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RESEARCH **Open Access**

Revolutionizing Nursing Higher Education: Virtual Reality-Based Elderly Care Service Practice Simulation: A Systematic Review

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Abstract
Nursing services in the elderly population play an important role in modern nursing practice, especially with the growth in the number of elderly. The presence of competent and trained nurses is crucial to providing effective care to this demographic. One potential method to improve nursing students' understanding and skills in aged care is the utilization of Virtual Reality (VR) technology to simulate aged services. This study aims to identify the virtual reality-based elderly nursing service simulation revolution through a systematic review. Systematic Literature Review is conducted by searching the data sources ScienceDirect, Pubmed, CINAHL, and Google Scholar. Inclusion and exclusion criteria based on the PICO approach, are used to select suitable articles, with a range of publication years from 2018 to 2022. Of the 2241 articles identified at the start of the study, 46 relevant articles were selected after narrowing through a review of titles and abstracts. Of these, 24 articles were selected for further analysis according to the research theme. The results showed that the use of VR technology significantly increased the competence of nursing students, and increased clinical skills, confidence, and understanding of human physiological anatomy. VR simulations have proven effective in providing services to elderly patients, including teaching elderly oral hygiene, training in the prevention of dizziness and falls, practicing ADL, and teaching relaxation techniques to reduce pain and symptoms of depression. The new opportunities in nursing higher education innovation, VR technology provides an immersive experience for students in caring for an aging population that is growing, along with technological developments.

Keywords: Virtual Reality, Nursing Education, Elderly Patients.

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1. INTRODUCTION

Nursing services to elderly patients are not only an important aspect of modern nursing practice but have also become increasingly urgent along with the phenomenon of population aging that has swept the global community. An elderly person is someone who has entered the age of 60 years and over (Prahlad & Chikka, 2017). The rapid growth in the number of elderly people is driven by increased life expectancy and changes in demographic structure. The number and proportion of people aged 60 years and over in the population continues to increase, with projections reaching 1.4 billion by 2030, and 2.1 billion by 2050 (Department of Economic and Social Affairs, United Nations, 2019). This has significant consequences, nurses not only become competent but also trained in caring for elderly patients who have increasingly complex needs. Nursing students, as prospective nurses, must have good competence in caring for the elderly. Facing the era of advanced technology like today, the emergence of Virtual Reality (VR) technology as an innovative tool shows great potential to change the paradigm of nursing education, especially in responding to the needs of elderly patients (Fukada, 2018).

The advancement of VR technology, particularly in today's world of education, offers exciting opportunities. As a new simulation tool, VR can significantly improve students' understanding of learning materials, allowing them to interact directly with situations relevant to elderly nursing (Hsieh et al., 2023). This not only facilitates theoretical understanding of concepts but also provides practical and interactive experiences with elderly patients in a virtual environment. However, students often find it difficult to get a patient simulation experience that fits their curriculum, especially in replicating the patient's body's response to treatment or changes in the patient's condition before and after treatment, which is difficult to achieve in conventional learning (Saab, et al., 2021).

The use of VR technology has proven effective in increasing students' understanding and skills when compared to conventional learning methods because VR-based learning is more interactive. Previous studies have shown that college students who learn through VR are able to retain 75% of the information they obtain, compared to conventional learning methods that only have a retention rate of only 5-10% (Lange et al., 2020; Mian et al., 2020) The advantage of VR technology lies not only in its flexibility in creating a learning environment that suits learning objectives but also in being a pandemic-friendly solution. Students can practice with virtual patients in various conditions including elderly patients with various health conditions (Hakim, 2020) This allows them to understand and respond to diverse situations they may encounter in real nursing practice. In addition, VR technology has also proven to be a pandemic-friendly solution. The COVID-19 pandemic has presented major challenges to nursing education due to physical distancing and strict health protocols. With VR technology, students can continue to practice and learn without having to be physically present in a health facility. This provides continuity in nursing education during emergencies such as pandemics (Kementerian Kesehatan Republik Indonesia, 2020).

