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EFFECTIVENESS OF VIRTUAL REALITY THERAPY ON STRESS LEVEL AMONG UNDERGRADUATE NURSING STUDENTS

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Abstract

Background: Stress is a major concern for nursing students globally, particularly those in post-RN programs, who balance full-time employment with academic responsibilities.
This study determines the effectiveness of Virtual Reality Therapy, using a calming virtual river ride with nature sounds and visuals to reduce stress.
Objective: The study aimed to determine the effectiveness of Virtual Reality Therapy in reducing stress levels among undergraduate nursing students.
Materials and methods: A quasi-experimental pre-post and follow-up design was used to determine stress levels in 34 post-RN nursing students from Ziauddin University Faculty of Nursing and Midwifery Karachi, Pakistan, recruited through purposive sampling. Stress was measured using the Perceived Stress Scale (PSS-10) which consists of 10 statements before, immediately after, and two weeks post-intervention. The two-week intervention, part of a 4-month study (September 2024 to December 2024), aimed at reducing stress. Data were analyzed with the Statistical Package for the Social Sciences version 26.0. Descriptive statistics were applied to demographic variables, while the Friedman Test and Repeated Measures ANOVA determined Virtual Reality Therapy effectiveness. Bonferroni Pairwise Comparison checked time-point differences, and Chi-square was used for demographic associations.

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Results: The intervention-administered participants showed substantial reductions in stress levels from their initial 20.44±4.36 through the post-intervention assessment of 10.35±3.63 while follow-up results remained at 10.41±1.76 ($p < 0.001$). Initiative success reduced moderate stress impacts among students as 91.2% (n=31) reported moderate stress before intervention yet only 2.9% (n=1) students maintained this level of stress after the intervention while no participants experienced moderate or high stress at the follow-up examination. The study registered substantial stress decreases from pre-intervention until the first and second post-intervention follow-up periods. Stress levels after the intervention depended on employment status along with professional experience yet age, gender, year in study, marital status and living circumstances demonstrated no meaningful relationship with stress levels.

Conclusion: Virtual Reality Therapy effectively reduced stress levels among undergraduate nursing students.

INTRODUCTION

This first section explains the background of the study, the problem statement, the purpose of the study, the research objectives, the research questions, the hypothesis, the significance of the study, operational definitions, as well as the international and national literature review.

1.1 Background

Stress is a major concern in nursing students across the globe especially those who are in post-RN programs (Xu, 2024). These students are not only continuing their education but also as competent and paid-up nurses at their clinical sites. This leads to a situation where the task is exponentially complicated in addition to being difficult. On one hand, they aspire to secure better academic performances, handling a lot of workloads, assignments, and practical, and on the other hand, they are also performing their hectic professional chores in clinical areas (Hawajri, 2023). Because they are constantly alternating between education and full-time employment, which lead very high-pressure lives, and persistent stress. This constant exposure causes a toll on their physical health and they are likely to develop fatigue, sleep disorders, or a chronic illness (Camara, 2020). Emotionally and psychologically, stress also results in anxiety, depression, burnout, and cognitive decline, which will decrease academic achievement. This overwhelming stress often leads to negative outcomes, such as poor performance in academic tasks and subsequent exhaustion of the students, which may force them to change their decisions to continue education or even choose a different career.

Most healthcare professionals employed in the healthcare sector are registered nurses (Kim, 2022). Nearly 21 million of the 43.5 million healthcare professionals worldwide, according to estimates from the World Health Organization (WHO), are nurses and midwives. The stress levels among undergraduate nursing students specifically for Post-RN students (nurses having diploma qualifications and entering studies for a Bachelor degree) are an important problem that deserves attention. This is attributable not just to the many causes of intrinsic stress factors mentioned by healthcare workers, but also to the detrimental and long-term manifestations of stress (Onieva et al., 2020). A study conducted in Taiwan

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reported that students enrolling in two-year post-RN programs also work full-time in hospitals as a result, they are frequently under a lot of stress from both their education and their shift job, and they sometimes use medication to help them for relaxation (Vo et al., 2023).

Nursing students seeking higher degrees after getting their diploma qualification in nursing face increased stress levels if uncontrolled, stress may have a variety of negative effects on physical and mental health reported by (Sokratous et al., 2023). Multiple studies reported that the challenging nature of nursing education, especially for post-RN nursing programs, emphasizes the significance of dealing with stress-related issues (Alvarez et al., 2019, Pulido, 2018; Chen et al., 2021, Aedh et al., 2015). Moreover, a study was conducted in India on stress among nursing students and reported a 20% prevalence rate of stress, among undergraduate nursing students (Floyd, 2010). Balancing theoretical knowledge with practical experiences can result in a stressful atmosphere, affecting both academic achievement and overall well-being and it can harm physical and mental health (Alvarez et al., 2019, Chen et al., 2021). Furthermore, it has been reported by Frank in their book 'Health and Academic Achievement' that stress can impair essential learning abilities in academic settings, lowering nursing students' academic performance and predisposing them to stress despair, and burnout (Pulido, 2018).
Over the years there are many traditional stress reduction techniques like Deep Breathing Exercises, Yoga, Progressive Muscle Relaxation (PMR), Aromatherapy, Arts, Music Therapy, and many more strategies have long been regarded as effective. Such practices which are meant to enhance relaxation and conscious regard to reality have been found to have a relaxing effect most of the time (Efendi, 2023). Nevertheless, effective as these techniques may be, the constant intensification of the rate of work in healthcare facilities along with other stressors, requires a search for more effective and versatile approaches. This is where the intervention using technological advancements such as Virtual Reality Therapy (VRT) becomes a viable solution (Naylor et al., 2020). As compared to other approaches, VRT offers an opportunity to transport the user into a controlled environment that is meant to promote relaxation and combat stress. Virtual Reality Therapy is a device-based intervention that involves the use of virtual environment technology with a special electronic device like a VR headset that empowers the user to experience a three-dimensional, computer-generated environment with a visual and auditory experience purposely designed to simulate a real environment (Cieślik et al., 2020). Specifically, electronic devices such as VR headsets help users to participate in an environment that makes them feel detached from the real-life equations they experience. This can easily be adapted, and as such is a more effective method of alleviating stress in the capacity of nursing learning.

Over the past few years, some empirical investigations have searched for evidence of using VRT to decrease stress, especially in the healthcare setting (Lim, 2021). Such results from a number of these studies are unilaterally positive, as shown in the case of an RCT conducted in Korea determined that VRT helped lower stress levels among nursing students. This is especially so as VRT provides users with a mental 'escape' from the immediately enclosing prescriptive routines of their daily lives; a prospect that has now been scientifically proven to have a positive lasting effect on the emotional and psychological health of users. As such, VRT offers a new way of decreasing stress through the simulation of a space

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within which a user can practice relaxation exercises or just relax (Piskorz, 2018). Similar findings have been found in other studies conducted in other health care settings whereby the VRT could be useful for stress reduction in health care students other than the nursing students because the stressors in their work settings will also require stress reduction uptake by the developed VRT. While the effectiveness of VRT is also evident in prior studies, there is a dearth of studies regarding the application of VRT in the context of post-RN nursing students (Ha, 2022). Therefore, this group with many difficulties can benefit from such interventions a lot. Since stress has been widely acknowledged as a concern to nursing students, especially those enrolled in Undergraduate Nursing Post-RN Programs, and since Virtual Reality Therapy is useful in managing stress in some other fields, this study aims to examine the effectiveness of VRT in reducing stress in Undergraduate Post-RN Nursing Students (Stone, 2024). Consequently, the study seeks to establish the extent to which the implementation of VRT influenced post-RN nursing students to generate more information on how technology-integrated learning could support nursing education and health status. A Randomized Control Trial (RCT) has been conducted in Korea and reported that virtual reality technology has developed in recent years as a possible tool for stress reduction and mental well-being enhancement, giving established therapies a new twist (Kim et al., 2021). Nursing students who reported high-stress levels during their clinical studies were seen engaging in negative behavior such as releasing, interrupting actions, and blaming themselves. The link between stress and negative mental health consequences, such as suicide and drug addiction, is becoming more widely acknowledged among undergraduate nursing students (Huai, 2024).

Moreover, a study conducted in Saudi Arabia described that 75.7% of female and 57% of male nursing students reported high levels of stress (Alshowkan, 2022). In addition, future healthcare professionals are vulnerable to burnout and emotional depletion brought on by persistent stress, which raises the probability of turnover and decreases the quality of treatment delivered (Cornine, 2020). However, over half of Pakistan's medical students (44.2%) reported experiencing life-related stress. In response to this problem, VRT has been proposed as a potential intervention to reduce stress levels, among undergraduate nursing students (Lee 2021). However, there is limited research on the effectiveness of VRT in reducing Post RN students' stress levels. Hence it is important to assess the effectiveness of VRT for stress management approaches in the context of Post RN students to have evidence-based results.

