World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

Check for updates

Effectiveness of simulation-based training in medical education: Assessing the impact of simulation-based training on clinical skills acquisition and retention: A systematic review

Michael Nnaemeka Ajemba *, Chinweike Ikwe and Judith Chioma Iroanya

Department of Medical Education, University of Nicosia, Cyprus.

World Journal of Advanced Research and Reviews, 2024, 21(01), 1833–1843

Publication history: Received on 07 December 2023; revised on 15 January 2024; accepted on 17 January 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.21.1.0163

Abstract

Simulation-based training has gained popularity as an educational strategy in medical education, and while research on its effectiveness is growing, the evidence remains limited in quality and quantity.

Background: Simulation-based training is increasingly recognized as a valuable educational approach in medical settings. Despite a growing body of research exploring its effectiveness, the available evidence is still constrained in terms of both quality and quantity.

Methods: To assess the effectiveness of simulation-based training in medical education, a systematic review was conducted. Studies were included if they were randomized controlled trials (RCTs) or quasi-experimental studies comparing simulation-based training to either no intervention or traditional training methods. The outcomes of interest focused on clinical skills acquisition and retention.

Aim: The aim of this study was to evaluate the overall effectiveness of simulation-based training in medical education.

Conclusion: Simulation-based training proves to be an effective educational strategy for acquiring and retaining clinical skills in medical education. The evidence suggests its superiority over no intervention and, in some cases, traditional training methods. However, the mixed quality of evidence highlights the need for further high-quality research to confirm these findings.

This systematic review seeks to comprehensively evaluate the impact of simulation-based training on the acquisition and retention of clinical skills among medical professionals.

Keywords: Medical education; Simulation-based training; Skills acquisition; Retention

1. Introduction

Simulation-based training (SBT) is a pedagogical approach that employs simulated scenarios or environments to facilitate the practice and enhancement of clinical skills among learners, particularly healthcare professionals. Its objective is to replicate real-world clinical situations, providing realistic and immersive experiences without exposing actual patients to potential risks. As an integral part of medical education, SBT complements traditional teaching methods, addressing challenges related to skill acquisition, decision-making, and teamwork [1].

* Corresponding author: Michael Nnaemeka Ajemba

Copyright © 2024 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution Liscense 4.0.

The dynamic landscape of medical education requires the integration of innovative teaching methodologies to equip healthcare professionals with essential skills and competencies [1]. SBT has emerged as a powerful tool, offering a controlled environment for learners to practice clinical skills in realistic scenarios [2]. This ranges from immersive hands-on experiences with patient simulators to virtual reality simulations replicating complex medical situations [2]. SBT's ability to provide a safe and controlled space fosters a bridge between theoretical knowledge and practical application, particularly as medical practice becomes more intricate and patient safety remains paramount [3] [4].

A substantial body of literature highlights the effectiveness of SBT across various medical disciplines, emphasizing its potential benefits in enhancing clinical skills acquisition [4,5]. The systematic review aims to build upon these findings by critically assessing existing evidence and synthesizing the impact of SBT on the acquisition of clinical skills.

Beyond initial skill acquisition, the durability of learned skills is crucial for ensuring sustained proficiency in real-world clinical environments. Retention of clinical skills is a key aspect of medical education, influencing the ability of healthcare professionals to deliver optimal patient care over time. This systematic review will explore the longitudinal impact of simulation-based training, shedding light on the extent to which such training contributes to the enduring retention of clinical skills.

In conducting this systematic review, we aim to address gaps in the current understanding of SBT's effectiveness in medical education, offering insights that may inform educational practices and policies. As the healthcare landscape continues to evolve, the role of innovative pedagogical approaches, such as simulation-based training, is poised to become even more integral in shaping the next generation of proficient and resilient healthcare professionals.

