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# A Scoping Review of Quasi-experimental Studies on Simulation-Based Learning in Medical Education: Trends and Insights from the Last Decade

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## Abstract

**Background:** Simulation-based learning (SBL) has become a key tool in medical education for developing practical skills and clinical decision-making. Despite the widespread use of this method, there remains a lack of comprehensive reviews of quasi-experimental studies in this area. Therefore, this study aimed to survey the trends and insights from quasi-experimental studies conducted over the past decade on simulation-based learning in medical education.

**Methods:** This scoping review was conducted using the framework outlined by Arksey and O'Malley, involving 5 key stages: (1) defining the research questions; (2) identifying relevant studies; (3) selecting studies; (4) extracting relevant data; and (5) summarizing and synthesizing the extracted data. Several databases were used to search for articles. These databases include PubMed, Scopus, Web of Science (WOS), ERIC, and Emerald. The search period spanned from January 1, 2014, to December 31, 2024.

**Results:** In this scoping review, 3052 articles were retrieved. After screening and applying the inclusion and exclusion criteria, 95 quasi-experimental articles were selected for final analysis. Basic medical education dominates research focus, and surgical training and obstetric care had the lowest concentration of studies. Simulation effectiveness is measured via Kirkpatrick's hierarchy, showing improvements in clinical skills and confidence.

**Conclusion:** This scoping review demonstrated that simulation-based learning is a growing educational method in medical education, contributing to the development of practical and clinical skills. The findings of this study can be beneficial for policymakers, educators, and researchers in medical education to enhance educational programs and utilize this method more effectively. It is recommended that adequate resources and proper training be allocated to maximize the effectiveness of simulation-based learning for both educators and students.

**Keywords:** Simulation-Based Learning, Medical Education, Quasi-experimental Studies, Medical Simulation

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## Introduction

Simulation-based learning (SBL) is an educational approach that replicates real-world clinical scenarios, allowing learners to develop critical thinking, decision-making, and procedural skills in a controlled, risk-free environ-

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***↑What is "already known" in this topic:***
Simulation-based learning (SBL) is increasingly used in medical education to improve clinical skills and decision-making. While numerous studies have explored the benefits of SBL, a consolidated review of quasi-experimental research in this area, specifically examining trends and insights over the past decade, is lacking, therefor comprehensive overview of quasi-experimental evidence is needed.

***→What this article adds:***
This review maps quasi-experimental SBL studies (2014-2024), identifying interventions, areas of application, and assessment level. It provides an overview, highlights gaps, and informs educators, policymakers, and researchers. This scoping review also offers a new perspective for teachers and educational planners on the utilization of simulation-based learning.

ment (1, 2). This method has gained widespread recognition in medical education for its ability to enhance clinical competence, teamwork, and communication skills while improving patient safety and quality of care (3). SBL provides students with opportunities to practice managing complex and rare medical situations, fostering both technical and non-technical skills essential for healthcare professionals (4).

Numerous studies have explored the effectiveness of SBL in various medical disciplines (5), assessing its impact on clinical skills acquisition (6), knowledge retention (7), and student engagement (8).

While randomized controlled trials (RCTs) have been widely used to evaluate simulation-based interventions, quasi-experimental designs have also gained traction due to ethical and practical limitations associated with randomization in medical education (9). However, despite numerous review studies examining the benefits of SBL through RCTs (10-12), a research gap remains in the consolidated assessment of quasi-experimental methods, despite their growing use in SBL research (13). Although these designs offer valuable insights into causal relationships in complex healthcare settings (14), their overall effectiveness and areas of application have not been thoroughly explored, highlighting the need for further investigation.

This scoping review aimed to map the existing quasi-experimental evidence on simulation-based learning in medical education over the past decade (January 1, 2014, to December 31, 2024). By identifying trends, research gaps, and the scope of existing studies, this review can provide insights into the application of quasi-experimental designs in SBL and their contribution to medical education research.

## Methods

This study was conducted using a scoping review method based on the Arksey and O'Malley framework (15). In this study, a scoping review was chosen to perform an initial assessment of the number and scope of relevant existing studies and to identify the nature and extent of evidence on the research topic, thereby extracting existing components of the subject. Consequently, the authors decided to conduct a scoping review of studies from the past 10 years up to the present to guide future research and identify areas that may require more focused systematic reviews. The outcomes of this study will help highlight research gaps and provide some direction for future investigations. The framework of Arksey and O'Malley's method is outlined below in Figure 1.

### *Determining the Research Question*

This research was guided by the question, "What is the overall trend of quasi-experimental studies on simulation-based learning in the past decade?" After discussion among the research team, more specific research questions were developed:

1. What SBL methods have been implemented using a quasi-experimental approach?

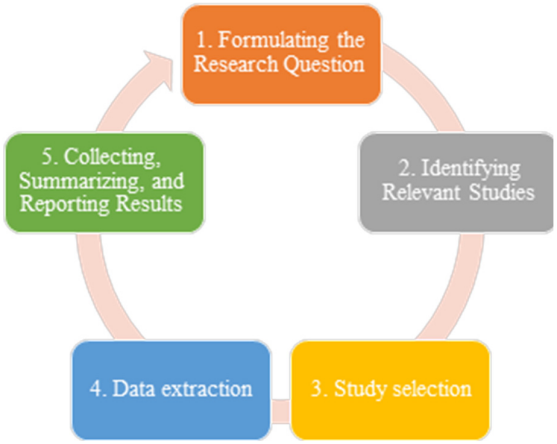


*Figure 1.* Steps in Conducting the Study

2. In which areas of medical education is SBL most frequently applied and studied?

3. How is the effectiveness of the simulation method interventions in articles based on Kirkpatrick's 4-level evaluation model?

### *Identifying Relevant Studies*

Multiple databases were used to identify relevant studies, including SCOPUS, WOS, ERIC, PubMed, and Emerald. The search period covered the dates from January 1, 2014, to December 31, 2024, ensuring studies from the past decade were included, as per the aims of this scoping review. This timeframe was consistently applied across all databases. The search strategy used for retrieving relevant articles are presented in Table 1.

The retrieved articles were imported into EndNote (Version 18) and systematically categorized based on predefined inclusion and exclusion criteria. Study selection began by screening titles and abstracts using these criteria, followed by retrieving the full texts of potentially relevant evidence for further review. The research team conducted searches from February 20, 2024, to April 8, 2024, allowing for 7 weeks with repeated search dates to ensure that no preliminary studies were missed. After consulting with a librarian, we formalized our primary search strategy to improve specificity.

### *Study Selection and Screening*

Initially, all retrieved articles were imported into EndNote software, duplicates were removed, and titles and abstracts were screened according to the predefined inclusion and exclusion criteria. To ensure consistency and rigor, these criteria were predefined based on the research questions and objectives.

### *Inclusion Criteria*

### *Study Design*

Original research articles employed a quasi-experimental design. This includes, but is not limited to, pretest-posttest studies, nonrandomized controlled trials, interrupted time series designs, and comparative studies





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*Table 1.* Simulation-Based Learning in Medical Education

| Concept 1: Simulation-Based Learning | | Concept 2: Medical Education | | Concept 3: Quasi-Experimental Studies |
|---|---|---|---|---|
| "Simulation-Based Learning" | | "Medical Education" | | "Quasi-Experimental" |
| "Medical Simulation" | | "Health Professions Education" | | "Quasi Experimental" |
| " Medicine Simulation" | | "Medicine Training" | | "Non-Randomized Controlled Trial" |
| "Healthcare Simulation" | | "Medical Training" | | "Nonrandomized Controlled Trial" |
| "Role-Playing Simulation" | | "Clinical Education" | | "Semi-experimental study" |
| "High Fidelity Simulation" | | "Health Education" | | "Pre-Experimental study" |
| "Game-Based Simulation" | | "Medical Student*" | | "Interventional study" |
| "Computer-Based Simulation" | AND | "Healthcare Professional*" | AND | "Interrupted Time Series" |
| "Clinical Simulation" | | "Resident*" | | "Time Series Analysis" |
| "Augmented Reality" | | "Physician*" | | |
| "Virtual Reality" | | "Nurse*" | | |
| "Surgical Simulation" | | "Midwifery" | | |
| "Simulated Training" | | "Midwife" | | |
| "Manikin Simulation" | | "Obstetric*" | | |
| "Simulated Patient" | | | | |
| "Virtual Patient" | | | | |
| " Simulation*" | | | | |

where randomization was not possible. Studies must have included a clear intervention using simulation-based learning.

### Population

The study population must consist of medical students, residents, fellows, physicians, nurses, or other healthcare professionals involved in medical education.

### Intervention

The intervention must involve SBL. This includes any type of simulation used for educational purposes, such as simulated patients, manikins, virtual reality simulations, computer-based simulations, or hybrid simulations. The simulation must be directly related to medical education or training.

### Outcome Measures

Studies must report on at least 1 measurable outcome related to the effectiveness of SBL. Examples include, but are not limited to, improvements in clinical skills, knowledge acquisition, changes in attitudes or satisfaction, patient safety outcomes, or time to competency. The outcome measure must be clearly defined.

### Language and Publication Date

Articles must be published in English and within the timeframe of January 1, 2014, to December 31, 2024, to align with the scope of this review.

### Full Text Availability

Full text of articles must be available.

### Exclusion Criteria

### Study Design

Studies employing nonempirical methodologies, such as literature reviews, systematic reviews, meta-analyses, editorials, commentaries, conference abstracts (without full text), and protocols, were excluded. Purely descriptive studies without an intervention were also excluded.

### Population

Studies not focused on medical education (eg, those focusing on engineering, or other fields outside of healthcare) were excluded.

### Intervention

Studies using simulation for purposes other than education or training (eg, simulation for entertainment or product testing) were excluded.

### Language and Publication Date

Articles published in languages other than English or outside the January 1, 2014, to December 31, 2024 timeframe were excluded.