1.2 Statement of Problem

Nursing students often experience high levels of stress due to the demanding nature of both their clinical and academic programs. This stress is known to vary widely, with studies reporting stress levels ranging from 9.2% to 88.0% in different contexts. A study done in Pakistan reported that 88% of undergraduate nursing students experience a moderate level of stress, while 4% report severe stress, mainly due to exposure to new and difficult subjects (Sultan et al., 2022). Similarly, another Pakistani study found a 44.2% prevalence of stress, highlighting factors such as academic pressure, faculty expectations, and clinical settings as major contributors. Moreover, studies from Ghana reported a 75% prevalence of stress among nurses, largely due to workload and lack of equipment and resources (Al et al., 2018).

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Additionally, study done in the United Kingdom and Nigeria reported a 68% perceived stress level among undergraduate nursing students, furthermore a study done in China found that 61.97% of nursing students reported high levels of stress, with nursing students more likely to experience stress than those in other disciplines (Zheng et al., 2022). These findings indicate that stress is a serious issue among undergraduate nursing students in various locations that need attention and stress relieving techniques such as VR technology can benefit the students.

1.3 Research Questions

- What is the effectiveness of Virtual Reality Therapy in reducing stress levels among undergraduate nursing students?
- What is the effect of demographic variables on stress levels among undergraduate nursing students?
- What are the perceived changes in stress levels among undergraduate nursing students after undergoing virtual reality therapy sessions?

1.4 Research Objectives

- To determine the effectiveness of Virtual Reality Therapy in reducing stress levels among undergraduate nursing students.
- To determine the effect of demographic variables on stress levels among undergraduate nursing students.
- To determine the perceived changes in stress levels among undergraduate nursing students after participating in virtual reality therapy sessions.

1.5 Research Hypothesis

- **Null Hypothesis**

H0: The VRT is not effective in reducing stress levels among undergraduate nursing students.

- **Alternate Hypothesis**

H1: The VRT is an effective approach to reducing stress levels among undergraduate nursing students.

1.6 Purpose of the study

The purpose of this study is to investigate the effectiveness of Virtual Reality Therapy interventions in reducing stress levels among undergraduate nursing students in Zia Uddin University Faculty of Nursing and Midwifery Karachi Pakistan. The study aims to identify the most effective strategies for reducing stress levels in this population, which can help improve their well-being, cognitive skills, clinical performance, burnout, and academic success as well as help in career development. However, the effectiveness of VRT intervention in reducing undergraduate nursing students' stress levels in the classroom setting is not evaluated in context. Therefore, the study intends to fill the gap in the literature regarding the effectiveness of VRT interventions in reducing stress levels among undergraduate nursing students in Pakistan.

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1.7 Significance of study

This study intended to explore the effectiveness of VRT in stress reduction among post-RN students. The findings of this study may help educational institutions in terms of the addition of stress reduction intervention for the nursing students for the future especially in the context of post-RN students who are enrolled in studies and side by they perform their duties and manage their social responsibilities. Understanding the specific application of VRT as a therapy for stress management in nursing students is of crucial importance, as it has the potential to not only enhance their academic performance but also improve their overall well-being and quality of life. Furthermore, the exploration of the effectiveness of VRT in this context could create the way for the integration of technologically-driven approaches to mental health care within nursing education, which would expand the scope of supportive resources available to Post RN students.

1.8 Operational Definitions

1.8.1 Stress

In this study, stress refers to the psychological and physiological responses of undergraduate nursing students to the challenges and demands of their educational program. The stress level of the students refers to those whose score is equal to or greater than 14 on the Perceived Stress Scale (PSS-10).

1.8.2 Undergraduate Nursing Students

Undergraduate nursing students are those nurses who hold a diploma in nursing and are currently enrolled in first- and second-year bachelor nursing programs (Post-RN BSN) at Zia Uddin University Faculty of Nursing and Midwifery Karachi.

1.8.3 Virtual Reality Therapy

A device (HTC Vive Device Version 2023), the intervention that engages undergraduate nursing students in the experiences of a relaxing river ride, by utilizing a special electronic device such as a VR headset which includes a Head-Mounted Display (HMD), to create a sense of presence and immersion. As part of the VRT experience, participants wore headphones and viewed a calming video that simulated a gentle river scene. They could relax and immerse themselves in the peaceful environment, with visuals of abundant trees and rocks along the riverbank, accompanied by the soothing sounds of flowing water and birds, adopted from previous research done in Jordan (El-Qirem et al 2023).

1.9.4 Effectiveness

The degree to which a VRT reduces the perceived stress levels that the scale (PSS-10) measures. If PSS-10 scores decrease following an intervention, this might be interpreted as the intervention being "effective" at reducing perceived stress among participants.

REVIEW OF LITERATURE

This section describes an integrative literature review on stress among undergraduate nursing students, focusing on the prevalence, management strategies, and interventions. It is divided into four sections: the first details the search strategy for relevant literature; the second examines the role of nurses in stress management; the third discusses the current knowledge gaps and stress levels among students; and the

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fourth explores educational strategies and interventions, particularly virtual reality-based techniques, to improve stress management practices among nursing students.

2.1 Search Strategies

A systematic approach was utilized to identify relevant research for this study. The following academic databases were searched during this process: such as Pub Med, Google Scholar, MEDLINE, and Cumulated Index to Nursing and Allied Health Literature (CINAHL). The search terms utilized during this process included "Nursing Students Stress" "Undergraduate Nursing", and "Virtual Reality-Based Intervention". Initially, 3500 article records were identified through electronic database searches (Google Scholar n=2000; Medline n=800; CINAHL n=500; PubMed n=200). After removing 1200 duplicates, irrelevant titles, articles not available in full form, and studies not published in the last 5 years, 2300 articles records remained. Following title and abstract screening, 500 records were excluded as irrelevant. The full text of 1800 articles were assessed for eligibility, with 1754 excluded for not meeting the inclusion criteria. Only those articles included that focus on the stress level of undergraduate nursing students. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses, (PRISMA-2020) guidelines were followed throughout the literature search for further description (See Appendix-I). Additionally, filters were also applied to limit the search results to studies published within the last 05 years and those articles written in English.

2.2 Global Burden of Stress Level among Undergraduate Nursing Students

The prevalence of stress among undergraduate nursing students is a growing concern in nursing education (Nayak, 2019, Masha'al et al., 2020, Nebhinani et al., 2020). Researchers found that nursing students, in comparison to other students, experience higher levels of stress (Aloufi et al., 2021). The findings of a research that was carried out in Hong Kong and used a cross-sectional design revealed that the prevalence rates of stress were correspondingly 41.1% among 661 nursing students working toward their Bachelor of Science in Nursing degree (Cheung et al. 2016). The literature on stress management in nursing education emphasizes the difficulties encountered by students, particularly post-RN nursing students, as they navigate a complex interplay of academic and clinical expectations. There are multiple traditional stress management strategies, such as mindfulness and cognitive-behavioural therapies, have been investigated in Iran (Rafati et al., 2017). However, there is a significant gap in knowing the potential advantages of virtual reality treatment for this population.

A systematic review was conducted in the Middle East and North Africa and reported that the prevalence of low, moderate, and high perceived stress was 0.8-65%, 5.9-84.5%, and 6.7-99.2%, The finding of the study also mentioned common stress factor such as clinical stressors (job assignments, workload and patient care) and academic stressors included lack of break time, course workload, load grade and exam (Chaabane et al., 2021). Moreover, a study conducted in India found that 30% of undergraduate nursing students experience mild stress, 63.33% experience moderate stress, and 6.67% experience severe stress (Singh and Chaturvedi, 2019). On the other hand, a pre-survey on Malaysian nursing students which showed that clinical assignments were the major cause of stress (Ab, 2019). Furthermore, another research done in Saudi Arabia showed that 50% of the students of pharmacy were

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anxious and stressed during their undergraduate program (Samreen, 2020). For measuring these stress levels there are multiple tools used, but the most reliable and valid tool that is globally used is the Perceived Stress Scale (PSS-10), The PSS-10 is a self-report questionnaire that includes items related to feelings, thoughts, and stressful experiences. The reliability of the tool was calculated through Cronbach's alpha value reported for this scale was 0.865 and the validity score was 0.796 (Chen et al., 2021).

Additionally, a systematic review and meta-analysis done in Taiwan also highlight that most of the nursing students (42.1%) experienced moderate stress. This study suggests that as students proceed in their nursing career their stress also increases with time (Vo et al., 2023). Similarly, one more study was conducted by Onieva to assess nursing students 'perceived stress levels and their association with anxiety, as well as the coping behavior used to reduce the effect of stress during clinical training. Overall, 47.92% of the students experienced a moderate level of perceived stress and only 25% perceived a high degree of stress. Furthermore, the correlation between perceived stress and anxiety was significant in the present study, i.e., students with high scores of perceived stress had higher anxiety scores (Onieva, 2020).

Moreover, In 2016-2017 a study was conducted at Aga Khan University Karachi, Pakistan which used the cross-sectional approach to collect data from 283 students from the medical departments of MBBS and nursing, surprisingly all the students were rated 19 on a scale created by the researchers i.e., Aga Khan University Anxiety and Depression Scale" (AKUADS). The study reported that female students were more prone to stress and anxiety as compared to male students and family problems were found to be the main cause in addition to the academic expectations from faculty and family members (Rehmani et al., 2018).

