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The Use of Simulation Training to Improve Knowledge, Skills, and Confidence Among Healthcare Students: A Systematic Review

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Abstract

Purpose: The use of simulation has become a routine part of education and training for health professionals in many health education facilities. The increased awareness of patient safety and recent advances in technology are the main incentives to use simulation to teach and evaluate clinical competencies. The primary purpose of this study was to review the best available evidence (level and quality) for the use of simulation training to improve clinical skills, knowledge, and self-confidence among healthcare students. Method: A systematic review of qualitative and quantitative literature published between 2000 and 2016 was undertaken using databases including PubMed, CINAHL®, and PsycINFO® databases as well as three journal collections within ProQuest. In addition to the database search, the literature search for this study included two additional activities: search results were compared against the bibliographies of the reviewed studies, and Google Scholar was used to search the Internet for relevant publications. Data from studies meeting inclusion criteria was extracted and summarized. The level and strength of evidence was rated for each study. Results: Of 1412 studies identified via the search strategy, 30 met the inclusion criteria for this systematic review. A wide variety of study designs, interventions, measurements, and simulation types were represented. Data for study location, health profession, sample size, purpose, simulation type, intervention, and outcome measure are presented via evidence tables by authors. Statistically and/or clinically significant improvements in knowledge, skills, and/or self-confidence following simulation training were reported. Primary and secondary outcomes were identified and summarized. Conclusions: Evidence demonstrates that the use of simulation in student education significantly improves knowledge, skills, and self-confidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. Future research employing high quality research designs focusing on debriefing practices, interprofessional education applications, validation of outcome measures, student satisfaction, and long-term information retention will contribute to the growing body of literature supporting best practices for simulation training in healthcare.

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The Use of Simulation Training to Improve Knowledge, Skills, and Confidence Among Healthcare Students: A Systematic Review

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Abstract
Purpose: The use of simulation has become a routine part of education and training for health professionals in many health education facilities. The increased awareness of patient safety and recent advances in technology are the main incentives to use simulation to teach and evaluate clinical competencies. The primary purpose of this study was to review the best available evidence (level and quality) for the use of simulation training to improve clinical skills, knowledge, and self-confidence among healthcare students. **Method:** A systematic review of qualitative and quantitative literature published between 2000 and 2016 was undertaken using databases including PubMed, CINAHL®, and PsycINFO® databases as well as three journal collections within ProQuest. In addition to the database search, the literature search for this study included two additional activities: search results were compared against the bibliographies of the reviewed studies, and Google Scholar was used to search the Internet for relevant publications. Data from studies meeting inclusion criteria was extracted and summarized. The level and strength of evidence was rated for each study. **Results:** Of 1412 studies identified via the search strategy, 30 met the inclusion criteria for this systematic review. A wide variety of study designs, interventions, measurements, and simulation types were represented. Data for study location, health profession, sample size, purpose, simulation type, intervention, and outcome measure are presented via evidence tables by authors. Statistically and/or clinically significant improvements in knowledge, skills, and/or self-confidence following simulation training were reported. Primary and secondary outcomes were identified and summarized. **Conclusions:** Evidence demonstrates that the use of simulation in student education significantly improves knowledge, skills, and self-confidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. Future research employing high quality research designs focusing on debriefing practices, interprofessional education applications, validation of outcome measures, student satisfaction, and long-term information retention will contribute to the growing body of literature supporting best practices for simulation training in healthcare.

INTRODUCTION

Background

Simulation is an exercise that mimics realistic functions in a simulated environment.[1] The use of simulation in the healthcare field started more than a hundred year ago; however, advances in teaching technology have contributed to a recent resurgence of interest spanning the past two decades. Healthcare simulation is used by numerous healthcare specialties and serves multiple purposes.[2] Simulation has become a routine part of education and training for healthcare students and professionals in many academic health education facilities because of 1) the recent advances in simulator technology, 2) increased awareness of patient safety, and 3) emphasis on healthcare outcomes and accountability.[3-5]

