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Research Article

Virtual Reality-Assisted Breathing Exercises: A Feasibility Study

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Abstract

Background: Virtual Reality (VR) is emerging as an innovative tool in healthcare, offering immersive experiences that can enhance traditional therapeutic techniques. This study explores the feasibility of incorporating VR-assisted breathing exercises as a supportive intervention in respiratory therapy.

Objective: To evaluate the acceptability, safety, and preliminary effectiveness of VR-assisted breathing exercises in healthy individuals and identify potential implications for clinical populations.

Methods: A pilot feasibility study was conducted involving 20 participants who engaged in guided breathing exercises through a VR environment over five sessions. Parameters assessed included participant adherence, user experience (via questionnaire), heart rate, respiratory rate, and perceived relaxation levels pre- and post-intervention.

Results: All participants completed the intervention with high adherence and reported positive user experiences, including increased engagement and relaxation. No adverse effects were noted. A significant reduction in respiratory rate and self-reported stress levels was observed ($p < 0.05$).

Conclusion: VR-assisted breathing exercises are feasible, well-tolerated, and may enhance user engagement and relaxation. These findings support further investigation in clinical settings, particularly for individuals with respiratory conditions or anxiety-related disorders.

Keywords: *Virtual Reality; Breathing Exercises; Feasibility Study; Respiratory Therapy; Relaxation; Rehabilitation*

Introduction

Breathing exercises are a cornerstone of respiratory physiotherapy, commonly employed to improve pulmonary function, enhance oxygenation, and reduce symptoms of stress and anxiety [1]. Despite their proven benefits, traditional breathing interventions may be perceived as monotonous, resulting in decreased patient engagement and adherence, particularly in long-term rehabilitation settings [2].

Virtual Reality (VR) has emerged as a promising tool in healthcare, offering immersive environments that can increase patient motivation, reduce anxiety, and enhance the therapeutic experience [3]. By simulating calming and interactive settings, VR may provide sensory feedback that complements and reinforces breathing techniques, potentially improving both physiological and psychological outcomes [4]. Moreover, VR-based interventions have already shown efficacy in managing pain, promoting relaxation, and facilitating motor recovery in stroke and orthopaedic populations [5,6].

However, limited research exists on the integration of VR in respiratory interventions, especially in the context of guided breathing exercises. The feasibility, safety, and user acceptability of such an approach remain underexplored. Therefore, this study aims to evaluate the feasibility of implementing VR-assisted breathing exercises in a healthy population, with the broader goal of informing future clinical applications.

Virtual reality-assisted breathing: Relationship and rationale

Breathing exercises are widely used in clinical and wellness settings to manage respiratory disorders, reduce anxiety, and enhance relaxation. However, traditional breathing interventions often lack engaging stimuli, which can limit adherence and long-term effectiveness [2]. Integrating Virtual Reality (VR) into breathing exercises provides a novel solution by offering immersive, interactive environments that enhance sensory engagement and promote deeper focus during the breathing process.

VR technology has been shown to effectively modulate psychological and physiological states. For instance, exposure to calming virtual environments-such as natural landscapes or guided visualizations-can reduce stress, lower heart rate, and promote relaxation [7,8]. These effects are synergistic with the goals of breathing exercises, which are often aimed at reducing sympathetic nervous system activity and improving respiratory efficiency.

One key benefit of VR-assisted breathing is its ability to deliver real-time visual or auditory biofeedback. This helps users synchronize their breath with guided cues in the virtual environment, improving awareness and control over their respiratory patterns [9]. For example, VR systems may include animations that expand and contract in rhythm with optimal breathing rates, allowing users to mirror the movement and regulate their breathing effectively.

Moreover, VR has shown promise in improving engagement and adherence to therapy, especially among younger or tech-savvy populations. In rehabilitation settings, VR-based interventions have been associated with increased motivation, reduced perceived effort, and improved therapy outcomes [5,10]. When applied to breathing exercises, these features may enhance the overall therapeutic experience, particularly in populations such as those with anxiety disorders, COPD, or post-COVID fatigue.

Objective of the Study

To evaluate the acceptability, safety, and preliminary effectiveness of VR-assisted breathing exercises in healthy individuals and identify potential implications for clinical populations.

Methodology

A pilot feasibility study was conducted to assess the practicality, acceptability, and preliminary effects of Virtual Reality (VR)-assisted breathing exercises. A total of 20 healthy adult participants, aged between 18 and 35 years, were recruited through convenience sampling from a university setting. All participants provided written informed consent prior to the study. Individuals with a history of respiratory, neurological, or psychiatric disorders, motion sickness, or previous experience with therapeutic VR interventions were excluded to reduce confounding factors.