Similarly, a cross-sectional study was conducted in Khyber Pakhtunkhwa, Pakistan assess the stress level of 260 students. In this study, male students were more stressed compared to female students. The mean age was 21.4 in this study. The study reported that the stress levels were negatively associated with the academic performances of the students. Worrying about the future, academic expectations and family problems were the main risk factors among these students. This study used the Perceived Stress Scale (PSS) as a data collection tool (Noreen, 2023).

2.3 Management of Stress Level

Stress can be managed through various methods, including pharmacotherapy, deep breathing exercises, yoga therapy, progressive muscle relaxation, arts and music therapy and tai chi. But a newer method, such as virtual reality therapy immerses individuals in calming virtual environments offering an effective interactive way to reduce stress, especially for those under academic pressure.

2.3.1 Pharmacotherapy

The most commonly used approach for the management of stress is the use of medications such as sedatives, antidepressants, tranquilizers, and anxiolytics (Baldwin et al., 2014; Williams et al., 2023). A study was conducted in Canada for the assessment of reduction in stress levels among students using antidepressants. The results displayed that among 113 students, 28 male and 85 female students using

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these medications were effective in reducing stress significantly (Lal et al., 2024). Notably, the use of pharmacological agents among students is not very common. Additionally, it has adverse effects such as dependency and orthostatic hypertension (Nolan, 1992). A review study conducted in Iran suggested that pharmacotherapy alone is not effective for the management of stress. (Nosratabadi et al., 2017).

2.3.2 Deep Breathing Exercises

There are many traditional stress reduction techniques utilized globally such as a randomized control trial study that has been conducted on Deep Breathing Exercises and reported that this therapy can help in lowering the stress levels and improve mental and physical well-being of undergraduate students (Lee et al., 2021). In terms of deep breathing, the study by Toussaint et al. (2021) found that this technique was highly effective in improving emotional regulation and inducing psychological relaxation. Participants who practiced deep breathing experienced significant reductions in anxiety and stress levels. The controlled, rhythmic breathing led to a calming effect on the mind, which was reflected in physiological markers such as lowered heart rate and reduced blood pressure. Deep breathing was also associated with an enhanced sense of focus and mental clarity. These findings underscore the value of deep breathing as a simple yet powerful tool to promote mental well-being and reduce physiological stress responses.

2.3.3 Yoga Therapy

A study was done on Yoga and they concluded that it helps decrease burnout and improve the quality of life among healthcare staff as mentioned in the systematic review (Wang, 2020). Similarly, another study conducted by Kinchen (2020), explored the effects of yoga on perceived stress, self-compassion, and quality of life among undergraduate nursing students. The results indicated that increased practice of yoga meaningfully decreased perceived stress, and increased self-compassion. It was also observed that students who performed yoga benefited from it because they had increased quality of life and mental and emotional health.

2.3.4 Progressive Muscle Relaxation

A study pointed out that PMR is a stress management technique that involves contraction and letting go of muscles in the body. About the effectiveness of this technique, a study by Allison et al., in 2020 defined how it helped diminish stress levels regarding nursing students. The stress level was measured both as a pre-treatment value and a post-treatment value of the progressive muscle relaxation program in the study. Similarly, one more study reported that it was evident that after the exercise training, the nursing students exhibited less stress and anxiety. The research showed that PMR alleviates scores of stress and anxiety among nursing students (Toqan, 2022).

2.3.5 Tai Chi

A study was done on Tai Chi, which is a specific pattern based on slow progressive movements and as stated this Tai therapy greatly reduces stress (Qi et al., 2022). Moreover, a systematic review and meta-analysis study done by Jiang et al. (2020) aimed at comparing the effectiveness of Tai Chi on psychological disorders in college students. The current research proposal sought to conduct a systematic review to systematically analyse the evidence that Tai Chi could have beneficial effects on the

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mental health of the target population, especially concerning stress, anxiety, and depression. The studies also suggested that Tai Chi held the potential to positively influence psycho-social symptoms related to psychological disorders based on higher results in diminishing anxiety and depression compared to control groups.

2.3.6 Aromatherapy

Furthermore, aromatherapy is a popular technique for stress reduction that makes use of essential oils extracted from plants. According to Whitten (2020), the aroma of certain oils might influence one's stress levels, metabolism, and mood. Seventy nursing students were randomly assigned to one of two groups: one that executed an experiment and another that served as a control. A non-absorbent pad was placed on the students' chair handles, 20 cm from their noses, and ten drops of sesame oil were added to it. The experimental group was given three droplets of damask rose oil and seven droplets of lavender oil, each containing 10% of the oil. Data was collected before, during, and immediately after the intervention (15 minutes) using a two-part questionnaire that contained demographic data and the State-Trait Anxiety Inventory 1. The results show that aromatherapy is helpful for test-averse nursing students. Hashemi (2021) found that both 15 minutes after the intervention and immediately after the test ended, the experimental group's state anxiety mean scores were significantly lower in the aromatherapy group compared to the sham group.

2.3.7 Arts and Music Therapy

Arts and Music therapy are effective in reducing stress. Music therapy, characterized by personally tailored music interventions, has been found to have a medium-to-large effect on stress-related outcomes (Giordano et al., 2020). Another quantitative synthesis done by De Witte et al. (2022) unveiled the efficiency of music therapy to address stress in diverse populations. The analysis showed that music therapy played a very worthy role in decreasing stress levels. The report showed that the impact of music therapy was most strongly manifested in the decrease in the level of physiological stress hormones and the increase in the quality of the emotional state. Furthermore, the review emphasized that the two study features that provided the greatest degree of improvement were personal and consecutive music therapy approaches. The study found that music therapy has the potential to unravel stress, especially given the cost-effectiveness and portability of the therapy.

2.3.8 Virtual Reality Therapy

Although conventional approach to stress management has for a long time been consider as appropriate. However, in developing countries such as Pakistan, the use of technology such as; Virtual reality technology is still unfamiliar to undergraduate nursing students. Such students, particularly those in the Post RN Program, rarely get time for regular stress-reducing activities such as; yoga, meditation, or even exercising because of their huge workload. However, understanding this need, the primary investigator intends to examine the effectiveness of VRT as a stress-managing tool for these students, thus trying to contribute to the body of knowledge on its efficacy, particularly in nursing education. Moreover, the incorporation of new technology such as Virtual Reality brings unique and complementary ways to stress management reported by (Naylor et al., 2020). Several research studies

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have determined the effectiveness of Virtual Reality therapies for stress reduction in nursing students. A study was conducted in Western Australia and reported that immersive VR was an excellent technique for stress reduction (McGarry et al., 2023). Similarly, a study conducted in the United States of America highlighted that nursing students during their initial clinical training discovered that VR-Based Progressive Muscle Relaxation was beneficial in lowering stress and anxiety levels (Son et al., 2022). A systematic review done on the usefulness of VR simulation in stress reduction reported that VR provides new simulation training chances to boost confidence and reduce stress (Velana et al., 2022).

Furthermore, another study conducted in Korea reported that Virtual Reality Technology has developed in recent years as a possible tool for stress reduction and mental well-being enhancement, giving established therapies a new twist (Kim et al., 2021). Moreover, a study conducted in Finland highlighted in their study that the brain's neuroplasticity allows VR to assist in "rewiring your brain" with healthier neurons or rerouting the old ones as you mature (Georgiev et al., 2021). Multiple studies including systematic reviews have indicated that VR therapy may be a helpful tool for stress management. VR therapy is a completely immersive experience that can promote nervous system control, making it a viable stress-reduction tool for nursing students and professionals (Ma et al., 2021, Best et al., 2022, Ioannou et al., 2020).

` One more study was conducted in Korea, and they concluded that both virtual reality and biofeedback relaxation sessions were beneficial in lowering stress and anxiety levels. Following both types of relaxation sessions, participants' anxiety levels and subjective stress ratings decreased significantly. However, there was no statistically significant difference in the efficacy of VR relaxing vs. biofeedback relaxation. According to the findings, both virtual reality and biofeedback may be employed as effective stress-reduction techniques (Kim et al., 2021). The study by Modrego et al. (2021) investigated the efficacy of a mindfulness-based program with and without virtual reality support to reduce stress in university students. The findings indicated that both interventions—mindfulness with and without VR—were effective in significantly reducing stress levels among participants. However, the group that received mindfulness training supported by VR experienced a more pronounced reduction in stress compared to the non-VR group. The incorporation of VR enhanced the immersive experience of mindfulness, leading to greater engagement and deeper relaxation. Overall, the study suggests that using VRT as a complementary tool in mindfulness-based stress reduction programs can further amplify the benefits of stress management in university students.

Additionally, a study conducted in the Netherlands reported that virtual reality relaxation is a practical and effective technique for lowering experienced stress among Intensive Care Unit nurses during the COVID-19 pandemic. The study discovered that taking a 10-minute break during work shifts using (VRT) resulted in a substantial reduction in perceived stress immediately after usage. Most ICU nurses who used (VRT) felt that it helped them relax. The biggest impediment to its usage, however, was the nurses' heavy workload. Overall, (VRT) shows potential as a useful and practical tool for healthcare personnel dealing with stressful conditions such as a pandemic (Nijland et al., 2021). In response to this problem, virtual reality therapy has been proposed as a potential intervention to reduce stress levels,

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among undergraduate nursing students, multiple studies suggested that this therapy is itself an effective intervention for stress reduction. However, there is limited research on the effectiveness of virtual reality therapy in reducing post-RN students' stress levels. Hence it is important to assess the effectiveness of VRT for stress management approaches in the context of Post RN students to have evidence-based results.