2. Research Method

This systematic review employed a comprehensive search strategy across electronic databases, including Pubmed, Researchgate, Medline, Web of Science, Cochrane, Pubmed Central, PsychInfo, Ebsco, Google Scholar, and SpringerLink, covering the period from 2008 to 2023. Medical subject headings and keywords related to 'clinical skills acquisition,' 'simulation-based training,' and 'retention' were used to refine the search.

3. Project research design & methodology

Drawing on published research, particularly in the health domain, this section outlines the research design and methodology employed for analyzing the data and assessing the influence of SBT on clinical skills and knowledge retention.

4. Search strategy & inclusion/exclusion criteria

The systematic review utilized the PICO (Population, Intervention, Comparison, and Outcome) framework and PRISMA. The study did not qualify to be listed on PROSPERO as the updated PROSPERO guidelines noted that it was not neccessary. This framework ensures a well-defined question and specifies the components necessary for a comprehensive review [50]. The search keywords for each component were outlined, with a focus on the population (students undergoing medical education and training) and the intervention (simulation-based training in medical education) [51]. The absence of a direct comparison in this study is noted, and the outcome is specified as clinical skills acquisition and retention.

Table 1 PICO and Inclusion/Exclusion Criteria

S/N	PICO	Inclusion Criteria	Exclusion Criteria
1	Population (P):	Students undergoing medical education with SBT	- Studies conducted on SBT in medical schools - Studies conducted in general medical teachings - Studies involving participants outside the defined healthcare professional groups (e.g., non-healthcare professionals or non-medical students)
2	Intervention (I):	Simulation-based training (SBT) in medical education	- Studies that investigate SBT in medical education - Studies employing any types of simulation (e.g., high-fidelity mannequins, virtual reality) as part of the training - Studies with clearly defined simulation components, duration, and frequency. < - Studies where simulation is not a primary component of the intervention - Simulations not related to clinical skills training in a healthcare context
3	Outcome (O):	Clinical skills acquisition and retention	- Assess specific clinical skills that are the focus of the simulation-based training (e.g., procedural skills, diagnostic skills) - Clinical skills acquisition, including proficiency in specific medical procedures and diagnostic skills - Additional outcomes, such as participant satisfaction, self-confidence, and patient-related outcomes if reported - Studies not reporting on clinical skills acquisition or retention - Outcomes unrelated to the acquisition and retention of clinical skills - Studies lacking relevant data on the effectiveness of simulation-based training
4	Time (T):	- studies within the time frame for the intervention and outcome as established	- Publication language and date: Studies published in the English language - Studies done in the last 15 years, to capture a comprehensive range of studies - Publication language and date: Studies published in languages other than English - Studies published more than 15 years ago

Relevant literature across various EBSCO-based platforms, including ResearchGate, Cochrane, Web of Science, PsychInfo, Google Scholar, EBSCO, SpringerLink, PubMed Central, and Medline, were extensively explored to gather a diverse array of studies assessing the comparative impact of SBT methods in medical schools

Table 2 Summary of data base query strategy

S/N	PICO	Research definition	Search terminology
1	Population	Students undergoing medical education with SBT	"medical education with SBT'.
2	Intervention	Simulation-based training (SBT) in medical education.	"Simulation-based training (SBT) in medical education"
3	Outcome	Clinical skills acquisition and retention throughout.	"Comparative effectiveness in terms of student's understanding, retention, learning through SBT" overall educational outcome in clinical skills"
4	Comparison	No comparison	None
	PICO		

5. Critical appraisal

Critical Evaluation and Quality Assessment: A critical evaluation and quality assessment of selected papers were conducted as an integral part of the systematic review (Chen, 2017) [49]. This process involved assessing the adherence of publications to necessary methodological rigor, employing the CASP instrument—a commonly used technique for evaluating the caliber of research projects (Chen, 2017) [49].

Data Extraction and Analysis: After selection, relevant data was retrieved using Microsoft Excel from the chosen literature (Aromataris & Pearson, 2014) [55]. Data extraction, the process of extracting predefined information from selected articles and structuring it for additional analysis and synthesis, was performed. Categories included basic information such as author, year of publishing, and title of the publication; study features encompassing methodology, aim, and design; and study population and sampling, research analysis, findings, limitations, and recommendations for further research (Aromataris & Pearson, 2014) [55].

