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Review Article

Competency-Based Learning and Simulation-Based Learning in Health Professions Education: A Narrative Review

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ABSTRACT

Background: Competency-Based Learning (CBL) and Simulation-Based Learning (SBL) support clinical skills, critical thinking, and professional competencies through personalized, experiential learning. Although CBL and SBL are conceptually complementary, their combined implementation and associated outcomes remain heterogeneous. This narrative review aimed to synthesize evidence on their implementation, educational outcomes, and contextual challenges in health professions education.

Methods: A structured search of PubMed, Scopus, ERIC, ProQuest, and Google Scholar identified studies published between 2015 and 2025 using relevant keywords. Following screening, eligible primary and secondary studies were narratively synthesized to examine educational outcomes, benefits, and challenges associated with CBL and SBL.

Results: Fourteen studies, including 12 primary studies and two systematic reviews, were included. In general, findings indicated that CBL and SBL were associated with improvements in skill acquisition, knowledge retention, learner engagement and performance-related outcomes across nursing, medicine, midwifery and other health professions education settings. High-fidelity simulation approaches appeared beneficial in procedural skill development, critical thinking, and performance in short- and long-term assessments. CBL may promote individualized learning, competency mastery, and soft-skill development, while integration with SBL increased learner engagement, confidence, and satisfaction. Together, these approaches may connect competency expectations with opportunities for practice, demonstration, and feedback. However, heterogeneous methodologies, implementation challenges, curriculum–practice mismatches, inconsistent assessment methods, and limited long-term follow-up rendered evidence regarding sustained competency outcomes inconclusive.

Conclusion: CBL and SBL may complement one another in supporting clinical skill development, competency assessment, learner engagement, knowledge retention, and performance. Simulation may be particularly valuable when aligned with deliberate practice, feedback-driven learning, and competency-based assessment. Nevertheless, heterogeneity in instructional design, implementation, and assessment, alongside limited long-term evidence and few studies evaluating integrated CBL–SBL models across diverse contexts, restricts generalizability. Methodologically rigorous research should establish standardized evaluation frameworks, identify optimal integration models, and assess the long-term sustainability and cross-context applicability of educational outcomes.

Keywords: Competency-Based Education; Simulation Training; Medical; Education; Learning Theories; Educational Measurement; Clinical Competence

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Introduction

Preparing health professionals for clinical practice requires educational approaches that support both the acquisition of knowledge and its application in professional settings. A central challenge in health professions education is ensuring that learners demonstrate the competencies required for practice, rather than assuming that completion of a prescribed training period establishes competence. Competency-Based Learning (CBL) addresses this challenge by organizing instruction and assessment around clearly defined, measurable learning outcomes, with progression determined by demonstrated achievement (1). Within this framework, individualized pacing, targeted instruction, deliberate practice, and ongoing formative feedback support learners in developing and refining their competencies (2). The emphasis therefore extends beyond knowledge acquisition to the demonstration of skills and the application of knowledge in practice-relevant tasks (1, 3). Implementing this approach requires learning environments that provide structured opportunities to practice, receive feedback, and demonstrate performance against explicit criteria. This need provides a rationale for examining Simulation-Based Learning (SBL) as a complementary approach to competency development and assessment in health professions education.

Simulation is an innovative and effective teaching approach that uses diverse technologies to recreate real-world situations in controlled, interactive, and immersive settings. These environments allow students to practice safely while strengthening their practical skills, problem-solving abilities, and decision-making capabilities (4). Across health professions, simulation-based education has been associated with improved knowledge and skills compared with no intervention (5). In nursing education, simulation has been integrated with competency-based curricula (6) and with problem-based learning (7). Competency-based curriculum design and assessment can help integrate learning across educational experiences (8).

Competency-based education has been proposed as a way to align health professions training with the needs of the populations graduates will serve (9).

However, the available evidence regarding their combined application remains fragmented across disciplines, educational levels, and clinical contexts (10-13). Studies address assessment design (14), competency assessment in simulation (15), competency-based education across disciplines (16-18), and simulation in endocrinology education (19). Their different populations and outcomes limit comparisons.

Consequently, educators and curriculum designers lack a consolidated evidence base regarding the conditions, mechanisms, and contextual factors through which the integration of these approaches may be most effective. Addressing this gap is important for informing evidence-based curriculum design, competency assessment strategies, and the implementation of simulation-supported competency-based education across health professions programs (20).

The integration of CBL and SBL is supported by several complementary educational theories. Constructivist and experiential learning perspectives suggest that learners develop deeper understanding and transferable competencies through active engagement in authentic tasks, reflection, and deliberate practice, which are operationalized in simulation through practice and feedback (21, 22). Similarly, situated learning theory emphasizes that knowledge acquisition is enhanced when learning occurs within realistic professional contexts, while cognitive load theory supports the use of appropriately structured and progressively complex simulation experiences, thereby reducing unnecessary cognitive burden (23, 24). Collectively, these perspectives suggest that CBL can define the competencies to be achieved, whereas simulation can provide contextualized opportunities to practice and demonstrate those competencies.

Given the heterogeneity in study designs,

educational settings, participant populations, intervention characteristics, and outcome measures across the available literature, a narrative review design is well-suited to identify, compare, and synthesize emerging patterns, educational strategies, theoretical perspectives, reported outcomes, and implementation challenges across different contexts.

Accordingly, this narrative review aimed to synthesize the available literature on CBL and SBL in health professions education, focusing on (1) their implementation as separate or integrated approaches, (2) reported educational outcomes, and (3) contextual and implementation factors that may influence their effectiveness.

