The effect of VR on college students' academic stress through interactive relaxation simulations

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Abstract
Academic stress on college campuses is a serious mental health issue among students, with high rates of anxiety and depression. This study analyzes the effectiveness of VR interventions in addressing academic stress, focusing on overall efficacy, the impact of personalization, key interactive elements, underlying psychological mechanisms, and user perceptions. In the methods section, this study used the PRISMA protocol, synthesizing 60 selected articles through a thematic review. The results indicate that VR is highly effective, comparable to behavior change training (BCT) and superior to the control group. Personalization through the personalized VR environment (PVRE) and interactive agents significantly enhances the effectiveness of key elements such as the natural environment. The primary mechanism identified is the sense of presence. Students reported a fairly high level of acceptance, although barriers such as cost and cybersickness still exist. In essence, VR is an effective and highly valued intervention for addressing academic stress among students, optimized through personalization and thoughtful design. However, practical implementation must address functional and cost-related challenges.

1. Introduction

College students often face significant psychological challenges, with academic stress consistently identified as a major contributor to poor mental health. Current research shows high rates of severe stress (21.3%), anxiety (23.3%), and depression (25%) among college students a situation that persists even three years after the onset of the COVID-19 pandemic (Kavvadas et al., 2023). This psychological stress is strongly correlated with academic pressure and often manifests as comorbid issues such as burnout, poor sleep quality, and excessive daytime sleepiness (Amaral et al., 2021). Consequently, there is an urgent and growing need for accessible and effective interventions to reduce stress and anxiety in this vulnerable population.

VR has emerged as an effective tool for mental health interventions; specifically, VR-based relaxation techniques to reduce stress particularly among college students have demonstrated superior efficacy in reducing state anxiety compared to traditional methods such as reading books (Riches et al., 2021). A 20-minute VR mindfulness session demonstrated a significant immediate reduction in symptoms of depression and anxiety, with positive effects lasting up to 1 week (Ma et al., 2025). Although VR appears to be a tool that can reduce anxiety, many of the relaxation apps currently available still seem rigid and impersonal; this approach often employs a one-size-fits-all model. (Heyse et al., 2020). The adoption of this technology by college students faces significant practical challenges; students' perspectives include issues such as high costs, hardware difficulties, and health concerns like motion sickness or cybersickness. A systematic review noted that cybersickness contributes to high dropout rates from interventions.

VR has proven to be an effective tool for reducing stress when compared to methods such as reading. (Modrego-Alarchon et al., 2025) Several systematic reviews confirm that VR is indeed effective for short-term relaxation to reduce stress and anxiety. (Camara & Hicks, 2019) These effects can last up to one week after the intervention. In fact, the effectiveness of Virtual Reality Therapy is considered comparable to standard therapy. Furthermore, VR used for mindfulness meditation has been shown to enhance positive effects, thereby improving students' exam performance (Seabrook et al., 2020).

However, in reality, there remains a significant research gap when it comes to academic stress specifically. For example, there is still no consensus on which interactive elements such as the environment, sound, or other haptic features are most effective at reducing stress (RQ 3). Furthermore, can personalized VR experiences increase the efficacy of relaxation? (RQ 2). Can psychological factors specifically mechanisms such as the sense of presence (feeling as if one is actually there) and immersion explain VR's success in alleviating stress? (RQ 4). There are practical issues such as implementation costs, hardware complexity, and the barrier of cyber sickness or nausea, which students often experience. In fact, this has been cited as one of the reasons participants drop out of VR therapy.

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2. Method

This study employed a Systematic Literature Review (SLR) approach based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. The systematic review method used is based on PRISMA 2020, as described by. This approach was adopted to ensure that the research process is systematic, comprehensive, and transparent, and to avoid duplicating previous studies.

2.1. Sample or Population

The sample data was obtained through the Publish or Perish application, and 699 articles were initially identified. From this initial screening process, 550 relevant articles were identified; after screening based on abstracts, 71 articles remained; the number of articles deemed truly relevant decreased to 16; subsequently, the snowballing technique was applied, resulting in an additional 44 articles. A total of 60 articles were used in this study. Figure 1 shown a PRISMA Diagram.