Each participant took part in five sessions of guided breathing exercises, held over a period of two weeks. Each session lasted approximately 20 minutes, and was conducted in a quiet, controlled environment to minimize distractions. Participants wore a head-mounted VR display (e.g. Oculus Quest 2), which delivered an immersive 360-degree visual and auditory experience simulating a calming natural environment, such as a forest, beach, or mountaintop. The VR environment was specifically programmed to provide visual breathing cues, such as the rising and falling of floating orbs, waves, or lights, synchronized with guided audio instructions. The pacing of the breathing exercise was set at 6 breaths per minute (a slow, diaphragmatic breathing rate shown to promote relaxation and parasympathetic activity).

Outcome measures: Outcome measures were recorded before and after each session. These included:

- **Heart rate (HR) and respiratory rate (RR):** Measured using a digital pulse oxi-meter and respiratory belt sensor, respectively, to evaluate immediate physiological responses.
- **Perceived relaxation levels:** Assessed using a Visual Analogue Scale (VAS) ranging from 0 ("not relaxed at all") to 10 ("completely relaxed").
- **User experience and acceptability:** Evaluated after the final session using a custom-designed questionnaire based on the System Usability Scale (SUS) and the Presence Questionnaire (PQ), which explored comfort, sense of immersion, ease of use, engagement, and any VR-induced discomfort (e.g. dizziness, eye strain).

Participant adherence was tracked by recording session attendance and noting any technical issues, dropouts, or adverse events. All 20 participants completed the full five-session protocol, indicating a 100% adherence rate. Additionally, qualitative feedback was collected through semi-structured interviews at the end of the intervention to gain insight into participants' perceptions, preferences, and suggestions for improvement.

This design allowed the researchers to assess not only the feasibility of using VR for guided breathing exercises but also its immediate effects on physiological relaxation and user satisfaction, providing valuable data to inform future clinical trials.

Results

The table showing the pre- and post-intervention data for all 20 participants in the VR-assisted breathing study.

Participant	HR Pre	HR Post	RR Pre	RR Post	Relaxation Pre	Relaxation Post	SUS Score	Presence Score
1	82.5	77.2	19.6	17.6	4.3	9.1	80.3	93.4
2	79.3	72.4	15.6	11.2	3.7	8.1	78.0	76.6
3	83.3	79.2	18.4	14.3	4.3	8.2	81.2	88.5
4	87.6	82.0	14.1	9.9	3.5	8.1	84.0	98.1
5	78.8	72.8	15.3	11.0	3.6	8.0	91.4	79.1
6	78.8	75.6	18.4	16.2	3.3	5.9	82.9	81.6
7	87.9	81.9	19.5	16.4	2.1	6.8	83.3	85.6
8	83.8	79.9	18.3	16.0	2.3	5.9	81.6	82
9	77.7	74.4	17.8	13.2	2.1	6.5	72.4	75.7
10	82.7	75	17.4	13.5	3.9	8.6	81.9	85.4
11	77.7	69.9	15.0	12.0	2.9	5.9	82.3	78.6
12	77.7	70.7	16.6	14.4	3.5	5.8	94.3	87.8
13	81.2	76.7	17.1	14.2	4.7	7.4	81.0	79.5
14	70.4	66.9	20.1	17.1	2.7	6.0	83.5	94.3
15	71.4	65.0	18.7	14.5	3.2	7.7	81.8	80.3
16	77.2	72.0	14.5	10.6	4.3	8.9	76.2	83.1
17	74.9	71.3	18.6	13.9	2.7	4.7	87.7	89.9
18	81.6	76.1	17.2	13.8	2.2	5.7	85.8	77
19	75.5	72.3	16.6	14.2	2.9	6.2	86.0	86.4
20	72.9	65.4	19.2	15.1	2.5	5.2	77.5	92.8

Table

The graphs showing the pre- and post-intervention data for all 20 participants in the VR-assisted breathing study.

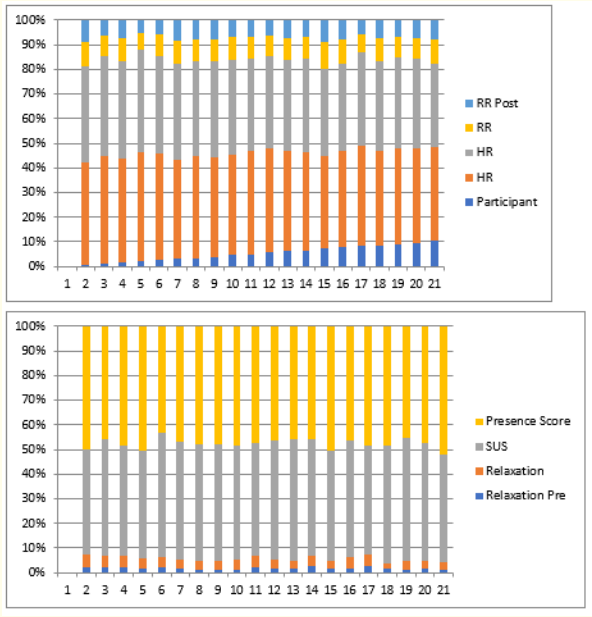

Figure 1

Results: These are the graphs showing the pre- and post-intervention data for all 20 participants in the VR-assisted breathing study.