Methods

Study Design

This study was conducted as a narrative review to critically analyze and synthesize the literature regarding the integration of CBL and SBL in medical education. The review was informed by the Scale for the Assessment of Narrative Review Articles (SANRA), which provides methodological guidance for improving the transparency, rigor, and reporting quality of narrative reviews (25). A narrative review design was considered appropriate as the available literature on CBL and SBL integration is characterized by substantial heterogeneity in study designs, educational settings, participant populations, interventions, and outcome measures. Given this diversity, the primary objective of the review was not to quantitatively aggregate findings but to identify, compare, and synthesize emerging patterns, educational strategies, theoretical perspectives, reported outcomes, and implementation challenges across different contexts. This approach enabled a broader conceptual understanding of how competency-based and SBL intersect within contemporary medical education.

This review synthesized and analyzed the literature on the integration of these learner-centered educational approaches into educational settings, focusing on their role in promoting clinical competence, skill development, and learner engagement. Reflecting the growing emphasis on competency-driven training and experiential learning in medical curricula, the review included articles published between 2015 and 2025 to examine recent developments, trends, and applications in the field.

Search Strategy

A comprehensive literature search was conducted to identify and retrieve studies examining the use of CBL and SBL in medical education. The search combined keywords including "competency-based education," "competency-based learning," "competency-based medical education," "simulation-based learning," "virtual simulation," "medical students," "Health professions student," "Nursing student," "Midwifery student," "Allied health student," "Health professions educator," "Healthcare professional," and "medical education." These terms were linked using the Boolean operators AND and OR to refine searches across PubMed, Scopus, ERIC, ProQuest, and Google Scholar.

The search included only articles published between 2015 and 2025 to capture recent developments in health professions education. The start of this period coincided with implementation of competency-based frameworks, including Entrustable Professional Activities (EPAs) and milestones (26), and the introduction of high-stakes simulation assessment in emergency medicine (27). Selecting this publication window helped align the evidence with contemporary educational practices, competency assessment approaches, and simulation technologies, enhancing the relevance of the review to current medical education. Table 1 presents the search terms organized according to the Population, Intervention, Comparison, and Outcome (PICO) framework.

Searching for "competency-based learning" AND "simulation-based learning" identified relatively few studies explicitly examining their integration. Nevertheless, the search results and included studies

Table 1: Search terms organized by population, intervention, comparison, and outcome

PICO(s)	Keyword / MeSH	Combined Search
Population	Medical student, Medical educator, nursing student, midwifery student, allied health student, health professions educator, healthcare professional, Health professions student	("Medical student" OR "Medical educator" OR "Nursing student" OR "Midwifery student" OR "Allied health student" OR "Health professions educator" OR "Healthcare professional" OR "Health professions student")
Intervention	Competency-based education, Competency-based learning, Competency-based medical education, Simulation-based learning, Virtual simulation, Experiential learning	("Competency-based education" OR "Competency-based learning" OR "Competency-based medical education" OR "Simulation-based learning" OR "Virtual simulation" OR "Experiential learning")
Comparison	–	–
Outcome	Educational outcomes, Clinical competence, Skills acquisition, Learner engagement, Knowledge retention	("Educational outcomes" OR "Clinical competence" OR "Skills acquisition" OR "Learner engagement" OR "Knowledge retention")

PICO: Population, Intervention, Comparison, and Outcome; MeSH: Medical Subject Headings.

provided indirect evidence suggesting that these approaches were used together or in complementary ways to support competency development in medical education.

Study Selection

Articles were selected according to predefined eligibility criteria. This narrative review included primary empirical studies using quantitative, qualitative, or mixed-methods designs, as well as relevant systematic reviews, to develop a comprehensive understanding of the integration of CBL and SBL in medical education.

The review aimed to summarize individual study findings and synthesize broader trends, educational strategies, and conceptual developments across the literature. Systematic reviews complemented primary studies by providing synthesized evidence on overarching patterns and areas of consensus. To reduce the risk of double counting, their evidence was considered at the level of synthesized conclusions rather than combined with outcome data from individual studies. Primary studies were examined independently only when they offered distinct evidence, contextual insights, or perspectives not adequately captured in the systematic reviews. This approach supported a comprehensive and nuanced synthesis while accounting for potential overlap between evidence sources.

To identify potential overlap, the reference lists of the two included systematic reviews were compared with the primary studies retrieved through the independent search. Studies and findings already covered by either systematic review were not counted as separate evidence.

Editorials, books, theses, and letters were excluded to preserve the review's focus on empirical research and systematic reviews. No geographical limits were applied; studies from any country were eligible if they met the predefined inclusion criteria. English was the prespecified publication language. The reviewers made an exception for two Persian-language studies as both directly addressed the review question. Table 2 outlines the inclusion and exclusion criteria.

Study selection proceeded in two stages: title and abstract screening, followed by full-text assessment. Reviewers independently screened titles and abstracts and assessed the full texts of potentially eligible studies. Disagreements were resolved through discussion and consensus, with a third reviewer consulted when necessary. The study selection process is illustrated in Figure 1.

Table 2: Overview of inclusion and exclusion criteria

Criterion	Inclusion criteria	Exclusion criteria
Study relevance	Articles examining the application, integration, or evaluation of competency-based learning and/or simulation-based learning in medical education.	Articles that do not address competency-based learning or simulation-based learning in health professions education.
Study design	Quantitative, qualitative, and experimental studies, alongside review articles.	Editorials, books, theses, and letters.
Source type	Peer-reviewed articles available in full text.	Non–peer-reviewed articles, grey literature, studies lacking rigorous methodology, and abstracts.
Language, region and time period	Articles published from 2015 through 2025 in any country. English was the prespecified language, with an exception for two Persian-language studies directly relevant to the review question.	Articles outside the publication period or in languages other than English, apart from the two Persian-language studies.

