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## EDITED BY

Teresa Martins,  
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## REVIEWED BY

Maria Rui Sousa,  
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Escola Superior de Enfermagem do  
Porto, Portugal  
Elisangela Argenta Zanatta,  
Universidade do Estado de Santa  
Catarina, Brazil

## \*CORRESPONDENCE

Bárbara Letícia de Queiroz Xavier  
✉ barbaraleticiaqx@hotmail.com

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# Clinical simulation with cyber patients in nursing education: a scoping review

Bárbara Letícia de Queiroz Xavier\*,  
Vinícius Rodrigues de Oliveira, Thais Targino Ferreira,  
Larissa Lilian Costa Firmino Segundo,  
Yasmim Yngrid Fernandes de Freitas and  
Richardson Augusto Rosendo Da Silva

Federal University of Rio Grande do Norte, Natal, Brazil

This study aimed to identify and map the existing evidence on clinical simulation with cyber patients in order to determine whether this strategy can fill existing scientific gaps and clarify its use in the teaching and learning process in nursing education. This is a scoping review, with a protocol registered on the Open Science Framework (OSF), DOI 10.17605/OSF.IO/GAXR6. For the development of this review, the guidelines and steps outlined in the Joanna Briggs Institute (JBI) Reviewer's Manual were followed. The search was conducted across 13 national and international databases. Articles, dissertations, and theses that addressed the academic training of nursing students using cyber patient simulation studies were selected, with no restrictions regarding location, time, or language. These studies were subsequently analyzed by two independent reviewers, with a third reviewer added to make the final decision. The final sample consisted of 24 studies out of the initial 6,669 identified, the majority of which originated from developed and developing countries. None of the selected studies specified the curriculum component in which clinical simulation was used, nor whether there was an interest in linking it to specific curricular components. Regarding the skills targeted through simulation, the main ones identified were: clinical, practical, communication, decision-making, and critical thinking skills. It can be inferred that simulation with cyber patients allows students to learn from mistakes without compromising patient safety and fosters the development of critical thinking, satisfaction, and self-confidence. Additionally, it presents a favorable cost-benefit ratio, as it proved to be a more affordable option compared to mannequin-based simulation.

## KEYWORDS

clinical simulation, simulation training, nursing education, computer simulation, communication, simulated patient

## 1 Introduction

Technology is a major ally in the advancement of education, transforming and complementing traditional teaching in schools, colleges, and universities (Batista and Cunha, 2021). Clinical simulation is a technology that employs one or more strategies to promote, enhance, or validate competencies. Competency is understood as the process of acquiring and building knowledge, skills, and attitudes within a social, cultural, historical, and political context (Kassutto et al., 2024).

Among innovations in education, the discovery and use of active methodologies have been on the rise. Clinical simulation is a teaching strategy that improves student engagement and reduces dropout rates in educational processes, while also assessing both technical and non-technical competencies, such as communication and professionalism (Soares and Azevedo, 2022).

Clinical simulation enhances the importance of patient safety by allowing learners to act without the risk of errors caused by inexperience, for example (Campanati et al., 2022). Similarly, virtual patient simulation is a new and emerging pedagogy that overcomes challenges such as the cost of maintaining physical objects and devices, the need for a specific environment, and limitations in availability. It also offers advantages like flexibility, freedom from spatial or temporal constraints, and the ability to repeat simulations multiple times (Banjo-Ogunnowo and Chisholm, 2022).

The Cyber Patient is an innovative simulation solution for acquiring knowledge and practical experience in a virtual environment, offered asynchronously. This technology allows students to interact with simulated patients and practice their clinical skills in a virtual clinical setting (Mukharyamova et al., 2020).

As the number of nursing students in higher education increases and technological advancements reach universities, the demand for clinical experiences also grows, as this is an essential part of the program. Clinical practice can then be conducted at any time, without the need for in-person interactions (Wiese et al., 2021).

Furthermore, considering its innovative character in health and nursing practice, education, and research, and its potential for simulating real clinical situations—enabling observation, decision-making, reflection, and greater student satisfaction—the Cyber Patient is seen as a valuable educational tool. It creates an environment that encourages student interest in further learning stages and integrates with face-to-face practice. It is an effective and lower-cost tool for students and professionals to vigorously develop clinical skills, and it may open new pathways for future educational research (Farahmand et al., 2020).

Positive effects from the incorporation of clinical simulation in nursing education have been observed. These effects have been confirmed by high-level evidence studies, such as systematic literature reviews and clinical trials. Ma et al. (2023) demonstrate that simulation-based education significantly contributed to improving communication skills and students' ability to handle complex situations, as well as promoting greater engagement and motivation in the learning process.

A clinical trial conducted by Costa et al. (2020) with nursing students found that, compared to traditional teaching, clinical simulation was more effective, as students were able to assimilate more information in less time and with higher quality. In addition, students whose learning process was based on clinical simulation showed greater confidence during the execution of professional nursing practices.

