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Virtual Simulation as a Teaching Strategy for Basic Life Support in Nursing Education: A Systematic Review

I Putu Juni Andika[1*], Seftiani Utami[2], Dian Putranto[3]
[1] *Kosala Panti Health Science College, Central Java, Indonesia*
[2] *Faculty of Health, Sumbawa University, Sumbawa Besar, West Nusa Tenggara*
[3] *RSUD dr. H. Soewondo Kendal*
**Corresponding author: juniputudtd@gmail.com*

ABSTRACT

Background: Certain training programs, like Basic Life Support training, must change to comply with the new social and physical distancing policies. Health care workers, including nursing students, may benefit from Virtual Simulation, instruction, in order to help them meet the Basic Life Suppport competencies. Therefore, innovation in learning methods through virtual simulation is needed to provide interactive and realistic learning experiences, as well as to enhance students' knowledge, clinical skills, critical thinking, and self-confidence before entering clinical practice."

Objectives: To examine the effectiveness of virtual simulation as a learning approach for Basic Life Support among nursing students.

Methods: The literature search was conducted across several databases, including Google Scholar, databases including ScienceDirect, Web of Science, and PubMed, covering studies published between 2019 and 2023. A total of 4,725 articles were initially identified. After title screening (N = 2,310) and abstract evaluation (n = 703), 75 full-text articles were reviewed. Finally, 15 studies that met the inclusion criteria were analyzed. Both English and Indonesian language publications were considered, following the PRISMA guidelines.

Results: Demonstrates the emergence of a new virtual simulation learning model that is combined with video-based instruction. During the course of the eight-hour intervention up to two weeks, several indicators of improvement were noted, including resiliency, self-efficacy, understanding, attitudes, skills, and ability to perform resuscitation. In addition, three articles with statistically significant results indicate that the mixed model is more effective when combined with e-learning websites and computer-based simulations. Three articles discuss that, out of the four blended learning models, the most effective parameter is the understanding capacity.

Conclusion: This indicates that BLS training should utilise a virtual simulation learning model that takes infrastructure, facilities and training modules into consideration.

Keywords: basic life support, nursing students, systematic review, virtual simulation

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BACKGROUND

Cardiac arrest represents a medical emergency that requires immediate intervention through Basic Life Support (BLS). According to the American Heart Association (2020), BLS encompasses all necessary actions aimed at preserving life during life-threatening situations. BLS, also referred to as Cardiopulmonary Resuscitation (CPR), involves a series of measures designed to restore and maintain the function of vital organs in individuals experiencing cardiac and respiratory arrest. These measures include performing chest compressions and providing ventilatory assistance (Ngirarung, Mulyadi, & Malara, 2017).

Each year, Europe reports around 275,000 out-of-hospital cardiac arrests, while the United States records about 420,000. Emergency medical services (EMS) handle approximately 38–55 cardiac arrest cases, yet survival from out-of-hospital resuscitation in North America remains below 5%. Data from the Resuscitation Guidelines indicate that 22.4% of 33,874 in-hospital cardiac arrest cases survive. These figures suggest high mortality rates both inside and outside hospitals, underscoring the need for better EMS response. The World Health Organization (2021) further reports that heart disease causes 17.8 million deaths annually, accounting for one-third of all global fatalities.

Everyone from children to the elderly should acquire Basic Life Support (BLS) knowledge and skills. Health students play a vital role as agents of change in advancing community health. Their mastery of BLS is a key factor in determining the success of cardiac arrest resuscitation efforts (Yunus et al., 2015). Therefore, developing effective learning methods is essential to enhance nursing students' understanding and performance of BLS procedures for cardiac arrest cases.

Teaching and learning activities, one of which occurs in the scope of nursing, has begun to apply the student center learning (SCL) method as an effective and efficient method of learning. In this method, students are made the center of the learning process and students are required to understand and be able to develop this knowledge (Huriah et al., 2018). However, according to (Choi, He, Chiang, & Deng, 2020, the current reality, students lack experience in treating patients. Therefore, a new innovation in learning methods is needed to improve the quality of nursing education (Choi et al., 2015). Simulation learning activities have been carried out from time to time. The face to face method has become a habit in the campus environment, especially nursing. Some experiences of the simulation method, face to face is one of the challenging ways for students because it provides opportunities for critical thinking, but this method is very time-constrained. The era of globalization requires everyone to create other innovations such as virtual simulation.