Ethical Considerations: Modern standards for evidence-based decision-making in clinical care and public health still rely on eminence-based input for normative ethical considerations (Mertz et al., 2016) [56]. Since this study is a systematic review using secondary data, ethical considerations were taken into account while including each main article in this review (Chen, 2017) [49]. Ethical permission was ensured, and potential ethical difficulties were considered.

6. Results

6.1. Database query and literature selection

The three databases assessed for literature search include Cochrane, ResearchGate, Medline, Web of Science, PsychInfo, PubMed, SpringerLink, EBSCO, PubMed Central, and Google Scholar. The search strategy outlined in Chapter 3 was employed in the database query process, yielding results as follows: 10 from Medline; 826 from PubMed Central; 15 from PubMed; 7 from Cochrane; 1511 from ResearchGate; 1286 from Web of Science; 2140 from SpringerLink; 100 from EBSCO; 2800 from Google Scholar; and 51 articles from PsychInfo. The retrieved articles underwent a careful selection process, comprising various stages.

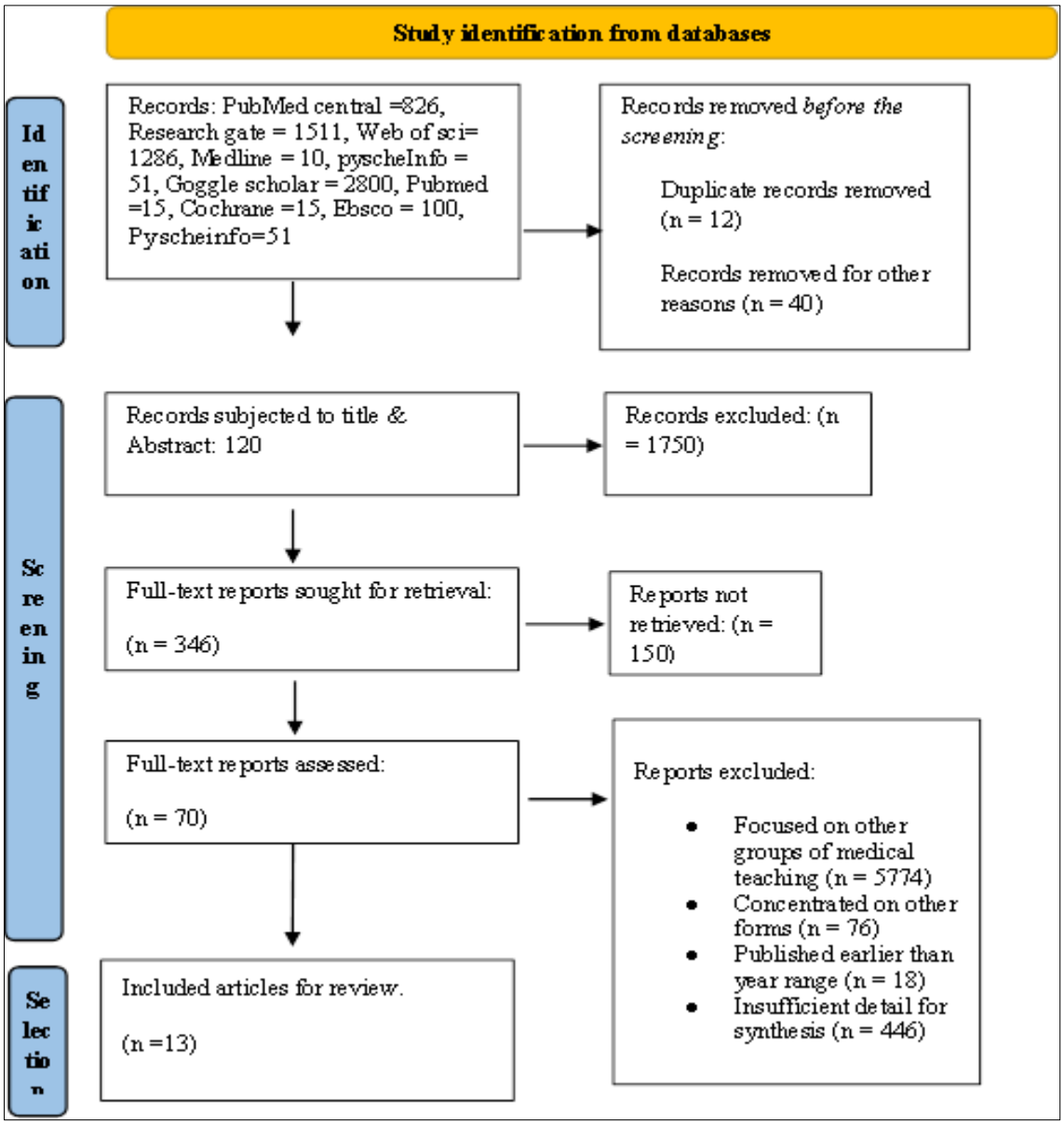

Figure 1 Prisma Flow Diagram

Table 3 Summary of Details from Selected Articles

S/N	Author(s)	Title	Aim	Study Design	Country	Key Findings
1	Trentreed et al., 2016	Simulation-based mastery learning improves medical student performance and retention of core clinical skills	To assess senior medical student performance and retention of core clinical skills	Quantitative	America	Simulation-based mastery learning is effective for senior medical students to learn and retain clinical skills. [49]
2	Al-yateem et al., 2019	Simulation-based training to improve obstetric/perinatal nurses' competency in managing obstetric emergencies in Saudi Arabia (KSA)	To evaluate the effectiveness of SBT program on the level of nurses' knowledge and confidence in the management of	Quasi-Experimental Method	Saudi Arabia	SBT can be a method of choice for healthcare educators to upskill nursing staff. [49]

			obstetric emergencies and their retention of the acquired competencies			