### Data Extraction

To ensure transparent and comprehensive reporting, this scoping review followed the guidelines outlined in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Extension for Scoping Reviews (PRISMA-ScR) checklist (16). This form was used to extract data from the included studies. A team meeting was held to ensure a shared understanding of terminology before distributing articles. The initial studies were assigned to 2 authors, and the data from the articles were



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then entered into the form. The data in the data extraction table included items such as the study code, year of study, article language, country, authors, participants, areas of simulation, and evaluation level.

### Summarizing and Reporting Results

After extracting data from the included studies, the data were systematically summarized and synthesized to clearly present the key findings. In this process, a standardized PRISMA Extension for Scoping Reviews form was used to ensure that data were collected uniformly and accurately.

### Steps for Data Synthesis

#### 1. Data Extraction

Data from each study included information about the research year, methodology, simulation fields used, and effectiveness evaluation results.

#### 2. Data Summarization

Extracted data were summarized in tables and figures to clearly visualize the subject distribution, geographical distribution, and effectiveness evaluation results.

#### 3. Data Synthesis

The summarized findings were combined to provide a comprehensive overview of the current state of simulation-based learning in medical education. This included analyzing the subject distribution of studies, geographical distribution, and effectiveness evaluation methods.

#### 4. Reporting the Results

The final results were presented in a comprehensive report that included key findings, study limitations, and suggestions for future research.

## Results

A total of 3052 articles were retrieved in the database search. After removing duplicates, 2215 articles remained for initial screening. The titles and abstracts were screened, resulting in 202 records of articles that were eligible for full review. An additional 103 records were excluded because they were either not aligned with the objectives of this research or were theses and books. After clarifying the data, 95 articles were selected for final analysis. The characteristics of the final extracted articles are included in Appendix 1. The PRISMA chart for article identification is presented in Figure 2.

### Publication Years of the Extracted Studies

As noted, 95 articles were included in the final analysis of this study. The results of the data review indicated that the fewest articles were related to the years of 2014, 2015, and 2017 (3 articles(17-19)), and most articles were from the year 2023 (31 articles, (20-50)). The publication year of the extracted studies, based on the number of articles

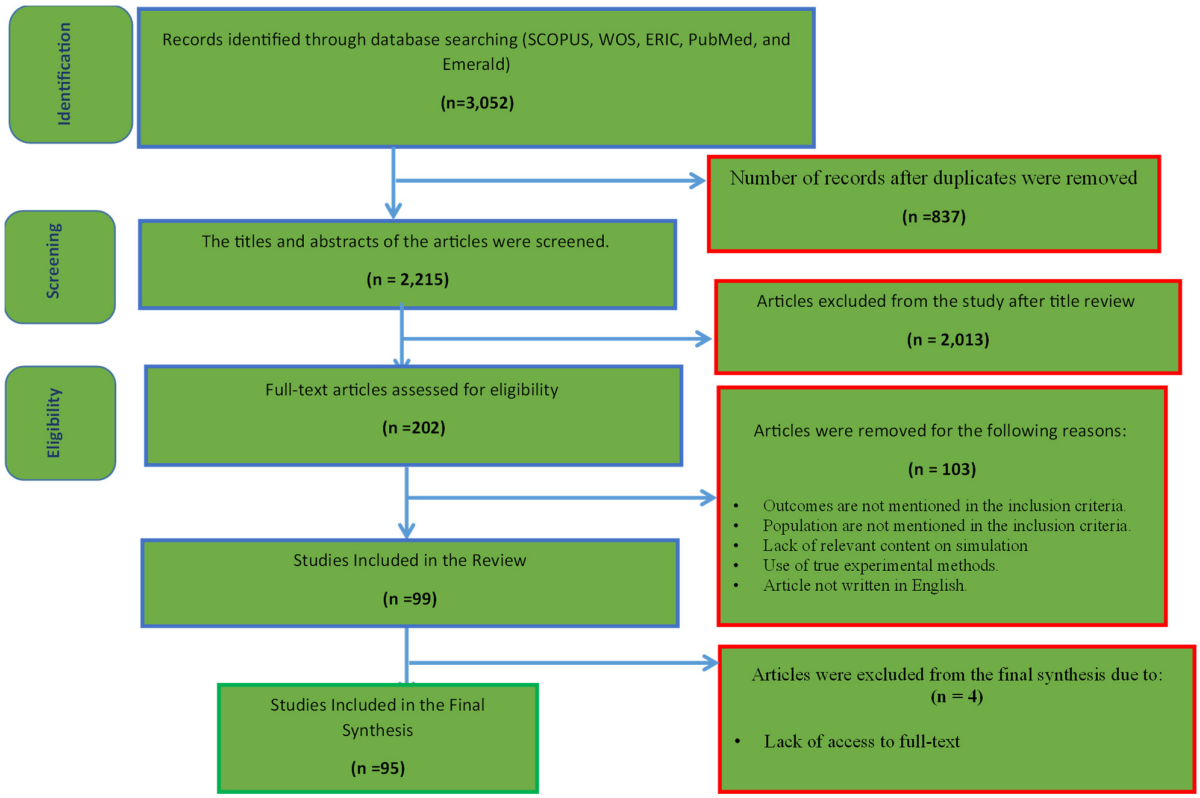


*Figure 2.* PRISMA Chart of Quasi-Experimental Studies on Simulation-Based Learning





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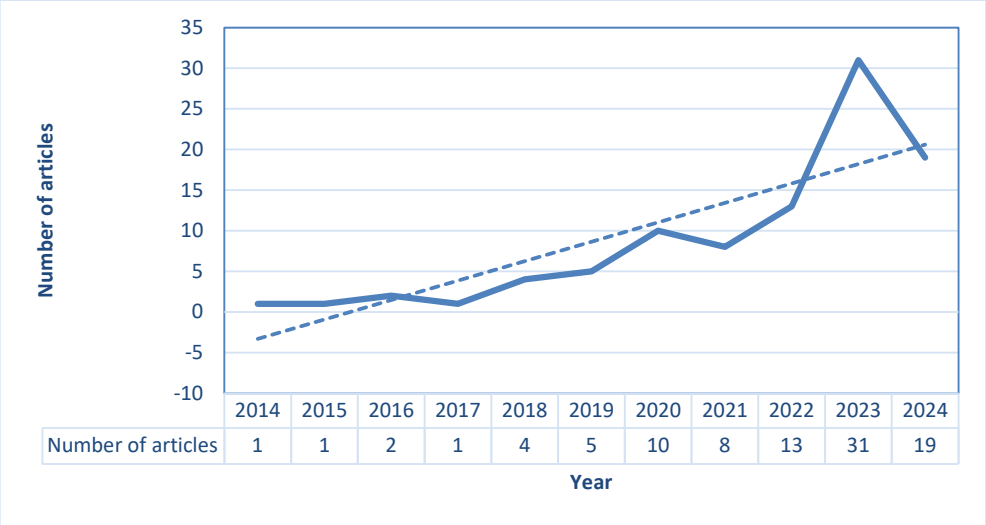


*Figure 3.* Publication years of the extracted studies.

per year, is presented in Figure 3.

### *Geographical Areas of the Extracted Studies:*

In the total 95 articles included in this study, 11 articles were from Iran (17, 27, 32, 36, 38, 94-99), 10 articles were from China (17, 28, 48, 49, 51-56), 8 articles were from Republic of Korea (18, 57-63), 8 articles were from Spain (20, 24, 30, 46, 64-67), 7 articles were from the United States (68-74), 7 articles were from Brazil (20, 29, 31, 45, 94-96), 5 articles were from Africa (16, 34, 39, 94, 95), 5 articles were from Turkey (21, 40, 74-76), 5 articles were from India (18, 30, 91-93), 4 articles were from Saudi Arabia (29, 38, 75, 76), 4 articles were from Pakistan (14, 86-88), 3 articles from England (47, 77, 78), 3 articles from Australia (35, 94, 95), 2 article from Finland (83, 84), 2 articles from Palestine (27, 31), 2 articles from Portugal (37, 82), 3 article from Taiwan (79-81), and 1 article from each of these countries: Vietnam (82), Egypt (83), Norway (84), Belgium (85), Poland (86), and Thailand (33). The number of studies by geographic continent is illustrated in Figure 4.

### *Fields of Simulation Used in the Extracted Studies*

The review of the extracted articles revealed that approximately 28% of the articles were related to the education of basic medical sciences (anatomy, parasitology, histology, microbiology, and physiology (20, 22-26, 28, 30, 42, 52, 56, 63, 64, 68-70, 79, 82, 84, 87-94), 25% were focused on nursing skills education (nursing knowledge, elder care, caregiving skills, confidence, and clinical reasoning (18, 33-37, 40, 43, 45, 46, 53, 57-60, 62, 66, 67, 71, 74, 77, 81, 95-101), 15% pertained to clinical skills training (injections, hemodialysis, and tracheal intubation (17, 29, 38, 39, 49, 50, 73, 75, 80, 102-105), 12% were related to surgical procedures and midwifery care (19, 21, 41, 44, 54, 55, 72, 83, 86, 92, 106, 107), and the remaining 20% encompassed areas such as cardiopulmonary resuscitation, emergency medicine, anesthesia, neonatal care, and others (27, 31, 32, 47, 48, 51, 61, 65, 76, 78, 85, 108-110). The fields of simulation use are presented below in Figure 5.

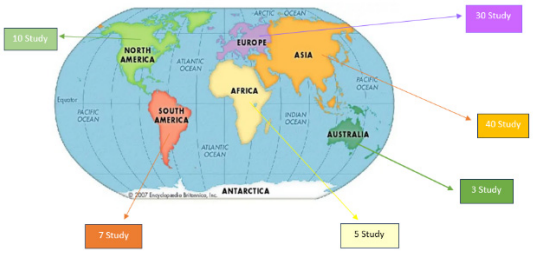


*Figure 4.* Distribution of Extracted Articles Based on Geographical Continents

### *Type of Simulation Used in the Extracted Studies:*

In total, 6 types of simulation have been introduced (111):

*1. Simple Models or Manikins:* This category includes low-cost simulators used for teaching cognitive knowledge or psychomotor skills, such as specialized models for performing enemas and hand-like simulators for intravenous injections. Also, 10% of the articles utilized this type of simulation for education, 18 of the articles used this method (21, 22, 25, 32, 34, 41, 47, 55, 57, 59, 72, 78, 83, 90, 95, 98, 107, 110).

