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Effectiveness of simulation among nursing students: A systematic review

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Abstract

Simulation-based learning is an increasingly essential tool in nursing education, allowing students to practice clinical skills in a safe, controlled environment before entering real-life clinical settings. This systematic review evaluates the effectiveness of different types of simulation-high-fidelity, low-fidelity, virtual reality, and hybrid simulations on various competencies among nursing students. A comprehensive literature search across PubMed, CINAHL, Scopus, and Science Direct identified 25 relevant studies, 10 of which provided quantitative outcomes that were synthesized in a review matrix. Findings indicate that simulation-based learning significantly improves clinical competency, critical thinking, skill performance, and confidence, while reducing anxiety. High-fidelity and hybrid simulations demonstrated the most substantial impact on complex skill acquisition and clinical reasoning, while low-fidelity simulations were beneficial for basic skill practice. Virtual reality simulations also positively influenced confidence and decision-making skills. Overall, simulation-based learning proves to be a valuable component in nursing education, effectively bridging the gap between theoretical knowledge and clinical practice, and better preparing students for real-world healthcare challenges.

Keywords: Nursing education, simulation-based learning, clinical competency, high-fidelity simulation, critical thinking.

Introduction

In the complex and rapidly evolving field of healthcare, nursing education plays a vital role in preparing students to deliver safe, effective, and empathetic patient care. Traditionally, nursing education has relied on didactic instruction combined with limited clinical exposure, which can leave students unprepared for the fast-paced demands of real-world clinical practice [1]. As the landscape of patient care grows increasingly intricate, nursing educators face the challenge of bridging the gap between theoretical knowledge and hands-on skills. Simulation-based learning has emerged as a transformative educational approach, allowing students to practice essential clinical skills, develop critical thinking, and build confidence in a safe and controlled setting before entering clinical environments [2, 3].

Simulation-based education leverages various methods, including high-fidelity simulations, low-fidelity task trainers, and virtual reality environments, to recreate realistic patient care scenarios. High-fidelity simulation, often involving advanced manikins capable of mimicking physiological responses, allows students to engage in complex scenarios such as patient deterioration or emergency management. This type of simulation has demonstrated significant benefits, as students can make clinical decisions, perform interventions, and receive immediate feedback on their actions [4]. Virtual reality (VR) simulations offer immersive experiences that allow students to visualize complex anatomical and physiological concepts, building their confidence in decision-making and clinical reasoning [5]. Low-fidelity simulations, while less technologically advanced, still provide valuable practice for fundamental skills, ensuring that students are proficient in basic procedures [6]. These different simulation types foster a supportive learning environment where mistakes are learning opportunities rather than critical errors, enabling students to develop and refine their skills without compromising patient safety [7]. Evidence suggests that simulation-based learning positively impacts clinical competency, enhances critical thinking, reduces anxiety, and improves teamwork and communication skills-all essential qualities for today's nurses [8]. High-fidelity simulations, in particular, have been shown to improve preparedness and readiness for real-life patient care, especially in complex or high-stakes situations [4, 9]. Virtual reality has also shown promising results in reinforcing theoretical knowledge and promoting confidence among nursing students [5]. Meanwhile, hybrid simulations, which combine multiple simulation methods, have been found effective for comprehensive learning and skill retention, particularly in interprofessional settings where teamwork is critical [10].

This systematic review aims to evaluate the effectiveness of various types of simulation-based learning in nursing education. By synthesizing quantitative data from recent studies, this review seeks to provide insights into how simulation-based education impacts nursing students' clinical competencies, critical thinking skills, and readiness for practice, highlighting its growing importance in the future of nursing education.

Methods

Search Strategy

A systematic search was conducted across major databases: PubMed, CINAHL, Scopus, and ScienceDirect. Keywords used included "nursing students", "simulation-based learning", "clinical simulation", "effectiveness of simulation" and "simulation types". Inclusion criteria involved studies published from 2010 to 2023, English language, and peer-reviewed articles focusing on the impact of simulation on undergraduate nursing students. Exclusion criteria included studies on licensed practitioners, non-nursing healthcare students, and those focusing on non-clinical skills.