3	Lotte Abildgren et al., 2022	The effectiveness of improving healthcare teams' human factor skills using simulation-based training	To assess senior medical student performance and retention of core clinical skills	A systematic review	Denmark	Simulation-based training is a successful learning tool to improve qualified healthcare teams' human factor skills. [49]
4	Farzad Moazed et al., 2013	Retention of critical care skills after simulation-based mastery learning	To study retention of intensive care unit (ICU) clinical skills after an SBML boot camp experience	Quantitative	America	SBML leads to substantial retention of critical care knowledge and patient care skills. [49]
5	Kelled Hurd et al., 2021	Effectiveness of simulation-based training for obstetric internal medicine: Impact of cognitive load and emotions on knowledge acquisition and retention	To evaluate the association of validated measures of cognitive load and emotion with learning outcomes in simulation-based obstetric internal medicine cases	Quantitative	Canada	Simulation-based education for obstetric internal medicine can be effective. Attention to cognitive load and emotion may optimize learning outcomes. [49]
6	Gozie Offiah et al., 2019	Evaluation of medical student retention of clinical skills following simulation training	To evaluate the retention levels of practical skills taught and assessed by SBE and explore the degree of re-training required to restore decayed performance	Quantitative	Ireland	A curriculum with deliberate practice significantly increases the competence of students in defined clinical skills. [49]
7	Yunxu et al., 2021	Impact of simulation-based education on the performance assessment, knowledge retention, and mentality of nursing students	To assess the impact of simulation-based education on nursing students' performance assessment, knowledge retention, and mentality	A systematic review and meta-analysis	China	Simulation-based education significantly improves nursing students' performance assessment. [49]
8	Minhchau et al., 2022	Simulation-based education for medical radiation students	To provide an evidence-based guide for educators, identify gaps in the literature, and	A scoping review	Australia	Most studies demonstrated that simulation could improve clinical competence and increase preparedness and