However, a conducted by Saab et al. (2022) explored nursing students' perceptions of using virtual reality in healthcare education through a qualitative approach. The findings revealed that nursing students generally viewed VR as a valuable and engaging tool for learning, particularly in enhancing their clinical skills and decision-making abilities in a safe, controlled environment. The students appreciated the realistic simulations, which provided opportunities for hands-on practice without risking patient safety. Overall, the study concluded that while VRT has great potential in healthcare education, thoughtful implementation is necessary to maximize its benefits.

Virtual reality therapy provides an immersive and interactive approach to stress management, offering a safe and controlled environment for individuals to learn and practice stress management techniques. It can be tailored to each individual's specific needs, allowing for personalized scenarios that directly address the underlying causes of stress. Additionally, it empowers individuals by enabling them to practice facing their stressors in a realistic yet non-threatening setting, leading to long-term benefits. Virtual reality therapy has shown effectiveness in reducing stress across various populations, making it a valuable tool for addressing a wide range of stress-related conditions.

2.3.9 Gaps in VR research for nursing students in Pakistan.

The global concern about nursing student stress arises because they need to handle demanding coursework alongside clinical work. VRT has emerged as a novel stress reduction approach among recent stress reduction interventions that involve Virtual Reality Therapy. Virtual Reality Therapy utilizes virtual simulated environments which demonstrates effectiveness in multiple health applications and educational scenarios to help users reduce their stress while developing better psychological wellness.
Research findings show that VRT shows promising effects in decreasing student stress. A research paper by Chang and Lai, (2021) investigated VRT functionality for medical students through brief VRT sessions which led to significant stress reduction and anxiety decrease. Rephrase the following sentence. Nursing students who engaged with nature-based VR environments reportedly experienced reduced stress according to Shorey and Ng, (2021).

The research by Saab et al., (2022) demonstrated that students in university showed enhanced mental health results when using VR-based interventions which helped both relaxation and emotional control. The researchers from Saab et al., (2021) found that VRT using nature-based environments creates relaxation which works well to decrease stress in nursing students who cope with stressful training conditions.

VR interventions designed for nursing students demand further exploration in Pakistani and other developing nations because those specific applications are not sufficiently researched. The research conducted by Choi et al., (2022) showed that stress management programs in Pakistan primarily lack

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both modern technological solutions and implementation of virtual reality systems. Plastic research in Pakistan investigates basic stress reduction techniques through counselling and relaxation approaches but does not prioritize technology-based interventions.

Pakistani nursing students experience distinctive obstacles of heavy academic responsibilities and demanding clinical tasks alongside minimal support structures which makes their stress significantly higher than students in other countries according to Chang and Lai, (2021). Effective stress reduction measures including VRT should be developed to serve both cultural needs and accessibility requirements since they may provide customized and engaging approaches to stress management.

The worldwide scientific evidence shows VR's positive effects for nursing student stress management yet there exists a research void focusing on Pakistani nursing students specifically. Research shows a substantial lack of available studies about using VR-based stress reduction interventions for nursing students in Pakistan. The research investigates how Virtual Reality Therapy works to decrease stress among undergraduate nursing students attending Ziauddin University in Karachi.

METHODOLOGY

This section describes the study setting, target population, study design, study duration, sample size, sampling technique, selection criteria, and methods for data collection, statistical analysis procedure and ethical considerations according to the study.

3.1 Study Setting

The study was conducted at Ziauddin University Faculty of Nursing and Midwifery North Nazimabad Karachi Sindh.

3.2 Target Population

The target population for this study was currently enrolled undergraduate students (Post RN) in both 1st and 2nd year at Ziauddin University Faculty of Nursing and Midwifery. The total number of enrolled students was 61.

3.3 Study Design

A pre-post single group quasi-experimental study design was used to answer the research questions. This method was chosen due to the research exclusively studied undergraduate nursing students who comprised the total participant group. The PI could not achieve random participant selection between control and experimental groups because they worked with limited numbers. The PI adopted a single-group pre-post research structure which enabled all participants to perform VRT while they checked their stress levels before intervention then right after and again two weeks post-intervention. A conventional RCT allocates study participants randomly to receive experimental intervention either through an experimental group or a control group or not. The ethical concerns arise when failing to offer an intervention because research has proved that VRT decreases stress levels effectively. The study avoided ethical problems linked to withholding intervention because it implemented a quasi-experimental setup which provided all subjects with VRT benefits.

When conducting research in uncontrolled natural environments researchers need more adaptable study plans than those used in controlled laboratories. The PI applied the quasi-experimental design to

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create an intervention schedule which accommodated participants' unique academic and clinical responsibilities but would not be possible in a protocol-bound RCT. The practical viability of the study depended on the time parameters and resource requirements needed to run an RCT as demonstrated by the randomization techniques and extensive sample sizes. A quasi-experimental design delivered adequate results about this particular participant group (undergraduate nursing students at a single institution) without requiring the complexity of an RCT.

3.4 Duration of Study

The study was completed in three months from September 2024 to December 2024.

3.5 Sample Size

The researchers utilized G*Power software to determine the sample size for their study because this software is popular among researchers who need to calculate power statistics and required sample sizes in psychological and educational investigations. The sample size determination for this research followed the approach used by El-Qirem et al. (2018) in their study about Virtual Reality Therapy (VRT) effects on stress among Jordanians. The reference research calculated effect size by comparing pre-intervention scores of perceived stress to post-intervention scores where the effect size equalled 3.05 (16.37-13.32) while pre-intervention and post-intervention standard deviations amounted to 6.77 and 5.19 respectively.

Research required a 95% confidence level and 5% absolute precision to calculate sample sizes using an 80% power of the test as the assumption. These specific threshold values in statistics confirm that the research study effectively detects actual effects when they exist. The designed study required a sample size of n = 34 according to calculations made through G*Power software. The research team rounded up the initial n = 38 to guarantee statistical analysis power would remain sufficient throughout the study despite possible participant attrition reaching 10%.

The study sample of n = 34 participants survived until the end of the research period thus maintaining sufficient strength to detect meaningful changes in stress levels at each evaluation point according to power analysis outcomes for selected statistical methods including Friedman Test and Repeated Measures ANOVA. A sample size of n = 34 fits properly for this quasi-experimental study employing multiple measurement scenarios and matches the numbers used in stress reduction studies with VR treatments such as the El-Qirem et al. (2018) research. The research design includes 34 participants which enable significant and clinically important findings to establish the effectiveness of Virtual Reality Therapy for nursing student stress reduction.

3.6 Sampling Technique

A non-probability purposive sampling technique was used.

3.7 Eligibility Criteria

The selection of participants for the study was based on a well-defined set of eligibility and exclusion criteria to ensure the accuracy and relevance of the results. The selection process focused on individuals who met specific qualifications related to their nursing education, stress levels, and prior exposure to

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stress management therapies. These criteria aimed to create a homogeneous group of participants to effectively investigate the effectiveness of Virtual Reality Therapy on stress reduction.

3.7.1 Inclusion Criteria

- Participation in the study was restricted to those individuals who were currently enrolled in a post-RN nursing program.
- Both male and female students were included, provided they voluntarily agreed to participate.
- To participate in the study, students were required to have a Perceived Stress Scale (PSS) score of 14 or higher. The PSS is a well-recognized tool used to measure the perception of stress, with higher scores indicating a greater level of stress.
- Those participants were included in this study who had not utilized Virtual Reality Therapy for stress reduction earlier on.

3.7.2 Exclusion Criteria

- Participants with known medical conditions affecting their eyes, ears, or neck movements were excluded.
- Males and females who were currently on stress management medications were also excluded.
- Any student, who did not agree to be part of the study, was eliminated from the study.
- Students who had previously received any form of intervention for stress management were excluded.

3.8 Data Collection Procedure

Researchers used a quasi-experimental design to determine how Virtual Reality Therapy (VRT) works at lowering stress levels for undergraduate nursing students. The Perceived Stress Scale (PSS-10) served as the main stress measurement because it functions as an established assessment method to determine how subjects label their life experiences as stressful.

The researcher used purposive sampling to pick participants who required the intervention benefits most. All undergraduate nursing students received invitations to participate in the research through the PSS-10 survey for stress evaluation. The VRT intervention selected students who received PSS-10 scores at least 14 points to participate given their moderate to high stress levels. Previous studies involving the PSS-10 used this threshold score of 14 to indicate substantial perceived stress according to Cohen et al. (1983).

All qualified students received comprehensive explanation about the research objectives and experimental procedures along with risks and benefits associated with VRT participation prior to the study commencement. All participants provided written informed consent while receiving assurance about their rights that included the voluntary nature of the study with an unrestricted right to stop participating anytime without consequences. The consent forms explained in detail that the VRT intervention had no mandatory participation requirements while also protecting personal data confidentiality.

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The Virtual Reality Therapy procedure with its equipment was explained to participants to help them feel confident about the intervention process. The participant first signed the consent form before the researcher offered the chance to ask questions regarding their understanding of the study and application procedures.