*2. Simulated Patients:* The use of this method dates back to the 1960s. In this approach, specific individuals are trained to portray a patient, primarily for teaching and evaluating history taking, physical examination, and communication skills. Also, 18% of the articles employed this type of simulation for educational purposes, and 18 articles used this method (17, 20, 24, 27, 31, 35, 38, 44, 50-53, 56, 75, 82, 84, 89, 93).





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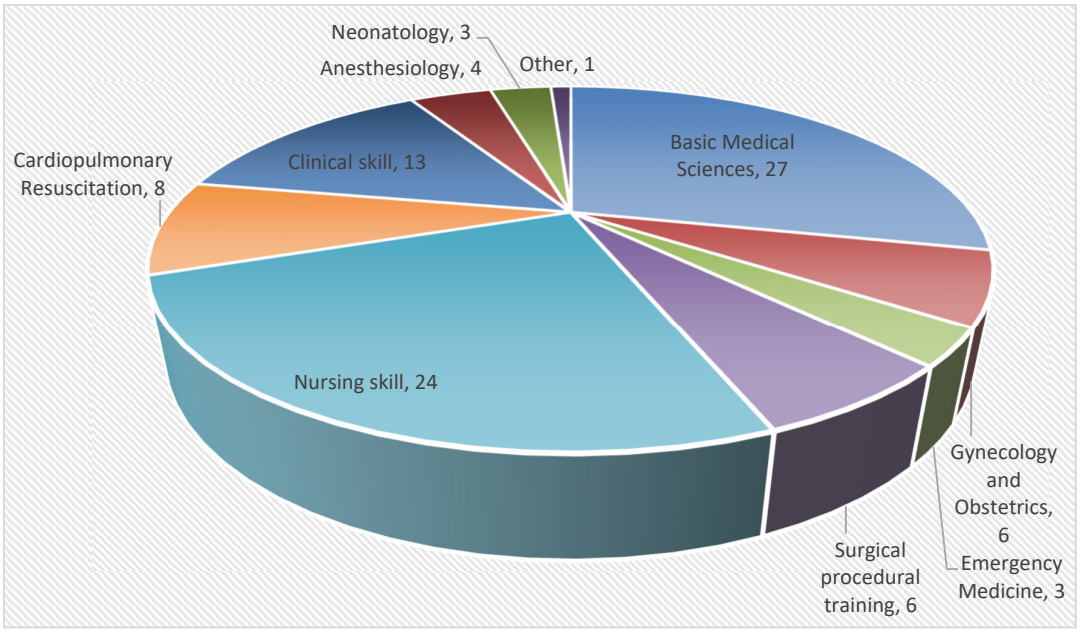


*Figure 5.* Fields of using simulation

*3. Computer-Based Clinical Simulation:* This simulation method became popular in the early 1980s, using digital devices and videos, such as DVDs and CDs, along with mobile phones and the internet in medical education. Also, 12% of the articles utilized this type of simulation for education, 13 of the articles used this method (23, 33, 37, 39, 40, 42, 48, 71, 80, 81, 86, 92, 94).

*4. High-Fidelity Procedural Simulation with Advanced Technology:* These are essentially static models enhanced with audiovisual features, touch, sensory inputs, and complex computer software, such as cardiovascular patient simulators that replicate various heart sounds and pulses. Also, 20% of the articles employed this type of simulation for educational purposes, 20 of the articles used this method (18, 29, 45, 49, 58, 64, 65, 68-70, 76, 85, 97, 99, 102-104, 106, 109, 112).

*5. Virtual Reality:* This method uses highly interactive computer simulations that sense the user's position and respond accordingly. The simulation can occur in 3 dimensions through computer monitors or by placing the individual in a closed environment using hand-controlled devices or other body components via multimedia, such as teaching cognitive diversion during painful procedures. Also, 28% of the articles utilized this type of simulation for education, 24 of the articles used this method (19, 26, 28, 30, 36, 46, 54, 61-63, 66, 67, 73, 74, 77, 79, 87, 88, 91, 96, 100, 101, 105, 108).

*6. High-Fidelity Interactive Simulators:* This approach was first used in anesthesia education in the late 1960s. These simulations involve a life-sized manikin, a computer placement station, and several interfacing devices that display the manikin's vital signs, drive monitors, and utilize computers to record medication levels, blood pressure, and heart sounds. The emergence of this type of simulator marked a shift from traditional manikins to modern ones. Also, 12% of the articles employed this type of simulation for education, 2 of the articles used this method (43, 60).


*Figure 6.* Word Cloud of Types of Simulation Used in the Extracted Studies



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A word cloud illustrating the types of simulation used in the extracted studies, based on the frequency of methods, is presented in Figure 6.

### *Effectiveness of Simulation-based Education Across Different Groups According to Kirkpatrick's Hierarchy*

A review of the effectiveness of simulation-based educational methods across 4 groups—medical science instructors, medical students, nursing students, midwifery students, and patients' families—using Kirkpatrick's 4-level evaluation model revealed that the most frequently assessed domain was participants' learning (68 articles: (17-19, 22-27, 29, 32-36, 38-40, 42, 43, 46-49, 52, 53, 55, 57-59, 61, 64-66, 68-70, 72-75, 77, 78, 80, 81, 84-94, 96-99, 101, 102, 104, 105, 108-110, 112)). Additionally, 27 articles (27 articles (20, 21, 28, 30, 31, 37, 41, 44, 45, 50, 51, 54, 56, 60, 62, 63, 67, 71, 76, 79, 82, 83, 95, 100, 103, 106, 107) examined both reactions and learning to assess the effectiveness of simulation-based education. However, the impact of SBL on behavior, patient outcomes, and direct clinical effects was not assessed. The effectiveness of simulation-based education across different groups, based on learning domains, is illustrated in Figure 7.

## Discussion

This study reviewed 95 quasi-experimental studies on simulation-based learning in medical education from 2014 to 2024. As illustrated in Figure 2, the trend in quasi-experimental simulation studies has been steadily increasing over the past decade. This upward trajectory highlights that simulation is becoming a widely adopted strategy in medical education, fostering hands-on learning and contributing significantly to enhancing patient safety (113). In traditional medical education, clinical skills are often broken down into simpler or smaller components, such as basic knowledge and skills. However, clinical skills typically require adaptation to real-world situations, and learners taught using traditional methods may struggle to connect the dynamics of change and the need for adaptability to clinical skills in a meaningful and relevant way. Simulation, by emphasizing real tasks and promoting integration in learning, can help reduce the fragmentation of content and better prepare students for the complexities of real-world clinical environments (114). Numerous instructional design models (such as the 4-Component Model of Van Merrienboer) focus on authentic learning tasks as the driving force for teaching and learning (115). This is because such tasks serve as tools to help learners integrate knowledge, skills, and attitudes, encourage the synthesis of component skills for problem-solving and task performance, and facilitate the transfer of what has been learned to new situations (116). SBL experiences help learners become psychologically more prepared and equipped to manage a situation as it unfolds in real life. The goal is to reduce errors in emergencies and make timely, critical decisions (117).

Simulation-based research employing quasi-experimental designs remains limited or largely absent in regions such as Africa, in contrast to its prevalence in Europe, North America, and Asia. This geographic disparity likely stems from the unequal global distribution of digital resources for medical education, which restricts access to

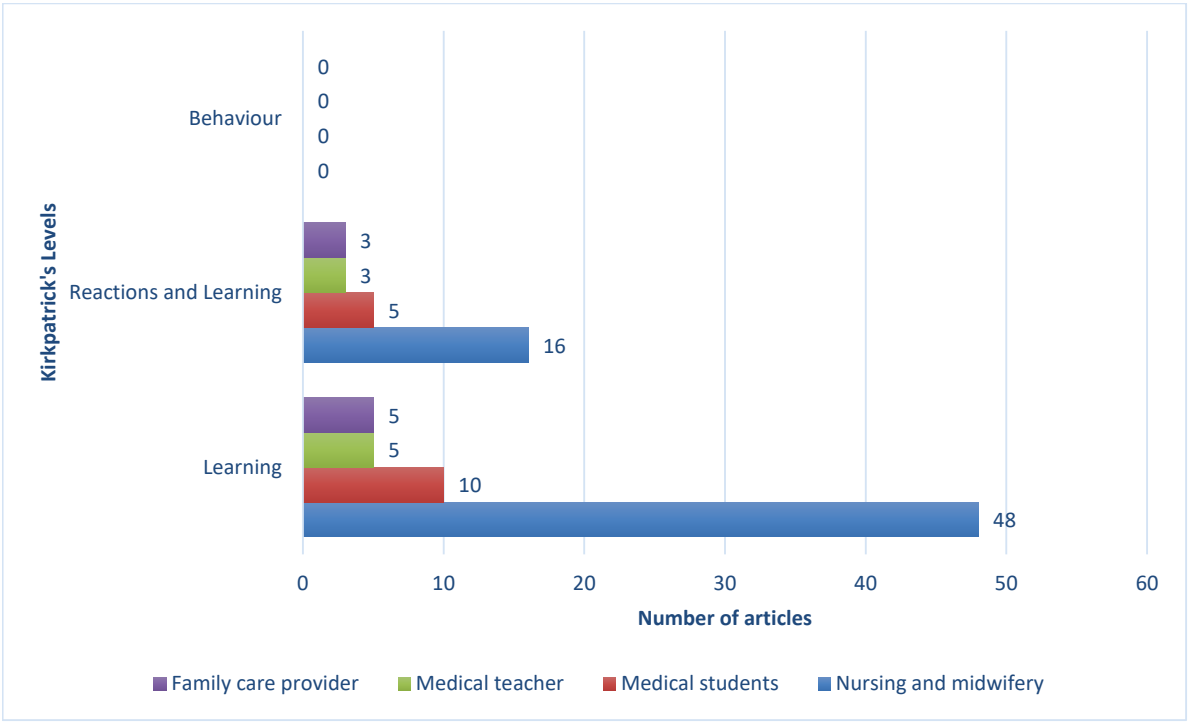


*Figure 7.* The effectiveness of simulation-based training in different groups based on Kirkpatrick's Levels of Evaluation





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simulation-based training in less developed areas. To promote equity in medical education, it is essential to expand access to simulation and digital learning tools across all regions, thereby supporting more balanced and inclusive educational opportunities for medical students worldwide (118). In resource-constrained settings, integrating simulation-based platforms into medical education can enhance learning efficiency by lowering the reliance on instructors and physical laboratory materials. As computer technologies advance, virtual reality has become an increasingly viable and cost-effective alternative for undergraduate medical training, facilitating broader adoption in low- and middle-income countries (119).