Simulation training offers a powerful learning experience, provides students with an opportunity to transfer theory to practice in an integrated learning environment, and serves as an efficient opportunity to practice skills, applying knowledge gained through lectures and/or reading assignments.[6] Research suggests many benefits of simulation for learners in the development of clinical skills when used within the context of education for students enrolled in healthcare professional programs.[7] Simulation training provides clinical practice challenges and supports student practice while developing knowledge and skills in an environment with no fear of harming patients, thus, reducing error and anxiety.[8-10]

Simulation education in healthcare involves the use of low-, mid-, and/or high-fidelity simulation experiences. The level of simulation fidelity is based on the degree to which the simulation imitates reality.[11,12] According to Neill and Wotton, "high-fidelity simulation, in which students engage in clinical scenarios replicating actual clinical situations, is now well integrated into nursing education."[13] There are various methods of simulation fidelity in teaching and learning.[14] For example, teaching knowledge, skills, and self-confidence in simulated healthcare settings can be achieved through the use of manikins, part-task trainers, computer-based simulations, virtual reality, multimedia, and standardized patients (SPs).[3,15-20] Numerous studies support the use of simulation for improved student outcomes in healthcare education to increase patient safety and reduce medical errors.[8-10,21,22] There is a growing body of evidence focusing on improved outcomes specific to knowledge, skills, and confidence level of students in professional training programs.[2,3,23-25]

Why it is important to do this Review

Currently, there are no specific best practice models (or gold standards) in simulation training research. Simulation-based research is still a new area and requires additional study to reveal the nuances of best practice. For example, limited data is available on the benefits of using a combination of two or more simulation types in a single simulation experience. Furthermore, debriefing, a conversation between the facilitator and learners after the simulation experience is "the heart and soul" of simulation and still largely ignored in the simulation research process.[6] Simulation studies do not use a specific framework for reporting the components and details of the simulation experiences such as briefing and debriefing practices and long-term retention of knowledge and skills after the simulation experience.[13] Results of this study characterize the current state of evidence in simulation training across healthcare professions including medicine, nursing, pharmacy, and allied health professions. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review.

Objective

The aim of this review was to systematically evaluate and analyze the best available evidence (level and quality) for the use of simulation training to improve knowledge, clinical skills, and self-confidence among healthcare students. The need to identify specific features as a framework for implementing simulation in health education exists. The rationale for including a variety of students from different health professions within the construct of a single study is that the benefits of simulation training extends to all healthcare professions students (medicine, nursing, pharmacy, and allied health) regardless of educational goals, objectives, and curricular differences in various programs.

METHOD

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol.[27] PRISMA is a guideline for authors to use for reporting systematic review methodology and results. This evidence-based approach is consistent with principles of high quality scientific research; providing enough details about the methodology for replication.

Database

Electronic databases available through the University of Arkansas for Medical Sciences (UAMS) were searched in November, 2016, and included PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL®) Plus with Full Text, and Psychological Information (PsycINFO®). Three journal collections within the ProQuest system were also searched: Health and Medicine, Psychology, and Social Science. In addition to the database search, the literature search for this study included two additional activities: 1) search results were compared against the bibliographies of recent literature reviews and current reviewed articles, and 2) Google Scholar was used to search for relevant publications. Relevant citations discovered were added to our search results. Search terms and strings are shown in Appendix A.

Inclusion Criteria

Research studies conducted for the purpose of undergraduate and/or graduate education employing the use of simulation types, such as manikins and/or SPs, regardless of the level of fidelity were included in this review. Simulation studies included in this review focused on knowledge, skills, and confidence level as outcome measures. Research designs eligible for inclusion were randomized controlled trials (RCTs), nonrandomized-controlled trials, quasi-experimental with one- or two- group pretest/posttest, observational-analytic, descriptive, and any type of qualitative or mixed-method design. Studies published in English in peer-reviewed journals after 2000 and available electronically were included (Table 1). Publications prior to 2000 were excluded as a result of changes in simulation technology over the past two decades. Simulation education, a complex connection and interaction between individuals and technology, has advanced significantly, positively impacting teaching and learning practices in simulation education. Thus, the focus of this review was on the current best evidence for simulation training.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• Simulation studies conducted for the purpose of health education • Students of health occupations are the target population • Used simulation manikins and/or SPs • Outcomes related to knowledge, skills, and confidence levels • All study designs • Published in peer-reviewed journals • Published in English • Available electronically	• Research without a specified design or review not focused on topic • Studies published before 2000