Other authors also highlight additional benefits of using clinical simulation in nursing education, such as enhanced decision-making abilities and clinical reasoning. However, these authors also point out some emerging demands, such as the need to update

academic curricula to include the topic of clinical simulation and the need for tools to assess students within the context of each curricular component, considering the dynamic nature of nursing practice (Görücü et al., 2024).

Cyber patient simulation is a digital and interactive learning method that focuses on developing cognitive and relational skills such as clinical reasoning and decision-making through interactions with virtual patients. Unlike traditional mannequin-based simulations, it does not involve hands-on training of technical skills, but offers a safe environment to practice complex scenarios, usually accessible online or offline. This approach complements other types of simulation and is especially useful for enhancing critical thinking and clinical judgment in nursing education, providing a clear distinction for readers less familiar with clinical simulation.

Although clinical simulation is well established as a widely used pedagogical strategy, especially in face-to-face contexts and with mannequins, the specific application of simulation with cyber patients in nursing education remains an emerging and underexplored field in the scientific literature. This gap may stem from the recent incorporation of advanced digital technologies into health education, which involves technical, pedagogical, and infrastructural challenges that not all institutions can quickly overcome.

Furthermore, existing discussions often address clinical simulation in a generic manner, without detailing the particularities and potential of cyber patients, which represent a type of simulation emphasizing cognitive and relational competencies such as clinical reasoning and decision-making as opposed to technical skills practiced in traditional simulations. This lack of detail contributes to the limited debate on the topic, especially at the national level, where these technologies are less widespread.

Therefore, this review aims to fill this gap by clarifying key concepts, mapping current applications, and identifying the benefits and limitations of cyber patient simulation in nursing education. The results are expected to provide a solid foundation to guide researchers, educators, and administrators in effectively incorporating this technology, fostering future research and curricular innovations that can enhance the quality and impact of nursing education.

In light of this gap and the need to develop increasingly effective, emotionally and psychologically safe simulated practices in the training process of the current generation of nursing students, this study aims to map the evidence regarding the use of cyber patient simulation in nursing education as a strategy to support the teaching and learning process.

## 2 Materials and methods

This is a scoping review with a protocol registered on the Open Science Framework (OSF), DOI 10.17605/OSF.IO/GAXR6. These reviews are characterized by examining a broad topic, mapping the literature in a specific field of interest, and identifying key concepts, theories, evidence, or research gaps (Levac et al., 2010). They can also be used to explore emerging areas and in situations where the

lack of evidence prevents the development of systematic reviews (Peters et al., 2020).

For the development of this review, we followed the guidelines of the Joanna Briggs Institute (JBI) Reviewer’s Manual, which outlines the steps of a scoping review as follows: (1) defining and aligning the objectives and research questions; (2) developing and aligning the inclusion criteria; (3) describing the search for evidence, selection, data extraction, and presentation of evidence; (4) evidence searching; (5) evidence selection; (6) evidence extraction; (7) evidence analysis; (8) presentation of results; and (9) summary of evidence, conclusions, and implications of the findings (Peters et al., 2020).

The research was conducted in 2024. Between May and July, the selection stages were carried out, including searches in databases, exporting to Rayyan software, and article screening. From August to October, the review was analyzed and written.

## 2.1 Definition and alignment of objectives and research questions

To define the research question, the PCC mnemonic was used, which highlights the population, concept, and context, as shown in Table 1 below:

## 2.2 Development and alignment of inclusion criteria according to the objectives and research questions

To be eligible for inclusion in the sample of this study, the following criteria were considered: type of publication (articles, dissertations, or theses), target population (undergraduate nursing students), research scope (focused on the academic training of nursing students using clinical simulation with a cyber or virtual patient), and availability of the full text.

It is important to highlight that, regarding publication availability, the authors made efforts to minimize exclusions related to this criterion by accessing platforms funded by the Brazilian Ministry of Education, which provide broad access to various journals worldwide. The following were excluded: reflection papers, editorials, and review studies (regardless of type). No restrictions were imposed regarding location, period, or language, to broaden the scope of research results.

## 2.3 Description of evidence search, selection, data extraction, and presentation

To identify relevant studies, multidisciplinary electronic databases in health sciences and repositories of theses and dissertations were used.

Peer-reviewed literature sources included: Cumulative Index to Nursing & Allied Health Literature (CINAHL); Medical Literature Analysis and Retrieval System Online (Medline)/PubMed; Embase;

TABLE 1 Scope review question according to PCC strategy.

Question	Population (P)	Concept (C)	Context (C)
What evidence is available on the use of clinical simulation with cyberpatient in the teaching/learning process of undergraduate nursing students?	Undergraduate nursing students	Virtual patient	Teaching/learning process

Source: Developed by the author (2024).

Web of Science (WOS); and Education Resources Information Center (ERIC).

Gray literature was searched in the following sources: CAPES Theses and Dissertations Catalog; DART-Europe E-Theses Portal; Electronic Theses Online Service (EthOS); Scientific Open Access Repository of Portugal (RCAAP); National ETD Portal; Theses Canada; Latin American Theses Portal; and WorldCat Dissertations and Theses.