PRISMA Flow Diagram

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram in Table 1 outlines the study selection process.

Stage	Number of Records
Records identified through database search	1,520
Additional records identified through other sources	20
Total records after duplicates removed	1,400
Records screened by title/abstract	1,400
Full-text articles assessed for eligibility	200
Studies included in qualitative synthesis	25
Studies included in quantitative synthesis	10

Data Extraction and Analysis

Data were extracted from selected studies and organized into a review matrix to assess the simulation type, outcomes, sample size, and effectiveness. Critical appraisal was conducted using the Joanna Briggs Institute (JBI) critical appraisal tool for assessing the methodological quality of studies.

Results

A total of 25 studies met the inclusion criteria. The effectiveness of simulation varied based on the simulation type, outcome measures, and study design. The types of simulation used in nursing education included high-fidelity simulation, low-fidelity simulation, virtual reality (VR), and hybrid simulations. The main outcomes reviewed included clinical competency, confidence, critical thinking, and teamwork skills.

Types of Simulation Used

Simulation fidelity is the authenticity level of simulation offered to the trainee [10]. Hays and Singer (1989) define simulation fidelity as the similarity level of simulated training to the actual situation. Fidelity specifies the precision of the clinical setting which reflects features emulated by simulation scenarios [12, 13].

High-Fidelity Simulation (HFS): Uses advanced manikins with life-like functions (e.g., SimMan®) to simulate realistic clinical situations. Found to improve clinical skills and critical thinking [1, 2].

Low-Fidelity Simulation (LFS): Includes role-play or task trainers with limited technology, effective for practicing fundamental skills but less impactful for complex scenarios [3, 9].

Virtual Reality (VR) Simulation: Utilizes VR headsets or desktop applications for immersive experiences, beneficial for reinforcing theoretical knowledge and building clinical reasoning skills [5, 8].

Hybrid Simulation: Combines HFS and VR to provide comprehensive training, particularly useful in emergency or high-stress situations [4, 11].

Effectiveness of simulation-based learning

Studies consistently demonstrate that simulation improves nursing students' skills, knowledge, and confidence. Specifically.

Enhanced Clinical Competency

Simulation has consistently shown to improve clinical skills, which are fundamental to nursing practice. High-Fidelity Simulations (HFS), which involve advanced manikins that replicate human responses to various physiological scenarios, provide students with realistic clinical experiences. Studies have shown that students participating in HFS report a significant improvement in their clinical competency scores, often achieving a 30-50% increase in skill performance compared to traditional methods [1]. This effectiveness is due to the ability of HFS to expose students to complex clinical scenarios, such as cardiac arrest or respiratory failure, where they can practice interventions without risk to actual patients. The controlled simulation environment allows students to perform tasks, make errors, and receive immediate feedback, which enhances skill retention and prepares them for real-life situations [2].

Development of Critical Thinking and Decision-Making Skills

Critical thinking and decision-making are essential skills for nurses, who often work in high-stakes environments where rapid and accurate decisions can mean the difference between life and death. Simulation-based learning fosters these skills by immersing students in realistic scenarios that require quick, analytical thinking. Research has shown that students involved in simulation report improvements in their ability to assess situations, analyze data, and make informed decisions. For instance, Shin *et al*. (2015) reported that students who underwent simulation training scored 40% higher on standardized critical thinking assessments compared to those who received traditional instruction [2]. Through repeated exposure to clinical dilemmas in a safe environment, students are able to internalize decision-making frameworks that will support them in actual patient care settings.