Procedure

Objectives, selection criteria, and a well-defined search strategy for this systematic review were set *a priori*. Following execution of the search strategy, the titles of articles were reviewed for relevancy, with those considered irrelevant being eliminated from further consideration. Abstracts of remaining studies were accessed electronically and reviewed for relevancy. Selected studies meeting inclusion criteria were downloaded and printed for full review. The simulation study review form developed for use in this study, shown in Appendix B, was attached to each of these research studies to aid in data extraction.

Data extraction

First and second authors assessed the eligibility and methodological quality of each study twice, independently and together to ensure no bias when determining the inclusion or exclusion of any studies. When differences of opinion were encountered, the study was discussed until the discrepancy was resolved. Studies that examined variables that were not integral to the purpose of the study were eliminated. Data were extracted from the study onto the review form and each study was rated for level and strength (quality) of evidence.

Evidence levels

Evidence levels proposed by authors of the Joanna Briggs Institute (JBI) Model of Evidence-based Healthcare were used for critical appraisal:[28]

- **Level 1:** Experimental Designs
  - Level 1.a – Systematic review of RCTs
  - Level 1.b – Systematic review of RCTs and other study designs
  - Level 1.c – RCT
  - Level 1.d – Pseudo-RCTs
- **Level 2:** Quasi-experimental Designs
  - Level 2.a– Systematic review of quasi-experimental studies
  - Level 2.b– Systematic review of quasi-experimental and other lower study designs
  - Level 2.c– Quasi-experimental prospectively controlled study
  - Level 2.d– Pre-test post-test or historic/retrospective control group study
- **Level 3:** Observational-Analytic Designs
  - Level 3.a– Systematic review of comparable cohort studies
  - Level 3.b– Systematic review of comparable cohort and other lower study designs
  - Level 3.c– Cohort study with control group
  - Level 3.d– Case controlled study
  - Level 3.e– Observational study without a control group (including qualitative research study designs)
- **Level 4:** Observational Descriptive Studies
- **Level 5:** Expert Opinion and Bench Research

Strength of evidence

Each of the studies meeting the inclusion criteria was also rated for quality (strength) of evidence and included three categories:

1. High – random assignment studies with low attrition of sample members and no reassignment of sample members after the original random assignments.
2. Moderate – random assignment studies that, because of flaws in the study design, execution, or analysis, do not meet all the criteria for the high rating; matched comparison group designs that establish baseline equivalence on selected measures; and single case and regression discontinuity designs.
3. Low – impact studies that do not meet the criteria for high or moderate.

RESULTS

The initial search strategy identified 1386 publications from four major databases and 26 studies from other sources, totaling 1412. Seven hundred and four duplicates were removed, leaving 708 publications for title review. The number of publications for each source after duplicate removal is shown in Table 2. Six hundred and fourteen publications were excluded due to irrelevancy on the basis of the title review. Ninety-four abstracts were reviewed with 40 deemed irrelevant. Full review was undertaken on the remaining 54 publications, identifying 30, which met the inclusion criteria and were subjected to data extraction and analysis of results. The PRISMA diagram was used to represent the study inclusion and exclusion process (Figure 1).

Primary outcomes were knowledge, skills and confidence. Secondary outcomes were anxiety reduction and satisfaction. Other secondary outcomes explored interprofessional education (IPE) and/or interprofessional practice (IPP) and preference and/or effectiveness of high fidelity and/or low fidelity simulations on students' outcomes. The majority of studies reported use of more than one outcome measure, combining knowledge and skills, skills and confidence, confidence and satisfaction, etc. Overall, studies reported statistically and/or clinically significant improvements in knowledge (N= 14),[3,8,29,33,35,39,40,42-44,48,52,54,55] skills (N= 20),[3,8,29,30,33-36,38-41,44,47-49,51-53,56] self-confidence (N= 19),[3,8,29-33,36-39,41,43,46,47,49,,50,52,53] and satisfaction (N= 7).[3,8,30,37,39,41,50] In addition, four studies reported decreased anxiety or inhibition.[8,40,45,53] Two studies evaluated the long-term impact of the simulated learning.[29,36]