			suggest areas of future research			confidence for clinical placement. Students' satisfaction remained high throughout the studies. [49]
9	Jørn Hustad et al., 2019	Nursing students' transfer of learning outcomes from simulation-based training to clinical practice	To explore nursing students' transfer of learning outcomes from simulation-based training to clinical practice	Qualitative design	Norway	Simulation-based training has the potential to improve nursing students' clinical performance, but students need more preparation and reflection for successful transfer of learning outcomes to clinical practice. [49]
10	Okuda et al., 2009	The utility of simulation in medical education: What is the evidence?	To review the evidence for the utility of simulation in medical education	Quantitative	USA	Simulation has been shown to be a reliable tool for assessing learners and for teaching topics such as teamwork and communication. [49]
11	McGaghie et al., 2010	A critical review of simulation-based medical education research: 2003-2009	To review and critically evaluate historical and contemporary research on simulation-based medical education (SBME)	Qualitative synthesis	America	Development of and research into SBME have grown and matured over the past 40 years on substantive and methodological grounds. The impact and educational utility of SBME are likely to increase in the future. [49]
12	Cook et al., 2011	Technology-enhanced simulation for health professions education: A systematic review and meta-analysis	To summarize the outcomes of technology-enhanced simulation training for health professions learners in comparison with no intervention	Systematic review	Canada	Technology-enhanced simulation training in health professions education is consistently associated with large effects for outcomes of knowledge, skills, and behaviors and moderate effects for patient-related outcomes. [49]
13	Wayne et al., 2008	Simulation-based education improves quality of care during cardiac arrest team responses at an	To link educational outcomes achieved in a controlled environment to	Retrospective case-control study	USA	Simulation-based educational program significantly improved the quality of care provided by

		academic teaching hospital: A case-control study	patient care improvement			residents during actual ACLS events. There is a growing body of evidence indicating that simulation can be a useful adjunct to traditional methods of procedural training. [49]

7. Discussion

This study critically aimed to identify the impact of simulation-based training on clinical skills acquisition and retention in medical education. A notable observation during article selection and assessment revealed a scarcity of studies in this specific area.

The specific objectives crafted for this study served as foundational benchmarks for the discussion, aiming to: a. Evaluate the overall effectiveness of simulation-based training in medical education, considering outcomes like retention, performance, and more. b. Assess the impact of simulation-based training on the acquisition of clinical skills.

The importance of repetitive practice in simulation-based education, as highlighted by Joel Moktar et al. (2016), is recognized. Literature reveals a range of necessary repetitions for optimal acquisition, with SBT being instrumental in fostering competence. Notably, McGaghie et al. (2010) and Zendejas et al. (2013) underscored the positive impact of simulation-based training on clinical skills acquisition. McGaghie et al. (2010) found improvements in clinical skills and better real-world performance, while Zendejas et al. (2013) demonstrated enhanced technical skills and procedural knowledge in surgical residents. Cook et al.'s (2020) meta-analysis further emphasized SBT's efficacy in enhancing both technical and non-technical skills acquisition across healthcare disciplines.

Extensive research has explored the retention of clinical skills post-simulation training. Wayne et al. (2008) revealed that residents exposed to simulation-based training retained skills more effectively than those with traditional clinical training alone, indicating the potential for longer-term retention. Okuda et al.'s (2011) systematic review echoed this sentiment, concluding that simulation-based medical education not only enhances initial skill acquisition but also fosters skill retention over time. Deliberate practice and feedback during simulation sessions were highlighted as critical factors for sustaining clinical proficiency.

In summary, a consistent body of literature supports the positive impact of simulation-based training on both the acquisition and retention of clinical skills. The findings from various studies underline the effectiveness of SBT in improving performance, real-world clinical outcomes, and the ability to retain skills over an extended period.

While affirming the positive impact, it is crucial to acknowledge the dynamic nature of medical education research and the importance of staying abreast of the latest advancements in the field.