3.9 Identification of Study Variables

- Dependent Variables: Stress Level.
- Independent variables: Virtual Reality Therapy Intervention.

3.10 Data Collection Tool

The Perceived Stress Scale (PSS-10) was used in this study. It was adopted from an online open resource (Mappi-trust.org) (See Appendix-J). The PSS-10 is a self-report questionnaire that includes items related to feelings, thoughts, and stressful experiences. The reliability of the tool was calculated through Cronbach's alpha, with a reported value of 0.865, and the validity score was 0.796 (Chen et al., 2021). Participants were asked to rate how often they had experienced certain feelings or thoughts in the past month on a 5-point Likert scale, ranging from 0 (never) to 4 (very often). The total score on the scale ranged from 0 to 40. A higher level of stress was indicated by higher scores, with a score of 0–13 indicating "Mild stress," 14–26 indicating "Moderate stress," and 27–40 indicating "High stress." The responses of participants were numerically coded, and the scores were added to determine the overall effectiveness of virtual reality therapy in reducing stress among undergraduate nursing students.

3.11 Methods for Data Collection

The self-administered questionnaire that was PSS-10 was used for data collection and the process was started after the permission from the concerned committees of Ziauddin University Karachi Faculty of Nursing and Midwifery (See Appendix-F). The study was divided into three phases:

Phase-I: Pre-Interventional phase

In the first phase, the subject under consideration, the undergraduate nursing students filled out the PSS-10 tool which serves as a measure of perceived stress (Appendix D). The participants were asked to fill out the PSS-10 scale by email communication so that the identity of participants would not be revealed in any way. First, the Primary Investigator (PI) asked for permission to conduct the study from the Dean of the Ziauddin University Faculty of Nursing and Midwifery and got a student list from the Students' Affairs Office at ZUFONAM and the Program Coordinator. With the permission of the participant teachers, the PI observations began approximately 20 minutes before the break time and entered the classroom. At this time, the PI offered a brief description of the research about to conduct, goals, aims of the study, and importance of the study. The PI provided the participants with the consent form in English, although the Urdu part was printed at the back of the English part as shown in Appendix C. On the consent, the data collection phase was initiated and the students were required to fill in the PSS-10 questionnaire (See Appendix D). It only took the participants 15-30 minutes to complete the form.

Prior to conducting the intervention, a **pilot test of the Virtual Reality Therapy (VRT)** was conducted on a small group of undergraduate nursing students at Peace College of Nursing Karachi, to assess the

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feasibility, clarity, and acceptability of the intervention. The purpose of this pilot testing was to ensure that the VRT content was appropriate, engaging, and effective for stress reduction in the target population.

Participants reported that the VRT session was relaxing, easy to follow, and helped them feel calmer and more focused. They expressed interest in attending similar sessions in the future and shared that the virtual environment provided a much-needed break from academic stress. Based on this favorable response, the intervention was considered valid and appropriate for the main study. This pilot experience strengthened the confidence of the researcher in proceeding with the full implementation of the VRT intervention.

A total of 45 undergraduate nursing students were screened using the PSS-10 tool. Among them, 10 students exhibited mild stress levels (PSS-10 score less than 14), 31 students were classified as having moderate stress, and 3 students demonstrated high stress levels. Students with mild stress were excluded from the study, while those with moderate and severe stress (PSS-10 score ≥14) were included in the intervention group. The greater number of participants from the first year reflects the larger class size compared to the second year, which had fewer enrolled students.

One day after completing the pre-questionnaire, the participants received an email notification about the VRT intervention. Students who had a PSS-10 result of 14 or above were included in the intervention group, while those who had scores below this were excluded from the present study. The intervention group was exposed to virtual reality (VR) therapy experience to reduce their stress level.

Phase-II: Interventional phase

After a gap of one day following the pre-interventional phase, the interventional phase commenced (See Appendix E). This phase consisted of Virtual Reality Therapy (VRT), which was adapted from a previous study. The mentioned study demonstrated that VRT was highly effective in reducing stress levels by 28.57% among university students (El-Qirem et al., 2022). Notably, PI possessed a training certificate in VRT, ensuring that the sessions were conducted with the highest level of expertise and strict adherence to therapeutic standards. This qualification was crucial in delivering a structured and professional intervention. The intervention group underwent four VRT sessions within two weeks in which they had VRT sessions on different days. A single session lasted for fifteen minutes since participants should spend adequate time within the therapy without interfering with educational activities. The structure of each 15-minute session was divided into two parts: The preparation participants took the first five minutes to explain how to use the VR headset with the remaining 10 minutes in the actual VRT session. The VRT sessions adopted the 13-HTC Vive device (See Appendix-G), which has an HMD that provides visual immersion with the headphones for the auditory part. The participants could have a real experience during the experimental activity since they were in a virtual environment that targeted stress reduction. All the participants in the intervention group received the therapy using the VR headset device, and the whole intervention group was divided into three subgroups. Every day before the session, the PI read out the general goal and purpose of the VRT and guidelines for the appropriate handling of VR headset devices. The context for carrying out the VRT sessions was informed by enhancing the environment to

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include the computer skills lab where the participants were briefed and taken through a process of putting on the VR headset device and initiating the virtual experience as shown in Appendix G. The intervention itself was less than 10 minutes long and was delivered in a relaxing virtual context. The participants were exposed to a video through a VR headset connected to a mobile device. In this experience, they were gently guided along a calm river surrounded by trees and rocks. The setting in the video was enhanced with soothing sounds of flowing water and birds, providing a full sensory experience designed to calm their emotions.

Regarding the timing of the sessions for this intervention, Monday to Thursday during the break times was considered appropriate. This type of scheduling was intended to exclude students from being occupied with their conventional curriculum activities and common academic process interruptions. Holding the sessions during the break time made the intervention easy to organize as a break time activity hence the participants could give their best in their studies yet get the therapy they needed. The combination of advanced technology, immersive virtual environments, and a well-timed schedule contributed to the effectiveness of the VRT sessions in reducing stress among nursing students. The proposed ambient has been obtained from the following source. **(https://store.steampowered.com/app/938760/River_Relaxation_VR/)** (See Appendix R). The proposed intervention was adopted from a previous study and permission from the author has been taken for the use in my study (El-Qirem et al 2022).

Phase-III: Post-Interventional phase

Immediately after the end of the four planned VRT sessions, the participants were requested to fill in the same standardized psychological assessment measure, the PSS-10, used during the pre-test phase. This was done to evaluate the changes in perceived stress levels that are in direct response to the above-mentioned intervention. The PSS 10 Version was given immediately after the last session to determine if any immediate changes in the participants' stress had occurred due to the VRT sessions.

Further, it was deemed necessary to assess the changes that could be observed two weeks after completion of the intervention phase; thus, participants filled out the PSS-10 questionnaire. This measure was designed to ask if the diminished stress that was assessed after the intervention had eradicable effects or if the participants found themselves experiencing stress again. The given period was selected to conduct a thorough evaluation of the therapy effects on the stress level and its maintenance.

As for assessment, both the post-test taken right after the implementation of the intervention and the follow-up post-test taken two weeks after the implementation of the intervention were similarly administered to the pretest to ensure equivalence of conditions. A copy of the assessment tool was sent by E-mail and all efforts were made to ensure optimum privacy and secrecy of the participants. Thus, by comparing the results of the post-test and follow-up test with the pretest score, this study has been able to assess not only the immediate impact Virtual Reality Therapy has had on the stress perception of the participants, but also the repeated usage of Virtual Reality Therapy meaningfully contributed to reduce perceived stress of the participants. The design facilitated the assessment of whether the advantages of VRT extended beyond the treated time frame.

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3.12 Statistical Analysis Procedure

The filled questionnaires and checklists were collected, and the data was entered and analyzed through the Statistical Package for Social Sciences (SPSS) version-26. The normality of data was checked through the Shapiro-Wilk test. Descriptive statistics such as demographic variables were presented through frequency and percentages for categorical variables (such as gender, marital status, language, and socioeconomic level.), whereas Mean and Standard Deviation were used for continuous variables (height, weight.). For the effectiveness of Virtual Reality Therapy in reducing stress levels, the **Friedman Test** was applied to compare pre- and post-intervention stress level among undergraduate nursing students, as it is suitable for analyzing repeated measures on non-parametric data. Additionally, **Repeated Measures ANOVA** was used to examine the differences in stress levels across multiple times. For pairwise differences between time points, **Bonferroni Pairwise Comparison** was applied. Chi-square test was applied to check the association among demographic variables.

3.13 Ethical Considerations

Ethical considerations were of utmost importance in this study on reducing stress among undergraduate nursing students through VRT. Participants were required to give informed consent, and we took thorough measures to protect their confidentiality and privacy. To achieve this, data anonymization using participant IDs instead of names was conducted. The research team will minimize harm and ensure voluntary participation without adverse consequences for those who refuse to participate. The study received approval from the Departmental Research Committee (DRC), Ethical Review Committee (ERC), and Board of Advanced Studies and Research (BASR) the transparency and honesty were to guide all communications with participants. Beneficence was prioritized, aiming to benefit participants without causing harm, and the research findings were disseminated to relevant stakeholders responsibly and respectfully.