Virtual simulation refers to a learning approach that uses computer-based systems to replicate real-world scenarios in an interactive and immersive three-dimensional (3D) environment. This method enables participants to engage in realistic experiences by exploring roles and dynamic situations that closely resemble actual clinical settings. Effective visualization in such simulations allows learners to understand contextual and physical changes within the simulated environment. Moreover, virtual simulation enhances students' comprehension of real-life situations, facilitates the observation of internal human anatomy, and supports faster acquisition of practical skills through experiential learning (Aebersold et al., 2018). Consequently, virtual simulation provides nursing students with broader opportunities to develop and refine their nursing competencies prior to clinical placements (Tutticci et al., 2018). As a pedagogical tool, clinical virtual simulation serves as a medium to strengthen knowledge, promote clinical reasoning, increase learning satisfaction, and ultimately improve students' self-efficacy (Padilha et al., 2019).

ISSN: 2614-3488 (print); 2614-3496 (online) Vol.9 No.1. October 2025. Page.163-176

OBJECTIVE

The aim of this systematic review is to present evidence regarding the effectiveness of virtual simulation as a learning approach in Basic Life Support (BLS) training for nursing education, both within academic settings and clinical environments, and to examine its impact on nursing students' knowledge levels.

METHODS

This systematic review was designed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and (PRISMA) guidelines (Moher et al., 2010). As stated by Aromataris and Pearson (2014), the main objective of a systematic review is to provide an objective and comprehensive synthesis of existing studies within a single scholarly work. The process involves identifying relevant literature, applying inclusion and exclusion criteria, conducting critical appraisals, and extracting data all of which should be performed by independent reviewers to minimize potential bias or human error that could influence the results. In this context, conducting a systematic review was considered the most appropriate approach to thoroughly explore current evidence on virtual simulation in Basic Life Support (BLS), including its influence on students' knowledge acquisition, skill retention, and overall impact on nursing education and daily practice (Aromataris & Pearson, 2014).

Search strategy
Google Scholar, PubMed, Sciene direct, to identify studies published from 2019 to 2023. text terms in the search "Basic Life Support" AND "Virtual Simulation" AND "Nursing Education" A range of keywords was utilized to identify relevant studies. The review included only peer-reviewed publications written in English and conducted on human participants. Additionally, manual searches of reference lists and other related materials were carried out to complement the database results. The complete search strategy is illustrated in Figure 1.