The most widely used field for simulation was basic medical sciences. However, simulation has been widely utilized not only in basic medical sciences but also across various domains of medical education, including surgical training, pediatric emergency care, radiology, catheterization, and interprofessional education. In the basic sciences, simulation offers medical students interactive, image-based learning experiences that are immersive, realistic, and tailored, providing exposure to scenarios and content that may not be readily accessible in traditional clinical settings (120). Simulation-based education can be beneficial across a wide range of fields and skill sets, with a potential impact on patient safety. To identify key skill sets, established frameworks have been developed to outline the roles and competencies of an effective physician. Three frameworks were considered, such as the Royal College of Physicians and Surgeons of Canada's 39 competencies and the 6 competencies established by the Accreditation Council for Graduate Medical Education in the United States (121).

In most of the articles, high-fidelity simulation (HFS) and virtual reality (VR) were used as the simulation platform. HFS and VR utilize software to create an immersive, simulated environment. Unlike traditional user interfaces, to experience virtual reality, users wear a headset that places them in a virtual experience, where they can interact with the environment and virtual characters realistically. VR allows users to learn from the experience, just as they would in real life (122). VR provides a platform for experiential learning, which was first introduced by John Dewey. According to Dewey, Learning is the process of revisiting experiences and reconstructing them in ways that give these experiences deeper meaning. This process allows individuals to consider new possibilities, guiding future experiences, and helping to anticipate their outcomes. Dewey believed that humans learn through practical approaches. This belief aligns Dewey with the philosophy of educational pragmatism. Pragmatists argue that reality must be experienced. From Dewey's educational perspective, this means that medical learners must interact with their environment to adapt and learn (123). It is important to note that performance improvements in a virtual environment may not necessarily transfer to the clinical setting. Therefore, the use of virtual reality alone may not be sufficient for medical students to fully master clinical skills, and the use of other educational methods should also be recommended as complementary. Hence, current virtual reality simulators should only be used to teach certain clinical skills to supplement practical hands-on experiences (119). Based on Kirk Patrick's 4-level evaluation model, the participant's learning from the training intervention and the evaluation of the behavioral changes associated with the simulation-based training intervention were, respectively, the most and least evaluated areas. Moreover, most simulation-based articles showed good effectiveness in the domains of attitude, knowledge, and skills. The Kirkpatrick model uses a 4-step system to collect data on training interventions and can ensure that training is effectively evaluated. These 4 levels are reaction, learning, behavior, and results (124). One reason for this finding is that as we move up the levels from reaction to results, the data collection and evaluation process becomes increasingly complex, costly, and time-consuming.

### *Limitations*

- In the scoping review method, unlike the systematic review approach, some articles may be overlooked.
- This study exclusively reviewed quasi-experimental research on simulation and excluded true experimental studies.

## Conclusion

Simulation has emerged as a rapidly growing form of education that has transformed medical training. The presence of simulation is an excellent way to increase learners' interest in acquiring practical medical knowledge. With patient safety as its core concept, simulation allows medical learners to make mistakes and learn from them. However, the use of simulation in medical education faces many barriers. One of the most significant obstacles is the lack of recognition and awareness of its benefits. In addition, assembling and transporting simulators requires financial resources and manpower, making it time-consuming. To optimize the use of this method, it is essential to address these barriers effectively.

### *Authors' Contributions*

Z.S. and S.N. conceptualization, Z.N. and A.B., and A.Zh. collected the data, S.Gh. and S.N. wrote the original draft. All authors reviewed the manuscript.

### *Ethical Considerations*

This study received approval from the ethics committee of the School of Medicine at Iran University of Medical Sciences (Code: IR.IUMS.FMD.REC.1403.015).

### *Acknowledgment*

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### *Conflict of Interests*

The authors declare that they have no competing interests.





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*Appendix 1.* The Characteristics of the Final Extracted Articles

| N. | Title | Country Year | Simulation fields | Simulator types | Participant | Kirkpatrick framework | Comparison method | Key Result |
|---|---|---|---|---|---|---|---|---|
| 1 | Impact of a Training Program on Gender-Based Violence of Medical Students: A Quasi-Experimental Simulation Study (20) | Spain 2023 | Gender-based violence | Simulated patient | Medical students | Levels 1 and 2 (knowledge, skills, and attitudes) | N/A | Gender-based violence education with clinical simulations and problem-based videos improves knowledge, skills, and attitudes related to gender-based violence in medical students. |
| 2 | Effects of virtual reality simulation on medical students' learning and motivation in human Parasitology instruction: a quasi-experimental study (28) | China 2023 | Human Parasitology | 3D Virtual Reality | Medical students | Levels 1 and 2 (knowledge, skills, and attitudes) | Online lecture | Learners exposed to simulation-based education exhibited significantly superior knowledge acquisition compared to those receiving traditional lecture-based instruction. Moreover, the simulation group demonstrated markedly better knowledge retention over time. |
| 3 | A combined behavioral economics and simulation-based medical education to promote effectiveness among medical residents in coping with workplace violence In Northern China: a quasi-experimental study (52) | China 2022 | Coping with workplace violence | Role Playing | Medical resident | Levels 1 (Perception, Attitude, and Self-Efficacy) | N/A | The findings indicated that participants in the simulation-based medical education group scored significantly higher in perception, attitude, and self-efficacy compared to those in the control group. |
| 4 | The effectiveness of emergency knowledge training of pediatric medical workers based on the knowledge, skills, and simulation model: A quasi-experimental study (51) | China 2022 | Basic Cardiac Life Support | Role Playing | Hospital medical staff (nurse, doctor, technician) | Levels 1 and 2 (knowledge, skills, and attitudes) | N/A | Pediatric medical staff had significantly higher overall emergency knowledge and teamwork scores after the training course. Medical staff attitudes toward the training were all positive. |
| 5 | Effectiveness of simulation-based cesarean section education on improving nonphysician clinician midwives' competency In performing cesarean section in Ethiopia: A quasi-experimental study (21) | Ethiopia 2023 | Obstetrics and Gynecology, Caesarean Section | Simulation moulage: Mama Birthie CS – simulator | Master of Clinical Midwifery | Levels 1 and 2 (Knowledge, confidence, and skills) | Regular academic exercises (morning meetings, bedside teaching, rounds, and seminars) | Pre-intervention and post-intervention knowledge scores of the intervention and control groups showed a statistically significant difference. In addition, cesarean section skills in the intervention group improved significantly compared to the control group. |
| 6 | The Effect of Expert Patient Simulation on Clinical Judgment: A Quasi-Experimental Study (44) | Ethiopia 2023 | Clinical judgment, skills, and team processes | Simulated patient | Bachelor of Midwifery graduates | Levels 1 and 2 (Satisfaction, knowledge, and self-confidence) | N/A | Clinical decision-making ability and confidence measures showed statistically significant and practical differences between before and after the simulation. |



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| N. | Title | Country Year | Simulation fields | Simulator types | Participant | Kirkpatrick framework | Comparison method | Key Result |
|---|---|---|---|---|---|---|---|---|
| 7 | Comparing the Effectiveness of Role-Play Simulation versus Real Patient Transferal Skills Training in Occupational Therapy for Students Saudi-Arabia- A Quasi-Experimental Study (38) | Saudi-Arabia 2023 | Clinical skills | Role-Playing | Medical students | Levels 2 (Clinical skills) | Real patient | Role-play simulation appears to be an effective method for student training, as no significant differences were observed in patient transfer performance between the simulation and control groups. This finding supports the integration of simulation-based training, particularly in scenarios where direct practice on critically ill patients may pose safety concerns. |
| 8 | Cognitive abilities and medical students' practice of physical exams: A quasi-experimental study (50) | Brazil 2022 | Physical examination | Auscultation simulators and role-playing. | Medical students | Levels 1 and 2 (Satisfaction, knowledge, and self-confidence) | N/A | Evaluation of the 49 participating students revealed statistically significant gains in knowledge and skills across abdominal, cardiac, and pulmonary domains, as well as notable increases in satisfaction and self-confidence. |
| 9 | The impact of using an academic electronic medical record program on First-year nursing students' confidence and skills in using e-documentation: A quasi-experimental study (40) | Australia2023 | Patient electronic medical record | An MR simulation program | Nursing students | Levels 2 (knowledge and self-confidence) | N/A | A total of 105 participants completed the survey. Following engagement with the academic electronic medical record (eMR) program and clinical site attendance, participants demonstrated significant improvements in both confidence and knowledge related to documenting on non-electronic adult observation charts and clinical notes. |
| 10 | The Impact of a New Pedagogical Intervention on Nursing Students' Knowledge Acquisition in Simulation-Based Learning: A Quasi-Experimental Study (84) | Norway 2018 | Deterioration of the patient's condition | Simulated patient | Nursing students | Levels 2 (knowledge) | Patient-based scenarios. | The intervention group scored significantly higher on the post-simulation knowledge test compared to the control group. In both groups, knowledge of symptoms received the highest scores, while knowledge of pathophysiology was the lowest. Notably, the intervention group outperformed the control group in both domains. |
| 11 | Impact of simulation-based training on bougie-assisted cricothyrotomy technique: a quasi-experimental study (55) | China 2024 | Cricothyrotomy | Role-Playing and Moulage | Anesthesiologists | Levels 2 (knowledge and confidence) | N/A | All participants were able to successfully perform the cricothyroidotomy procedure, with a significant reduction in completion time from pre- to post-test (85.0 to 59.0 seconds). Checklist scores improved significantly, and survey results showed increased confidence in all key procedural steps following the training. |
| 12 | Virtual Reality Simulation-Based Clinical Procedure Skills Training for Nursing College Students: A Quasi-Experimental Study (62) | Korea 2024 | Enemas, nasogastric feeding, and catheterization | VR | Nursing students | Levels 1 and 2 (Satisfaction, skill, and self-confidence) | Mannequin | The study found no significant differences between the VR and control groups in confidence, task engagement, or learning satisfaction. However, the VR group showed significantly higher proficiency in nasogastric feeding and key components of catheterization. |
| 13 | Simulation-based mastery improved nursing skills In BSc Nursing Students: a quasi-experimental study (98) | Iran 2020 | Suction, nasogastric tube feeding, packed cell transfusion, change of fluid box | Role-Playing and Moulage | Nursing students | Levels 2 (Skill) | Traditional education | Baseline comparisons showed no significant differences between groups. Post-intervention, both groups demonstrated significant improvement; however, Cohen's test indicated that the simulation-based mastery model was significantly more effective than traditional instruction. |