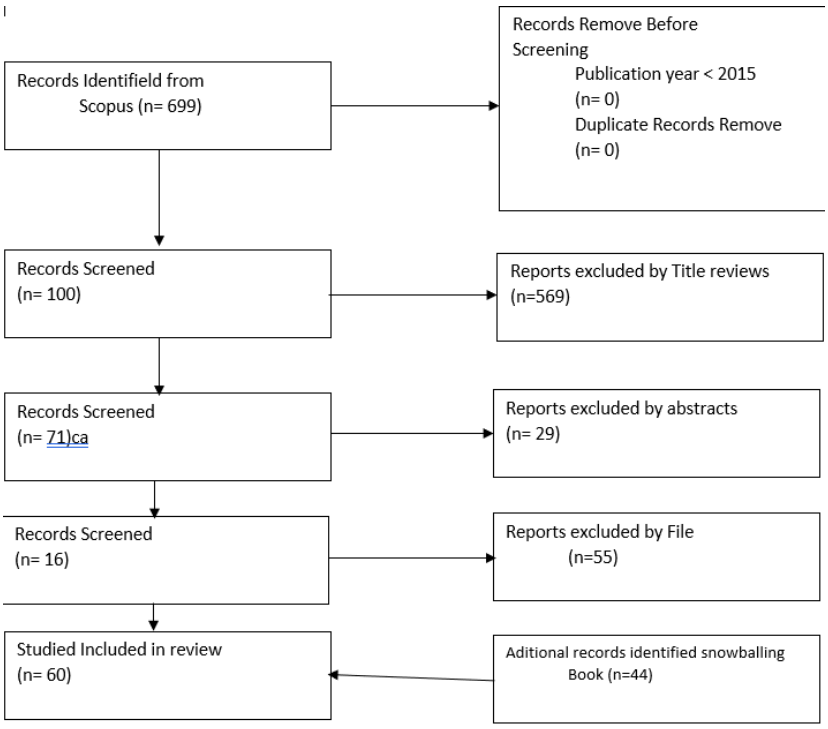

Figure 1. PRISMA Diagram

2.2. Procedure

Data collection was conducted by searching for articles in the Google Scholar database on September 24, 2025. The search was conducted using the keywords "Virtual Reality" OR "VR" AND "Academic Stress" OR "Mental Health" AND "university student." The article screening process consisted of four steps: first, identifying articles based on their titles; second, identifying them based on their file types; third, identifying them based on their abstracts; and fourth, identifying them by reviewing the full text.

2.3. Data Measurement

Data collection in this SLR study involved the selection of articles based on strict inclusion and exclusion criteria can be seen in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Journal articles	Review books
Articles available for download and full-text reading	Articles not available for download or full-text reading
Articles written in English	Articles written in languages other than English

2.4. Data Analysis

Data analysis was conducted through a systematic review of 60 selected articles; to clarify the focus of the study, the data synthesis was centered on answering five research questions (RQs). The research questions are as follows: (1) How effective is VR in reducing stress and anxiety among college students? (2) Does personalizing

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VR enhance the relaxation experience and efficacy? (3) Which interactive VR elements such as the environment, sound, or other features are most effective at reducing students' academic stress? (4) How do psychological mechanisms such as the sense of presence and immersion explain VR's success in reducing stress? (5) What are the perceptions, acceptance, and barriers students experience when using VR for academic stress intervention?

