

Virtual Simulation Design for Clinical Competency in Nursing Education: A Systematic Review with Implications for Gerontechnology-Enabled Care in Ageing Societies

Fong Nga Yee Rachel & Dr. Lam Kam Ki Stanley
School of Nursing and Health Sciences
Hong Kong Metropolitan University

Background / Objectives

Population ageing is accelerating worldwide, increasing demand for nursing care and placing greater pressure on healthcare systems. The global population aged ≥ 60 years is projected to rise from 1 billion in 2020 to 2.1 billion by 2050 (World Health Organization, n.d.-a), while the world is expected to face a nursing shortage of 4.5 million by 2030 (World Health Organization, n.d.-b). At the same time, limited clinical placements have intensified the need for innovative and accessible training approaches. Two-dimensional (2D) virtual simulation (VS) has emerged as a promising strategy for developing clinical competency in undergraduate nursing students. This review synthesized evidence on the effectiveness of 2D VS, with implications for workforce preparation in ageing societies and gerontechnology-enabled care environments.

Methods

A systematic review guided by the Joanna Briggs Institute (JBI) Manual was conducted. Five electronic databases were searched for randomized controlled trials published between 2020 and 2025. Eligible studies involved undergraduate nursing students, 2D non-immersive VS interventions, and competency-related outcomes. Study selection followed PRISMA 2020 principles. Ten studies were included in the final synthesis.

Results

Ten randomized controlled trials from eight countries were included, with sample sizes ranging from 30 to 351 participants. Interventions included serious games, screen-based simulation, tele simulation, and structured virtual learning platforms. These addressed both psychomotor tasks, such as CPR, intramuscular injection, resuscitation, and medication administration, and more complex scenarios involving nursing diagnosis, patient deterioration, and clinical judgment.

Across studies, 2D VS most consistently improved psychomotor performance, especially for procedural and repeatable tasks. Stronger outcomes were associated with opportunities for repeated practice, immediate feedback, and low-risk rehearsal. Blended approaches, in which VS was combined with standard teaching, low-fidelity practice, or structured reflection, were often associated with stronger learning outcomes than stand-alone VS (Li et al., 2024). Student confidence and satisfaction also improved in most studies, suggesting that VS supports both technical learning and positive affective outcomes.

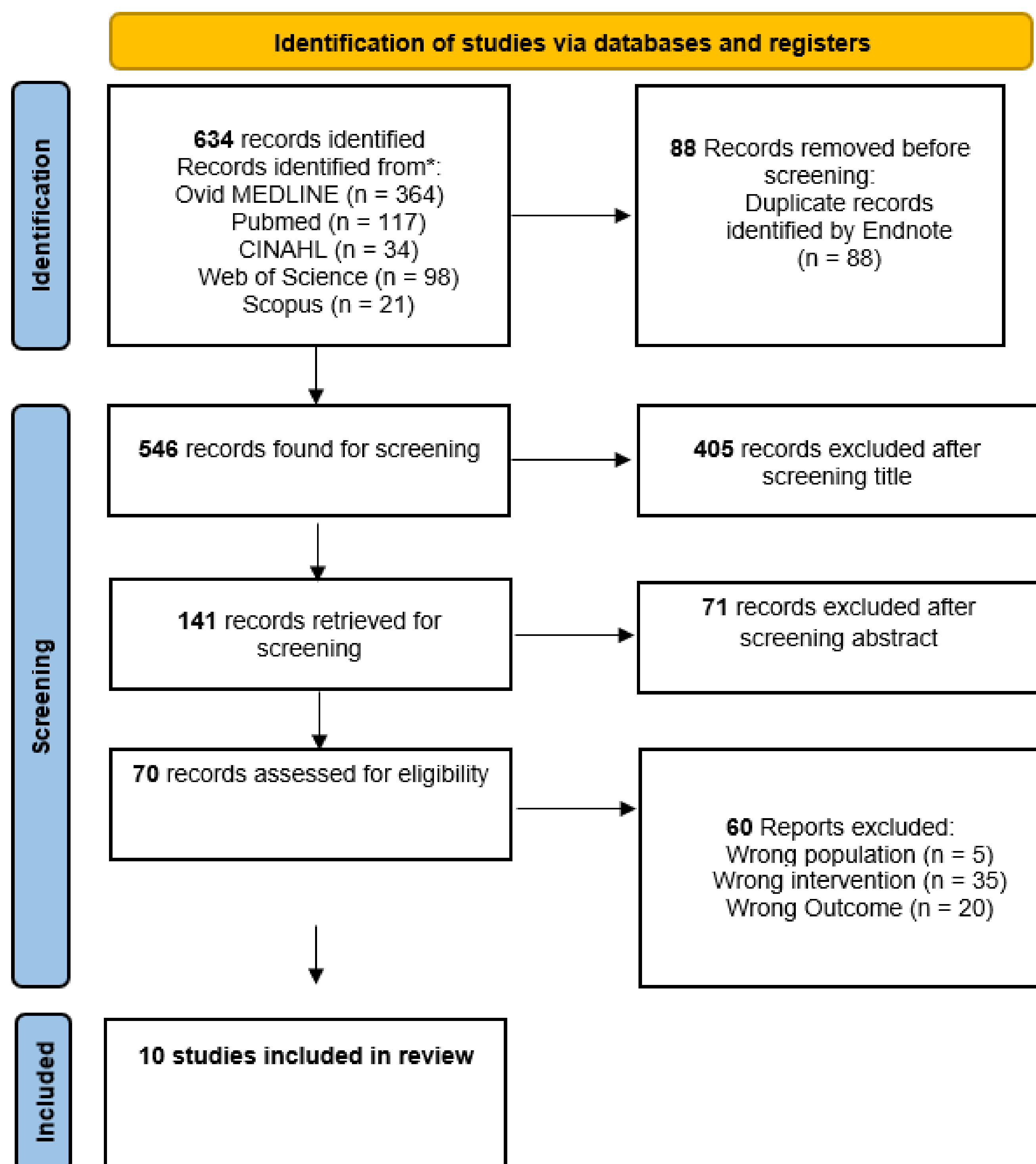
However, evidence for higher-order clinical reasoning was less consistent (Haerling et al., 2023; Ordu & Çalışkan, 2023). One trial found no significant improvement in diagnosis prioritization (Ordu & Çalışkan, 2023), while another reported that screen-based VS was inferior to mannequin-based simulation for clinical judgment and patient care performance (Haerling et al., 2023). These findings suggest that 2D VS is effective for foundational and procedural competency development, but may be less capable of reproducing the complexity required for advanced reasoning and integrated judgment. Interpretation should therefore remain cautious.