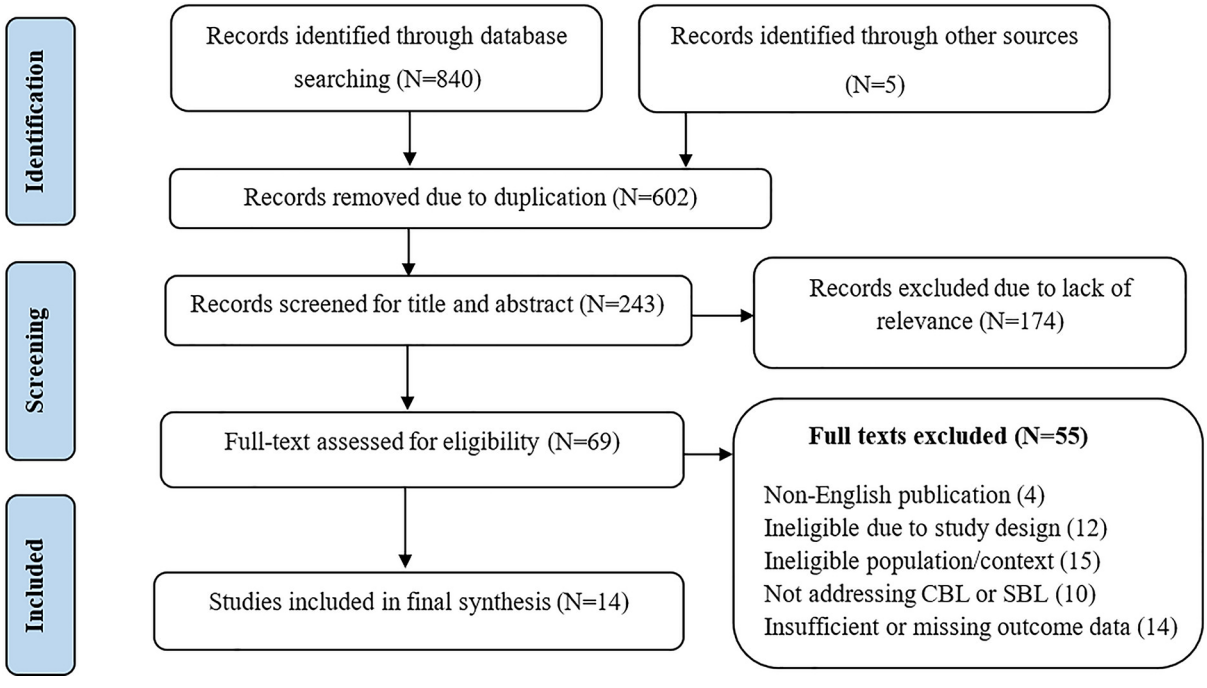


Figure 1: PRISMA flow diagram of the study selection process

Data Extraction

Data were systematically collected using a structured extraction form developed by the review team. Three reviewers independently extracted and cross-checked the data to ensure consistency, accuracy, and completeness. The reviewers had prior experience in medical education research, which contributed to the interpretive reliability of the data extraction and synthesis processes. The extracted information included study title, author(s), year of publication, study objectives, educational context, study design, characteristics of the competency-based and simulation-based interventions, outcome measures, and principal findings. Discrepancies were resolved through discussion and consensus. The extracted data were then synthesized narratively to identify recurring themes, educational outcomes, implementation strategies, and gaps in the literature.

Quality Assessment

Given the narrative design of this review, no formal risk-of-bias assessment was performed using systematic review appraisal tools. Instead, data extraction captured key methodological features of the included studies, such as study design, educational setting, intervention characteristics, outcome measures, and reported limitations. These features informed the description of heterogeneity and the interpretation of findings, rather than serving as a basis for assigning methodological quality ratings. Findings were therefore not weighted through informal judgments of studies as "stronger" or "weaker," and causal inferences were avoided when unsupported by the underlying study designs. This approach supported an inclusive synthesis while preserving rigor in the interpretation of the evidence.

Data Synthesis and Analysis

The extracted data were synthesized narratively through an iterative thematic process. Three reviewers independently examined the data to identify recurring concepts, educational outcomes, implementation strategies, and reported challenges. Emerging patterns were then compared and discussed, and the final themes were agreed upon by consensus. Studies were grouped by their primary focus, including competency development, clinical skill acquisition, learner engagement, assessment practices, implementation strategies, and challenges related to integrating CBL and SBL. Within and across these groups, similarities and differences were examined in relation to educational settings, learner populations, intervention characteristics, instructional designs, and reported outcomes. The resulting themes were organized into broader conceptual categories to develop an integrated account of the available evidence and identify gaps in the literature.

Results

Fourteen studies were included in the review, four of which were conducted in Iran. Of these, twelve were primary studies and two were systematic reviews. The literature encompassed diverse methodological approaches, including quantitative, qualitative, mixed-methods, quasi-experimental, experimental, Delphi, survey-based, and review designs. These studies explored CBL, SBL, or the overlap between the two in medical and health professions education, with varying degrees of explicit integration. The main educational outcomes examined were the development of clinical competence, skill acquisition, learner engagement, assessment and feedback, and improvements in performance.