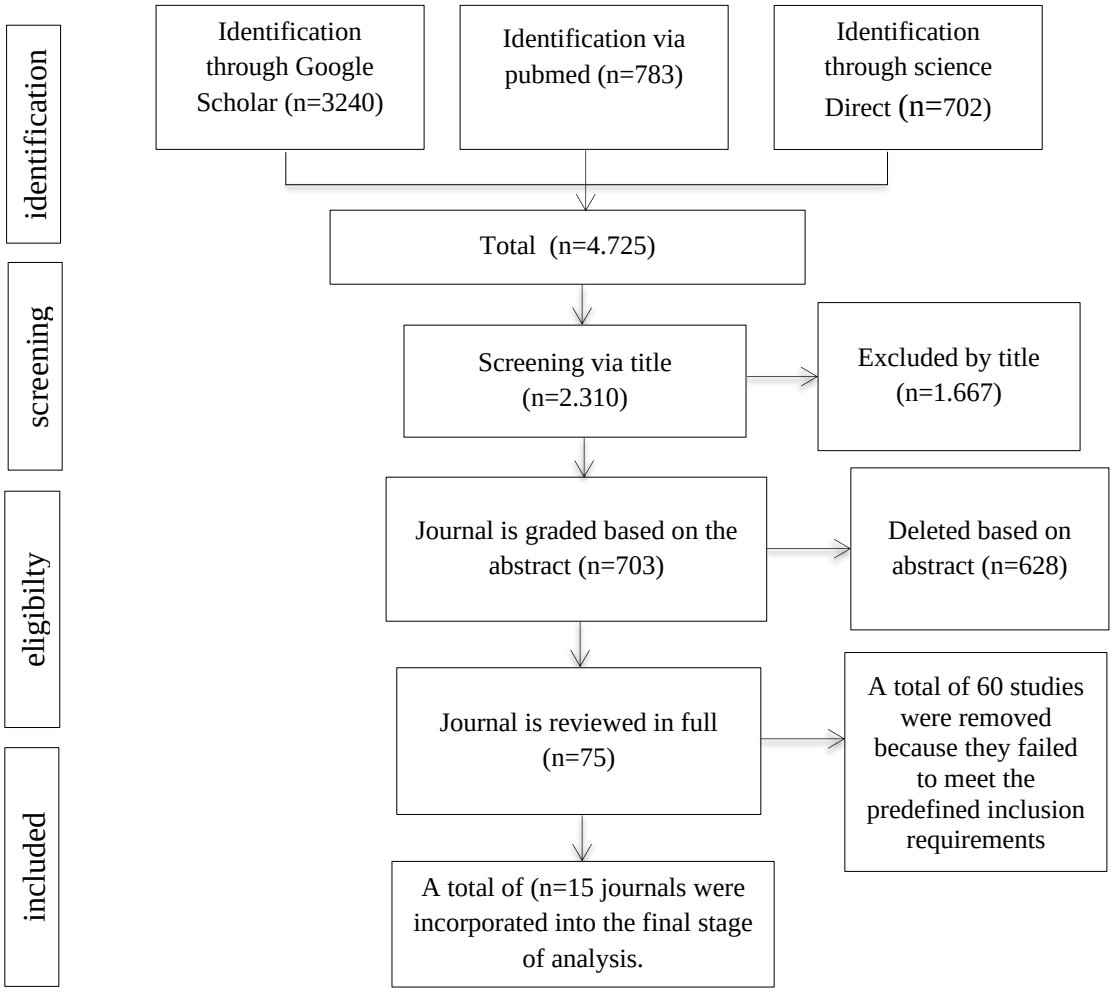
Eligibility Criteria for the Study

Research articles were considered eligible if they explored the impact of virtual or VR-based Basic Life Support (BLS) simulations on nursing students' retention of BLS-related knowledge, skills, attitudes, and their perceived application of BLS (see Table 2). To be included in this review, studies were required to meet the following criteria:

- Population: Primarily nursing students.
- Intervention: Implementation of Basic Life Support training or simulation activities.
- Outcomes: Evaluation of BLS effectiveness through either objective or subjective measures, including BLS competency, safety and rescue performance, and nursing students' attitudes and perceptions toward the use of virtual BLS simulations.

ISSN: 2614-3488 (print); 2614-3496 (online) Vol.9 No.1. October 2025. Page.163-176

Figure 1. PRISMA



The studies analyzed in this systematic review comprised a total of fifteen research articles. Five studies were conducted in Indonesia, involving laboratory settings, classrooms, and nursing departments. Two studies originated from the United States, carried out in laboratories, simulation education centers, and clinical learning environments. One study from Taiwan was implemented in both laboratory and classroom contexts. A study from Turkey utilized classroom and virtual simulation game settings. Two studies from Brazil were conducted in laboratories and classrooms using simulation-based learning. Additionally, one study from Italy applied virtual simulation in a classroom environment, one from Germany took place in a laboratory and virtual simulation education center, one from Spain in a laboratory-based virtual simulation center, and one from Hungary employed virtual simulation within a classroom setting. The research included in this review was conducted between 2019 and 2023.