Implications for Gerontechnology-Enabled Care

These findings suggest that 2D VS may act as a scalable scaffold for preparing nursing students for digital, technology-supported, and ageing-focused care. It may be especially useful for building foundational competency before clinical exposure in care contexts involving chronic illness, multimorbidity, safety monitoring, and technology-assisted decision-making. Future gerontechnology-oriented simulation should place greater emphasis on branching scenarios, guided reflection, and decision-making support to better prepare students for complex geriatric care and future workforce readiness in ageing societies.

Key Messages

- 2D virtual simulation most consistently supports psychomotor skill development.
- It also improves student confidence and satisfaction.
- Evidence for higher-order clinical reasoning remains mixed.
- VS may serve as a scalable preparatory tool for gerontechnology-enabled care.



PRISMA flow diagram adapted from PRISMA 2020.

Selected reference:

World Health Organization. (n.d.). Ageing and health. <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>
World Health Organization. (n.d.). Nursing and midwifery. <https://www.who.int/news-room/fact-sheets/detail/nursing-and-midwifery>
Haerling, K., Kmail, Z., & Buckingham, A. (2023). *Journal of Nursing Regulation*, 13(4), 33–43.

Study	VS format	Target competency	Miller level	Main finding
Haerling et al. (2023)	Screen-based VS	Post-op care, safety/Communication	L2-L3	No cognitive advantage; inferior to mannequin-based simulation for some clinical judgment/performance outcomes.
Blanié et al. (2020)	Serious game	Patient deterioration /Clinical reasoning	L2	No significant improvement in script concordance test scores; satisfaction and motivation improved.
Goldsworthy et al. (2021)	Virtual auscultation	Heart/Lung sound recognition	L2-L3	Improved auscultation-related competency, especially murmur identification.
Gokalp et al. (2025)	Game-based learning	Intramuscular injection	L3	Significantly improved psychomotor performance, confidence, and comfort.
Li et al. (2024)	Online VS + low-fidelity practice	CPR	L3	Improved CPR skill performance and self-directed learning in blended design.
Mahou et al. (2024)	Screen-based simulation	Medication administration /Dosage calculation	L2-L3	Improved dosage-calculation knowledge and selected OSCE performance; satisfaction/self-confidence increased.
Ordu & Çalışkan (2023)	Virtual gaming simulation	Diagnosis/Goal setting/ Prioritisation	L2	Improved diagnosis and goal-setting, but not diagnosis prioritization.
Sarvan & Efe (2022)	Serious game simulation	Neonatal resuscitation	L3	Improved ventilation and chest-compression skills; no between-group knowledge difference.
Soares et al. (2023)	Telesimulation / virtual scenario	Cardiorespiratory arrest management	L2-L3	Improved post-test performance compared with traditional teaching.
Yun & Kang (2024)	vSim + collaborative debriefing	Problem-solving / Decision-making	L2-L3	Collaborative reflection-based debriefing improved knowledge, problem-solving, self-confidence, and satisfaction.

Li, Y., Lv, Y., Dorol, R. D., & Wu, J. (2024). *Australasian Emergency Care*, 27(1), 37–41. <https://doi.org/10.1016/j.auec.2023.07.006>

Ordu, Y., & Çalışkan, N. (2023). *Nurse Education in Practice*, 68, 103593.

<https://doi.org/10.1016/j.nepr.2023.103593> WHO Ageing and Health WHO Nursing and Midwifery Li study Ordu study