The search strategy involved the identification of descriptors and keywords, beginning with an exploratory search to identify the main Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS) related to the topic. To identify relevant studies and expand results across databases, the search strategy was built using controlled vocabularies (DeCS and MeSH), free-text terms, and subject descriptors.

A search was also conducted to identify relevant synonyms and keywords. The search strategy was subsequently expanded, reviewed, and refined by a librarian. We emphasize that it was not necessary to contact the authors of the included studies, as the information available in the articles identified within the initial pool of 6,669 records, was sufficient for the screening and data extraction processes. Table 2 presents the complete search strategy, based on the consulted sources.

## 2.4 Evidence search

After data collection, the records were identified, grouped, and imported into Rayyan software to manage study selection and duplicate removal. Titles and abstracts were screened in pairs using the inclusion and exclusion criteria established in the research protocol. In cases of disagreement, consensus was sought, and final decisions were made by a third reviewer.

## 2.5 Evidence selection

Following title and abstract screening, the metadata of eligible publications were retrieved and organized in a Microsoft Excel® database (2021 version). Full-text articles were read in pairs to determine inclusion or exclusion from the final sample. All information regarding the inclusion of studies, eligibility criteria, and reasons for exclusion was documented in a flowchart following the PRISMA-ScR guidelines (Moher et al., 2018).

TABLE 2 Complete search strategy.

Data source	Search strategy
CINAHL	SU “Simulation Training” OR AB “Simulation Training” OR SU “Interactive Learning” OR AB “Patient Simulation” OR SU “Patient Simulation” OR SU “High Fidelity Simulation Training” OR AB Telesimulation OR SU “Virtual simulation” OR TI ciberpatient OR SU ciber-patient OR MH “computer simulation” OR SU “computer simulation” SU “Computer-assisted learning” AND (MH Students OR SU Student* OR MH “Students, Nursing” OR SU “Pupil Nurse” OR SU “Nursing Student*” OR MH nurs*) AND SU “Training Technique” OR TI Teaching OR MH “Teaching Methods” OR AB “Academic Training” OR SU “Educational Technic” OR MH Learning OR SU “Learning Methods”
Medline/Pubmed	(“Simulation Training”[Mh] OR “Interactive Learning”[title] OR “Patient Simulation”[Mh] OR “High Fidelity Simulation Training”[Mh] OR Telesimulation[title] OR “Virtual simulation”[title] OR ciberpatient[text word] OR ciber-patient[text word] OR “computer simulation”[title] OR “Computer-assisted learning”[title]) AND (Students[Mh] OR Student* [title] OR “Students, Nursing”[Mh] OR “Students, Nursing”[tiab] OR “Pupil Nurse”[tiab] OR “Nursing Student*”[tiab]) AND (“Training Technique”[title] OR Teaching[Mh] OR Teaching[title] OR “Teaching Method”[title] OR “Academic Training”[title] OR “Educational Technic*”[title] OR Learning[Mh] OR Learn* [title]) Após resultado incluir o filtro – NOT (Animals[Mh] NOT humans[Mh])
Web of Science	TS=(“Simulation Training” OR “Interactive Learning” OR “Patient Simulation” OR “High Fidelity Simulation Training” OR Telesimulation OR “Virtual simulation” OR ciberpatient OR ciber-patient OR “computer simulation” OR “Computer-assisted learning”) AND TI=(Student* OR “Students, Nursing” OR “Pupil Nurse” OR “Nursing Student”) AND TI=(“Training Technique” OR Teaching OR “Teaching Method” OR “Academic Training” OR “Educational Technic*” OR Learning)
Embase	“Simulation Training” OR “Interactive Learning” OR “Patient Simulation” OR “High Fidelity Simulation Training” OR “simulation-based training” OR Telesimulation OR “Virtual simulation” OR ciberpatient OR ciber-patient OR “computer simulation” OR “computational simulation” OR “computer-based simulation” OR “Computer-assisted learning”:ti,kw,ab AND (“Nursing Student” OR “nurse student” OR “Pupil Nurse” OR Nurs*):ti,kw,ab AND (“Training Technique” OR Teaching OR “Teaching Method” OR “Academic Training” OR “Educational Techn*” OR Learning OR “learning situation” OR “knowledge acquisition”):ti,kw,ab
Centro de Informações sobre Recursos Educacionais (ERIC)	Descriptor:“Computer Simulation” OR descriptor:“Computer Assisted Instruction” AND descriptor:“Nursing Students” OR descriptor:“Nursing Education” OR nursing AND descriptor:Learning OR Instrution
Catálogo de Teses e Dissertações da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)	“Simulação clínica” OR “clinical simulation” OR “Simulação de Paciente” OR “Patient Simulation” AND “Enfermagem

(Continued)

TABLE 2 (Continued)

Data source	Search strategy
Portal de Teses Eletrônicas DART-Europa	Clinical simulation AND nursing
Serviço online de Teses Eletrônicas (EthOS)	Clinical simulation AND nursing
Repositório Científico de Acesso Aberto de Portugal	Clinical simulation AND nursing
Portal Nacional de ETD	“Clinical simulation” AND nursing
Teses Canadá	Clinical simulation
Portal de Tesis Latinoamericanas	“Simulação clínica” OR “clinical simulation” OR “Simulação de Paciente” OR “Patient Simulation” AND Enfermagem OR nursing
Dissertações e Teses sobre Gatos do Mundo	Clinical simulation “AND” nursing “AND” Learning

Source: Developed by the author (2024).