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| 14 | Effect of standardized patient simulation-based pedagogy embedded with lecture in enhancing mental status evaluation Cognition among nursing students in Tanzania: A longitudinal quasi-experimental study (93) | Tanzania 2024 | Mental health | Simulated patient | Nursing students | Levels 2 (Cognition and skill) | Real patient | Following the training, students in the intervention group demonstrated a significantly greater improvement in psychological status assessment scores compared to the control group. |
| 15 | Efficacy Testing of a Multi-Access Metaverse-Based Early Onset Schizophrenia Nursing Simulation Program: A Quasi-Experimental Study (60) | Korea 2022 | Schizophrenia | Metaverse | Nursing students | Levels 1 and 2 (Satisfaction, knowledge, and skill) | Online lecture | Following the intervention, the experimental group showed significant improvements in knowledge of early-onset schizophrenia, critical thinking, and communication facilitation skills compared to the control group. The metaverse-based nursing simulation program effectively enhanced these core competencies in nursing students. |
| 16 | The effect of simulation-based education on parental management of fever in children: a quasi-experimental study (100) | Iran 2022 | Managing fever in children by parents | Children's models | Parents of children with fever | Levels 1 and 2 (knowledge and performance) | Routine interventions | The intervention group showed a statistically significant improvement in fever management knowledge and practice scores post-intervention, whereas the control group exhibited no significant change. |
| 17 | Effects of a Clinical Simulation-Based Training Program for Nursing Students to Address Social Isolation and Loneliness in the Elderly: A Quasi-Experimental Study (30) | Spain 2023 | Relieving social isolation and loneliness in the elderly | High-Fidelity Practical Training | Nursing students | Levels 1 and 2 (knowledge and attitude) | Asynchronous Theoretical Training | Simulation-based online training significantly improved participants' knowledge, attitudes toward older adults, and ability to address social isolation, with high satisfaction and strong alignment with best educational practices. |
| 18 | The effect of simulation-based advanced cardiac life support training for nursing students' self-efficacy, attitudes, and anxiety In Palestine: a quasi-experimental study (31) | Palestine2023 | Advanced cardiac life support | Interactive simulations | Nursing students | Levels 1 and 2 (attitude, anxiety, and self-efficacy) | N/A | Improvements in self-efficacy were observed following training. Anxiety levels decreased after the simulation, which was statistically significant. Self-efficacy scores were significantly higher after the simulation. |
| 19 | The effect of a simulation-based training program in basic life support on the knowledge of Palestinian nurses: a quasi-experimental study in governmental hospitals (27) | Palestine2023 | Basic Life Support | CPR mannequins | Nursing students | Levels 2 (knowledge) | Conventional adult BLS training | Simulation-based training significantly improved nurses' knowledge, with statistically significant differences in pre- and post-test scores across hospital settings. |



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| 20 | The effects of normal vaginal birth simulation training in the clinical skills of midwifery students: a quasi-experiment study (41) | Iran 2023 | Vaginal delivery | Vaginal birth moulage | Midwifery student | Levels 1 and 2 (knowledge, skill) | lectures and practical work | The difference in skill scores between the groups (intervention and control) was statistically significant. The results showed that in the intervention group, 29 students were assessed from good to excellent, while only ten students in the control group achieved a good level, and the rest were assessed at a low level. |
| 21 | Effectiveness of high-fidelity simulation in training emergency medicine physicians in point of care ultrasonography in Pakistan: A quasi-experimental study (102) | Pakistan 2020 | Focused assessment with sonography in trauma (FAST) | High-fidelity simulation | Emergency physician | Levels 2 (knowledge and interpretation) | N/A | The group's mean and percentage performance improved from 6 and 40 percent before the intervention to 14.5 and 96.6 percent after the intervention. All 31 participants reported improved comfort levels and high self-confidence after attending the workshop. |
| 22 | Simulation Training Program of Pediatric Appropriate Technology Improves Knowledge for doctors and nurses in Zanzibar: A Quasi-experimental Study (94) | Tanzania 2020 | Pediatric knowledge care | Computer-based simulation | Physician and nurse | Levels 2 (knowledge) | N/A | Pediatric knowledge significantly improved post-training (from 44.32 to 82.11, $p < 0.0001$), with pediatric life support as the most effective domain. The passing rate increased markedly, and training effectiveness was similar between doctors and nurses despite a slight pre-test difference. |
| 23 | Does simulation suffice? Teaching procedural skills in undergraduate medical students-observational quasi-experimental study (86) | Poland 2019 | Basic procedural skills | Computer-based simulation | Medical students | Levels 2 (skill) | N/A | Students achieved high final scores, with the integration of simulation techniques, educational videos, and the Python-based approach positively impacting OSCE performance, particularly in invasive procedures such as peripheral venous cannulation and bladder catheterization. |
| 24 | Construction and practice of a comprehensive nursing skills course with simulation in an RN-BSN program in China: a quasi-experimental study (56) | China 2022 | Nursing skills | Role-playing | Nursing students | Levels 1 and 2 (satisfaction, self-efficacy) | N/A | The mean scores for satisfaction, confidence, training exercises, and simulation designs were high. Confidence, active learning, collaboration, support, and problem solving were significantly higher among participants with more work experience compared to those with less experience. |
| 25 | Early Clinical Simulation Exposure May Enhance Academic Performance of Medical Students: A Quasi-Experimental Study in Saudi Arabia (75) | Saudi Arabia 2024 | Clinical skill | Simulated patient | Medical students | Levels 2 (Academic performance) | Traditional education | Exposure to early simulated preclinical courses during the preclinical years has a significant positive impact on student performance in the clinical years of medical school. This promises to reduce the redundancy of medical education and make medical studies more interesting, relevant, contemporary, and practical. Implementing early simulation courses at the preclinical level, with the mandate and support of government initiatives, would be a major step forward in medical education in Saudi Arabia. |
| 26 | Evaluating the impact of hybrid simulation in enhancing the learning domains of medical undergraduates: a quasi-experimental study (105) | India 2024 | Learning domains of medical undergraduates | Simulated patient | Medical undergraduates | Levels 2 (Knowledge, skills, attitude) | Video lectures | All assessment domains in the simulation group showed significant improvement post-intervention, except for the cognitive domain. |



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| 27 | The effect of repeated high-fidelity in situ simulation-based training on self-efficacy, self-perceived leadership qualities, and team performance: A quasi-experimental study in a NICU setting (85) | Belgium 2021 | Self-efficacy and team performance | High-fidelity simulation | Nurse and midwife | Levels 2 (Self-efficacy and team performance) | N/A | Participation in repeated high-fidelity in-situ simulation-based training resulted in a significant increase in self-efficacy ($p < 0.001$) and perceived self-leadership quality ($p < 0.001$). However, the intervention did not lead to a statistically significant improvement in team performance ($p = 0.209$). |
| 28 | The impact of unsuccessful resuscitation and manikin death during simulation on nursing students' resuscitation self-efficacy: A quasi-experimental study (78) | England 2022 | Resuscitation self-efficacy | High-fidelity manikin simulation | Nursing students | Levels 2 (Self-efficacy) | Successful resuscitation | Both groups demonstrated improved self-efficacy following the simulation, and the mannequin's death during resuscitation in the experimental group did not negatively impact resuscitation self-efficacy. |
| 29 | Mindfulness for stress and anxiety management in nursing students in a clinical simulation: A quasi-experimental study (46) | Spain 2023 | Mindfulness | SP | Nursing students | Levels 2 (stress and ) anxiety | Traditional education | The focused online mindfulness intervention proposed in this study reduced physiological parameters, stress, and anxiety in a clinical simulation. |
| 30 | The impact of rapid cycle simulation and deliberate practice on nursing Student's resuscitation self-efficacy: A quasi-experimental study (47) | England 2023 | Resuscitation self-efficacy | Manikin and role-playing | Nursing students | Levels 2 (self-efficacy) | Manikin | Both groups showed improved self-efficacy after the simulation, with a marginal, non-significant difference in post-test scores between the control and experimental groups. |
| 31 | Effect of a Simulation-Based Handover Education Program for Nursing Students: A Quasi-Experimental Design (58) | Korea 2021 | Handover knowledge, Self-efficacy, Handover performance competency | High-fidelity simulation | Nursing students | Levels 2 (knowledge and ) performance) | Traditional education | There was a significant enhancement in handover-related knowledge, self-efficacy, and overall competency in performing handovers. |
| 32 | Clinical simulation in nursing professionals' late retention of knowledge and self-confidence: a quasi-experimental study (87) | Brazil 2022 | Cardiopulmonary arrest situations | High-fidelity simulation | Nursing students | Levels 2 (Self-confidence and Knowledge) | Dialog lecture class | While the experimental group exhibited a notable improvement in self-confidence, there was no significant long-term retention of knowledge. |
| 33 | The effect of simulation-based vaginal birth and obstetric emergency training for health professionals working in emergency department: a quasi-experimental study (106) | Turkey 2021 | Vaginal birth and obstetric emergencies | High fidelity simulator | Physicians and nurses | Levels 1 and 2 (Knowledge level, active learning, team collaboration, satisfaction with learning) | Traditional education method | Participants showed improved knowledge of vaginal birth and obstetric emergencies, with consistently high average ratings in active learning engagement, teamwork, and satisfaction. |
| 34 | Effects of the simulation-based training program on attitudes of nurses towards older adults: a quasi-experimental design study (96) | Turkey 2021 | Attitudes of Nurses Towards Older Adults | High-fidelity simulation with an aged simulation suit | Nurses | Levels 2 (Attitudes) | Traditional education method | Participants demonstrated a marked enhancement in their positive perceptions and attitudes toward older adults. |