The two systematic reviews synthesized evidence on the effectiveness of CBL and SBL in healthcare education. Vermylen and colleagues (28) investigated competency-based simulation training for procedural skills, reflecting an approach that integrates CBL and SBL frameworks. By comparison, Alharbi and colleagues (29) focused exclusively on SBL in nursing education. Consistent with the narrative review approach, findings from these reviews informed the identification of overarching patterns, shared findings, and emerging trends, rather than duplicating evidence from primary studies. Their findings were considered alongside those of the primary studies to support a more comprehensive synthesis. The characteristics of the included studies are summarized in Table 3.

Despite variation in research methods and educational settings, recurring patterns emerged in the outcomes associated with CBL, SBL, and, in some studies, their intersection. The two systematic reviews reported generally favorable findings for selected educational outcomes, particularly skill acquisition and knowledge, although their scopes differed and neither should be interpreted as direct evidence of a unified CBL–SBL model (28, 29). Primary studies across different disciplines provided more granular insights into specific mechanisms, such as feedback processes, fidelity levels, and assessment alignment, that appeared to influence these outcomes.

Table 3: Detailed characteristics of the included studies

Author(s)	Year	Study Design	Field/Level	Country	Intervention Type	Key Outcomes
Vermylen and colleagues (28)	2025	Systematic review with meta-analysis	Medical procedural skills; Multidisciplinary healthcare	Multiple	CBL simulation	More effective than noncompetency-based simulation for skill outcomes.
Fisk and colleagues (30)	2025	Qualitative (semi-structured interviews)	Emergency medicine residency	Canada	CBL simulation	CBE elevated role of simulation for assessment (e.g., entrustable professional activities).
Alharbi and colleagues (29)	2024	Systematic review	Nursing education (undergraduate/postgraduate)	Multiple	Simulation-Based Learning (SBL)	Consistent and significant improvements in knowledge and skills; mainly life-saving skills
Cole and colleagues (31)	2024	Delphi study	Undergraduate nursing students	United States	CBL simulation assessment tool	Consensus on 111 items appropriate for assessing competence in simulation.
Alt and colleagues (32)	2023	Survey-based study, PLS-SEM analysis	Education, Health Management, Social Work (undergraduate)	Israel	CBL + Formative assessment feedback	CBL positively associated with personal, social, and methodological soft skills.
Qin and colleagues (33)	2022	Randomized controlled experiment	Undergraduate medical students (Radiology)	China	Practice-based learning via Smart class (PACS simulator and case-based learning) vs. traditional teaching	Smart-Class group achieved higher quiz scores, application subscore on final exam, and higher ratings on learning interest.
Araújo and colleagues (34)	2021	Intervention study (Before-and-after)	Vocational nursing students (Primary Health Care)	Brazil	Clinical simulation (4 scenarios) vs. theoretical skill demonstration	More knowledge; higher immediate and delayed cognitive performance.
Farsi and colleagues (35)	2021	Randomized controlled trial	Nursing students (CPR training)	Iran	SBL vs. Serious game with smartphone	Both simulation and serious game groups improved CPR knowledge and skills compared to control.

Author(s)	Year	Study Design	Field/Level	Country	Intervention Type	Key Outcomes
Ka Ling and colleagues (36)	2021	Experimental study	Undergraduate nursing students (Code blue management)	Malaysia	High-Fidelity Patient Simulation (HFPS) vs. Low-Fidelity Patient Manikins (LFPM)	Knowledge scores favored HFPS. Changes in critical thinking disposition varied by subscale.
Habibli and colleagues (37)	2020	Randomized pretest–posttest study	Nursing students (Adult BLS-CPR)	Iran	Simulation-based education + Conventional training	Intervention group had significantly higher knowledge and performance scores immediately and at 3 months
Nyoni and colleagues (38)	2019	Qualitative study / Gap analysis	Post-basic midwifery students and educators	Lesotho	CBL midwifery program	Found a substantial gap between curriculum design and enactment.
Dusch and colleagues (39)	2018	Experimental survey-based study	Final-year medical students (Ambulatory care)	Germany	Ambulatory care simulation with competency-based learning objectives	Simulation well-structured and created sense of time pressure; improved self-rated ability to fill narcotic prescription forms.
Hashemi and colleagues (40)	2017	Quasi-experimental	Healthcare providers (Postpartum depression training)	Iran	Simulated patient (patient-actor) vs. Lecture	Both methods improved knowledge and performance, but the simulated patient method was more effective and preferred by most participants.
Heidarza-deh and colleagues (41)	2015	Quasi-experimental	Undergraduate nursing students (CPR training)	Iran	Mannequin-based simulation vs. Computer-based simulation	CPR self-efficacy improved in both groups; the between-group difference was not statistically significant.

BLS: Basic Life Support; CBE: Competency-Based Education; CBL: Competency-Based Learning; CPR: Cardiopulmonary Resuscitation; HFPS: High-Fidelity Patient Simulation; LFPM: Low-Fidelity Patient Manikins; PACS: Picture Archiving and Communication System; PLS-SEM: Partial Least Squares Structural Equation Modeling; SBL: Simulation-Based Learning

However, the direction and magnitude of reported effects were not uniform; several studies reported neutral findings, contextual barriers, or limited generalizability beyond their specific settings.

The included studies were published between 2015 and 2025 and originated from diverse geographical regions, indicating that these educational strategies have garnered attention across multiple settings within competency-based and simulation-based approaches. The studies represented a variety of educational contexts, including nursing education, medical procedural skills training, radiology education, emergency and multidisciplinary healthcare education, and primary healthcare training. Methodologically, the evidence base was heterogeneous and included qualitative, quantitative, mixed-methods, quasi-experimental, experimental, Delphi, survey-based, and systematic review designs. Figures 2 and 3 show the distribution of the included studies by country and publication year, respectively.