In an effort to revolutionize nursing higher education, we conducted a systematic review to explore the use of VR technology in simulating aged nursing services. This approach not only opens up new insights in understanding, and skills but also puts patient safety at the forefront. By mapping the development of VR technology in nursing education in elderly patients. This study aims to identify the virtual reality-based elderly nursing service simulation revolution.

2. RESEARCH METHOD

This study utilized a Systematic Literature Review approach to explore the use of Virtual Reality (VR technology in nursing education, elderly care simulations, and elderly care. A comprehensive search was conducted by searching for Pubmed, ScienceDirect, CINAHL, and Google Scholar using keywords such as "nursing education" OR "nursing student" AND "virtual reality in education" OR "simulation nursing care" AND "elderly nursing care". In the

early stages, article searches were carried out based on the notation "AND/OR" to expand the search. The review covered articles published between 2018 and 2022, including qualitative, quantitative , and mixed-method studies. Eligibility was determined using the PICO framework, the population is nursing education, intervention is VR in education or simulation nursing home care, and outcome is VR homecare simulation model for elderly nursing care, with no comparison element. Articles were filtered from an initial 2,241 to 182 based on title and abstracts, and ultimately 24 original research articles were selected for analysis.

Data extraction followed a standardized process to gather essential details from the studies, such as study design, population, intervention, outcomes, and conclutions. A risk of bias assessment was also performed to ensure the quality of evidence. The study selection process was illustrated a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram to provide a clear overview of the systematic approach taken.

