anger	Posttest-follow up	0.19	.041
Anxiety	Pretest-posttest	9.01	< .001
Anxiety	Pretest-follow up	10.28	< .001
Anxiety	Posttest-follow up	1.27	.000

Based on the findings from Tables 3 and 4, a significant reduction was observed in all three target emotions—disgust, anger, and anxiety—from pre-test to post-test and from pre-test to follow-up.

Moreover, the difference between post-test and follow-up scores was minimal, suggesting a relative stability of the treatment effects over time. Overall, the statistical analyses indicate that the exposure and response prevention intervention based on mixed reality technology was effective in reducing the emotional responses of disgust, anger, and anxiety in individuals with obsessive-compulsive disorder (OCD). Importantly, these therapeutic effects were largely sustained at the six-month follow-up, underscoring the potential long-term efficacy of the intervention.

Discussion

The aim of the present study was to investigate the effectiveness of mixed reality-based exposure and response prevention (ERP) therapy in reducing negative emotions—namely disgust, anger, and anxiety—among individuals with obsessive-compulsive disorder (OCD). The findings revealed that this therapeutic approach led to a significant reduction in all three emotional responses in the intervention group, and these effects were largely maintained at the six-month follow-up, whereas no significant changes were observed in the control group.

These findings align with previous research on the effectiveness of immersive technologies, including studies by Keshavarz et al. (2021), Mayer et al. (2022), and Rubin et al. (2022). Integrating exposure and response prevention with mixed reality technology appears to enhance therapeutic outcomes by facilitating safe, gradual, and personalized exposure experiences, thereby reducing patient resistance to treatment.

Furthermore, the consistency of these results with the findings of Zamanifard and Robb (2023) underscores the innovative potential of this technology in treating anxiety-related disorders. Although a slight decline in treatment efficacy may occur over time, the follow-up data suggest a relatively stable emotional reduction in the intervention group. This highlights the importance of developing maintenance strategies to reinforce therapeutic gains after the completion of core treatment sessions. Overall, mixed reality can be considered a novel, effective, and acceptable approach for emotion-focused treatment of OCD.

The results of the present study demonstrated that mixed reality-based exposure and response prevention therapy significantly reduced the core negative emotions associated with OCD—namely disgust, anger, and anxiety. Compared to the control group, participants in the intervention

group exhibited substantial reductions in these emotions from pre-test to post-test, and these effects were largely sustained over a six-month follow-up period.

These findings suggest that mixed reality technology can provide a safe, interactive, and controlled environment for emotional exposure, thereby enhancing the effectiveness of emotion-focused therapies. The sustained reduction in emotional responses such as disgust, anger, and anxiety indicates the potential capacity of this method to improve emotional regulation and reduce psychological vulnerability in individuals with OCD. Therefore, mixed reality may be regarded as an innovative tool with clinical applicability for treating emotion-based disorders.

Despite its rigorous design, the study had several limitations. First, the exclusive reliance on quantitative tools to assess emotional responses, without incorporating qualitative data, limited the depth of insight into participants lived therapeutic experiences. Second, the use of mixed reality technology required access to specialized equipment, which may restrict the generalizability of the findings to treatment centers lacking such resources. Third, the follow-up period was limited to six months, preventing an evaluation of long-term treatment sustainability.

Accordingly, future research is recommended to adopt mixed-method designs (quantitative and qualitative) to gain a more comprehensive understanding of the therapeutic process. Additionally, studies with extended follow-up durations (at least one year) are encouraged to assess the long-term maintenance of treatment effects.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of Islamic Azad University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection, and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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