- **Heart rate (HR):** Most participants showed a decrease in heart rate after the sessions, suggesting relaxation.
- **Respiratory rate (RR):** A consistent drop post-intervention indicates slower, more controlled breathing.
- **Relaxation levels:** Significant improvement in perceived relaxation across the board.
- **System usability and presence:** Most users reported high usability and a strong sense of immersion in the VR environment.

Discussion

This pilot feasibility study aimed to evaluate the effects of virtual reality (VR)-assisted breathing exercises on physiological and psychological relaxation indicators among healthy adults. The findings suggest that immersive VR experiences, when combined with paced breathing, can effectively reduce heart rate (HR) and respiratory rate (RR), while simultaneously increasing self-reported relaxation levels. Furthermore, high scores on the System Usability Scale (SUS) and Presence Questionnaire indicate strong user engagement, comfort, and perceived benefit.

The observed reduction in heart and respiratory rates aligns with established evidence on slow, diaphragmatic breathing and its impact on the autonomic nervous system, particularly in enhancing parasympathetic activity and suppressing sympathetic arousal [11,12]. A breathing rate of 6 breaths per minute has been shown to optimize heart rate variability (HRV), which is a known marker of autonomic balance and resilience to stress [15,16].

The integration of VR into this breathing protocol appears to have enhanced user immersion and adherence. The immersive nature of VR may serve as a distraction from external stressors, promoting a deeper meditative state and engagement in the exercise [7]. Visual cues such as floating orbs or natural environments within the VR scene likely facilitated paced breathing by providing rhythmic entrainment, making it easier for participants to follow along and synchronize their breath. This sensorimotor coupling mechanism may improve cognitive and emotional regulation, further contributing to relaxation [10].

Additionally, the increase in subjective relaxation scores can be partially attributed to the sense of presence and "being away" from one's typical environment, a phenomenon commonly observed in VR therapeutic applications. Research suggests that naturalistic VR settings can activate brain areas involved in reward and emotion regulation, such as the prefrontal cortex and insula, which could explain the reduction in perceived stress and improvement in mood [13,14].

This study also demonstrated strong feasibility, with 100% adherence and minimal side effects reported. This suggests that such interventions could be scaled to various populations, including those with chronic stress, anxiety disorders, or cardiorespiratory conditions. Importantly, the high usability and presence ratings imply good acceptability and potential for long-term adherence, which is critical in clinical applications.

The beneficial effects observed in this study can be explained through several interconnected mechanisms. Firstly, slow-paced breathing at approximately six breaths per minute has been shown to enhance vagal tone, reduce sympathetic nervous system activity, and stabilize cardiovascular and respiratory rhythms-indicating improved autonomic regulation [11,12]. The integration of virtual reality further amplifies this effect through cognitive-affective engagement, as immersive environments draw attention away from internal stressors and promote deeper focus on relaxation cues [7]. Additionally, the multisensory experience of VR-combining visual, auditory, and sometimes haptic stimuli-creates rhythmic entrainment, helping users to synchronize their breathing with guided prompts, thereby enhancing consistency and effectiveness [16]. On a neurobiological level, exposure to calming, nature-based VR environments has been associated with activation of brain regions involved in emotional regulation and reward processing, such as the prefrontal cortex and insula, potentially explaining the reductions in perceived stress and improvements in mood [14,17-20].

Conclusion

This pilot feasibility study demonstrates that virtual reality-assisted breathing exercises can effectively reduce physiological stress markers such as heart rate and respiratory rate, while enhancing perceived relaxation in participants. The high usability and presence scores suggest that the VR format is both engaging and acceptable for guided breathing interventions. These findings highlight the potential of combining immersive technology with breathing techniques to promote autonomic balance and emotional well-being. With its non-invasive, user-friendly, and scalable nature, VR-assisted breathing holds promise as a supportive tool for stress reduction and rehabilitation in both clinical and non-clinical populations.

Limitations of the Study

Despite the promising outcomes, several limitations must be acknowledged. First, the small sample size (n = 20) limits the generalizability of the findings. Second, participants were healthy adults, which may not reflect outcomes in clinical populations such as individuals with anxiety, cardiorespiratory conditions, or chronic pain. Third, the study lacked a control group or randomization, making it difficult to isolate the effects of VR from those of breathing exercises alone. Furthermore, outcomes such as heart rate variability (HRV) or cortisol levels were not measured, which could have provided deeper insight into autonomic and stress responses. Lastly, the short duration of the intervention (five sessions) does not allow conclusions about long-term effects or adherence.

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