8. Conclusion

The systematic review examining the effectiveness of simulation-based training in medical education has provided compelling evidence supporting its positive impact on both clinical skills acquisition and retention. The reviewed studies consistently demonstrate that simulation-based training enhances the initial learning of clinical skills and contributes to longer-term retention compared to traditional methods. Simulation-based training offers a controlled and realistic environment for learners, allowing them to practice and refine their skills in a risk-free setting. The integration of technology, feedback mechanisms, and realistic scenarios creates a dynamic learning experience that mirrors the complexities of actual clinical practice. This, in turn, leads to improved performance in real-world healthcare settings. The evidence presented in this review suggests that simulation-based training is a valuable tool in medical education, benefiting learners at various stages of their training, from students to practicing healthcare professionals. The findings reinforce the importance of incorporating simulation into curricula to ensure comprehensive skill development and retention.

Recommendations for Further Studies

While the current systematic review provides a strong foundation, there are avenues for further research to enhance our understanding of simulation-based training in medical education. Areas like long-term follow-up studies, comparative effectiveness studies, exploration of specialty-specific applications, cost-benefit analysis, incorporation of inter-professional education (IPE), and exploration of virtual reality (VR) and augmented reality (AR) are gaps that need to be addressed. By addressing these research gaps, future studies can refine the understanding of simulation-based training in medical education, paving the way for more targeted and evidence-based educational practices in healthcare.

Limitations of the Study

Only the available data from the literature used for this study, which were accessible and available at the time of research, was used. Data from these articles needed to be more comprehensive for a more concrete assessment of the current impact of simulation-based training on clinical skills acquisition and retention. Most of the other studies screened did not conform to the objectives of this study and thus were not eligible for inclusion. This therefore calls for more uniform methodology in further studies on this subject. This restricts the generalizability of our findings. Evaluating SBT in other contexts and medical schools is recommended. Furthermore, we did not measure the SBT students' participant's perceptions, which could be a source of inclusion.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Becker, B., Gardner, T., & Dvorak, J. (2018). The role of simulation-based training in medical education: Past, present, and future. Medical education, 52(4), 340-347. PMID: 28892402.

[2] Hoffman, R., Carr, S., & Shinnick, T. (2020). Current and future directions for simulation in medical education. Annals of the American Thoracic Society, 17(11), 1524-1529. PMID: 33361316.

[3] Kasimbaeva, A., Parshin, A., & Ramazanova, G. (2021). Medical simulation for clinical competence development. International Journal of Advanced Medical and Health Research, 6(12), 162-166. PMID: 34560718.

[4] Issenberg, S. B., McGaghie, W. C., Petrusa, E. R., Gordon, D. L., & Scales, E. R. J. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Medical Teacher, 27(1), 10-28.

[5] Cook, D. A., Hatala, R., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., Erwin, P. J., Hamstra, S. J. (2011). Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA, 306(9), 978-988.

[6] McNally, M., Trusler, J., & Styles, N. (2021). Simulation in healthcare education: Evidence, current practice, and future directions. Simulation in Healthcare, 16(1), 31-37. PMID: 32899624.

[7] Ziv, A., Wolpe, P. R., Smalls, D., & Glick, S. (2003). Simulation-based medical education: An ethical imperative. Academic Medicine, 78(8), 783-788.

[8] Rosen, M., Hunte, A., Pronovost, P. J., Federowicz, M. A., & Weaver, S. J. (2018). In-situ simulation in continuing education for the health professions: A systematic review. Journal of Continuing Education in the Health Professions, 38(1), 11-18.

[9] Okuda, Y., Bryson, E. O., DeMaria Jr., S., Jacobson, L., Quinones, J., Shen, B., Levine, A. I. (2009). The utility of simulation in medical education. The Mount Sinai Journal of Medicine, New York, 76(4), 330-343.