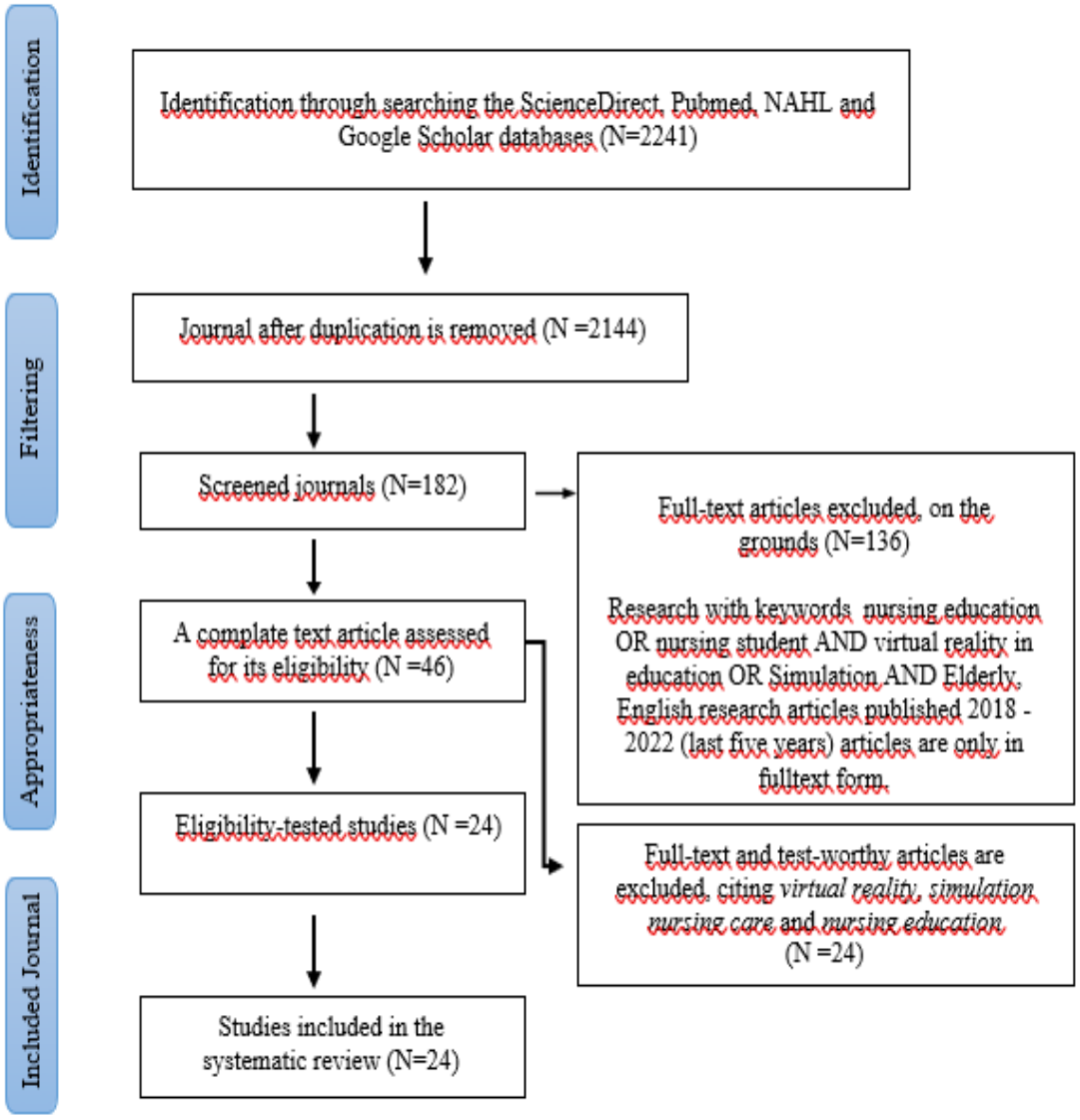

Figure 1. Diagram PRISMA

3. RESULTS AND DISCUSSION

The results of the review of 24 articles have provided strong evidence that the use of Virtual Reality (VR) technology has revolutionized nursing higher education and nursing service practices described below.

Table 1. VR-based nursing services simulation in nursing higher education

Author and Year	Objective	Method	Results
(Saab, et al., 2021)	Improvement of clinical skills of nursing students	A descriptive quantitative study, conducted at the State University of Ireland with a research design using thematic analysis. The respondents consisted of 26 nursing students, and the data were analyzed inductively.	VR simulations are conducted to train various nursing skills, deepen the understanding of human physiological anatomy, as well as improve problem-solving abilities, and clinical decision-making.
(Rodríguez-Abad et al., 2022)	Wound care practices in patients suffering from foot ulcers with Augmented Reality (AR).	The quasi-experimental study, conducted at the School of Nursing of the University of Santiago de Compostela, Spain, involved 137 students divided into a control group (65 students, non-AR teaching) and an experimental group (72 students, AR-based teaching). Knowledge and skills about foot ulcer treatment were measured through a pre-post test and two validated questionnaires were used to evaluate the effect of AR on the experimental group.	The use of AR in simulating wound care practices in foot ulcers provides improved performance, while encouraging nurses' positive attitudes in patient care.
(Kim et al., 2021)	Simulated clinical practice of nursing students with patient-centered care.	A descriptive qualitative study, conducted with 20 nursing students of a 4-year undergraduate program. The 6 focus groups used Zoom video interviews, with 3 to 4 participants per group, to understand their experiences. The data was analyzed using inductive content analysis.	The use of Virtual Reality (VR) technology in simulated clinical practice increases the confidence and competence of nursing students in providing patient-centered care.
(Berg & Steinsbekk, 2020)	Independent practice of nursing students using virtual reality (VR) applications.	A randomized controlled trial of a non-inferior parallel group, followed by 146 students in the VR group and 143 students in the TP group. All students practiced measuring blood pressure, ear thermometers and oximeters with 20 minutes each for both	Individual self-practice using VR increased nurse competence by 24.8% compared to traditional methods.