2.6 Data extraction

A data extraction tool was developed in accordance with the objective and guiding question of this review. The extracted data were organized in a spreadsheet created in Microsoft Excel 2021, including information on: type of publication, year of publication, country of origin, academic background of the first author, study objective, methodological design, technology theme, target population, educational level, purpose of the technology, technology validation, concept of cyber patient, impacts of technology use, and limitations to its application.

2.7 Evidence analysis

The findings were analyzed qualitatively based on the Content Analysis method proposed by Bardin (2016). As recommended by the author, this analysis was carried out in three stages: pre-analysis, material exploration, and interpretation of results.

In the pre-analysis stage, the authors performed an initial reading of the selected studies to gain familiarity with the material and form preliminary impressions of the content.

In the material exploration stage, an immersive, thorough, and repeated reading of the material was conducted, focusing on relevant information and content similarities. These were examined and grouped into two thematic categories: characterization of the review studies and skills developed through clinical simulation using cyber patients.

Finally, during the result interpretation stage, meanings were assigned to the findings through inferential techniques, aiming to answer the research questions and discuss the outcomes in light of the scientific literature.

## 2.8 Presentation of results

The extracted data were synthesized and presented in descriptive tables, aligned with the study's objective and guiding question. The results were described in full, in narrative form, following the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR).

## 2.9 Summary of evidence, conclusions, and implications of the findings

Following the completion of the previous stages, the results of the scoping review were summarized and linked to the study's objective. Accordingly, the study's conclusions were substantiated and presented. Knowledge gaps that may arise during the development of the scoping review were highlighted to guide future research.

## 3 Results

A total of 6,669 studies were identified through the database searches, of which 1,179 were excluded due to duplication. This exclusion occurred after the articles were exported to Rayyan software. Thus, 5,490 studies were selected for the peer screening process, during which titles and abstracts were read and the eligibility criteria applied. At this stage, 5,371 studies were excluded, and 119 were selected for further assessment. Of these, 57 were deemed unsuitable after content analysis due to misalignment with the scope of the present study. A third reviewer was consulted to decide on the inclusion or exclusion of the conflicting studies, resulting in the exclusion of 45 studies. Consequently, 74 studies remained and were read in full. After this review, the final sample consisted of 24 selected studies, as shown in [Figure 1](#). Of the selected documents, 22 (91.7%) were journal articles and two (8.3%) were theses, published between 2010 and 2022, with a higher concentration of publications in the last 6 years, particularly in 2020 (25%). It is noteworthy that no publications were identified in 2011 or 2012. The studies in the sample showed high homogeneity regarding language, with publications in English (91.7%) or Portuguese (8.3%).

The studies were conducted in 15 different countries, with the United States being the most represented (25%), followed by Brazil, South Korea, Malaysia, and Spain (8.3% each), with only one study selected from each of the remaining countries. Regarding study design, quasi-experimental studies were predominant (37.5%), followed by mixed-methods studies (20.8%) and descriptive (qualitative) studies (12.5%).

A detailed description of the studies included in the sample is presented in the table below:

It was observed that none of the selected studies specified the curricular component in which the clinical simulation took place or whether there was an interest in relating it to specific curricular components. Regarding the target skills addressed through simulation, the main ones were clinical, practical, communication, decision-making, and critical thinking skills. The lack of detail on

the curricular component in the selected studies reflects a gap often observed in the literature on clinical simulation. Previous reviews point out that many studies focus on validating the effectiveness of simulation in acquiring specific skills, without integrating it in an articulated way into institutional curricular planning ([Elvén et al., 2023](#)). These are listed in [Table 3](#).

## 4 Discussion

This lack of formal integration limits the ability to scale up simulation interventions as an integral part of the core curriculum. An integrated curriculum model that combines simulation with theoretical and clinical blocks in a progressive manner promotes the development of clinical competencies and critical thinking in a more systematic way ([Silva et al., 2023](#)).

The virtual simulation environment offers students the opportunity for repetitive training, greater control over their actions, and represents a viable teaching alternative. When well-structured, it enables a consistent learning process ([Huddar et al., 2021](#)). Recent studies provide evidence that simulation activities in education frequently involve various dramatized scenarios, including patient simulators, trained individuals acting as patients, mannequins, or computer software ([Handeland et al., 2021](#)).