3. Results and Discussion

3.1. Results

VR interventions have shown great potential as an efficient therapeutic method for reducing stress and anxiety. Several studies indicate that VR is more effective at reducing anxiety than passive methods such as reading or watching meditation videos (Camara & Hicks, 2019; Kaplan-Rakowski et al., 2021). This effectiveness takes various forms, ranging from brief 20-minute mindfulness interventions with effects lasting up to one week, to VR environments such as beaches, rural settings, or forests, which have been shown to reduce stress more effectively than indoor control scenarios (Anderson et al., 2017; Ma et al., 2025). This demonstrates that VR exposure therapy (VRET) and VR treatment (VRT) have proven to be as effective as standard therapies such as CBT, as well as when compared to waiting lists or conventional treatments (Tan et al., 2025; Valmaggia et al., 2016). A key advantage of VR lies in its ability to enhance interactive physiological interventions; VR-based biofeedback has been shown to be as effective as 2D biofeedback in improving heart rate variability (HRV), though some participants reported higher levels of preference, motivation, and concentration with the VR format (Rockstroh et al., 2019). This platform also supports the integration of complex therapies, with a pilot study combining mindfulness and CBT with heart rate feedback for patients with panic disorder (Seol et al., 2017). This effectiveness extends to specific groups among college students. The "Digiwell" intervention has been shown to reduce psychological stress, with effects lasting up to three months (Ruini et al., 2024). Meanwhile, for children being treated in the hospital, 360° live video can reduce feelings of loneliness and anxiety.

Intervention mechanisms with a specific format in VR are crucial for effectiveness. Personalization within the virtual environment is a crucial aspect; research has shown clear evidence that a Personalized Realistic Virtual Environment (PRVE) is more effective than a Static Realistic Virtual Environment. More than 90% of PRVEs provide a high level of relaxation and are effective in reducing anxiety (Pardini et al., 2022). Social interaction with virtual agents is recognized as a key mechanism that goes beyond passive information reception. A study comparing interactions with a virtual agent ("Sarah") to a control group that merely read instructions demonstrated that interacting with the agent successfully reduced learning stress (Ranjbartabar et al., 2018). This finding also highlights the presence of a significant moderator variable, in which users' preferences for virtual agents are influenced by their personality type, indicating that there must be a match between the user and the agent's design. From a technological perspective, the use of 360° VR video as an intervention was well-received by participants as a modality. This immersive experience proved effective in modulating affect, particularly in significantly increasing positive affect while reducing negative affect (Evans et al., 2020). The analyzed research focuses on developing responsive interventions, resulting in a conceptual model for an adaptive VR relaxation system. This model is designed for virtual content such as environments, sounds, and other interactions, allowing users to respond directly to their identified emotional states. This adaptive system aims to dynamically optimize and personalize the relaxation experience (Heyse et al., 2020). Effective VRE is considered "personalized" for each patient, allowing therapists to tailor exposure to specific stimuli that patients find distressing (Maples-Keller et al., 2017). For example, in a VRET study addressing public speaking anxiety, a "sandbox-type paradigm" was applied one that allows participants to create their own exposure scenarios by modifying elements such as the environment and the audience's mood (Lindner et al., 2020). Personalization can also be implemented through options; one study ("vRelax") allowed each participant to choose the type of virtual environment they preferred during the sixth session, which may enhance the fit and comfort of the experience (Ahn et al., 2025).

The mechanisms underlying the success of VR, as well as specific intervention elements that impact outcomes. From a qualitative user perspective, VR's realism and its ability to present immersive, soothing real-world elements as if one were in a serene environment are key factors in reducing stress and anxiety (Zuniga Gonzalez et al., 2021). The psychological mechanism of embodiment or the illusion of having a virtual body is recognized as a very powerful element; evidence shows that this mechanism functions reciprocally. For example, experiencing the illusion of having a body in a virtual world while in an uncomfortable position triggers a real physiological stress response, such as an increased heart rate and a decrease in Heart Rate Variability (HRV) (Bergström et al., 2016). In terms of sensory design and context, a comparison across modalities shows that both traditional VR and immersive multisensory environments (IME) are effective at reducing anxiety levels, although IME demonstrates a slightly higher average reduction (Baktash et al., 2024). However, other findings indicate that the content presented has a more significant impact than the technology itself. Viewing meditation videos set against natural backgrounds such as forests or rivers significantly improves mental health compared to a classroom setting. And these benefits are evident regardless of the device used, namely VR (Shin et al., 2025). This study shows that short-term interventions are sufficient to produce effects. A 10-minute VR

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mindfulness session was found to significantly improve mindfulness and positive affect (Seabrook et al., 2020). An RCT ("Mind Nature") demonstrated that therapeutic benefits stem from "nature-specific and mindfulness-specific content," such as immersive activities (gardening, rowing) supplemented with guided mindfulness audio (Ma et al., 2025). This intervention proved more effective, demonstrating a significant reduction in anxiety and negative effects compared to an active placebo control (other VR games), which isolated the content as the causative factor (Ma et al., 2025). Furthermore, a key functional element of VR is its ability to simulate situations that are impractical, costly, or difficult to replicate in the real world such as flying, combat scenarios, or large audiences while giving therapists full control over the dosage and exposure stimuli (Maples-Keller et al., 2017).