		the VR group and the TP group.	
(Rossler et al., 2019)	Simulated fire safety in the operating room (OR).	The design of the pre-post test experiment involved 20 nursing students who were randomized into a control group and intervention to assess knowledge and skills about fire safety in the operating room (OR).	VR simulations are used to train students in fire safety aspects in the operating room (OR).
(Üzen Cura et al., 2020)	Simulation of modalities to improve nursing skills.	Simulation experiment 3 modalities. Students were divided into 3 groups to implement the "Respiratory Sound Assessment" scenario using standard patients, high-fidelity simulations, and partial task trainers.	VR-based practice simulations give nursing students the opportunity to upskill on standard patients.
(Liaw et al., 2020)	Practice interprofessional communication skills in a virtual environment.	A randomized controlled trial was conducted with 120 college students to evaluate team training using virtual reality and live simulations. Interprofessional attitudes and performance surveys were conducted before, immediately after, and 2 months after the intervention.	Interprofessional communication training through VR provides results comparable to other methods, demonstrating better scalability.
(Liaw et al., 2019)	Improvement of interprofessional competence.	A randomized controlled trial was conducted with 40 care teams that carried out 3 learning activities, namely web-based instruction, virtual reality (VR), and simulation exercises. Random assignment into 3 learning sequences and evaluation of results was carried out with Pre-test and post-test.	Simulated interprofessional nursing practice increases student satisfaction in the learning environment.
(Choi & Schmutz, 2020)	Practice the skill of bandaging wounds.	Evaluation of the usability of the system, carried out to evaluate the use of 2D mice and 3D haptic devices as interfaces in a Virtual environment.	VR-based simulations in practice of bandaging wounds help enhance engaging learning experiences.
(Matthews et al., 2020)	Emergency practice.	A Virtual Reality application usability study, assessing the usability of VR training applications for emergency	Simulating emergency practices using VR increases student confidence, reduces the risk of errors, and

		medicine on commercially available VR hardware.	improves patient safety.
(Permana et al., 2019)	Nursing care practice in patients with acute respiratory disorders.	Development of VR simulation, developing storyboards for VR simulation as a method of practicing nursing care skills in cases of acute respiratory infections.	The development of VR simulation in acute respiratory care nursing is a safe solution to train students without the risk of disease transmission.
(Al Khasawneh et al., 2021)	Anatomical practice of physiology.	Evaluation of simulation efficacy, using the NLN/Jeffries Nursing Education Simulation Framework to assess the satisfaction and confidence of S1 Nursing students in educational simulations.	The development of VR-based physiological anatomy simulations is the basis for understanding nursing care delivery.

Table 1. shows that the application of VR and AR technology in nursing education includes a wide range of clinical practices and upskilling. The technology is used to train clinical skills, wound care, self-practice, fire safety, interprofessional communication, and emergency care. Studies show that VR and AR can improve nursing students' competence, confidence, and knowledge, as well as provide a safe and immersive learning environment. In addition, VR-based simulations also help understand physiological anatomy and train the care of patients with acute respiratory disorders.

Nursing education curricula around the world, are basically focused on developing clinical skills. When students enter the clinical environment early in learning, their hope is to be able to implement safe and timely evidence-based interventions, while keeping patients and students safe. The use of Virtual Reality (VR) technology not only makes learning more interesting, but also more fun, memorable, and inclusive for students. More importantly, VR allows college students to practice and develop their skills safely, with no risk to real patients. This indirectly builds their confidence and provides a supportive environment for nursing students (Saab, et al., 2021).

Chronic wounds are a serious public health problem worldwide, with providing optimal care to patients suffering from foot ulcers a top priority in nursing practice. Therefore, nursing students need to acquire the competencies necessary to provide evidence-based care. Augmented Reality (AR) technology is the latest innovation in health science education that can help nursing students achieve these skills (Rodríguez-Abad et al., 2022). Concrete examples of how VR is used in nursing education, such as wound care training, patient-focused nursing, and operating room safety simulations can provide a clear picture of its implementation. The use of Virtual Reality (VR) technology has been shown to increase the confidence and competence of nursing students in providing patient-centered care (Kim et al., 2021). Independent practice by nursing students using virtual reality (VR) applications has also been shown to increase nurse competence by 24.8% compared to traditional methods (Berg & Steinsbekk, 2020). In addition, nursing students interested in entering the operating room need to have fire safety knowledge and skills. VR simulations have been used to train students in fire safety aspects in operating rooms (Rossler et al., 2019). VR-based simulation is an effective modality that can improve nursing skills. This gives nursing students the opportunity to improve their skills in patients with standard conditions (Üzen Cura et al., 2020).