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| 35 | Impact of a simulation-based interprofessional workshop (LINKS) on Portuguese healthcare students' Perception of roles and competencies: a quasi-experimental pilot study (42) | Portugal 2023 | Interprofessional Education (IPE) | Simulation-based workshop | Medical and nursing students | Levels 2 (Perception of roles, competencies, attitudes towards teamwork, and collaborative practices) | Traditional medical and nursing education | Improved awareness of IP learning relevance, self-competency in IP practice, and attitudes towards IP teamwork. Statistically significant differences between pre- and post-scores for both groups. Positive feedback for curricular integration. |
| 36 | Ventilator-Associated Pneumonia Bundle of Care Training of Nursing Officers Using Simulation and Its Impact on Their Knowledge and Incidence of Ventilator-Associated Pneumonia: A Quasi-Experimental Study (108) | India 2024 | Ventilator-Associated Pneumonia (VAP) Prevention | Mannequin and simulated patient monitor | Nursing officers | Levels 2 (Knowledge and practice) | Traditional teaching methods (lecture and video demonstration) | The training resulted in a significant improvement in knowledge and clinical practice; however, the reduction in VAP incidence was minimal and not statistically significant. |
| 37 | The Modification of Vital Signs According to Nursing Students' Experiences Undergoing Cardiopulmonary Resuscitation Training via High-Fidelity Simulation: Quasi-Experimental Study (65) | Spain 2018 | Cardiopulmonary Resuscitation (CPR) Training | High-Fidelity Clinical Simulation (HFCS) using a mannequin with physiological responses | Nursing students | Levels 2 (Stress and anxiety levels with learning) | Traditional CPR training | Increased heart rate, stress, and anxiety before simulation; decreased stress and anxiety after repeated simulations. |
| 38 | Can High-Fidelity Patient Simulation Be Used for Skill Development in Junior Undergraduate Students? A Quasi-Experimental Study (49) | China 2023 | Skill Development | High-Fidelity Patient Simulation (HFPS) with structured guidelines | Junior Undergraduate Nursing Students | Levels 2 (Problem-solving (PS) and Clinical Reasoning (CR) abilities) | Standard HFPS without structured guidelines | Significant improvement in Problem-solving and Clinical Reasoning abilities in the intervention group after HFPS with structured guidelines. |
| 39 | The effect of simulation-based education on nursing students' knowledge and performance of adult basic cardiopulmonary resuscitation: A randomized clinical trial (110) | Iran 2020 | Adult basic cardiopulmonary resuscitation (BLS-CPR) | CPR mannequins | Nursing Students | Levels 2 (Knowledge and performance of adult BLS-CPR) | PowerPoint presentation and movies | Improved knowledge and performance scores immediately and three months after the intervention, compared to the control group. |



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| 40 | Clinical simulation in cognitive performance, satisfaction, and self-confidence in learning: a quasi-experimental study (90) | Portugal 2020 | Nursing consultation in community nursing vaccination | Clinical simulation sessions | Nursing Students | Levels 2 (Cognitive knowledge, satisfaction, self-confidence) | Traditional skill class | Improved cognitive performance, satisfaction, and self-confidence in the experimental group compared to the control group. |
| 41 | A quasi-experiment to evaluate the effects of a a blended approach of simulation learning and podcasting on caring behaviors (77) | England 2016 | Nursing caring behaviors | Medium-fidelity simulation scenarios and podcasting | Nursing Students | Levels 2 (Caring behaviors) | High-fidelity simulation learning | Higher scores in caring behaviors in the intervention group post medium-fidelity simulation and podcasting compared to the control group. |
| 42 | Effectiveness and Utility of Virtual Reality in Infection Control Simulation for Children With COVID-19: Quasi-Experimental Study (63) | Korea 2022 | Infection control for pediatric patients with COVID-19 | Virtual Reality Infection Control Simulation (VRICS) | Nursing Students | Levels 1 and 2 (PPE knowledge, infection control performance, self-efficacy, realistic immersion, learner satisfaction) | Traditional instruction without VR simulation | The experimental group showed significant improvements in PPE knowledge, infection control performance, and self-efficacy compared to the control group, along with high satisfaction and immersion scores. |
| 43 | Development of clinical competence by undergraduate students in simulation-based teaching: quasi-experimental study (36) | Brazil 2023 | Clinical competence for coronary syndrome care | High-fidelity simulation | Nursing Students | Levels 2 (Knowledge retention, technical skills, non-technical skills communication) | Traditional theoretical strategies (case study, dialogued theoretical class) | Significant improvement in knowledge retention (87.6% after 30 days), high percentage of correct answers in technical skills (e.g., attaching pulse oximeter, administering medication). |
| 44 | Nursing Student Satisfaction with Crisis Management Game-Based Training: A Quasi-Experimental Study (37) | Iran 2023 | Emergency and crisis management | Game-based training (GBT) | Nursing Students | Levels 1 and 2 (Satisfaction and anxiety) | Case-based training | Improved satisfaction, reduced anxiety, realistic clinical scenarios, decision-making, and increased confidence. |
| 45 | Using Simulation Training to Promote Nurses' Effective Handling of Workplace Violence: A Quasi-Experimental Study (53) | Taiwan 2019 | Workplace violence management for nurses | Real-workplace scenarios | Nursing staff members | Level 2 (Perception of aggression, confidence in coping with patient aggression) | N/A | Significant improvement in self-perception and confidence against workplace violence. |
| 46 | Blended learning and Simulation in nursing education: A quasi-experimental study on a nursing institute (39) | Africa 2023 | Nasogastric tube insertion | Blended learning: e-learning followed by simulation | Nursing Students | Level 2 (Declarative and procedural knowledge, completion time) | Traditional theoretical teaching | Higher declarative knowledge in Simulation and Blended groups compared to Traditional, improved procedural knowledge, and reduced completion time in the Blended group. |
| 47 | Effectiveness of a simulation-based mastery learning to train clinicians on a novel cricothyrotomy procedure at an academic medical centre during a pandemic: a quasi-experimental cohort study (72) | USA 2021 | Cricothyrotomy procedure | Cricothyrotomy simulator | Surgery residents | Level 2 (Cricothyrotomy skills) | Traditional training | All participants scored above the minimum passing standard (93%) at posttest. Significant improvement in cricothyrotomy skills. |



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| 48 | Effects of Standardized Patient Simulation and Mobile Applications on Nursing Students' Clinical Competence, Self-Efficacy, and Cultural Competence: A Quasi-Experimental Study (82) | Vietnam 2024 | Clinical surgical nursing | Standardized patient simulation and mobile applications | Nursing Students | Levels 1 and 2 (Clinical competence, self-efficacy, cultural competence, satisfaction) | Traditional surgical nursing education | Statistically significant improvements in clinical competence, self-efficacy, and cultural competence in the experimental group; High satisfaction with simulation training. |
| 49 | The Changes of Nursing Students' Assessment Skills at a Simulated Setting: A Quasi-Experimental Study (17) | China 2014 | Health assessment skills in nursing | Human patient simulator (SimMan) | Nursing students | Level 2 (Health assessment skills (communication, symptom assessment, physical examination, patient education, history inquiry) | Traditional learning with static manikins and theoretical classes | Overall score of health assessment skills increased from the first session to the last, with significant improvements in communication and symptom assessment. |
| 50 | Clinical simulation as a Nursing Fundamentals teaching method: A quasi-experimental study (89) | Brazil 2022 | Nursing fundamentals skills | Clinical simulation scenario | Nursing students | Level 2 (Knowledge gain in technical-cognitive areas) | | Both groups had cognitive evolution, but the intervention group had a higher knowledge gain than the comparison group (p=0.016). |
| 51 | Development and Effectiveness of a Rapid Cycle Deliberate Practice Neonatal Resuscitation Simulation Program: A Quasi-Experimental Study (61) | Korea 2024 | Neonatal Resuscitation | Rapid Cycle Deliberate Practice (RCDP) simulation | Nursing students | Level 2 (Neonatal Resuscitation knowledge, Neonatal Resuscitation self-confidence, clinical decision-making skills) | Traditional high-fidelity simulation | Significant improvement in clinical decision-making skills, Neonatal Resuscitation self-confidence, and simulation effectiveness in the experimental group compared to the control group; No significant difference in Neonatal Resuscitation knowledge. |
| 52 | Effectiveness of High-Fidelity Simulation in Nursing Education for End-of-Life Care: A Quasi-experimental Design (99) | Pakistan 2020 | End-of-Life Care | High-fidelity simulation using computerized manikins | Nursing students | Level 2 (Attitudes towards care) | N/A | Significant positive attitude change detected. Improved readiness to provide end-of-life care and ability to deal with own emotions. |
| 53 | Effectiveness of simulation-based learning regarding management of post-COVID complications in terms of knowledge, clinical decision-making ability, and self-efficacy among nursing students: A quasi-experimental study (35) | India 2023 | Management of post-COVID complications | Standardized patients | Nursing students | Level 2 (Knowledge, Clinical decision-making ability and Self-efficacy) | Conventional teaching on COVID-19-related topics | The experimental group demonstrated significant improvements in both post-test knowledge and self-efficacy scores. |
| 54 | The effect of simulation on nursing students' knowledge about colostomy irrigation: a quasi-experimental study (34) | Brazil 2019 | Colostomy irrigation | Belly simulator in a laboratory | Nursing students | Level 2 (knowledge retention) | Traditional lecture class with slide presentation and video | The Intervention Group showed significantly better knowledge retention compared to the Control Group. |