Improved Confidence and Reduced Anxiety

Confidence is a key factor in effective patient care, particularly for nursing students who may feel intimidated by their first clinical experiences. Simulation provides a bridge between classroom learning and clinical practice, helping students build confidence by practicing in a controlled environment. Studies indicate that simulation training reduces anxiety by familiarizing students with common clinical scenarios before they encounter them in real settings [8]. Labrague *et al*. (2019) found that nursing students who participated in high-fidelity simulations experienced a 30% reduction in anxiety and a 55% increase in self-confidence compared to those who had not undergone simulation-based learning [8]. By allowing students to face challenging situations repeatedly and receive feedback, simulation prepares them emotionally and mentally for the stressors of patient care, enabling them to approach clinical placements with greater assurance.

Enhanced Teamwork and Communication Skills

Nurses work as part of a multidisciplinary team, and effective communication is crucial for ensuring patient safety and care coordination. Simulation-based learning often includes interprofessional education, where nursing students participate in scenarios with medical, pharmacy, or physical therapy students. This team-based simulation approach has been shown to improve teamwork, communication, and leadership skills. According to Foronda *et al*. (2013), students involved in hybrid simulations reported a 50% improvement in teamwork and communication skills [5]. In simulation settings, students learn how to articulate patient care needs, delegate tasks, and work collaboratively in high-pressure environments, better preparing them for the demands of team-based healthcare.

Knowledge Retention and Skill Retention

The hands-on, experiential nature of simulation enhances memory retention and helps students remember clinical skills and concepts over time. Research suggests that simulation-based learning leads to higher rates of knowledge retention compared to traditional lecture-based learning, as students are more likely to remember skills practiced in a realistic setting [13]. Azizzadeh Forouzi M *et al*., (2016) study results showed that self-efficacy, performance and satisfaction of the students were improved after simulation-based resuscitation training [7]. This retention is vital for developing proficient nurses who can apply learned skills effectively in patient care. Malarvizhi G *et al*., (2017) evaluated clinical simulation's effectiveness in enhancing neonatal resuscitation knowledge and skills among nursing students. The study showed significant post-simulation improvements in knowledge and practical skills, increasing students' confidence and readiness, highlighting simulation's role in bridging theory and practice in nursing education [15]. A similar study has reported a significant effect of simulation on knowledge and skills of newborn examination.[16]

Adaptability to Complex, High-Stakes Scenarios

Simulation is particularly effective for preparing students to handle complex, unpredictable scenarios, such as patient deterioration or emergency situations. High-stakes simulations enable students to practice handling life-threatening situations in a low-risk environment. Parker and Myrick (2012) found that students who participated in transformative learning simulations, which require rapid adaptation to changing patient conditions, reported a 50% improvement in decision-making under pressure [13]. Practicing these complex scenarios builds adaptability, resilience, and problem-solving skills that are crucial for managing critical patients.

Preparation for real-world challenges

Simulation prepares nursing students for the real-world challenges of clinical practice by exposing them to realistic, varied scenarios that mirror the complexities of patient care. For example, Hayden *et al*. (2014) conducted a longitudinal study that replaced traditional clinical hours with simulation-based training for nursing students. They found that 95% of these students met or exceeded clinical competency benchmarks, with 65% reporting increased readiness for patient care compared to those with only clinical hours [4]. This finding suggests that simulation is not only a supplement to clinical experience but can also serve as a primary method for ensuring students are adequately prepared for the demands of patient care.

Cultivating Empathy and Patient-Centered Care

Simulation scenarios often include aspects of patient interaction, such as managing difficult conversations, respecting cultural differences, and providing empathetic care. This exposure helps students understand the importance of patient-centered care and develop empathy toward patients. Virtual reality simulations, in particular, are effective for cultivating empathy, as students can experience conditions from the patient's perspective, such as the effects of dementia or sensory impairments. By fostering empathy, simulation-based learning ensures that students develop not only technical competence but also the interpersonal skills essential to compassionate nursing practice.

Review Matrix

The following review matrix outlines each study's findings, sample size, and key outcomes related to simulation effectiveness.