Table 1. Overview of Literature Search Results for the Systematic Review

No	Author, year and country	Title and Study design	Simulation type	Intervensi	Sample	Conlusion
1	Rahmawati &	The Effect of Simulation Of	Manikin (viartual	one group pre-test post-	N = 61	Nursing students'

ISSN: 2614-3488 (print); 2614-3496 (online) Vol.9 No.1. October 2025. Page.163-176

	Sulistiya Ningsih, (2020) Bengkulu, Indonesia	The Basic Life Support Tranning On Nursing Student"s Knowlegde (pre-experimental study)	simulation) of CPR, LCD, laptop	test approach		knowledge is good because with the training of basic life support (BHD) through viatual simulation, nursing students are more confident and able to provide assistance in cases of cardiac arrest.
2	Chang et al., (2019) Taiwan	A situation-based flipped classroom to improving nursing staff performance in advanced cardiac life support training course (Quasy-experiment)	Videos showing and virtual simulasi correct postures for CPR (BHD).	Pretest-posttest	N=60	The results showed that student nurses who learned with the proposed BHD-related virtual simulation approach had better learning achievement, motivation, and satisfaction.
3	Yudha Chrisanto & Novitasari, (2023)	Effect Of Basic Life Support Training Simulation (BHD) On	Simulasi BTCLS	Pretest-posttest	N=32	Knowledge and motivation of students after

ISSN: 2614-3488 (print); 2614-3496 (online) Vol.9 No.1. October 2025. Page.163-176

	Lampung, Indonesia	Knowledge And Motivation Of Students About Handling Traffic Accident Incidents (A quantitative, using a quasi-experimental design)				virtual simulation of basic life support (BHD) training There are good changes in knowledge and motivation.
4	Karolyne et al., (2018) Brazil	Development of a virtual simulation game on basic life support (Qualitative)	Role Playing Game – educational simulation game about basic life support	Role Playing Game – educational simulation	N=60	Learning with visual simulation can support the teaching of basic life support (BHD) techniques for nursing students stimulating the development of learning strategies.
5	Jamil & Merisdawati, (2022), Malang, Indonesia	Effectives Of Blended Learnig Basic Life Support (BHD) Tranning On Knowlegde Of Student Nurisng (Preexperimental Study)	Virtual-simulation CPR (BHD) training	Pretest-posttest	N=229	There is an effect of BLS (BHD) training using virtual simulation with nursing students' knowledge of cardiac arrest

						management.
6	Aksoy et al., (2019) USA	Performance Monitoring via Functional Near Infrared Spectroscopy for Virtual Reality Based Basic Life Support Training (Crossectional)	3D Medsim VR Simulation of Basic Life Support (BHD)	group 3 (With Prior VR experience/prior BLS Knowledge)	N=22	Scores obtained from VR-based BLS simulation related to Basic Life Support (BHD) as an effective tool for assessment that supports nursing student simulation educators by improving cognitive during training.
7	Rahmawati & Ningsih, (2020) Bengkulu, Indonesia	Effectiveness Of Audiovisual-Based Tranning On Basic Life Support Knowlegde Of Student Nursing In Bengkulu (quasi-experiment)	BHD simulation video, cardiopulmonary resuscitation (CPR) phantom	Pretest-posttest	N=64	Audiovisual simulation-based training is effective in improving students' knowledge of basic life support (BHD).
8	Castillo et al., (2023) Spain	Efficacy of Virtual Reality Simulation in Teaching Basic Life Support and Its Retention at 6 Months	Virtual simulation of Basic Life Support	Control group – experimental group	N=241	Learning with VR simulation there is an increase in knowledge and skill competenc

		(Experimental study)				ies in training, Basic Life Support (BHD).
9	Nur et al., (2023) Yogyakarta, Indonesia	Basic Life Support Training: The Effectiveness and Retention of The Distance-Learning Method (quasi-experimental study)	Online simulasi *Basic Life Support*	one group pre-test and post-test	N=64	Distance learning method with online simulation for BHD training effectively improves nursing students' BHD knowledge and skills.
10	Aksoy, (2019) Turkey	Comparing the effects on learning outcomes of tablet-based and virtual reality-based serious gaming modules for basic life support training: Randomized trial (a randomized)	Game Virtual simulasi *Basic Life Support*	Pretest-posttest	N=50	The results showed that virtual simulation games are more effective in learning Basic Life Support (BHD).
11	Veloso et al., (2019) Brazil	Learning by teaching basic life support: a non-randomized controlled trial with medical students (A non-randomized controlled trial)	Simulasi *Basic Life Support*	Pretest-posttest	N=92	The medical students who graduated through the Basic Life Support (BHD) simulation teaching activity