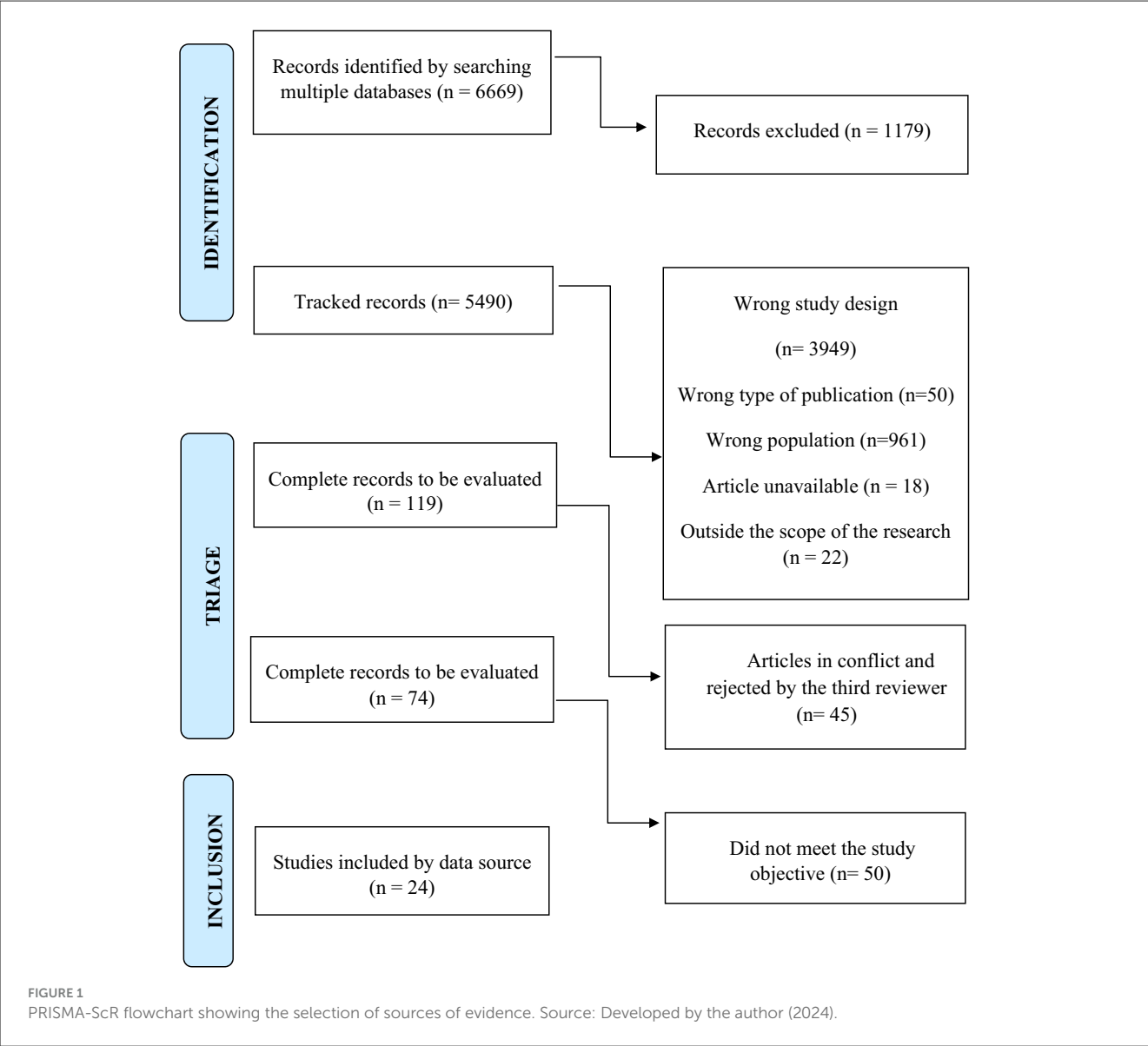
Moreover, some studies suggest that nursing students feel more confident participating in virtual simulations, as it represents a safe environment for practice. The use of cyber patients has proven to be a methodological support tool for applying skills previously acquired by students, allowing them to experience both theoretical and practical components. This enables continuous improvement and provides greater opportunities for the development of clinical reasoning through the use of virtually simulated scenarios ([Redmond et al., 2020](#)).

Considering that nursing work processes require practical skills combined with clinical reasoning—both essential for care—experimental teaching methods have shown that the implementation of scenarios and simulation programs offers students better opportunities to understand clinical practices and to take initiative in decision-making. This contrasts with students who rely exclusively on clinical practice and traditional academic environments. Virtual Simulation has proven to be promising and essential for developing critical thinking skills in nursing, decision-making, communication, practical abilities, and clinical reasoning ([Riancho et al., 2015](#)).

Furthermore, the creation of a cyber patient facilitates the visualization of a patient, making simulation a useful tool for deepening understanding of the proposed subject ([Hirano et al., 2016](#)). It also allows students to learn from mistakes without compromising patient safety ([Jiménez-Rodríguez and Arrogante, 2020](#)).

In the past decade, nursing education has incorporated simulation as an innovation in learning. Research conducted between 2014 and 2017 indicated that simulation is an effective form of education, going beyond the traditional clinical learning model ([Huddar et al., 2021](#)). The use of cyber patients offers students a safe environment, real-time feedback, and the chance to practice skills they may not otherwise observe in real-life settings. This has proven





beneficial to nursing students’ clinical practice knowledge (Al Gharibi and Arulappan, 2020).