Thematic Synthesis of Reported Educational Outcomes

While the majority of included studies reported favorable outcomes associated with CBL and SBL, the findings were not uniformly positive across all studies or all outcome measures. Several studies identified implementation challenges, contextual barriers, and limitations affecting the transferability and sustainability of educational outcomes across settings (28-30, 38, 39). Positive effects were most consistently observed in relation to clinical skill development (28, 29, 35, 37), procedural competency (28), CPR self-efficacy (41), knowledge retention (34, 37), and the application of knowledge in practice (33). These benefits were particularly evident in high-stakes clinical and procedural contexts, such as Cardiopulmonary Resuscitation (CPR) (29, 35, 37, 41), code blue management (36), and radiology training (33). Furthermore, the integration of SBL within competency-based frameworks appeared to enhance learning curves, support deliberate practice, and facilitate structured feedback processes, thereby strengthening the link between theoretical knowledge and practical competence. However, variations in instructional design, assessment approaches, resource availability, and educational context influenced the magnitude, consistency, and long-term sustainability of these outcomes.

Analysis of the included studies identified three overarching themes related to the integration of CBL and SBL in health

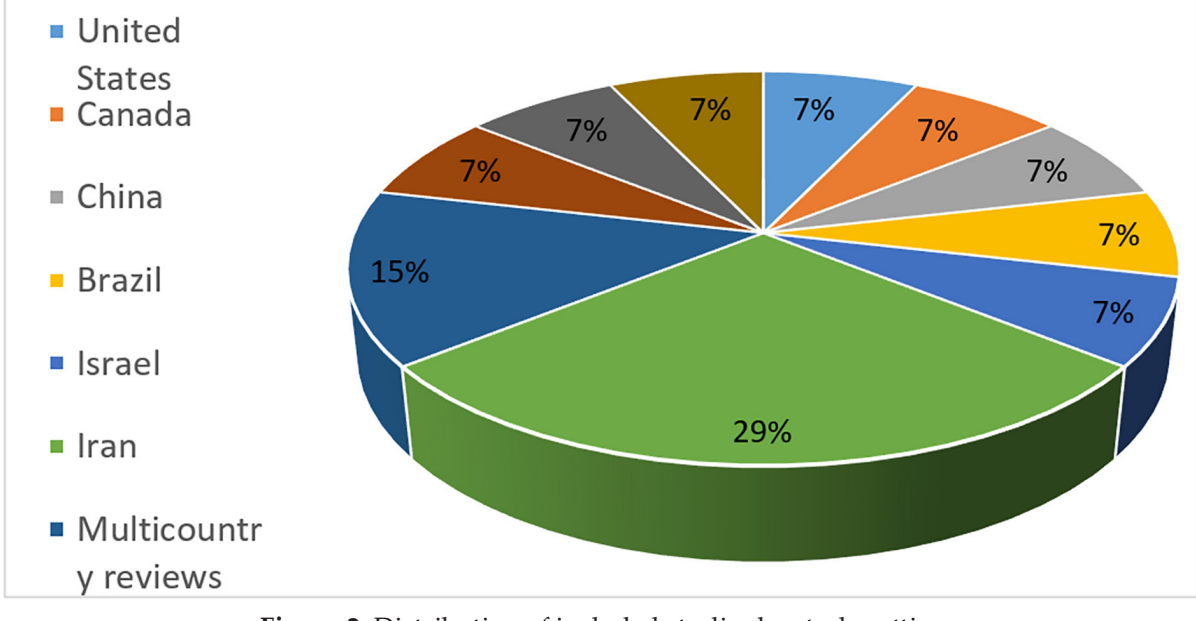


Figure 2: Distribution of included studies by study setting

professions education: (1) improvement in clinical skills and knowledge, (2) role of competency-based simulation in assessment and training, and (3) implementation challenges and contextual limitations. These themes provided the organizing framework for the narrative synthesis, as illustrated in Figure 4.

Theme 1: Improvement in Clinical Skills and Knowledge

Across several included studies, simulation-based and competency-based interventions were associated with improvements in knowledge retention, procedural skills, self-efficacy or performance-related outcomes.