						had superior theoretical and practical performance than the control group.
12	Ingrassia et al., (2020) Italy	Augmented Reality Learning Environment for Basic Life Support and Defibrillation Training: Usability Study (Kuantitative, Experiment)	Virtual Reality simulasi *Basic Life Support*	Kuesioner	N=62	AR Simulation of Basic Life Support (BHD) is very effective in applying in nursing education in improving knowledge and skills.
13	Moll-Khosrawi et al., (2022) Germany	Virtual reality as a teaching method for resuscitation training in undergraduate first year medical students: a randomized controlled trial (controlled randomized study)	Virtual Reality simulasi *Basic Life Support*	Pretest-posttest	N=104	BHD training with VR Simulation seems to be superior in teaching technical Basic Life Support skills.
14	Francis et al., (2020) USA	Operating Room Virtual Reality Immersion Improves Self-Efficacy Amongst Preclinical Physician	VR simulasi *Basic Life Support*	Group intervensi dan group control	N=52	The results are very significant, providing objective data that can be used for Basic Life

		Assistant Students (Randomized double-blinded controlled experi- ment)				Support by incorporating VR simulation as a learning tool.
15	Kovács et al., (2019) Hungary	The timing of testing influences skill retention after basic life support training: a prospective quasi-experimental study (quasi-experimental study)	Virtual simulasi *Basic Life Support*	Post-test	N=464	Testing skills during BHD training using VR simulation is very effective.

Methodology Characteristics

Of the 15 articles reviewed, ten articles used a quasy-experimental study research design (Chang et al., 2019; Ingrassia et al., 2020; Jamil & Merisdawati, 2022; Kovács et al., 2019; Nur et al, 2023; Rahmawati & Ningsih, 2020; Rahmawati & Sulistiya Ningsih, 2020; Yudha Chrisanto & Novitasari, 2023), three articles used a randomized controlled trial research design (Aksoy, 2019; Moll-Khosrawi et al., 2022; Veloso et al., 2019), one article used a crossectional research design (Aksoy et al., 2019) and one study used a qualitative design (Karolyne et al., 2018).

Simulation type

This review emphasizes the use of virtual simulation, including manikins and digital simulation systems, for several reasons. Manikins integrated with virtual simulation provide more advanced features and realistic physiological responses, resulting in a stronger impact on learners. Virtual simulation has been effectively utilized for both educational purposes and the evaluation of clinical competencies. The use of virtual or augmented reality (VR/AR)–based assessments is recognized as one of the most effective approaches for evaluating clinical and physical examination skills in nursing and medical education. Compared to conventional testing methods, learner assessments conducted through virtual simulation are considered more precise and reliable. Overall, this review highlights that virtual reality–based simulations and manikins represent the most frequently applied types of simulation in nursing education.

RESULTS

From the total of fifteen reviewed studies, six articles reported that nursing students who participated in Basic Life Support (BLS) learning through virtual simulation demonstrated higher learning achievement, stronger motivation, and greater satisfaction with the learning process (Aksoy, 2019; Chang et al., 2019; Jamil & Meirisdawati, 2022; Karolyn et al., 2018; Rahmawati & Sulistiya Ningsih, 2020; Yuldha Chrisanto & Novitasari, 2023).

Meanwhile, five other studies indicated that the use of virtual reality–based simulation contributed to improved knowledge acquisition, competence, and practical skills in Basic Life Support training (Aksoy et al., 2019; Castillo et al., 2023; Francis et al., 2020; Ingrassia et al., 2020; Kovács et al., 2019).