Table 2. Number of hits for each database after the duplicate removal

Database	Total
PubMed	394
CINAHL	149
PsycINFO	78
ProQuest- Social Science Journals ProQuest- Psychological Journals ProQuest- Career and Technical Education: Health & Medicine	17 18 44
Additional Sources	8
Total	708

Note. CINAHL= Cumulative Index to Nursing and Allied Health Literature; PsychINFO= Psychological Information.

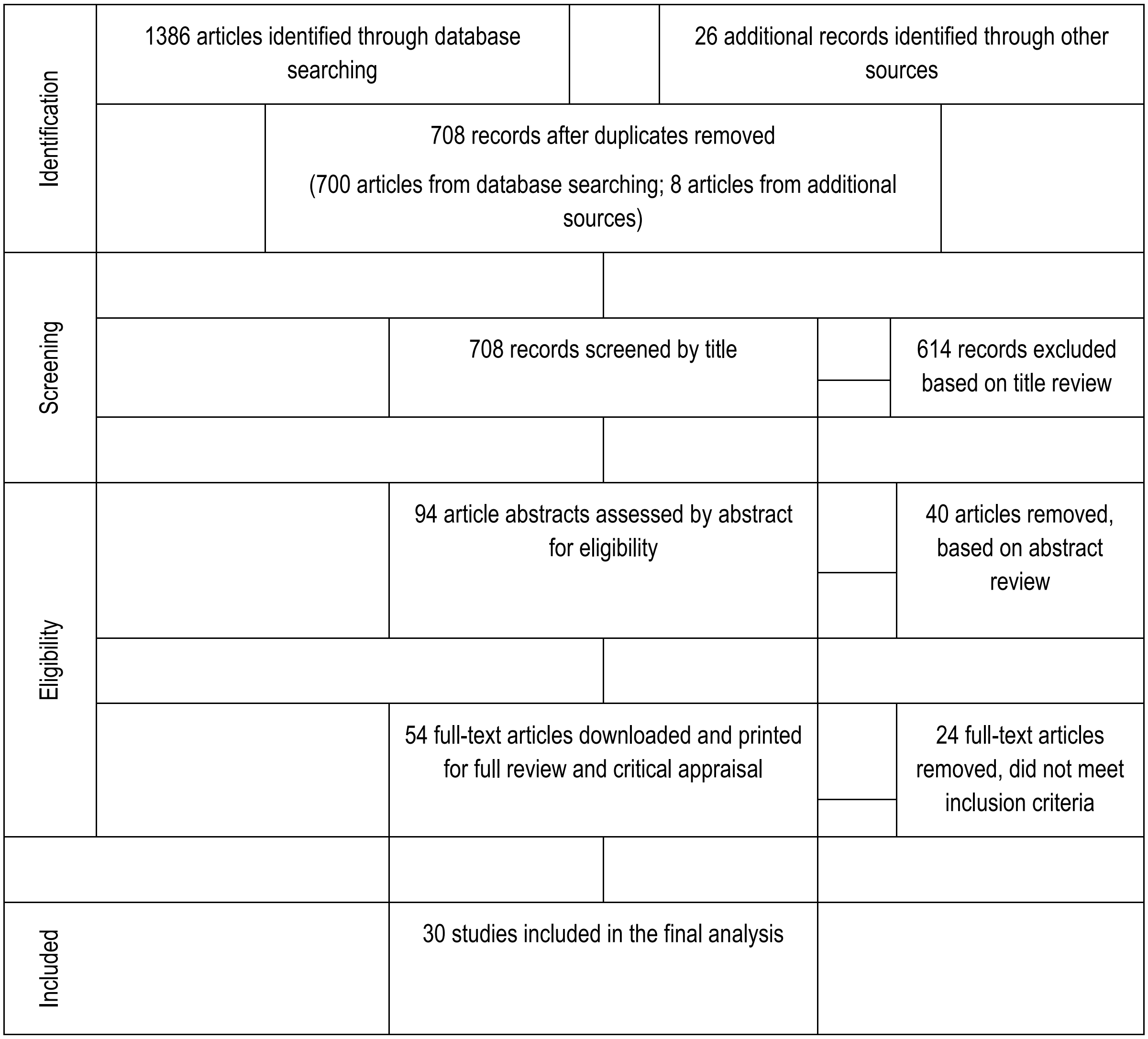

Figure 1.
The search process consisted of identification, screening, eligibility checks, and inclusion in the study as shown on the study inclusion flow diagram. Numbers of studies excluded and the basis of the exclusion are detailed.

Characteristics of the included studies
Studies varied in their study designs, simulation duration, preparing for simulation, intervention, and assessment measures. Several study designs were used: pretest posttest design (N=11),[3,31,32,36,39,43,47,48,50,52,55] posttest design (N=10),[37,41,44-46,49,51,53,54,56] mixed methods design (N=4),[8,38,40,42] qualitative study (N=3),[33-35] and RCTs design (N=2).[29,30] This review shows that the pre/post test study design and posttest study design were the most commonly used method for evaluating the effectiveness of simulation training. The duration of simulation training ranged from 30 minutes to a few weeks during the semester. Characteristics for each of the studies included in this review are shown in Table 3.

The reviewed studies were conducted in the following health disciplines: audiology, medicine, nursing, physical therapy, pharmacy, and physician assistants. The majority of studies reported outcomes from a single healthcare profession, while three studies reported IPE cohorts and queried students regarding IPP.[34,38,55] The three IPE cohort studies included pharmacy and nursing, nursing and medicine, and pharmacy, medicine and nursing. Undergraduate and graduate students from the specified health professions participated in the simulation-based learning experiences. Of the 30 studies, 11 reported use of standardized patients or parents,[8,34,35,38,42,44,45,47,49,51,55] 13 employed the use of manikins,[29-32,36,37,40,41,43,,48,50,52,56] and 6 used a hybrid approach as teaching or intervention strategies.