In a study conducted with third-year nursing students, participants reported improved knowledge in patient management, increased awareness of clinical issues, better recognition of nursing roles, and the development of non-technical skills such as active listening, communication, empathy, and trust-building (Jiménez-Rodríguez et al., 2020).

Evidence shows that cyber patient simulation is a more affordable option when compared to mannequin-based simulation. In a comparative study, the cost-effectiveness of both methods was found to be generally equivalent; however, cyber patient simulation was up to three times more economical. While cyber simulation costs approximately one dollar, mannequin-based simulation costs just over three dollars. This confirms it as an active and accessible methodology, broadening its usability for universities with limited resources (Haerling, 2018).

During the debriefing process, nursing students reflect on their simulation experience, having the opportunity to review their assessments, nursing interventions, observations, and patient responses. This process facilitates students’ analysis of their own thought processes and allows instructors to provide feedback and evaluate participants’ rationale for their interventions (Shea, 2015).

Simulation becomes a teaching strategy because it requires active learning and immediate feedback from the technology used. In this setting, students have autonomy within the scenarios and are free from interruptions and distractions caused by other participants. It also offers students the opportunity to interact with clinical scenarios and patients on interactive platforms with realistic features. Compared to traditional study methods, which offer limited experiences, simulation with a cyber patient allows students to repeatedly practice the same scenario and receive feedback (Turrisse et al., 2020), thereby enhancing the quality of practical experiences and developing an innovative pedagogy for undergraduate nursing education (Hudder et al., 2021).

TABLE 3 Studies in the sample.

Author, year, country, and language of publication	Study design	Aim of the study	Main results
Razak, R. A.; Hua, K. B., 2013/Malásia/Inglês	Descriptive study (qualitative)	To find out whether first-year nursing students are able to learn and develop psychomotor skills for basic nursing care using a web-based learning environment.	Web-based learning not only provided students with a powerful tool for instruction, but also gives them a new insight into different learning methods. Bandura and Vgotsky's social learning theory and scaffolding in the researcher offers promising instructional learning results as indicated in the analysis. Therefore, these learning theories of constructivism promote and build students' cognitive and psychomotor skills.
Foronda, C. et al., 2014/EUA/Inglês	Pre-test and post-test study of a group	Evaluating a virtual simulation intervention to teach leadership styles to students in a master's program in nursing education.	The students showed an improvement in cognitive knowledge after the virtual simulation exercise. With the use of virtual media, simulation is expanding, as are educational research efforts.
Georg, C.; Zary, N., 2014/Suécia/Inglês	Mixed methods design	Developing and evaluating a virtual patient model optimized for learning and evaluation needs in nursing education.	A Nursing Design Model of the virtual patient was developed consisting of three layers. Layer 1 contains the patient's history and ways of interacting with the data, Layer 2 includes aspects of the iterative clinical reasoning process and, finally, Layer 3 includes measurable outcomes.
Shea, K., 2015/EUA/Inglês	Mixed methods study	Comparing two debriefing methods: the traditional method and Debriefing for Meaningful Learning DML.	There were no statistically significant differences in the evaluation scores. The data from the DML and the Simulation and Debriefing questionnaire suggested that the students valued the role of nursing, teamwork and communication experiences during the simulation.
Moule, P. et al., 2015/Reino Unido/Inglês	Mixed-methods design	Develop five online PV simulation scenarios to meet the learning needs of nurses and healthcare professionals caring for men with prostate cancer.	The majority of interviewees reported an increase in knowledge and suggested that they would recommend the resource to others. Some positive aspects of the resource were highlighted. Interviewees also commented on areas of weakness, some of which were addressed later.
Günay Ismailoglu, E.; Zaybak, A., 2017/Turquia/Inglês	Quasi-experimental study	To compare the effectiveness of a virtual intravenous simulator with a plastic arm model in teaching intravenous catheter insertion skills to nursing students.	The results indicated that psychomotor skills and satisfaction scores were higher in the experimental group, while clinical psychomotor skills and self-confidence scores were similar in both groups. More students in the control group reported experiencing symptoms such as cold and sweaty hands, significant restlessness and tense muscles than those in the experimental group.
Bortolato-Major, C., 2017/Brasil/Português	Intervention study longitudinal and quantitative	Evaluating the contribution of teaching based on high-fidelity simulation to the development of clinical skills by nursing students.	The results showed that simulation-based teaching promoted stress control, self-confidence, reflective thinking through debriefing and the satisfaction of nursing students with their learning.
Haerling, K. A., 2018/EUA/Inglês	Quasi-experimental study	Comparing the learning outcomes between students who took part in mannequin-based simulation activities and students who took part in virtual simulation activities.	There were no significant differences in quantitative measures of learning or performance between participants in the virtual and mannequin-based simulation groups.
Peddle, M. et al., 2019/Austrália/Inglês	Case studies	To explore what participants learned about non-technical skills after interactions with virtual patients.	Overall, students from both years and universities reported that interactions with virtual patients developed knowledge and skills in all categories of non-technical competencies, to varying degrees. Third-year students suggested that interactions with virtual patients enabled the development of knowledge and skills, as well as the practice of selected non-technical competencies in the clinical environment.
Foronda, C. L. et al., 2018/EUA/Inglês	This is a mixed-methods design with a qualitative, descriptive and quantitative approach.	To explore the preferences and perceived learning outcomes of pre-licensure nursing students who engaged in a virtual simulation experience using vSim for nursing.	Around half of the students (49%) agreed or strongly agreed that the virtual simulation was easy to navigate. 32% answered "neutral" and 19% disagreed or strongly disagreed. When asked if the content was directly relevant to their role as a nurse, 89% agreed or strongly agreed, 9% were neutral, and 2% disagreed or strongly disagreed.
Santos, E. C. N.; Mazzo, A., 2018/Brasil/Português	Experimental, randomized study.	Comparing clinical simulation simulator with a simulated patient.	This study presents relevant results relevant, as it shows high levels of satisfaction, self-confidence and knowledge of the simulation in both groups after the simulated practices.
Khraisat, A. M. S. et al., 2020/Malásia/Inglês	Descriptive study	Creating a simulation in an online course using a three-dimensional learning management system in a virtual learning environment.	The objective-based evaluation was carried out by measuring learning outcomes through the Structured Objective Clinical Examination and the pre-post IMI knowledge gain test, which was tested primarily with a pilot group and then administered to both the intervention and control groups.