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| 55 | The effect of simulation education based on flipped learning on academic engagement, motivation, and performance of nursing students: A quasi-experimental study (22) | Iran 2023 | Nursing skill | Mannequin | Nursing students | Level 2 (Academic performance, learning motivation, and academic engagement) | Instructor-led practical demonstrations | There were no statistically significant differences between the two groups in performance, learning motivation, or academic engagement. |
| 56 | Effectiveness of simulation-based teaching of ventilatory management among non-anesthesiology residents to manage the COVID-19 pandemic - A Quasi experimental cross-sectional pilot study(109) | India 2020 | Ventilatory management of COVID-19 patients | High-fidelity human patient simulator | Clinical specialties | Level 2 (Knowledge and skill) | Traditional didactic teaching. | The study showed a significant improvement in knowledge and skills in ventilatory management among non-anesthesiology residents. The direct observation of procedural skills (DOPS) indicated that 88.4% of trainees met or exceeded expectations. |
| 57 | Simulation-based Interprofessional Education (IPE) for Enhanced Attitude and Teamwork of Anesthesiology Residents and Nurses Anesthesia Students in Iran (32) | Iran 2023 | Teamwork | Mannequin | Anesthesiology residents and nurse anesthesia | Levels 1 and 2 (Knowledge level, active learning, team collaboration, satisfaction with learning) | Routine education. | The intervention group demonstrated a significant improvement in overall attitude and teamwork scores across all subscales—roles and responsibilities, communication, and patient-centered care—post-intervention. |
| 58 | Effectiveness of Simulation-Based Learning In Terms of Competency Regarding Pre-Term Newborn Care Among Nursing Students: A Quasi Experimental Study (23) | India 2022 | Pre-term newborn care | Video demonstrations and hands-on training | Nursing students | Levels 1 and 2 (Knowledge level, active learning, team collaboration, satisfaction with learning) | Traditional teaching methods. | Simulation-based learning enhanced knowledge and clinical decision-making but did not significantly outperform traditional methods in skill acquisition. |
| 59 | Effectiveness of a standardized patient simulation programme in undergraduate nursing students 6 months after Implementation: A quasi-experimental study (24) | Spain 2023 | Communication skills, self-efficacy | Standardized patient | Nursing students | Level 2 (attitude and self-efficacy) | N/A | The study found that students' self-efficacy and perceived communication skills improved and were maintained after six months. Resilience showed improvement even six months following the intervention. In terms of transferring skills to clinical practice, students reported moderate to high use of the communication skills learned in the simulation. |
| 60 | Investigating the Impact of Maternal Birth Simulator Training on Critical Thinking Skills Among the Community Midwife Diploma Students: A Quasi-experimental Study (95) | Pakistan 2024 | Critical thinking skills | Maternal birth simulators | Midwife | Levels 1 and 2 (Critical thinking skills and satisfaction) | Traditional teaching methods. | The study showed that maternal birth simulator training significantly improved the critical thinking skills of Community Midwife students. |



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| 61 | Virtual Simulation for Last-Year Nursing Graduate Students in Times of Covid-19: A Quasi-Experimental Study (67) | Spain 2021 | Nursing Education | Virtual Simulation | Nursing students | Levels 1 and 2 (Knowledge, Skill Acquisition, Satisfaction, and Self-Confidence) | Health-care assistant contract | Knowledge improved post-training, skills acquired were significant, and high levels of self-confidence and satisfaction were achieved. |
| 62 | Simulation Strategies to Develop Undergraduate Nurses' Skills to Identify Patient Deterioration: A Quasi-Experimental Study (101) | Australia 2024 | Patient deterioration | Rapid Cycle Intentional Simulation | Nursing students | Level 2 (Situational awareness, clinical decision-making, appropriate clinical actions, and reducing incorrect clinical actions) | Standard Simulation | Rapid Cycle Intentional Simulation significantly improved student performance in recognizing and responding to patient deterioration and reduced incorrect clinical actions compared to the standard simulation. |
| 63 | A comparison of the effects of teaching through simulation and the traditional method on nursing students' self-efficacy skills and clinical performance: a quasi-experimental study (88) | Iran 2022 | Nursing care | Simulation-based models | Nursing students | Level 2 (Self-efficacy skills and clinical performance) | Traditional teaching method | The intervention led to a significant increase in both the mean self-efficacy scores of the participants and their mean clinical performance scores. |
| 64 | Association between game metrics in a simulation game and nursing students' surgical nursing knowledge –a quasi-experimental study (92) | Finland 2024 | Surgical Nursing Knowledge | Simulation gameplaying | Surgical Nursing Knowledge | Levels 2 (Knowledge) | Traditional methods | The intervention significantly improved students' surgical nursing knowledge, with higher simulation game scores correlating with better performance on the knowledge test. |
| 65 | Simulated directed learning in life education intervention on the meaning of life, positive beliefs, and well-being among nursing students (81) | Taiwan 2019 | Health education | Videos and storytelling | Nursing students | Levels 2 (Knowledge level and perceptions) | Traditional teaching | The intervention led to a significant improvement in the nursing students' meaning of life, positive beliefs, and well-being. Additionally, the mean self-efficacy scores increased significantly, and the mean clinical performance scores rose from 2.16 to 4.57 after the intervention. |
| 66 | Simulation-based medical education: teaching normal delivery on an intermediate fidelity simulator to medical students (19) | Pakistan 2017 | Normal vaginal delivery | Intermediate fidelity simulator | Medical students | Levels 2 (Knowledge level, skill, and perceptions) | Traditional teaching method | The intervention led to significantly better skill performance in the experimental group, with the mean skill performance score in Group B being 8.91±3.20 compared to 5.67±1.84 in Group A. Both groups showed knowledge improvement, as assessed by enhanced scores from pre-test to post-test. |
| 67 | Effects of Simulation on Nursing Students' Knowledge, Clinical Reasoning, and Self-confidence: A Quasi-experimental Study (18) | Korea 2015 | Nursing care | High-fidelity simulation | Nursing students | Levels 2 (Knowledge acquisition, clinical reasoning skill And self-confidence) | Didactic lectures | The intervention significantly improved knowledge and clinical reasoning scores in the simulation group, with higher mean knowledge scores for GI bleed and CS scenarios compared to the control group. |



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| 68 | A time management intervention using simulation to improve Nursing students' preparedness for medication administration in the clinical setting: A quasi-experimental study (112) | Australia 2017 | Preparedness for medication administration | low-fidelity simulated environment | Nursing students | Levels 2 (Perception and ability) | Standard clinical simulated laboratory sessions | The intervention led to significant improvements in perceived preparedness for medication administration in specific areas. Students in the intervention group showed significantly better ability to clarify unclear instructions, monitor patients' conditions post-medication administration, and assess medication effectiveness. |
| 69 | Effects of High-Fidelity Postpartum Care Management Simulation on Nursing Students: A Quasi-Experimental Design (45) | Turkey 2023 | Postpartum care management | High-fidelity simulation | Nursing students | Levels 1 and 2 (Satisfaction and Self-efficacy) | Traditional case study | The intervention led to a significant increase in student satisfaction with the training method. |
| 70 | Call for Activation of Simulation Modules for Nursing Students' Achievement and Satisfaction of Normal Labor: A Quasi-Experimental Study (83) | Egypt 2018 | labor procedures | Mannequin and videos | Nursing students | Levels 1 and 2 (practical skills and satisfaction) | Demonstrations | The intervention group showed significantly greater practical achievement and satisfaction, with notable improvements in labor procedure skills and positive responses to simulation-based learning. |
| 71 | Effectiveness of a Hemorrhage-Control Task Simulator for Training Nursing Students: A Quasi-Experimental Before-After Study (64) | Spain 2024 | Hemorrhage control | High-fidelity simulation scenario | Nursing students | Levels 1 and 2 (Knowledge level, Self-efficacy, practical skills) | N/A | The intervention led to significant improvements in knowledge, self-efficacy, and practical skills among nursing students. Practical skills improved as evidenced by a reduction in the time to control hemorrhage from 76.38 seconds to 41.69 seconds immediately after the intervention. |
| 72 | Effect of simulation on knowledge, self-confidence, and skill performance in the USA: A quasi-experimental study (68) | 2016 USA | Pediatric respiratory patient care | Midlevel-fidelity simulation | Nursing students | Levels 2 (Knowledge, self-confidence, and skill performance) | Traditional teaching method (paper/pencil case study). | Both groups showed significant gains in knowledge and skill performance, with no significant difference between them; however, the case-study group reported higher self-confidence than the mid-fidelity simulation group. |
| 73 | Effect of an educational intervention on nursing knowledge about enteral nutrition therapy: A quasi-experimental study (25) | Brazil 2023 | Enteral nutrition therapy | Clinical simulation scenarios | Nurses | Levels 2 (Knowledge) | N/A | The intervention significantly enhanced nurses' knowledge of enteral nutrition, with large effect sizes across all domains. Participants also reported improved clinical reasoning and positive learning experiences. |
| 74 | Simulation strategies to increase nursing student clinical competence in safe medication administration practices: A quasi-experimental study (69) | USA 2021 | Safe medication administration practices | High-fidelity simulation | Nursing students | Levels 2 (Medication administration knowledge, competency And confidence) | Standard training methods | The intervention significantly enhanced competency and confidence in the intervention group, while knowledge scores increased in both groups without reaching statistical significance. |