[3,33,39,46,53,54] Briefing before the simulation events was reported and included lectures, online and laboratory training, small learning groups, training on manikins, a problem based learning (PBL) case, and/or learning courses. Nine studies implemented debriefing or group discussion after the simulation experiences.[3,8,34,39,40,43,47,50,55] Students' performance included peer, SP and/or faculty evaluation. The majority of studies used non-validated surveys and questionnaires developed by faculty or clinical personnel to measure the three main outcome categories knowledge, skills, and confidence, in addition to direct observation and written and practical examinations.

Table 3. Study characteristics

Reference	Study Location	Design	Health Profession(s)	Study Sample	Study Purpose	Simulation Type	Intervention	Outcomes Measure
Alanazi et al (2016)[3]	United States	Pretest posttest	Audiology (2nd and 3rd year Doctor of Audiology students)	N=14	Assess the effect of the combined use of trained standardized parents and a baby simulator on students' hearing screening and counseling knowledge and skills	SPs Manikin (Baby Isao, Intelligent Hearing Systems)	Clinical course and training on the baby simulator Complete interactive web-based hearing screening Briefing	Pre- post-self confidence questionnaire of knowledge and skills Satisfaction survey
Ander et al (2009)[36]	United States	Pretest posttest	Medicine (3rd year students)	N=104	Evaluate lifesaving clinical skills and comfort level immediately after simulation training and after 1.5 years	Manikin and other medical equipment	30-minute lecture, small learning groups, and assessment at 5 skills stations	Pre/post performance checklist and level of comfort questionnaire
Baska et al (2015)[37]	United States	Posttest	Nursing (1st and 4th semester pre-licensure students)	N=66	Assess the difference between the use of LFS and HFS on students' outcomes and satisfaction	Manikins	Training on low and high fidelity manikins Briefing	Students' satisfaction and self-confidence scale Simulation design scale
Bearnson & Wiker, (2005)[33]	United States	Qualitative	Nursing (1st year students)	N= not given	Explore the benefits and limitations of using SPs as a substitute for traditional clinical experience in medication administration	Manikin (HPS6, Medical Education Technology) SPs	6 weeks of traditional clinical rotations 3 different SPs scenarios (one student provided total care for one patient)	Students completed post simulation survey about what they had learned