Psychological and technological mechanisms are essential to the success of VR interventions. Most often referring to "presence" or a sense of reality, specific research on virtual reality experiences concludes that there are consistent positive effects, such as reduced stress and increased relaxation. These effects are largely facilitated by the sense of "presence" within the environment (Spano et al., 2023). VR technology's ability to create a "Place Illusion" the feeling of being in that location and a "Plausibility Illusion" the perception that events within the environment are authentic causes users to react to virtual scenarios as if they were actually happening (Slater & Sanchez-Vives, 2016). This realism is confirmed from the user's perspective: users find VR highly effective in reducing stress and anxiety because its realistic elements help them feel calm, as if they were in a comfortable setting (Zuniga Gonzalez et al., 2021). The power of this illusion is so great that it can be harnessed for opposite therapeutic purposes, such as exposure therapy. Furthermore, a study demonstrated that 360° videos can effectively simulate an exam environment, providing a high degree of realism and immersion that can trigger anxiety symptoms similar to those experienced during a real exam, thereby holding potential as an intervention tool (Doğan et al., 2025). In addition to presence, another psychological mechanism identified is flow that is, total engagement and focused attention achieved through the use of VR and the enhancement of the digital body. This has proven to be a powerful mechanism capable of triggering real physiological reactions; research shows that experiencing illusions such as a sense of ownership in a virtual environment while in an uncomfortable position can directly trigger physical stress responses, such as an increase in heart rate and a decrease in HRV. Thus, this mechanism plays a role in the acceptability and effectiveness of interventions such as mindfulness.

Research indicates that users generally have a high level of acceptance of VR interventions. VR-based relaxation interventions show potential to be well-received by the public for short-term relaxation and for reducing stress (Riches et al., 2021). This is supported by research on interventions such as mindfulness, which shows that brief 10-minute sessions using VR not only enhance mindfulness and positive emotions but also result in high levels of satisfaction, indicating that VR is highly accepted for mindfulness practice (Seabrook et al., 2020). College students, in particular, demonstrate a very optimistic outlook regarding the potential of VR. The majority of college students view VR positively because it is immersive and interactive (Baxter & Hainey, 2020). This also extends to therapeutic applications; students reportedly show significant interest in using VR as a therapeutic tool for psychological stress and depression, compared to conventional interventions such as medication or counseling (Jin et al., 2023). However, some researchers have also clearly highlighted challenges and anxieties. The main challenges typically experienced by students include relatively high costs, the complexity of the hardware, and physical health issues such as nausea or cybersickness (Baxter & Hainey, 2020). Meta-analysis of the data indicates that VRET is likely to be better tolerated by patients; one study in this research found a VRET refusal rate of 3%, which is significantly lower than the 27% refusal rate observed with in-vivo exposure (Maples-Keller et al., 2017). The feasibility of real-world implementation is supported by findings that VRET remains effective even when used with affordable consumer VR devices and administered by regular clinical psychologists who have received "as little as 3 hours of VR training" (Lindner et al., 2020). Specifically, regarding the student population, a study in Jakarta concluded that VR interventions for academic stress are a coping method that is "more effective and relevant for the current generation of students" (Maulidina & Fatimah, 2024).