Intervention method of providing Basic Life Support (BHD)

Among the fifteen reviewed studies, five implemented a scenario-based intervention conducted inclassroom and laboratory settings by integrating virtual reality simulations into nursing education curricula. This approach aligns with competency development in procedural skill courses or practice-based learning, such as Basic Life Support (BLS) training (Aksoy et al., 2019; Castillo et al., 2023; Chang et al., 2019; Jamil & Meirisdawati, 2022; Kovács et al., 2019; Rahmawati & Sulistiya Ningsih, 2020). Two other studies applied intervention methods using virtual games designed to simulate BLS procedures (Aksoy, 2019; Karolyn et al., 2018). The virtual simulation strategy is recognized as one of the most effective digital learning approaches to enhance nursing students' understanding (Moll-Khosrawi et al., 2022). The use of this method has been shown to positively influence nursing education by improving students' self-efficacy, knowledge acquisition, and learning experiences, ultimately leading to better performance outcomes when compared with pre-test results prior to the intervention (Yuldha Chrisanto & Novitasari, 2023).

DISCUSSION

Based on the analysis of fifteen reviewed studies, the following discussion can be presented. Training in Basic Life Support (BLS) using virtual simulation has been shown to enhance nursing students' competence and confidence in performing resuscitation procedures effectively. This approach helps prepare them to act as capable responders during emergency situations. Nursing students demonstrated effective use of virtual simulation and manikin-based learning methods. Overall, the performance scores related to Basic Life Support implementation increased significantly after receiving training according to the established BLS sequence (Rahmawati & Sulistiya Ningsih, 2020).

Nursing students who engaged in Basic Life Support (BLS) training through the proposed virtual simulation approach demonstrated higher levels of learning achievement, motivation, and satisfaction (Chang et al., 2019). Following the virtual BLS simulation, students showed notable improvements in both knowledge and motivation. These changes indicate that virtual simulation-based training is an effective strategy to achieve the intended learning objectives. Moreover, the use of virtual simulation as a teaching method has proven to be highly effective, as it enables students to directly apply the concepts learned, thereby enhancing their motivation and engagement in the learning process (Yuldha Chrisanto & Novitasari, 2023).

The Basic Life Support (BLS) educational virtual simulation game was developed in 13 stages, with nine focusing on BLS content and the remaining providing general orientation for game progression. This pedagogical approach has been validated by experts in the field. Virtual simulation games offer an engaging and interactive learning experience that helps students relate more closely to real clinical practice while fostering reflection and critical thinking. Moreover, such simulation-based games, which are grounded in current American Heart Association guidelines and Ausubel's Theory of Meaningful Learning, enable learners to experience scenarios that closely resemble real-life situations (Karolyne et al., 2018).

Emergency situations frequently occur both within healthcare settings and in the broader community, making it essential for healthcare professionals to be adequately prepared to manage the challenges and disruptions that may arise during such events. In addition to the performance scores generated by the assessment system integrated into the

virtual simulator or Basic Life Support (BLS) game module, evaluating the cognitive or mental workload during the training process can serve as a complementary measure to assess participants' readiness (Aksoy et al., 2019)

CONCLUSION

Virtual simulation–based learning can enhance the instruction of Basic Life Support (BLS) techniques for nursing students by fostering the development of effective learning strategies. Training in BLS using virtual reality simulation has been shown to be more effective in improving technical proficiency compared to conventional teaching methods.

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CONFLICTS OF INTEREST

It is the policy of the Journal of Nursing Practice (JNP) to ensure all authors disclose to the readers any real or apparent conflict (s) of interest that may have a direct bearing on the subject matter of the article.

It is intended that any potential conflict (financial or otherwise) should be identified openly so that the readers may form their own judgement about the article with the full disclosure of the facts. Authors must state all their sources of funding and any other financial and personal relationships that might bias their work. It is for the readers to determine whether the authors' outside interest may reflect a possible bias in either the exposition of the conclusions presented. The editors reserve the right not publish if a sponsor asserted control over the authors' right to publish their results.

The corresponding author needs to complete and submit this form when submitting a manuscript. The corresponding author shall gather and list the potential conflict of interest from the co-authors, if there is any.

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