RESULTS

This section summarizes the frequency distribution of demographic variables among participants, with data following a normal distribution. The mean represents the average stress score. It also discusses the effectiveness of Virtual Reality (VR) therapy in reducing stress among undergraduate nursing students during pre-intervention, post-intervention, and follow-up phases. The study examines the relationship between demographic variables and stress scores at a 0.05 significance level. The study explores the distribution of demographic variables to contextualize the sample. It compares pre-post and follow-up-intervention of stress levels to evaluate the effectiveness of VR therapy, with Figure 1 visualizing these changes in n=34 students. Moreover, the study investigates whether factors like age and gender influence stress level changes.

4.1 Distribution of Demographic Variables

Table 4.1 shows a total of 34 participants who participated in the study. Among these 30 (88.2%) belonged to the 25-30 years age group and 4 (11.8%) belonged to the 31-35 years age group. Most of them 21(61.8%) were female and 13 (38.2%) were male. The students who were studying in the first year were 23 (67.6%) while second-year students were 11(32.4%). In terms of professional experience most

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of them 25(73.5%) had 1-5 years, 8 (23.5%) had 6-10 years and only 1(2.9%) had 11-15 years of professional experience. Half of them 17 (50%) were single and the rest of them 17 (50%) were married. Most of the subjects 30 (88.2%) were living with their families and only 4 (11.8%) subjects were living alone. Among all participants most of them 25 (73.5%) were Full-time students, full-time employed, some of them 8 (23.6%) were Full-time students while only 1 (2.9%) was full-time student, part-time employed.

4.1 Distribution of Demographic Variables

n=34	Frequency (%)
Age	
25-30	30(88.2)
31-35	4(11.8)
Gender	
Female	21(61.8)
Male	13(38.2)
Year of Study	
First Year	23(67.6)
Second Year	11(32.4)
Professional Experience	
1-5 Years	25(73.5)
6-10 years	8(23.5)
11-15 years	1(2.9)
Marital Status	
Married	17(50)
Single	17(50)
Living Situation	
Alone	4(11.8)
With Family	30(88.2)
Employment Status	
Full-time student	8(23.6)
Part-time employed	1(2.9)
Full-time student, full-time employed	25(73.5)

4.2 Effectiveness of virtual reality therapy on stress among undergraduate nursing students

Table 4.2 shows the effectiveness of virtual reality therapy on stress among undergraduate nursing students. It has been observed that in pre-phase the score was 20.44±4.36 which decreases to 10.35±3.63 after intervention and becomes 10.41±1.76 in up phase (p-value 0.001)

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Table 4.2 Effectiveness of virtual reality therapy on stress among undergraduate nursing students

Stress Score	Mean±Std	p-value
Pre	20.44±4.36	
Post	10.35±3.63	<0.001
Follow-up	10.41±1.76	

Repeated measure ANOVA was applied. P-value <0.05 is considered significant.

4.3 Effectiveness of intervention on stress levels

Table 4.3 shows the effectiveness of intervention in stress levels. It has been noted that in pre-phase 31 (91.2%) were experiencing moderate stress which drastically decreased to 1(2.9%) in post-phase and became 0(0%) in the follow-up phase (p-value <0.001)

Table 4.3 Effect of intervention on stress levels

Stress Level	Frequency (%)			p-value
	Mild Stress	Moderate Stress	High Stress	
Pre	0(0)	31(91.2)	3(8.8)	
Post	33(97.1)	1(2.9)	0(0)	<0.001
Follow-up	34(100)	0(0)	0(0)	

Friedman test had been applied
p-value<0.05 considered significant

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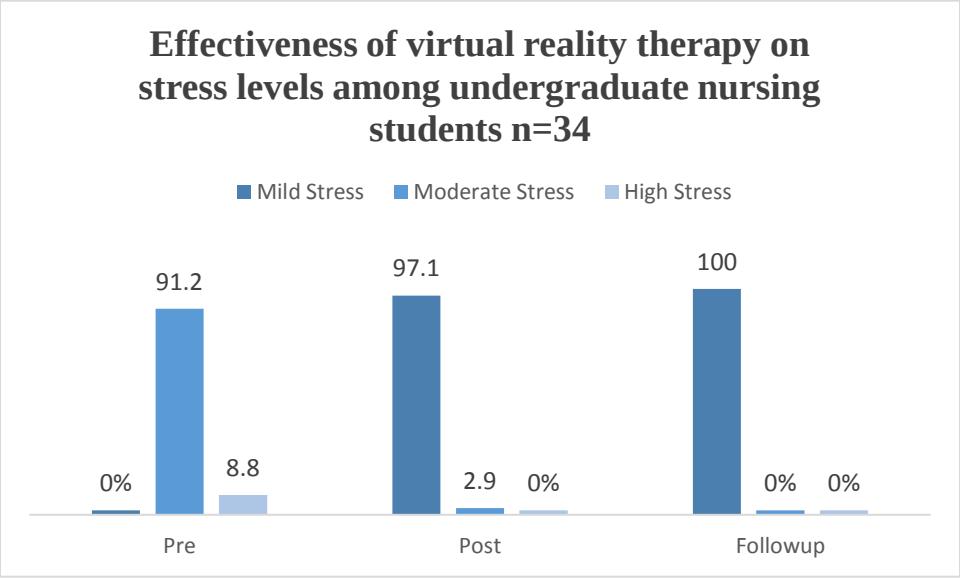
Fig 4.1 Effectiveness of virtual reality therapy on stress levels among undergraduate nursing students n=34



4.4 Pair-Wise comparison of stress score

Table 4.4 shows a pairwise comparison of stress scores. It has been observed that there was a significant difference found in scores of pre with post 10.08±0.903 (p-value <0.001). It was also observed that there was a significant difference found in scores of pre-with follow-up 10.02±0.749 (p-value <0.001). On the contrary, there was no difference found in scores of posts with a follow-up phase.

4.4 Pair-wise comparison of stress score after Intervention

Stress Score	Mean Diff ± St Error	p-value
Pre-Post	10.08±0.903	<0.001
Pre-Follow-up	10.02±0.749	<0.001
Post-Follow-up	0.59±0.58	0.999

Bonferroni pair-wise comparison test was applied
p-value<0.05 considered significant

4.5 Association of demographic variables concerning stress level after intervention

The table shows the association of demographic variables concerning stress levels after intervention. It was observed that there was a significant association between professional experience and employment status with stress level. Subjects who had 1-5 years of experience, and 6-10 years of experience of them had mild stress levels while subjects who had 11-15 years of experience all of them 1(100%) had moderate stress levels (p-value <0.001). Of subjects who were full-time students all of them 8(100%) had mild stress and for those who were full-time students, part-time employed all of them 1(100%) had

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moderate stress while subjects who were Full-time students, Full-time employed, all of them 25 (100%) had mild stress (p-value <0.001). On the other hand, there was no significant association found in age, gender, year of study, marital status and living situation with stress levels

Table 4.5 Association of demographic variables concerning stress level after intervention

n=34	Frequency (%) Mild Stress	Moderate Stress	p-value
Age			
25-30	29 (96.7)	1(3.3)	0.882
31-35	4(100)	0(0)	
Gender			
Male	12(92.3)	1(7.7)	0.382
Female	21(100)	0(0)	
Year of Study			
First Year	22(95.7)	1(4.3)	0.999
Second Year	11(100)	0(0)	
Professional Experience			
1-5 Years	25(100)	0(0)	
6-10 Years	8(100)	0(0)	<0.001
11-15 Years	0(0)	1(100)	
Marital Status			
Single	17(100)	0(0)	0.999
Married	16(94.1)	1(5.9)	
Living Situation			
Alone	4(100)	0(0)	0.999
With Family	29(96.7)	1(3.3)	
Employment Status			
Full-time student	8(100)	0(0)	
Full-time student, Part-time employed	0(0)	1(100)	<0.001
Full-time student, full-time employed	25(100)	0(0)	

The chi-square test of the association had been applied P-value<0.05 considered significant.

DISCUSSIONS

This section is focused on discussing the effectiveness of Virtual Reality therapy in coping with stress levels among undergraduate nursing students. Additionally, it evaluated the changes in stress levels across the pre-intervention, post-intervention, and follow-up phases. This study's findings shed some light on the demographic characteristics; gender, age, marital status, living situation, year of study, professional experience, and employment status. In addition, intervention categories seem to contribute

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to or influence the stress reduction results of VR therapy and how these results align or contradict the literature in this field. It illustrates the potential of VR therapy in managing stress while discussing previous studies that provide further perspective on its potential effects and range of usage.

5.1 Discussion of Stress levels on demographic variables

In the current study factors such as gender, age, marital status, living situation and year of the study did not find a significant effect on stress levels after the intervention in this study. While the findings of the present study highlighted that professional experience and employment status were widely related to stress in the post-phase. These findings contrast with other studies that indicated demographic variables, especially professional experience and employment status, played a significant role in reducing stress levels.