(Continued)

TABLE 3 (Continued)

Author, year, country, and language of publication	Study design	Aim of the study	Main results
Redmond, C. et al., 2020/Irlanda/Inglès	Descriptive study (qualitative)	Developing a virtual patient with a chronic wound and evaluating the perceived learning gains from engaging with this resource.	This study provides evidence that virtual simulation allows nursing students the opportunity to practice skills and utilize theory repeatedly in a safe environment, without being hindered by a lack of resources such as clinical placement availability and a declining faculty.
Kang, K. A. et al., 2020/Coreia do Sul/Inglès	Quasi-experimental study	To examine the learning effects of vSim by comparing three different educational modalities on nursing care for children with asthma.	vSim* stands out as an effective educational simulation method. Simulation practice using vSim combined with high-fidelity simulation can be an effective educational method for nursing students. The study can be considered evidence of the need for an educational method, such as vSim, that enables self-practice repetitive before the high-fidelity simulation, instead of applying only the high-fidelity simulation, to maximize the educational effects and improve clinical performance. *Online training platform.
Jiménez-Rodríguez, D. et al., 2020/Espanha/Inglès	Descriptive study (qualitative)	Exploring third-year nursing students' perceptions of simulated video nursing consultations.	The nursing students indicated that they had improved their knowledge of GBV victim management (mainly their awareness of the problem, recognition of the role of professional nursing and performance of non-technical skills), although they also mentioned the need for ongoing training.
Jiménez-Rodríguez, D.; Arroigante, O., 2020/Espanha/Inglès	A descriptive cross-sectional study.	To explore the satisfaction and perceptions of undergraduate nursing students about simulated video consultations using the high-fidelity simulation methodology.	A mixed method was used with 93 undergraduate nursing students, using a satisfaction questionnaire (quantitative data), which included a section of observations (qualitative data). Of the total sample, 97.8% of the students expressed high overall satisfaction with the simulated consultation video, highlighting its practical usefulness and positive learning outcomes.
Kang, S. J.; Hong, C. M.; Lee, H., 2020/Coreia do Sul/Inglès	Pre-test and post-test study of a group	Comparing critical thinking disposition and self-directed learning ability before and after virtual simulation among Korean nursing students.	There were no statistically significant differences between the assessments of critical thinking or self-directed learning skills before and after the virtual simulation. However, a subscale on self-directed learning ability, "gathering resources for learning," showed statistical significance.
Wiese, L. K.; Love, T.; Goodman, R., 2021/EUA/Inglès	Randomized quasi-experimental study.	To investigate whether nursing students with a bachelor's degree, before obtaining their license, acquired more knowledge from a live or virtual disaster simulation.	The students retained more empirical knowledge after the virtual task compared to the disaster simulation, except for two items relating to triage. Neither age, years of schooling nor GPA affected the test results. However, the students' own assessment of learning did not differ between the live and virtual simulations.
Hudder, K. et al., 2021/Canadá/Inglès	Quasi-experimental study	To fill the gap in knowledge about the effectiveness of a virtual simulation compared to traditional laboratory-based learning to support students' knowledge, skills and self-confidence in newborn care.	The results show that the students' acquisition of knowledge about assessing newborns is greater when the content and demonstration were given through virtual simulation, but the students' satisfaction and self-confidence were greater with the opportunity to take part in face-to-face laboratory activities.
Chang, H.-Y. et al., 2021/Taiwan/Inglès	Randomized experimental study	To test the hypothesis that nursing students who have used a mobile learning application.	The implementation of a mobile application for simulation learning had a positive impact on the knowledge and skills performance of nursing students, as well as reducing the cognitive load of learning.
Hosseini, M.; Ahmady, S.; Edelbring, S., 2022/Irà/Inglès	Quasi-experimental study.	Investigating the effects of using a virtual patient simulator on the acquisition of clinical decision-making skills in nursing students during the COVID-19 pandemic.	The clinical decision-making ability of nursing students was compared before (48/04 ± 12/77) and immediately after the training (91/49 ± 7/66) using paired tests, and a statistically significant difference was found ( $P = 0.009$ ). In addition, before the intervention, most students were thinking analytically (63/80%) and making clinical decisions, while after the intervention, most students had an analytical-intuitive model of clinical decision-making (63/80%).
Manik, M. et al., 2022/Indonésia/Inglès	Mixed methods design	Describe the perspectives of Indonesian nursing students regarding the use of vSim for NursingTM.	The results showed that 14% of respondents strongly agree and 54% agree that virtual simulations are easy to use. Around 54% of respondents agreed and 32% strongly agreed that the content of the virtual simulation was relevant to the nurse's role was relevant to the nurse's role, with the majority of respondents (92%) supporting future use.