Bloomfield et al (2015)[38]	United Kingdom	Mixed methods (Included pretest posttest design)	Nursing and Medicine*	Nursing students N=51 Medical students N=24	Enhance students' ability to communicate with dying patients and their families	SPs	Focus groups Educational intervention	Pre- post-simulation questionnaire
Brown & Chronister (2009)[31]	United States	Pretest posttest with control group	Nursing (Senior students)	Intervention group N=70 Control group N=70	Determine the effect of simulation activity on critical thinking and self-confidence in ECG nursing course	Manikin (Laerdal's SimMan)	Experimental group received weekly lectures (350 minutes), and simulation training with debriefing (150 minutes) Control group received only lectures (400 minutes)	Both groups were evaluated for critical thinking on the ECG SimTest computer exam Self-confidence form
Catling et al (2016)[39]	Australia	Pretest posttest	Nursing (1st year midwifery students)	N=71	Determine whether pre-clinical simulation workshops increase students' knowledge, skills, and satisfaction	SPs Manikin (Sophie's mum, Model-med International)	10-minute briefing 2-day workshop	Online survey pre- and post-the simulation survey
Copper et al (2010)[40]	Australia	Mixed methods (Included posttest design)	Nursing	N=51	Examine the ability of students to respond to deteriorated or at risk of deterioration patients Assess the relationships between knowledge (situation awareness) and skill performance	Manikin (Laerdal's Advanced Life Support computerized)	2 video recorded simulated scenarios 2 simulation exercises on the manikin followed by video-based debriefing	MCQ items assess student's knowledge Skills test on manikin Situation awareness yes/no questionnaire during simulation
Curtis et al (2016)[41]	Australia	Posttest	Nursing	N=509	Evaluate peer to peer facilitated student via the use of simulation experiences	Manikin (Sim Anne, Laerdal Medical)	Three clinical courses Instructional videos	A 16-item questionnaire Self-confidence in learning scale

Dearmon et al (2013)[8]	United States	Mixed methods (Included pretest posttest design)	Nursing (Bachelor students)	N=50	Evaluate the effect of a 2-day simulated clinical nursing course of students' knowledge, anxiety, skills confidence, and satisfaction	SPs	Interview and physically assess SPs. Students simulated the experience in the next day in groups and provided a care plan. Ten students participated in two focus groups (n=4; n=6)	The KA, SCA, PSS and STAI were used pre- and post simulation Satisfaction was assessed after the simulation
Guvenc et al (2016)[42]	Turkey	Mixed methods (included posttest design)	Nursing (Senior students)	N=104	Evaluate students' communication experience with an English speaking patient	SP	A course of the rational use of medicines SP encounter	Data collection form Interview
Halm et al (2011)[43]	United States	Pretest posttest	Medicine (2nd year students)	N=50	Determine if the use of a PBL case with a simulation training improve toxicology knowledge and confidence	Manikin (Laerdal SimMan)	PBL case, simulation training on the manikin, group discussion about the clinical case followed by debriefing session	Online test to determine their baseline knowledge Second online test after the simulation. Survey regarding their confidence level
Hoellein et al (2009)[44]	United States	Posttest	Medicine (3rd year students)	N=92	Assess the impact of a CAM workshop using SPs on knowledge and skills	SPs	4-hour CAM workshop includes 4 SP cases with assigned readings before SPs encounter	100-item written exam Nine-SP stations exams Post SPs encounter written exercise
Hunag et al (2015)[45]	Taiwan	Posttest	Medicine	N=253	Determine the influence of gender on communication skills	SPs	2-hour training session SPs encounter	Checklist rating completed by SPs Global rating scores competed by the examiner