The findings of the current study revealed that gender did not play a significant role in the effectiveness of virtual reality therapy for stress reduction among undergraduate nursing students. This contrasts with other studies, such as a cross-sectional study conducted by Johnson et al. in 2018 with 120 nursing students in the United States, which reported that females experienced significantly lower stress levels post-intervention compared to males. Similarly, a longitudinal study by Sharma and Verma in 2019 involving 150 undergraduate nursing students in India indicated that female students demonstrated greater receptiveness to stress-reduction interventions. However, similar findings were also reported in a randomized controlled trial by Smith and Wong in 2021 with 80 nursing students in Australia, which found no significant gender differences in stress levels. A quasi-experimental study by Patel et al. in 2020, involving 60 participants in the United Kingdom, suggested that male students experienced more significant reductions in stress levels, while an observational study by Carter and Adams in 2017 with 95 nursing students in Canada concluded that stress reduction was not influenced by gender. The lack of gender-related differences observed in the current study may be due to the nature of the virtual reality intervention used, which could have been equally effective for both male and female students. It is also possible that other factors, such as individual stress levels, coping strategies, or familiarity with technology, played a more significant role in the effectiveness of the therapy. Contradictions in previous studies could arise due to differences in cultural contexts, sample sizes, or the specific interventions used for stress management.

The research study assessed Virtual Reality Therapy (VRT) effectiveness in lowering undergraduate nursing student stress by investigating the effect of demographic variables including gender and age alongside marital status and residency and educational year factors and professional experience and employment conditions on intervention outcomes. The analysis revealed that gender together with age and marital status and living situation and year of study did not make a significant difference in stress levels yet stress levels significantly increased according to professional experience and employment status after the intervention. The research findings expand the knowledge about population characteristics which affect or do not affect stress reduction through VRT and will serve as a foundation for additional research in this area.

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In contrast to some earlier findings the present research discovered gender made no noteworthy difference to the effectiveness of VRT as a stress reduction method. A research study by Zheng et al., (2022) with 120 nursing students in America uncovered that females experienced statistically larger stress reduction after completing the intervention program than boys. According to McGarry et al., (2023) female nursing students demonstrated better acceptance rates for stress reduction interventions compared to their male counterpart population of 150 undergraduate students based in India.

Various research studies yield different findings on this subject. Modrego-Alarcón et al., (2021) implemented a randomized controlled trial involving 80 nursing students from Australia to study intervention response without detecting any substantial stress variation between genders. The research by Nijland et al., (2021) showed that male nursing students from the UK experienced greater reduction in stress after the intervention thus indicating that stress response differences can depend on specific settings.

The design of an immersive calming virtual reality intervention makes it equally effective for both male and female participants which may explain why researchers found no significant gender difference in this study. The study indicates that personal variations among participants in their stress tolerance capabilities and technology experience might have influenced stress management results more than their gender designation. Culture-based variations together with Pakistani socio-cultural elements affecting gender-specific stress patterns may be responsible for the diverse findings between research studies. The study included both male and female participants in the same VRT environment to reduce any bias created by gender differences which proved that technological stress management interventions have potential universal benefits.

The relationship between stress reduction after the intervention was strongly determined by both work experience and employment status rather than gender. Stress levels among students decreased after receiving VRT because those with longer professional careers together with full-time workers demonstrated better results. Previous research reflects the present finding that people with workplace experience tend to build effective coping strategies for academic stressors. Piskorz and Czub, (2018) established that healthcare workers together with nursing students who possess job experience show better stress management skills compared to their inexperienced counterparts. Work situations encourage individuals to develop coping mechanisms that result in better resilience capabilities over time.

The experiment showed employment status as a factor for stress reduction because students who worked experienced larger perceived stress decreases after taking part in VRT. Those students who work experience increased competence in managing their stress since their employment environments offer structured learning opportunities for these abilities. Employed participants together with those with professional experience showed decreased stress after VRT yet the intervention stayed as a main contributor to stress management.

This research showed that professional experience and employment status affected stress reduction while age together with marital status and living situation did not influence the results. The literature

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shows inconsistent evidence about these studied variables. The research by Zheng et al., (2022) showed that students who are older and handle academic along with personal and professional responsibilities tend to experience more stress. This study discovers no statistical connection between the sample demographics which influence the outcomes of the intervention program. The combination of academic workload and educational stress seems to affect nursing student stress more than student-specific family or personal conditions. The fundamental character of stressors seems to surpass individual characteristics when understanding how VRT therapy affects individuals' levels of distress.

This research produces findings which show major conflicts exist in scholarly works about how demographic features contribute to stress reduction through VRT interventions. Effects of stress management interventions prove significantly different between research groups depending on gender, age or professional experience but current findings stand alongside this study without observing similar variations. The differences might stem from various cultural setups because different locations display unique stress factors and ways to handle them. Societal expectations for nursing students in Pakistan differ from those in Eastern countries as well as Western ones which results in unique stress reactions and management styles.

The conflicting results in this study could be explained by both sample size variations and methodological differences among the diverse research methods. Studies that use bigger sample populations and extended monitoring would probably reveal a broader spectrum of stress reduction effects while small-scale studies mainly show pronounced demographic patterns.

Moreover, the finding of the current study reported no significant differences were found among age groups, likely due to the limited age range of the participants. The participants of the current study were aged between 25-35 years, with the majority (88.2%) belonging to the 25-30 age group. The findings suggest no significant differences were found in stress reduction across these age groups. The result of the current study aligns with previous studies including a cross-sectional study conducted by Camara and Hicks in 2020 in Australia involving 200 university students aged 18-30 years. This study found that VR was effective in reducing stress across all age groups, with no significant differences observed between younger and older participants. This consistency further supports the conclusion that age may not be a determining factor in stress reduction within these age ranges. Similarly, Nijland et al. 2021, conducted a study in the Netherlands, that included 56 intensive care unit nurses and reported that VR interventions reduced stress regardless of age, providing further support for the current results. Additionally, Kim. 2021 conducted an open randomized trial in South Korea with 120 participants aged 20-35 years and observed consistent stress reductions using VR, mirroring the outcomes of this study. However, Modrego-Alarcón et al. 2021 conducted a study with 280 university students in Spain and found a contradictory finding highlighted those younger participants benefited more from VR interventions, suggesting age-related differences in stress reduction. The limited age range in the current study might have neutralized potential age-related differences. Expanding the age range in future studies could provide more nuanced insights into how VR impacts stress across different age groups.

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In terms of marital status, half of the participants in the current study were married (50%) and the other half were single (50%). No significant differences in stress levels were found based on marital status, it could be possible due to the balanced distribution of marital status among participants. While married students may have had family support their academic pressures were similar to those faced by single students which could have neutralized any notable differences in stress levels following the VR intervention. However, a similar finding was reported in a cross-sectional descriptive correlational study conducted by Sokratous et al. 2023 in Cyprus studied 150 postgraduate nursing students and found that marital status had no significant effect on stress levels. This suggests that being married or unmarried did not have a substantial effect on the stress experienced by these students. Contrastingly, a cross-sectional survey conducted by Alvarez et al. 2019 in the United States found that married nursing students reported higher baseline stress levels and less reduction post-intervention. The balanced marital status distribution in this study likely minimized its effect on stress outcomes. Cultural and familial dynamics could explain the variations reported in other studies.

Regarding living situations, the majority of participants (88.2%) lived with their families, while a minority (11.8%) lived alone in the current study. No significant differences in stress levels were found based on living situation, which contrasts with a descriptive study conducted by Singh and Chaturvedi. 2019 in India found that students living alone experienced higher stress compared to those living with their families. The study indicated that the lack of a supportive family environment along with the challenges of independence and adjustment, led to increased stress levels among students living away from home. Similarly, a cross-sectional survey conducted by Noreen et al. 2023 in Pakistan reported significantly higher stress levels in students living away from family, emphasizing the importance of familial support. This Contradiction from the literature may suggest that the findings of the current study were not influenced by living conditions, possibly due to the small number of participants living alone, which could have neutralized the potential effect of living situation. The findings of this study indicate that a supportive family environment may help reduce stress, while cultural and socioeconomic factors may account for the discrepancies in other studies.

Moreover, the current study found that the year of study, whether first-year or second-year, did not significantly affect stress levels following the intervention. It was clear that the academic year had little to no effect on stress reduction outcomes. This implies that the VR intervention was effective for both first-year and second-year students alike. In a similar vein, a study conducted by Modrego-Alarcon et al. 2021 among university students engaged in mindfulness-based interventions, some with VR support and some without VR support, to alleviate stress, aligns closely with the results of the current study in terms of stress reduction outcomes. While the study did not focus on the year of study as a variable, it involved students from various academic years. It showed that both mindfulness programs successfully reduced stress, independent of the student's year of study. This supports the current study's results that the year of the study did not significantly correlate with stress levels after the intervention. Moreover, the results of Camara and Hicks et al. 2020 are in contrast with the findings of the current study. They found that VR therapy effectively alleviated stress among students at various academic levels. However,

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they observed that first-year students typically experienced higher baseline stress levels than their seniors.