(Continued)



TABLE 3 (Continued)

Author, year, country, and language of publication	Study design	Aim of the study	Main results
Chang, C.-Y.; Kuo, S.-Y.; Hwang, G.-H., 2022/Taiwan/Ingls	Quasi-experimental study	To explore the application of chatbot technologies and their effectiveness in nursing education.	The knowledge-based chatbot system group had better critical thinking when compared to the conventional teaching group. In addition, the knowledge-based chatbot system can effectively increase students' satisfaction with learning when compared to conventional teaching.

Source: Developed by the author (2024).

Because this type of simulation allows students to practice in controlled environments, they are able to train repeatedly without causing real harm to patients, as the simulations are virtual. It also allows them to connect theoretical knowledge with practice, thus improving decision-making skills (Hosseini et al., 2022). This modality provides a safe environment and, with technological advances, enables repetitive training in a risk-free setting (Kang et al., 2020).

It is important to highlight that simulation scenarios cannot fully replicate the essence of real-life situations that students may encounter in professional practice. These situations involve individual aspects of each clinical case, as well as the psychosocial and cultural uniqueness of the individuals who seek healthcare services (Redmond et al., 2020).

Although students view virtual simulation positively in terms of knowledge acquisition, clinical simulation in laboratory settings was better received as a tool for increasing self-confidence and satisfaction (Hudder et al., 2021). Some challenges presented by simulation include technical issues, such as internet connection failures (Jiménez-Rodríguez and Arrogante, 2020).

In simulated scenarios, the simulated patient allows for the integration of both technical and non-technical skills and competencies. However, dramatization has certain limitations, as not all procedures can be performed on simulated patients. To address this challenge, some studies used a hybrid patient model, such as combining a pelvic model with a simulated patient during catheterization practice (Santos and Mazzo, 2018).

Learning methods should encourage students to actively experiment with their skills and knowledge, as this can enhance their understanding of the nurse's role (Handeland et al., 2021).

In some studies, it was shown that in simulation activities, participants expressed an intention to focus on safety if they were to repeat the scenario. In contrast, participants using mannequin-based models focused on communication. This highlights the importance of investing in simulation design resources aimed at specific learning outcomes, improving the participant experience, and mitigating any negative effects of stress on learning (Haerling, 2018).

5 Limitations of the study

Based on the review conducted, the gaps identified within the researched scope include the lack of comparative studies regarding the use of simulation in nursing practices within a multidisciplinary team, with a focus on the same central

theme and on the clinical problem-solving capacity of each team member. Additionally, comparisons across different periods during undergraduate studies are lacking, which would help assess leadership capacity and confirm theoretical learning through health practices that more closely reflect real-world situations at any level of healthcare delivery.

Among the fully reviewed and selected studies, no clear correlation was found between simulation and specific curricular components. These observations suggest the need for further exploration of these issues, as previously highlighted by other researchers, who identified them as gaps that should be addressed in the scientific literature through future studies and applied simulated educational practices.

6 Conclusion

It can be inferred that cyber patient simulation provides nursing students with increased confidence through repetitive training. Moreover, scenarios developed through simulation programs offer students improved opportunities to develop clinical practices and take initiative in decision-making.

Simulation with virtual patients allows students to learn from mistakes without compromising patient safety. Key elements of the teaching/learning process such as the development of critical thinking, satisfaction, and self-confidence were highlighted across the studies reviewed. In terms of cost-effectiveness, this type of training proved to be a more affordable option when compared to mannequin-based simulation.

Author contributions

BQ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. VR: Conceptualization, Data curation, Formal analysis, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. TT: Data curation, Formal analysis, Software, Writing – original draft. LL: Data curation, Formal analysis, Software, Writing – original draft. YF: Data curation, Formal analysis, Software, Writing – original draft. RA: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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