Training in communication skills in clinical practice is essential to enhance interprofessional collaboration. A trial study involving 120 medical and nursing students showed significant improvements in their work attitudes after going through team training using VR technology (Liaw et al., 2020). Simulated interprofessional nursing practice using VR technology has also been shown to increase student satisfaction in the learning environment (Liaw et al., 2019). In addition, VR-based simulations in wound bandage practice have helped enhance the engaging learning experience for college students (Choi & Schmutz, 2020). Critical thinking skills are important in the nursing profession. Simulation with VR technology can be complementary in the mannequin-based training (Matthews et al., 2020). Furthermore, the development of VR simulation in acute respiratory disorder nursing care is a safe solution to train students without the risk of disease transmission (Permana et al., 2019). Learning through simulations provides opportunities for nursing students to practice clinical skills in a variety of conditions and situations. It also enhances students' clinical decision-making skills, so they feel more confident in treating patients like those in a clinical setting and feel satisfied with their learning (Al Khasawneh et al., 2021).

Table 2. Nursing Interventions in elderly patients on VR

Author and Year	Objective	Method	Results
(Prasertsakul et al., 2018)	VR-based vestibular rehabilitation training in elderly patients for dizziness reduction.	VR-based vestibular rehabilitation training on 32 elderly people divided into an intervention group (n =16) and control group (n =16). After participating in exercise for 6 months	The intervention group experienced a significant decrease in dizziness, improved balance and mobility ($p<0.05$).
(Singleton et al., 2022)	Education in patients with hypoglycemia.	This study evaluated the impact of VR use on short-term knowledge of hypoglycemia through randomized controlled trials. A total of 171 second-year nursing students from 2 campuses in the UK participated, divided into a control group (n = 88) and an experiment (n = 83). The analysis was carried out using Partial Least Squares Structural Equation Modeling, comparing the results of pre and post-test surveys between VR simulation methods and normative teaching.	The VR simulation showed significant results ($p = 0.000$) compared to conventional methods of education about hypoglycemia. The simulation is also effective in identifying key points.
(Zahedian-Nasab et al., 2021)	Prevention of fall patients with balance exercises	This clinical trial involved 60 elderly people in nursing homes, divided into	Balance exercises using VR in elderly people in nursing

	using VR for 6 weeks.	intervention and control groups. The intervention group participated in Xbox Kinect-based VR exercises twice a week for 6 weeks, while the control group performed regular exercises. The research tools used include demographic questionnaires, Berg Balance Scale (BBS), Timed Up and Go (TUG), and Falling Efficacy Scale (FES).	homes can improve balance, decrease fear and improve quality of life. Fall fear scores were significantly reduced in the intervention group compared to the control group (p <0.001).
(Sadeghi et al., 2021)	Effect of 8 weeks of balance training traditionally, VR and combined on elderly men to prevent falls.	Balance training on 64 elderly men was divided into 3 groups, namely the traditional balance training group, the group using VR, and the traditional combined group with VR	. The traditional and VR combined balance training group resulted in greater thigh muscle strength improvements.
(Liao et al., 2020)	Physical and cognitive training in older adults with mild cognitive impairment.	A single, randomized controlled trial was conducted in Taipei, Taiwan with 34 elderly people with mild cognitive impairment. Participants were randomized to either VR-based physical and cognitive training groups or combined training for 36 sessions over 12 weeks. Evaluation included global cognition, executive function, verbal memory, and IADL at pre and post-intervention. Changes in prefrontal cortex activation were measured using functional near-infrared spectroscopy (NIRS).	VR-based physical and cognitive training in older adults showed significant improvements in global cognition (P<0.001), verbal memory (P=0.002), and Instrumental Activity Daily Living (IADL) (P<0.001) after the intervention.
(Yang et al., 2022)	VR-based cognitive training and brain exercise in the cognitively impaired elderly	Cognitive training and brain exercise were conducted on 99 elderly people with cognitive impairment divided into intervention group and control group. The intervention group was given a series of VR and sports-based games of 24 sessions	This intervention group experienced improved brain, cognitive, and physical health.