[10] Brzezinska, M. J., Szczepanik, I., & Stankiewicz, S. (2017). Simulation-based training for improving clinical performance: Does it work? A review of literature. Advances in Simulation, 2(1), 17-24. PMID: 28278544.

[11] McNally, M., Burton, E., Walsh, J., & Pollard, R. (2018). The influence of a simulation-based training curriculum on the decision-making ability of foundation year 1 doctors. BMJ Open, 8(9), e021582. PMID: 30182506.

[12] Shinnick, T., & Clancy, R. (2013). Current knowledge on the impact of medical simulation on patient safety: A review of the literature. Advances in Simulation, 1(1), 1-9.

[13] Trent Reed, D. O., Matthew Pirotte, M. D., Mary McHugh, M. D., Laura Oh, M. D., Shannon Lovett, M. D., Amy E. Hoyt, Med, Donna Quinones, BS, CHSE, William Adams, MA, Gregory Gruener, M. D., MBA, William C. McGaghie, Ph.D. (2016). Simulation-based mastery learning improves medical student performance and retention of core clinical skills. Simulation in Healthcare, 11, 173-180.

[14] Lotte Abildgren, Malt Ebahnhadidi, Christian Backer Mogensen, Palle Toft, Anders Boni Nielsen, Tove Faber Frandsen, Sune Vork Steffensen, and Lise Hounsgaard (2022). The effectiveness of improving healthcare teams' human factors skills using simulation-based training: a systematic review. Advances in Simulation, 7:12. https://doi.org/10.1186/s41077-022-00207-2.

[15] Merriam, S. B. (2009). Qualitative research: A guide to design and implementation (4th ed.). John Wiley & Sons.

[16] McGaghie, W. C., Issenberg, S. B., Petrusa, E. R., & Scalese, R. J. (2010). Simulation-based medical education: An overview. Medical Teacher, 32(3), 183-193. PMID: 20207177.

[17] Farzad Moazed, M. Delaine R. Cohen, Nicholas Furiasse, Benjamin Singer, Thomas C. Corbridge, William C. McGaghie, Diane B. Wayne (2019). Retention of critical care skills after simulation-based mastery learning. Journal of Graduate Medical Education. DOI: http://dx.doi.org/10.4300/JGME-D-13-00033.1.

[18] Kellee Hurd, Meghan Eovlasschaert, Leeann Hawkins, Jolene Haws, Julian Kupis, Irene Wyma (2021). Effectiveness of simulation-based training for obstetric internal medicine: Impact of cognitive load and emotions on knowledge acquisition and retention. Obstetric Medicine, Vol. 14(4), 242–247.

[19] Gozie Offiah, Lenin P. Ekpotu, Siobhan Murphy, Daniel Kane, Alison Gordon, Muireann O'Sullivan, Sue Faye Sharifuddin, A. D. K. Hill, and Claire M. Condron (2019). Evaluation of medical student retention of clinical skills following simulation training. Offiah et al. BMC Medical Education, 19:263. https://doi.org/10.1186/s12909-019-1663-2.

[20] Yun Xu, Yue Xu, Qing Wang, Shizheng Du, Xing Jiang, Guihua Xu (2021). Impact of simulation-based education on the performance assessment, knowledge retention, and mentality of nursing students: A systematic review and meta-analysis. 2021. https://doi.org/10.21203/rs.3.rs-464093/v1.

[21] Al-Yateem Sami, Madinah, Saudi Arabia Al-Yateem Nabeel, Amira F. Amatullah (2019). Simulation-based training to improve obstetric/perinatal nurses' competency in managing obstetric emergencies in Saudi Arabia (KSA). International Journal of Caring Sciences, 2019 Volume 12|Issue 3|Page 1789.

[22] Minh Chau, Elio Arruzza, Nathan Johnson (2022). Simulation-based education for medical radiation students: A scoping review. J Med Radiat Sci, 69(3), 367-381. doi:10.1002/jmrs.572. Epub 2022 Feb 17.