Regarding professional experience, the current study found a significant association between professional experience and stress levels following the intervention. Participants predominantly had 1-5 years of professional experience (73.5%), with smaller proportions having 6-10 years (23.5%) and a few with 11-15 years (2.9%). The findings revealed that individuals with 1-5 years and 6-10 years of experience reported no moderate stress. Interestingly, a few participants with 11-15 years of experience did report moderate stress, indicating that professional experience could play a significant role in stress levels after the intervention. It appears that those with less experience (1-10 years) gained more relaxation from the intervention, showing a significant stress reduction, while those with more experience (11-15 years). However, a similar result was found in a study conducted in the Netherlands by Nijland in 2021 aimed to assist Intensive Care Unit (ICU) nurses in managing stress during the Corona Virus Disease-19 (COVID-19) pandemic through the use of VR relaxation techniques. The study observed that nurses with varying levels of professional experience responded positively to VR relaxation, though the level of stress reduction varied slightly depending on their years of experience. The findings indicate that professional experience affects stress levels, with individuals who have less experience seeing more advantages from VR intervention. Furthermore, the findings of the current study can be compared to those of Kim's 2021 research, which was an open randomized control trial aimed at evaluating the effectiveness of VR in alleviating stress. The results of Kim's 2021 contrast with the findings of the current study findings. Kim investigated how VR affects stress levels. The results from Kim et al. 2021 indicated that VR interventions successfully reduced stress for all participants, irrespective of their professional backgrounds or experiences.

Lastly, in addition to employment status, the current study found a significant association between employment status and stress levels following the intervention. Most of the participants in the current study were full-time students and full-time employees (73.5%), while others were full-time students only (23.6%) and some were full-time students and part-time employees (2.9%). According to the current study participants who were full-time students and full-time employed had mild stress levels in the post-intervention phase while full-time students and part-time employees had moderate stress levels after VRT. This difference in stress levels could attributed to the varying time pressures and responsibilities faced by the participants. Full-time students with part-time jobs often struggle to balance academic work and job duties, leading to greater stress and fewer opportunities for relaxation. On the other hand, full-time students who also work full-time may have a more predictable and structured schedule, helping them manage their stress more effectively. The result of the current study aligns with Arora and Mahapatra 2022 conducted a study in India that found VR interventions effective in reducing stress among employees regardless of their employment status. Similarly, McGarry et al. 2023 also highlighted that nursing students with part-time jobs may have faced similar challenges. It is also important since work-related stress added to it could have made them prone to stress making them more responsive to the VR intervention. In contrast to the findings of the current study, Modrego-Alarcon et al. 2021 did not

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establish a correlation between employment status and experience in stress reduction. This difference may arise from the different types of interventions—VR and mindfulness—which may work differently depending on the individual's stressors. The VR intervention in the current study may have been more effective for participants with high levels of work-related stress.

5.2 Stress scores in pre-, post, and follow-up phases

The current study findings show a notable decrease in stress scores, with the average stress score dropping from 20.44 ± 4.36 before the intervention to 10.35 ± 3.63 after the intervention, and 10.41 ± 1.76 during the follow-up phase ($p < 0.001$). These findings of the current study align with the study of McGarry et al. 2023, who highlighted the effectiveness of VR therapy in alleviating stress among young adults. Similarly, Modrego-Alarcon et al. 2021 explored the effectiveness of a mindfulness-based program, both with and without VR support among university students. They highlighted that mindfulness interventions enhanced by VR led to greater stress reduction compared to traditional approaches. The findings of Modrego-Alarcon et al. 2021 are also similar to the findings of the current study. Furthermore, Camara and Hicks et al. 2020 carried out an experiment utilizing VR to alleviate state anxiety and stress in university students. They discovered that VR effectively reduced both stress and anxiety levels. The findings of their study are consistent with the results of the current research. Similarly, El-Qirem et al. 2023 investigated the impact of VR therapy on stress, anxiety, and physiological measures among university students in Jordan. Their research also revealed significant decreases in stress and anxiety symptoms following the VR intervention, echoing the findings of the current study.

Statistical significance helped researchers establish if the recorded stress level reductions through Virtual Reality Therapy (VRT) properly belonged to the intervention effect or resulted from simple chance. Several statistical tests were used in this research analysis. The researcher employed Repeated Measures ANOVA to analyse data collection points which included pre-intervention and post-intervention stages alongside follow-up stages. The VRT intervention successfully reduced stress levels since stress levels differed significantly between intervention time points according to a p-value below 0.05. The Friedman Test confirmed the effectiveness of VRT in stress reduction through its non-parametric assessment which produced a p-value less than 0.001 during the post-intervention phase. The Bonferroni Pairwise Comparison test helped identify the selected time points where differences became substantial. Students showed significant decreases in stress through the measurements taken at pre-intervention and post-intervention along with pre-intervention and follow-up. However, no significant difference was detected when comparing post-intervention to follow-up which indicated stress remained low. These statistical results demonstrated significant changes because the p-values remained below 0.05 in all comparisons of stress levels. The results supported that the VRT intervention successfully diminished participant stress because p-value outcomes remained below 0.05 for all conducted tests. The collected data confirms VRT stands as an effective practice to decrease stress among undergraduate nursing students.

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5.3 Stress levels in pre-, post, and follow-up phases

The shift from moderate stress in 91.2% of participants before the intervention to mild stress in 97.1% after the intervention, and 100% in the follow-up phase, highlights the significant impact of VR therapy. These results relate to Nijland et al. 2021, who assessed VR relaxation techniques for intensive care nurses during the COVID-19 pandemic. The study found a significant drop in perceived stress levels after VR sessions. Similarly, Piskorz and Czub. 2018 supported these findings, demonstrating VR's effectiveness in reducing stress and pain in paediatric patients during venepuncture procedures, although their focus was on young patients rather than on nurses or university students.

The reductions in stress scores observed between the pre-and post-intervention phases reflect the findings from the studies. Both McGarry et al. 2023 and Modrego-Alarcon et al. 2021 reported significant stress reduction following VR interventions. However, some differences emerge in the scope and nature of stress reduction. Because McGarry et al. 2023 emphasized stress relief in the young population, and Nijland et al. 2021 focused on healthcare professionals, the present study targets undergraduate nursing students.

5.4 Conclusion

This study adds to the growing body of evidence that VR can effectively reduce stress among undergraduate nursing students. The findings highlight the importance of professional experience and employment status in influencing how individuals perceive and cope with stress. The absence of significant effects from factors like age, gender, year of study, marital status, and living situation indicates that VR's effectiveness in reducing stress may be relevant across various demographic groups. The noted reductions in stress from pre-phase to post-phase and follow-up phase are consistent with existing studies, reinforcing the potential of VR as a valuable intervention for stress management. Further investigation into the combination of VR and mindfulness practices could provide additional advantages, especially for groups experiencing higher levels of stress.

4.5 Strengths

The strengths of this study are evident in its thorough design and detailed analysis of how VR therapy can help reduce stress in undergraduate nursing students. Firstly, the study focuses on a well-defined group of 34 participants, which makes its findings particularly relevant to nursing students. The research design included several phases that are pre, post and follow-up allowing for a comprehensive look at the long-term effects of VR therapy on stress levels.

The statistical techniques employed, such as repeated measures ANOVA and the Friedman test, confirm that the results are statistically significant, with a p-value of less than 0.001 indicating a strong intervention effect. Moreover, the study examines how different demographic factors affect stress reduction, providing a deeper understanding of how elements like professional experience and employment status can shape outcomes.

By demonstrating the effectiveness of VR therapy across various stress levels, the research positions VR as a valuable tool for managing stress. Additionally, the inclusion of pairwise comparisons of stress scores enhances the study by clearly illustrating the differences between the pre-intervention and post-

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intervention phases, as well as between the follow-up and post-intervention phases. In summary, the study offers compelling evidence for the potential of VR therapy to alleviate stress among nursing students, adding important insights to the fields of stress management and VR interventions.

5.6 Limitations

While this study offers important insights into how effective VR therapy can be effective in reducing stress among undergraduate nursing students, there are several limitations to keep in mind. Firstly, the sample size of 34 participants is quite small, which may restrict how well the findings can be applied to a larger and more diverse population. A larger sample could yield more reliable data and possibly uncover additional factors that contribute to stress reduction.

Moreover, the study is limited to nursing students, which may not accurately reflect the stress experiences or responses of students in other fields. This narrows the applicability of the results to other academic areas. Another limitation is the absence of a control group, making it challenging to conclusively link the changes in stress levels solely to the VR intervention. Without a comparison group, we cannot dismiss the influence of other external factors on the results. Lastly, the study does not investigate the long-term effects of VR therapy beyond the follow-up period, raising questions about how sustainable the stress reduction might be over time.

5.7 Recommendations

Based on the findings and limitations of this study, several recommendations can be made for future research and practice. First, it would be beneficial for future studies to include larger and more diverse samples to enhance the generalizability of the results. This approach would help determine whether VR therapy is effective across various fields and among students from different cultural, demographic, and educational backgrounds.

Second, the inclusion of a control group would enhance the validity of the findings by enabling comparisons between participants who receive the VR intervention and those who do not. This would help clarify the specific effects of VR therapy on stress reduction, ensuring that any observed changes are genuinely attributable to the intervention. Future research should also investigate the long-term effects of VR therapy beyond the follow-up phase, examining whether the stress-reducing benefits persist over time. Additionally, it would be worthwhile to assess the impact of combining VR therapy with other stress-reducing techniques, such as mindfulness or physical activity, to see if a more integrated approach produces better outcomes. Lastly, it is advisable to use objective measures of stress, such as physiological indicators in conjunction with self-reported data to provide a more precise assessment of stress levels.

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