3.2. Discussion

This study synthesized the findings from 60 articles to analyze the use of VR as an intervention tool for reducing academic stress among college students. The study demonstrates strong evidence that VR interventions for Research Question 1 are highly effective; consistently, VR is more effective at reducing state anxiety compared to passive methods such as reading and is even comparable in effectiveness to standard therapies like cognitive behavioral therapy (CBT). This effectiveness is demonstrated across various approaches, ranging from brief mindfulness interventions with effects lasting one week, to nutriregulation sessions that allow users to control their brain's alpha waves, to exposure therapy (VRET) for addressing social anxiety. This success is closely tied to the psychological mechanisms described in RQ 4. The literature consistently identifies a sense of presence as the primary mediating factor. VR's ability to generate a "place illusion" the feeling of actually being in a location and a "plausibility illusion" the feeling that a situation is authentic causes users to react to scenarios as if they were real, thereby triggering a physiological relaxation response. In addition to presence, the experience of "flow" or engagement has also been shown to be an effective mediator in reducing symptoms of anxiety, stress, and depression. The connection to RQ 4's mechanisms and the interactive elements of RQ 3 is very clear. It was found that certain elements, such as natural settings like

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beaches or villages and multisensory elements (IME), are highly influential. This supports RQ 4, in which these elements are effective because they directly increase levels of immersion and presence factors crucial to the intervention's success.

This study emphasizes a shift toward user-centered design. The findings related to RQ 5 perception and acceptance show that students demonstrated a very high level of acceptance of VR as an intervention tool. With a positive view of VR due to its interactive and immersive nature, they even showed a strong preference for VR as a therapeutic method compared to medication or counseling. This high level of acceptance provides a foundation for implementation; however, the findings in RQ 2 indicate that success is highly dependent on customization. Evidence that 90% of users preferred the personalized VR environment (PRVE) over the standard VR environment (SVRE) suggests that a one-size-fits-all approach in VR therapy may prove less effective. The intervention, which allows users to choose a user-defined environment for interacting with avatars in a virtual setting tailored to the user's personality, proved effective in terms of personalization (RQ 2), and the high acceptance rate (RQ 5) indicates that students, as users, are ready to adopt this technology if it is well-designed. Although the main results are positive, it is important to recognize the limitations of VR's efficiency. Several studies have shown mixed results; for example, while VR has been shown to enhance positive effects, it does not significantly impact overall psychological well-being, among other findings. This suggests that VR has its limitations; although it is effective in reducing emotional stress, negative impacts, and anxiety, its effectiveness cannot be applied to all types of academic stress, particularly stress related to cognitive performance or mastery of complex motor skills.

This study identified several research gaps that should be addressed in the future. Most studies particularly those focusing on short-term effectiveness are often limited to a single session or brief intervention. Longitudinal studies that regularly monitor the effects of VR interventions over the course of an academic semester to evaluate long-term stress resilience and well-being are still rare. Although implementation challenges in RQ 5 have been identified particularly regarding technical costs and cybersickness or nausea research testing solutions in academic and university settings, such as cost-saving measures or practices to reduce nausea, remains minimal. The aspect of personalization in RQ 2 is largely theoretical, based on predefined options. Research on real-time adaptive models that respond to biometric data such as brain-computer interface (BCI) frameworks is in its early stages, and this represents the most urgent area for future research.

4. Conclusion

This study concludes that VR is a well-accepted intervention tool for alleviating academic stress and anxiety among college students. The main findings for RQ 1 show that VR is as effective as standard therapies such as CBT when compared to activities like reading. This also relates to RQ 4, which is determined by psychological mechanisms such as a sense of presence and flow, and is further supported by the interactive elements in RQ 3, such as an immersive natural environment and embodiment. This study emphasizes that personalization in RQ 2 whether through a customizable PVRE environment or interactive virtual agents can enhance the effectiveness of relaxation. Although students demonstrated a fairly high level of acceptance in RQ 5 even preferring VR over conventional therapy widespread adoption continues to face obstacles, including high hardware and technical costs, as well as user concerns regarding cybersickness or nausea and potential side effects.

Based on the findings and limitations identified in this study, several recommendations are provided for future research. Longitudinal studies are important for assessing the long-term effectiveness of VR interventions on stress resilience, given that current research tends to focus more on short-term effects. It is recommended that applied research be conducted to develop practical solutions to address the implementation challenges identified in RQ 5 such as cost and cybersickness or nausea in a campus environment. To address the limitations in RQ 2, future research should test adaptive intervention models directly by combining biometric data or brain-computer interfaces (BCI) to produce a more dynamic and efficient relaxation experience.

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All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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Declaration of Conflicting Interests

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Data Availability

The datasets generated during and/ or analysed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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