		with a duration of 100 minutes each.	
(Spiegel et al., 2019)	Effective and drug-free therapy for the very painful.	A randomized prospective trial compared the effectiveness of VR. VR can be used as a therapeutic tool in patients who are very painful. 120 subjects (61 VR; 59 controls). Pain scores were measured before and after the intervention, as well as after 48 and 72 hours.	Pain was significantly reduced in patients given the intervention using VR (P<0.04) compared to the control group. VR is recommended to be used as a non-pharmacological initial therapy and made its SOP.
(Waliño-Paniagua et al., 2019)	Neurorehabilitation for patients with multiple sclerosis (MS).	The OT group underwent 20 conventional OT sessions, twice a week. The Occupational Therapy (OT) and VR groups followed 20 30-minute game-based VR intervention sessions plus conventional OT sessions. Assessments were carried out before and after the intervention using the Purdue Pegboard Test, Jebsen-Taylor Hand Function Test, and Grooved Pegboard Test.	The intervention of Occupational Therapy with VR in 13 patients with multiple sclerosis showed clinical improvements in accuracy and effectiveness of movement compared to Occupational Therapy without VR in 13 people in the control group.
(Chang et al., 2022)	VR-based oral hygiene maintenance training for the elderly	This VR-based oral hygiene maintenance training was attended by 23 elderly people for 6 weeks, divided into the intervention group (n = 11) and the control group (n = 12).	The intervention group experienced significant improvements in knowledge, attitudes, self-efficacy, and intensity compared to the control group.
(Hayden et al., 2022)	Recreational therapy for elderly patients.	The VR recreation program is developed in three phases. Phase 1 involves identifying the needs of residents and staff through focus groups, surveys, and observations. Phase 2 created 10 VR experiences based on the findings of Phase 1. Phase 3 implements and evaluates the VR experience.	VR is a technology that replaces the real environment by creating an environment that indulges the senses of older adult individuals through images and sound. Content is made interesting, individuals become

			complacent in a new world, making it easier to divert their problems and pains.
(Cieślik et al., 2023)	Use of VR to relieve symptoms of depression and anxiety in elderly women	The use of VR with elements of psychotherapy, relaxation, and aesthetics of the elderly garden Women with depressive symptoms. The 60 elderly were divided into 30 elderly intervention group and 30 elderly control group.	The intervention group showed a significant reduction in symptoms of depression and anxiety compared to the control group.

Table 2. shows that Virtual Reality (VR) technology can be used in various aspects of nursing services to elderly patients. Its uses include vestibular rehabilitation to reduce dizziness, balance and muscle strengthening exercises to prevent falls, physical and cognitive training for those with cognitive impairment, as well as brain training activities for cognitive health. In addition, VR is also used as a non-pharmacological therapy for pain management, neurological rehabilitation of conditions such as multiple sclerosis, oral hygiene maintenance training, recreational therapy to improve quality of life, and psychotherapy and relaxation techniques to relieve symptoms of depression and anxiety.

VR-based nursing services for elderly patients are innovations in the provision of health care by nurses to elderly patients, utilizing VR technology for vestibular rehabilitation, increasing muscle strength and balance to prevent falls, physical and cognitive training, brain sports activities, pain management, rehabilitation of knee and hip osteoarthritis, neurorehabilitation, maintenance of oral hygiene, recreational therapy, and efforts to relieve symptoms of depression and anxiety.

VR-based vestibular rehabilitation training has proven to be significantly beneficial for reducing dizziness, improving balance, and improving mobility in the elderly (Prasertsakul et al., 2018). Providing education to elderly patients about hypoglycemia through VR simulation has been shown to provide significant results compared to conventional methods. These simulations help elderly patients understand information better, through visual understanding, improve their understanding and skills in managing hypoglycemia, and increase confidence in coping with their health conditions (Singleton et al., 2022).

Elderly patients often experience problems with balance and fear of falling, which can interfere with their daily activities. Prevention of patient falls through thigh muscle strength exercises for 8 weeks and balance exercises for 6 weeks using VR can improve balance, reduce fear and improve the patient's quality of life. The results showed a significant decrease in the fall fear score was significantly reduced in the intervention group compared to the control group, $p < 0.001$. The exercise experience becomes more enjoyable and engaging for patients, so they are more motivated to keep doing it (Sadeghi et al., 2021; Zahedian-Nasab et al., 2021).