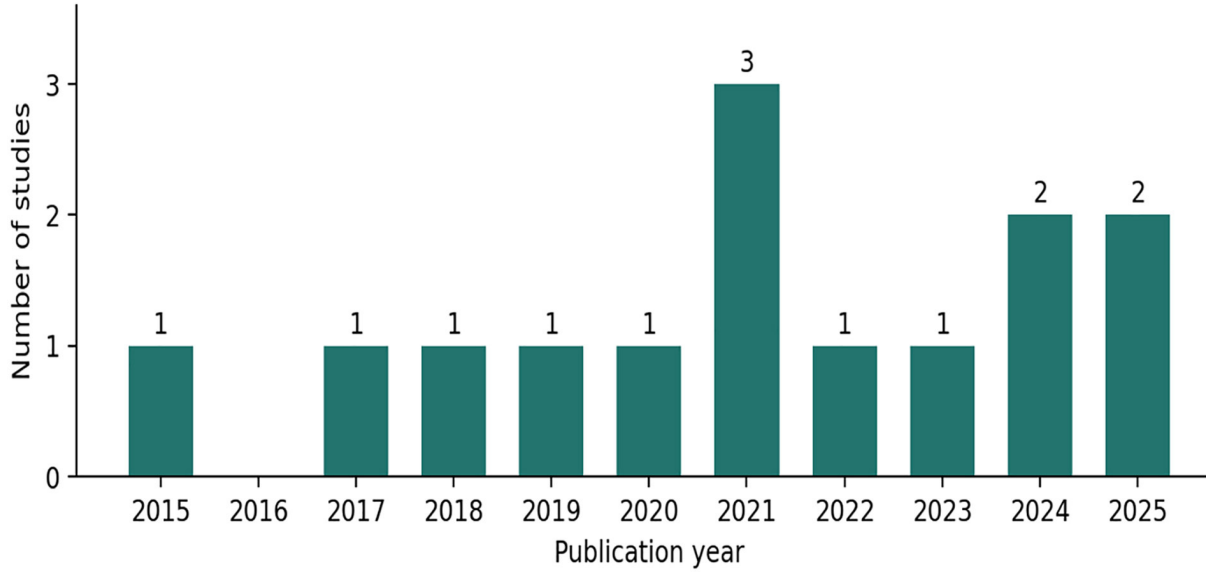


Figure 3: Distribution of included studies by publication year

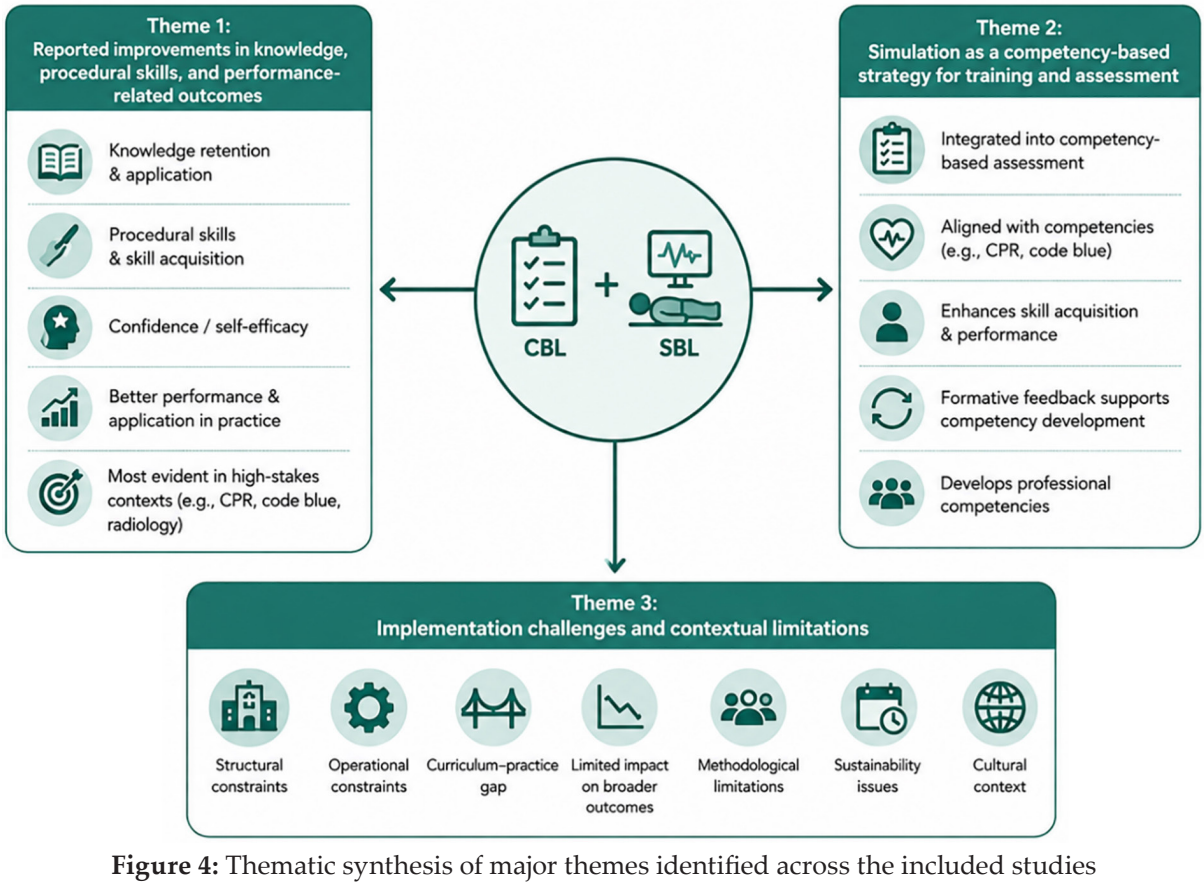


Figure 4: Thematic synthesis of major themes identified across the included studies

A meta-analysis found that competency-based simulation produced larger gains in procedural skills than noncompetency-based simulation. Effects on clinical behavior and patient outcomes were smaller (28).

Radiology students using a simulated image archive scored higher on applied questions and rated their diagnostic reasoning more favorably (33). Nursing studies reported better knowledge retention after simulation (34, 37). In a code blue exercise, knowledge scores favored high-fidelity simulation, while changes in critical thinking disposition varied by subscale (36).

The improvements in knowledge and skills reported across these studies appeared to be closely tied to the structured, feedback-rich nature of simulation-based interventions. This connection between skill development and assessment processes is further elaborated in the next theme, where several studies explicitly examined how competency-based frameworks incorporated simulation for training and assessment purposes.

Theme 2: Role of Competency-Based Simulation in Assessment and Training

A number of studies highlighted the role of competency-based frameworks in integrating simulation into various forms of assessment, including summative high-stakes evaluations, criterion-referenced competency-based assessments, cognitive-level assessments, self-perception measures, and standardized critical thinking instruments within structured training programs (28, 30-33, 36). In emergency medicine, simulation scenarios have been aligned with competency requirements and training experiences, facilitating the development of essential clinical skills, including lifesaving procedures such as CPR (30, 35-37). In nursing education, a Delphi panel developed a competency-based assessment tool for simulation (31). Other nursing studies evaluated the effects of simulation on knowledge and skills (29, 34, 35). In addition, CBL combined with formative assessment and feedback supported the development of professional competencies, including personal, social, and methodological skills, although feedback alone showed a more limited direct impact (32).