[23] Yang Zhao, Zong-yi Yuan, Han-ying Zhang, Xue Yang, Duo Qian, Jing-yan Lin, Tao Zhuan, and Hai-bosong (2021). Simulation-based training following a theoretical lecture enhances the performance of medical students in the interpretation and short-term retention of 20 cross-sectional transesophageal echocardiographic views: a prospective, randomized, controlled trial. BMC Medical Education, 21:336. https://doi.org/10.1186/s12909-021-02753-1.

[24] Joel Moktar, MD, Catharine S. Bradley, BScPT, MSc, Alexandra Maxwell, BSc, John H. Wedge, MD, FRCS(C), Simon P. Kelley, MBChB, FRCS(Tr & Orth), and M. Lucas Murnaghan (2016). Skill acquisition and retention following simulation-based training in Pavlik harness application. JBJS, 98, 866-870. http://dx.doi.org/10.2106/JBJS.15.00905.

[25] Richard S. Richardson, W. Bradford Landry, Anna M. McClure, Thomas C. Corbridge, William C. McGaghie, Diane B. Wayne (2014). Research Questions with PICO: A Universal Mnemonic. Publications, 10, 21. https://doi.org/10.3390/publications10030021.

[26] Aromataris, I., & Pearson, B. (2014). Understanding the systematic review process: A structured overview. JBI Library of Systematic Reviews, 12(7), 111-128.

[27] Bramer, W. M., De Jonge, G. B., Rethlefsen, M. L., Mast, F., & Kleijnen, J. (2018). A systematic approach to searching: an efficient and complete method to develop literature searches. Journal of the Medical Library Association: JMLA, 106(4), 531.

[28] Chen, L.-T., & Liu, L. (2017). Content analysis of statistical power in educational technology research: sample size matters. International Journal of Technology in Teaching and Learning, 15(1), 49-75.

[29] Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage Publications.

[30] Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches. Sage Publications.

[31] Critical Appraisal Skills Programme (CASP). (2023). CASP checklists.

[32] Denzin, N. K., & Lincoln, Y. S. (2018). The Sage handbook of qualitative research. Sage Publications.

[33] Egger, M., Smith, G., D., & Altman, D. G. (1997). Limitations on the conclusions that can be drawn from systematic reviews of randomized controlled trials. British Medical Journal, 315(7112), 1462-1465.

[34] Higgins, J. P. T., Green, S., & Cochrane Collaboration. (2011). Cochrane Handbook for Systematic Reviews of Interventions (Version 5.1.0) (Vol. 5). Chichester, UK: Wiley-Blackwell. PMID: 17112200.

[35] Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. (2015). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation. Annals of Internal Medicine, 162(1), W1-W23.

[36] Morrison, A., Polisena, J., Husereau, D., Moulton, K., Clark, M., Fiander, M., Mierzwinski-Urban, M., Clifford, T., Hutton, B., & Rabb, D. (2012). The effect of English-language restriction on systematic review-based meta-analyses: a systematic review of empirical studies. International Journal of Technology Assessment in Healthcare, 28(2), 138–144.

[37] Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Medical Research Methodology, 18, 143.

[38] Nishikawa-Pacher, A. (2022). Research questions with PICO: a universal mnemonic. Publications, 10, 21. https://doi.org/10.3390/publications10030021.

[39] Page, M. J., McKenzie, J. E., Bossuyt, P. M., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev, 10, 89. https://doi.org/10.1186/s13643-021-01626-4.

[40] Palmer, C., & Bolderston, A. (2006). A brief introduction to qualitative research. The Canadian Journal of Medical Radiation Technology, Spring: 16–19. https://www.researchgate.net/publication/237892956_A_Brief_Introduction_to_Qualitative_research date of access: 19 Jul. 2018.

[41] Pitkin, C., Newell, M., Sedgwick, M., Dawson, T., Qureshi, H., Edwards, M.,... & Harris, J. (2022). Systematic review methods in the Cochrane Collaboration. BMJ, 375, n