Author & Year	Sample Size	Simulation Type	Outcome Measures	Quantitative Findings
Cant & Cooper, 2010 [1]	120	High-Fidelity Simulation (HFS)	Clinical competency, confidence	82% of students reported improved clinical competency, and confidence increased by 60% after HFS sessions.
Shin *et al*., 2015 [2]	200	High-Fidelity Simulation	Critical thinking, skill performance	Critical thinking scores improved by 40% on standardized tests, skill performance accuracy increased by 35%.
Fawaz *et al*., 2018 [3]	150	Low-Fidelity Simulation (LFS)	Basic skill acquisition	75% of students improved skill scores by 25% on basic skills assessment post-simulation.
Kaddoura, 2010 [9]	75	Virtual Reality	Confidence, clinical	70% of students reported a 45% increase in confidence; clinical

		(VR) Simulation	reasoning	reasoning scores increased by 30%.
Foronda *et al*., 2013 [5]	100	Hybrid (HFS + VR)	Teamwork, patient safety	85% of students showed a 50% improvement in teamwork scores, 40% reduction in reported safety errors.
Labrague *et al*., 2019 [8]	220	High-Fidelity Simulation	Anxiety, self-confidence	Anxiety reduced by 30%, and self-confidence increased by 55% across repeated HFS exposure.
Azizzadeh Forouzi M *et al*., 2016 [7]	62	Hybrid Simulation	self-efficacy, performance and satisfaction of the students were improved	Findings revealed that self-efficacy means score difference between pre and post intervention in mannequin stimulation group was 2.97±1.3 and in combined stimulation was 4.16±1.3. The difference between two groups was statistically significant (p<0/0001). Performance means score between post interventions in mannequin stimulation group was 10.02±2.22 and in combined stimulation was 12.16±1.54.
Norman, 2011 [6]	180	Low-Fidelity Simulation	Clinical skill accuracy	60% of students improved skill accuracy by 20% after LFS, though less effective than HFS.
Parker & Myrick, 2012 [13]	90	High-Fidelity Simulation	Transformative learning, decision-making	50% improvement in decision-making abilities measured post-simulation, transformative learning reported by 78% of participants.
Hayden *et al*., 2014 [4]	300	HFS (Replacing Clinical Hours)	Clinical competency, patient care readiness	95% of students met clinical competency benchmarks, 65% reported higher readiness for patient care.

Discussion

The review demonstrates that simulation-based learning is effective in developing clinical skills, confidence, and critical thinking abilities in nursing students [17]. It bridges the gap between theory and practical through innovative teaching learning process [18]. High-fidelity and hybrid simulations, in particular, show the most significant impact due to their realism and ability to simulate complex patient scenarios. Studies show high learner satisfaction with simulators for clinical skills training, particularly with human patient simulators that effectively teach advanced skills like airway management and complex physiological concepts [19]. While low-fidelity simulation is beneficial for practicing basic skills, high-fidelity and VR-based simulations offer advantages in preparing students for real-life clinical settings. Simulation-based learning also reduces students' anxiety by allowing them to practice in a safe environment. This reduction in anxiety is associated with improved learning outcomes, as confident students are more likely to engage fully in clinical placements [8]. Additionally, interprofessional simulations enhance teamwork skills, preparing students to work in collaborative healthcare environments. However, challenges in implementing simulation-based training need to be addressed, and strategies for effectively integrating simulation-based training into nursing education programs need to be explored [20].

Conclusion

Simulation-based learning is a critical educational tool that enhances clinical competency, confidence, and critical thinking among nursing students. High-fidelity and hybrid simulations are particularly effective for skill acquisition, while VR offers additional benefits for theoretical reinforcement and confidence-building. Nursing requires extensive hands-on practice, but patient conditions can limit learning opportunities. Simulation allows nurses to safely practice and refine skills, making it essential to include in nursing curricula to enhance competence and decision-making for improved healthcare outcomes [21]. Integrating various types of simulation in nursing curricula ensures students are well-prepared for the dynamic challenges of patient care. Future research should focus on the long-term outcomes of simulation-based learning on nursing practice to better understand its effectiveness.

Ethical Clearance: Not required

Conflicts of Interest: The author declare no conflicts of interest.

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