The studies described several uses of simulation in competency-based assessment (28, 30, 31), and other included studies indicated that these benefits varied across contexts. The next theme examines implementation challenges and contextual limitations across CBL and SBL interventions that appeared to influence the effectiveness and sustainability of educational outcomes.

Theme 3: Implementation Challenges and Contextual Limitations

Despite the reported benefits, several studies identified implementation challenges and contextual barriers. In midwifery education, Nyoni and colleagues identified a substantial gap between curriculum design and implementation, linked to differences in faculty and preceptor competencies and limited clinical learning resources (38). These findings suggest that even well-designed competency-based programs may encounter considerable obstacles in practice. In ambulatory care, Dusch and colleagues found a greater increase in students' self-rated ability to complete narcotic prescription forms, with little evidence of a broader advantage (39).

Methodological limitations, including small sample sizes, single-center designs, and reliance on self-reported data, also restricted the interpretation and generalizability of findings (29, 37). Heidarzadeh and colleagues measured perceived CPR self-efficacy before and after training; both groups improved, with no significant difference between computer and mannequin simulation (41). In the code blue study, most critical thinking disposition subscale scores declined after training, despite gains in some outcomes (36). While targeted simulation activities enhanced specific procedural skills, evidence for broader competency gains was limited (39).

Discussion

This narrative review synthesized

evidence from 14 studies examining CBL, SBL, and their intersection in health professions education. Three overarching themes emerged: improvements in clinical skills and knowledge, the role of competency-based simulation in assessment and training, and implementation challenges and contextual limitations. Overall, the findings suggest that CBL and SBL may offer complementary contributions to learning, with favorable outcomes reported particularly for knowledge acquisition and procedural skill development (28, 29, 33-35, 37). Studies examining competency-based applications of simulation also highlighted opportunities to align practice and assessment with defined performance expectations (28, 30, 31). However, the evidence does not establish the effectiveness of a unified CBL–SBL model, as the extent of integration varied and relatively few studies directly evaluated combined approaches. Differences in study designs, educational settings, and outcome measures, together with limited long-term follow-up, further constrain conclusions about sustained competency development and transfer to clinical practice. These findings support consideration of simulation as a means of implementing competency-based principles while underscoring the need for more rigorous evaluation of integrated approaches.

Several interconnected educational processes help explain the effectiveness of this integration. First, simulation puts competency-based principles into practice by giving learners repeated, structured opportunities to demonstrate the expected competencies through observable performance (28). Second, feedback in simulation environments helps learners identify performance gaps, refine their approaches, and consolidate their skills through cycles of deliberate practice (28). Third, standardized and reproducible simulation scenarios allow educators to assess competencies consistently across learners, supporting objective evaluation within competency-based frameworks (28, 30). Taken together, these mechanisms may help explain why simulation embedded in competency-based curricula was associated with favorable outcomes in several of the included studies. However, the heterogeneity of the evidence precludes firm conclusions about the relative contribution of each mechanism (28-31).

Miller's Pyramid of Clinical Competence provides a theoretical framework for understanding how simulation and competency-based curricula complement each other (42). Competency-based curricula define expectations for learners at each of the pyramid's four levels, progressing from "knows" through "knows how" and "shows how" to "does" (42). Simulation plays a critical role in operationalizing these levels, particularly the "shows how" stage, by allowing learners to demonstrate clinical reasoning, procedural ability, and decision-making in realistic but safe settings (27, 42). Through repeated practice and feedback, simulation may facilitate the transition from competence demonstration in simulated environments to performance in real clinical practice (28, 30). In this sense, simulation functions not merely as an instructional technique but as a bridge between theoretical knowledge and authentic clinical performance (28). The present findings suggest that simulation may serve as an important mechanism for operationalizing competency-based education by creating structured opportunities for learners to progress from cognitive understanding ("knows" and "knows how") to observable performance ("shows how").

A key finding of this review is that CBL and SBL appear to function as complementary educational approaches rather than as independent instructional strategies. Competency-based frameworks provide explicit learning outcomes, performance standards, and assessment criteria (43, 44), whereas simulation offers a structured environment in which these competencies can be practiced, demonstrated, and evaluated (45). Consequently, simulation operationalizes competency-based principles by transforming abstract competency expectations into

observable learner performance (42). This alignment may contribute to the favorable findings reported in several studies, although the direction and magnitude of outcomes varied across educational contexts, interventions, and assessment approaches.

Taken together, the included studies suggest that simulation can improve procedural competence, improve performance on applied radiology questions, and support knowledge retention (28, 29, 33, 34). These outcomes can be explained through experiential learning mechanisms (46), in which learners engage in concrete experiences, receive structured feedback, and refine their performance through deliberate practice. Simulation environments create opportunities for iterative learning cycles in which mistakes can be analyzed and corrected without risk to patients. Within competency-based curricula, explicit performance standards guide these learning cycles and help learners develop the targeted competencies (28, 30).