Physical and cognitive exercise, as well as VR-based brain exercise activities in elderly with VR-based cognitive impairment in older adults with cognitive impairment, have shown significant improvements in general cognition, verbal memory, and independence in daily activities following the intervention. VR technology has great potential in aiding the rehabilitation of elderly adult patients by focusing on improving their brain health, physical health, and cognitive health (Liao et al., 2020; Yang et al., 2022).

VR has also proven to be an effective non-pharmacological therapeutic tool in managing pain in patients. The results showed a significant reduction in pain levels in patients receiving the VR intervention, compared to the control group. VR helps patients distract themselves from

perceived pain, reducing discomfort, stress, and anxiety that can exacerbate pain. In addition, excessive use of painkillers can also be reduced through VR therapy, which has the added benefit of reducing adverse side effects (Spiegel et al., 2019).

Occupational therapy interventions with VR in multiple sclerosis (MS) patients have shown clinical improvements in movement accuracy and effectiveness compared to occupational therapy without VR. Therefore, VR can be an effective occupational therapy option for patients with MS, helping to improve motor skills, balance, and body coordination (Waliño-Paniagua et al., 2019) VR-based oral hygiene maintenance training improves knowledge, attitude, self-efficacy, and intensity in elderly patients (Chang et al., 2022). VR-based recreational therapy with elements of psychotherapy, relaxation, and garden aesthetics offers an attractive alternative for elderly adult patients by creating experiences that pamper their senses, help distract them from the problems and pain they are experiencing, as well as improve mental well-being, lowering their symptoms of depression and anxiety in a treatment environment (Cieślik et al., 2023; Hayden et al., 2022).

Revolutionizing Nursing Higher Education through Virtual Reality-Based Elderly Care Service Practice Simulation

Chronic injuries are a major focus in nursing practice, and Virtual Reality plays an important role in shaping student competencies. Examples of the use of Augmented Reality (AR) in health science education, such as in wound care training, provide a real picture of the implementation of this technology ((Rodríguez-Abad et al., 2022). VR increases the confidence and competence of nursing students in providing patient-centered care (Kim et al., 2021). Not only in wound care, but VR has also proven effective in various contexts. Nursing students who underwent independent practice with VR applications experienced an increase in competence by 24.8% compared to traditional methods (Berg & Steinsbekk, 2020b). VR simulation is also used in training students in fire safety aspects in the operating room (Rossler et al., 2019), presenting VR as an effective modality for improving nursing skills (Üzen Cura et al., 2020).

Nursing students also need to practice interprofessional communication and collaboration skills. Improving student work attitudes after going through team training using VR technology (Liaw et al., 2020) Interprofessional nursing training using VR has also been shown to increase student satisfaction in the learning environment (Liaw et al., 2019) VR-based simulations in wound bandage practice provide an interesting learning experience for students (Choi & Schmutz, 2020), while critical thinking skills, essential in nursing, can be improved with VR simulations (Matthews et al., 2020). On the VR-based nursing service side for elderly patients, this technology opens up various innovations. From vestibular rehabilitation to physical and cognitive training, VR has proven its benefits. For example, thigh muscle strength training with VR can reduce the fear of falling and improve balance in elderly patients (Sadeghi et al., 2021; Zahedian-Nasab et al., 2021) VR-based recreational therapy also provides an interesting alternative to improve the mental well-being of elderly patients (Cieślik et al., 2023; Hayden et al., 2022) The use of VR in education and nursing services for the elderly has a positive impact.

This study has several limitations, including the small sample size that makes the generalization of results limited, as well as variations in study design that make it difficult to compare results. In addition, the absence of standard protocols for VR interventions leads to variable outcomes and a lack of evaluation of costs means that the feasibility of large-scale adoption has not been measured.

4. CONCLUSION

The use of VR allows students to practice in a variety of situations that reflect aged care services, which is indispensable to understanding their duties and responsibilities thoroughly. The importance of scenario planning and integrated action by lecturers is also an integral part of this approach. VR technology opens up opportunities to improve nursing students' self-

reflection and critical thinking skills. This innovation not only changes the educational paradigm but also provides nursing students with an immersive experience in preparing them to care for a growing elderly population. By continuing to harness the potential of VR technology, nursing education can continue to evolve and adapt to the increasingly complex demands of society. Future research hopes to evaluate the use of this technology.

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