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*Appendix 1.* The Characteristics of the Final Extracted Articles

| N. | Title | Country Year | Simulation fields | Simulator types | Participant | Kirkpatrick framework | Comparison method | Key Result |
|---|---|---|---|---|---|---|---|---|
| 75 | Designing and evaluating an Oncologic Emergencies escape room game for undergraduate nursing students: The ONCEM quasi-experimental pilot study (91) | Turkey 2024 | Oncologic emergencies | Escape room game | Nursing students | Levels 2 (Motivation, satisfaction, and Self-confidence) | N/A | The intervention resulted in high student motivation, satisfaction, and self-confidence, along with significant recognition of simulation design features. |
| 76 | The Collaboration Among Pediatric Residents, Nursing and Midwifery Students for Newborn Health: A Quasi-experimental Study on Interprofessional High-Fidelity Patient Simulation (26) | Turkey 2023 | Casualty triage and management skills | Online scenario-based Visually | Emergency nurse | Levels 2 (Knowledge and skill) | N/A | The intervention significantly enhanced students' casualty triage and management skills, with notable pre- to post-assessment score increases. Positive feedback indicated VEMS was perceived as an effective educational method. |
| 77 | Saving patient x: A quasi-experimental study of teamwork and performance in simulation following an interprofessional escape room (70) | USA 2021 | Teamwork and communication | An escape room followed by a high-fidelity simulation | Nurse and pharmacy | Levels 2 (Attitudes and performance) | Traditional interprofessional simulation | Students who completed the escape room before the simulation showed higher simulation performance scores, reflecting improved teamwork, though changes in teamwork perception did not differ significantly between groups. |
| 78 | The effect of escape room clinical evaluation method on satisfaction, learning, and preparedness to practice as interns of nursing students (103) | Iran 2022 | Clinical nursing skills | Escape room | Nursing students | Levels 1 and 2 (Satisfaction and practice) | Traditional clinical evaluation | The study highlighted significant improvements in teamwork, problem-solving, critical thinking, communication, and clinical skills. Students reported high satisfaction levels and enhanced learning post-test compared to pre-test. |
| 79 | Impact of high-fidelity simulation exposure of nursing students with their objective structured clinical examination: A quasi-experimental study (29) | Saudi Arabia 2023 | Clinical decision-making, clinical judgment, and nursing skills | High-fidelity simulation | Nursing students | Levels 2 (Performance) | Traditional clinical training | Students with High-fidelity simulation exposure demonstrated significantly higher OSCE scores compared to those without. This indicates that High-fidelity simulation training effectively enhances students' clinical reasoning, decision-making, and judgment, making it a valuable addition to nursing education. |
| 80 | Effect of case study versus video simulation on nursing students' satisfaction, self-confidence, and knowledge: A quasi-experimental study (71) | USA 2019 | Clinical reasoning and care for cardiac patients | Video simulation | Nursing students | Levels 2 (Satisfaction, self-confidence, and Knowledge) | Written case studies | While both methods improved satisfaction and self-confidence, video simulations demonstrated better knowledge scores and engagement, particularly for visual learners. Participants valued the realistic and interactive nature of video simulations, which helped them connect theoretical knowledge to clinical practice. |
| 81 | The effectiveness of a simulation game on nursing students' self-evaluated clinical reasoning skills: A quasi-experimental study (97) | Finland 2020 | Clinical reasoning skills | A three-dimensional simulation game | Nursing students | Levels 2 (Skill) | N/A | The study found significant improvements in clinical reasoning following the simulation game, highlighting the effectiveness of gamified simulations. |



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| 7 | Title | Country Year | Simulation fields | Simulator types | Participant | Kirkpatrick frame-work | Comparison method | Key Result |
|---|---|---|---|---|---|---|---|---|
| 82 | Development and Evaluation of a Pediatric Nursing Competency-Building Program for Nursing Students in South Korea: A Quasi-Experimental Study (57) | Korea 2021 | Pediatric nursing | Simulation scenarios | Nursing students | Levels 2 (Performance) | Case reports | The program significantly enhanced pediatric nursing competency and clinical performance in the experimental group, though no significant differences were observed in problem-solving ability. |
| 83 | Real-world virtual patient simulation to improve diagnostic performance through deliberate practice (73) | USA 2021 | Diagnostic reasoning | Virtual Patient | Medicine residents | Levels 2 (Skill) | N/A | After 9 hours of Virtual Patient-based deliberate practice, interns improved their diagnostic accuracy from 33% to 50% and imaging appropriateness from 33% to 65%. |
| 84 | Evaluation of nurs-ing process compe-tencies, nursing quality, and patient safety using virtual simulation with debriefing: A quasi-experimental study (33) | Thailand 2023 | Nursing care quality | Virtual video simulation | Nursing students | Levels 2 (Performance) | Virtual training | Virtual video simulation combined with immediate debriefing can effectively improve nurses' competencies in the nursing process, nursing care quality, patient safety, and reduce care left undone. This educational approach is particularly valuable in contexts like the COVID-19 pandemic, where traditional training methods were disrupted. |
| 85 | Comparison of the effects of simulation training and prob-lem-based scenarios on the improvement of graduating nurs-ing students to speak up about medication errors: A quasi-experimental study (80) | Taiwan 2020 | Medication safety and communication skills | Video-based simulation | Nursing students | Levels 2 (Skill) | N/A | Both simulation training and problem-based scenarios improved students' ability to identify and report medication errors, but simulation training yielded significant-ly better results. Experimental group students improved their error-reporting rate more effectively than the control group. |
| 86 | Does Clinical Simu-lation Learning Enhance Evidence-Based Practice? A Quasi-Experimental Study Involving Nursing Students (66) | Spain 2024 | Evidence-based practice | High-fidelity simulation | Nursing students | Levels 2 (Performance) | N/A | The study demonstrated significant im-provement in students' Evidence-based practice skills and knowledge after the high-fidelity simulation program. Partici-pants' scores in these dimensions in-creased significantly, while the attitude dimension showed positive, but not statis-tically significant, changes. |
| 87 | High-fidelity simu-lation versus case-based discussion for training undergradu-ate medical students in pediatric emer-gencies: a quasi-experimental study (104) | Brazil 2024 | Pediatric emergency care | High-fidelity simulation | Medical students | Levels 2 (Knowledge, self-confidence, and performance) | Case-based discussion | Both high-fidelity simulation and case-based discussion improved self-confidence and knowledge scores significantly, with no differences between groups in these aspects. However, HFS was superior to case-based discussion in enhancing clini-cal reasoning, communication, attitude, and leadership, as measured through simulation checklists. |
| 88 | The impact of simulated operating rooms in a clinical skill center on operating room students' skills and satisfaction: A semi-experimental study (107) | Iran 2024 | Operating room skills | Simulated operating rooms | Operating room students | Levels 1 and 2 (Skill and satisfaction) | Traditional training in the Clinical Skills Center | The intervention group demonstrated significantly higher skills and satisfaction levels, with students in the simulated environment outperforming the control group in both areas. |



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| 89 | Addressing Culturally Based Hidden Bias and RacisM (A-CHARM) Using Simulation Experiences, Nik's Story: A Quasi-Experimental Study (74) | Canada 2024 | Cultural humility and cultural diversity | Virtual simulation | Nursing students | Levels 2 (Knowledge) | Traditional training | Simulation-based education enhances clinical reasoning, decision-making, and teamwork in nursing students. High-fidelity and virtual simulations improve cultural awareness and professional judgment, preparing students for real-world challenges. Escape room activities boost teamwork performance, while cultural humility training fosters inclusive and empathetic care. |
| 90 | Effect of Training on the Use of Personal Protective Equipment Equipment by Simulation Method on the Level of Occupational Anxiety of Nurses Working in Intensive Care Units of COVID-19 (43) | Iran 2023 | Proper use of personal protective equipment | Interactive simulation | Nurses | Levels 2 (Skill) | N/A | Despite structured sessions, anxiety levels remained unchanged post-intervention. The study suggests integrating simulation with other educational methods for better stress management. Combining approaches may enhance both skill acquisition and emotional resilience. |
| 91 | Implementing simulation in oncology Emergencies education: A quasi-experimental design (76) | Jordan 2019 | Oncology emergencies | High-fidelity simulation | Nursing students | Levels 1 and 2 (Knowledge, self-confidence, and satisfaction) | Traditional face-to-face teaching | High-fidelity simulation with debriefing significantly enhanced nursing students' knowledge, self-confidence, satisfaction, and self-efficacy in managing oncology emergencies, supporting its effectiveness for complex clinical training. |
| 92 | Development and evaluation of a neonatal intensive care unit medication safety Simulation for nursing students in South Korea: a quasi-experimental study (59) | Korea 2022 | Medication safety in neonatal intensive care units | Scenarios with high-fidelity mannequins | Nursing students | Levels 2 (Knowledge and performance) | Traditional learning guide | The experimental group showed significant gains in communication clarity and patient safety competency, with simulation effectively enhancing students' ability to address medication errors in the NICU. |
| 93 | Effectiveness of a Game-Based Mobile App for Educating Intensive Critical Care Specialist Nurses in Extracorporeal Membrane Oxygenation Pipeline Preflushing: Quasi-Experimental Trial (48) | China 2023 | Pipeline preflushing skills | Game-based mobile app | Nurses | Levels 2 (Skill) | Traditional face-to-face teaching | At the end of the study, both groups showed improved ECMO preflushing theory and skill scores, with the experimental group performing significantly better than the control group. |
| 94 | Investigating the impact of virtual simulation experiment and massive open online course (MOOC) on medical students' wound debridement training: a quasi-experimental study (54) | China 2024 | Wound debridement techniques | Virtual simulation | Medical students | Levels 1 and 2 (Knowledge, skill, and satisfaction) | Massive Open Online Course (MOOC) | The experimental group, which used the virtual simulation model, had significantly higher theoretical test scores, better animal experiment report scores, and shorter operation times compared to the control group. Additionally, the experimental group reported higher satisfaction with the teaching method and believed it to be a trend for future medical education. |
| 95 | The Effect of Integrated Simulation Experiential Learning Disaster Nursing for Enhancing Learning Outcomes Among Undergraduate Nursing Students: A Quasi-Experimental Study (79) | Taiwan 2024 | Disaster nursing | Integrated Simulation Experiential Learning | Nursing students | Levels 2 (Knowledge, attitudes, and satisfaction) | Traditional classroom | The Integrated Simulation Experiential Learning model led to significant enhancements in nursing students' knowledge, satisfaction, attitudes, and self-confidence compared to traditional methods, with the most marked improvements observed in knowledge and satisfaction, where the intervention group outperformed the control group. |



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