Another key contribution of integrating SBL into competency-based frameworks lies in improving assessment practices. Traditional educational models often rely heavily on time spent in training or exposure to clinical environments. In contrast, competency-based approaches emphasize performance-based evaluation. Simulation enables direct observation of learner performance in standardized scenarios, making it possible to assess clinical competencies, decision-making processes, and teamwork skills in a structured and reproducible manner (45, 47). Furthermore, the integration of simulation with EPAs and competency mapping allows educators to connect learning activities with clearly defined clinical responsibilities (30). This assessment function is critically important because it shifts evaluation from what learners know to what they can actually do, thereby providing structured and potentially more standardized evidence of learner performance when appropriate assessment tools, scenarios, and rater procedures are used. For medical educators, this means that simulation-based assessment can inform decisions about learner progression, identify areas needing remediation, and document competency achievement for credentialing purposes.

The findings may also be interpreted through the lens of situated learning theory (23), which emphasizes that knowledge and skills are most effectively acquired within authentic contexts of practice. By recreating realistic clinical environments, simulation enables learners to engage in meaningful professional activities before entering actual patient-care settings. In one controlled study, students who used a manikin during a case discussion scored higher on a subsequent clinical reasoning test (48). This contextualized learning process supports not only the acquisition of technical skills but also the development of communication, teamwork, and decision-making skills (49).

Importantly, the literature also suggests that the impact of simulation extends beyond technical skill acquisition. Several studies highlight improvements in critical thinking, learner confidence, and non-technical competencies such as communication and teamwork. These dimensions are essential components of professional competence and reflect the multidimensional nature of clinical expertise. Simulation scenarios, particularly those involving complex or emergency situations, provide authentic contexts in which both technical and cognitive aspects of performance can be integrated (28, 29, 36, 49).

Beyond individual learner outcomes, these findings suggest that CBL and SBL can play a central role in competency-based curriculum design across the health professions. Educators can use competency frameworks to define the capabilities learners need for independent clinical practice, then design cases, simulations, and assessments around those capabilities. This alignment makes expectations clear and gives learners structured opportunities to practice and demonstrate the skills required in contemporary healthcare.

At the program level, assessing performance against explicit standards can

strengthen accountability by showing how well learners meet curricular goals. Educators can use these results to identify gaps and direct instructional time and resources toward the competencies that require further development.

Limitations and Suggestions

This narrative review did not pool effect sizes, and the evidence does not support causal conclusions. Although the search covered multiple databases, the choice of keywords and the requirement for peer-reviewed full texts may have excluded relevant studies and introduced selection and publication bias. The language criterion may also have limited coverage. Selecting two Persian-language articles for their relevance introduced an element of judgment that could affect reproducibility. Few studies examined CBL and SBL together, so conclusions about their complementary effects rely largely on indirect comparisons. Differences in study design, educational setting, outcome measures, and follow-up duration, together with methodological limitations in individual studies, also made it difficult to compare and synthesize findings. Four of the 14 included studies were conducted in Iran, which may limit the transferability of the findings to settings with different curricular, institutional, or cultural characteristics.

Given the limited and heterogeneous evidence, the review offers tentative guidance for curriculum design. Educators might align simulation scenarios and assessment criteria with explicit competency-based learning objectives. Faculty development could support this work by helping educators facilitate simulations, assess performance against those criteria, and provide feedback. Future studies could directly compare integrated CBL and SBL with either approach alone to clarify the contribution of combining them. Where feasible, structured assessments and longitudinal follow-up could help establish whether learners retain knowledge, maintain skills, and apply what they have learned in clinical practice.

Conclusion

This narrative review suggests that simulation can support competency-based learning in health professions education. When simulation activities are aligned with clearly defined competencies, learners have structured opportunities to practice clinical skills, receive feedback, and demonstrate their performance against explicit standards. Few studies directly evaluated the integration of CBL and SBL, and differences in study designs and outcome measures make it difficult to determine which approaches to integration are most effective.

The included studies point to several conditions that may influence implementation, including the range of simulation scenarios available, the timing and consistency of assessments, faculty preparation, and institutional support. Four of the 14 studies were conducted in Iran, underscoring the need to examine how well the findings transfer to other educational and healthcare settings.

Future studies should map simulation tasks to specific competencies and use comparable study designs and validated outcome measures to evaluate different approaches to integration. Longitudinal assessment in clinical settings is particularly important for determining whether gains observed in simulation translate into sustained performance in practice. Research across educational systems with different resources would clarify where and under what conditions these approaches are most effective.

Abbreviations

CBE: Competency-Based Education
CBL: Competency-Based Learning
EPAs: Entrustable Professional Activities
SBL: Simulation-Based Learning

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Authors' Contribution

TF contributed to the conceptualization of the review, literature search and analysis, synthesis of the reviewed evidence, and drafting of the initial manuscript. ShJ contributed to the analysis and organization of the reviewed literature, development of the manuscript, and critical revision of the content. ZK contributed to the conceptualization and supervision of the review process, validation of the synthesized findings, critical revision and editing of the manuscript. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare no competing interests and accept full responsibility for the accuracy, originality, and integrity of the manuscript. Zahra Karimian, a member of the Editorial Board, took no part in reviewing the manuscript or making any editorial decisions concerning it. The manuscript was independently assessed by reviewers appointed by the Editorial Board, without her knowledge or involvement.

Ethical Considerations

This narrative review analyzed and synthesized findings from previously published studies. As the authors collected no primary data from human participants or animals, the review required neither institutional ethics approval nor informed consent. The authors followed the principles of academic integrity, transparency, and responsible research conduct. Efforts were made to report the findings faithfully, synthesize the evidence objectively, and avoid plagiarism, selective reporting, and misinterpretation.

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Availability of Data and Materials

This narrative review draws on findings from previously published studies, all of which are cited in the reference list. No primary data were collected. The data used in the synthesis will be made available by the corresponding author upon request.

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