Isenberg et al (2015)[46]	United States	Posttest	Medicine (3rd year student)	N=195	Evaluate the validity of students' self-assessment of skills and confidence during working on manikin and encounter SPs	Manikin (Rectal Examination Model, Fort Atkinson, WI; a Multi-venous IV Training Arm & NG Tube and Trachestomy Care Simulator, Laerdal; Advanced Catheterization Trainer & Suture Pad, Limbs and Things, United Kingdome) SPs	3 clinical simulated case scenarios on manikins and encounter SPs	Checklists and rating scales of general skills and specific procedures were completed by students and SPs
Kaplan & Ura (2010)[47]	United States	Pretest posttest	Nursing (Senior students)	N=97	Increase students' confidence and quality of care	SPs	4-hour simulation experience and IP training using SBAR method followed by SPs encounter and debriefing	Faculty direct observation and self-rated of confidence level pre/post simulation
Kim & Kim (2015)[48]	South Korea	Pretest posttest (Crossed over design)	Nursing	Intervention Group=48 Control group=46	Assess the effects of simulation experiences on students' knowledge, skills, and self-confidence	Manikins	Baseline test Lectures for the control group 2-hour simulation training for the intervention group	A 10-item MCQ 4-phase rubric to test skills
Koo et al (2014)[34]	United States	Qualitative	Pharmacy and Nursing*	Pharmacy students N=14 Nurse practitioner students N=32	Evaluate students' perception on IPE experience on improving communication skills and awareness of other team members' roles	SPs	8-hour course followed by two 45-minute clinical scenarios to take case history, physical examination and communicate with other healthcare students Debriefing and focus groups discussion	Semi-structured IP questionnaire with and without open-ended questions was completed by 30 volunteers

Langen et al (2011)[49]	United States	Posttest	Physician assistant (2nd year students)	N=65	Expose students to more difficult case history taking scenarios to test their confidence level and counseling skills	Actor SPs Students SPs	5 scenarios performed by 13 SPs	Actor SPs provided students with verbal and written feedback after the simulation exercise Faculty observed the simulation and filled out a skills checklist
Mackey et al (2014)[35]	Singapore	Qualitative	Nursing (3rd and final year students)	N=15	Determine the learning outcomes (knowledge and skills) of being SP	SPs	Three clinical roles were performed by trained students SPs	Audio-taped focus group interview guided by 4 open-ended questions with observation and evaluation of students SPs skills
Nimalkar et al (2015)[29]	India	Randomized control trail	Medicine (Final year students)	HFS group N=50 LFS group N=51	Compare the acquisition of neonatal resuscitation skills and the retention of these skills after 3 months	Manikins (HFS: SimNew B; LFS: Resusci Baby Basic; Laedral Medical)	Lectures Hands-on training	A 40-question written test Megacode assessment (American Academy of Pediatrics)
Ohtake et al (2013)[50]	United States	Pretest posttest	Physical therapy (1st year Doctor of Physical Therapy students)	N=43	Examine students' level of skills confidence and satisfaction after the exposure to an ICU SP	Manikin (Hal model S3101, Gaumard Scientific)	30-minute orientation session followed by the simulation event and a 40-minute debriefing session	Pre- and post-simulation skills Satisfaction survey
Rickles et al (2009)[51]	United States	Posttest	Pharmacy (2nd year Doctor of Pharmacy students)	N=127	Determine the impact of a lecture-laboratory course with SPs on students' communication skills during baseline, midpoint and final stages	SPs	Online, lectures, and laboratory learning. SPs cases related to lectures	Laboratory written exams CSAF filled out by SPs Two surveys to students/ and SPs

Roh et al (2014)[52]	South Korea	Pretest posttest	Nursing (2nd year students)	N=255	Evaluate the effectiveness of integrated simulation resuscitation training with clinical practice on students' knowledge, skills, and self-confidence	Manikin (Resusci Anne Skills Reported, Laedral Medical)	Three groups (simulation training only, simulation with clinical practice, and simulation with clinical observation) Basic life support training 2-hour simulation resuscitation training 80-hour clinical placement	Pre- post- self-rated questionnaire
Sarmasoglu et al (2016)[53]	Turkey	Posttest with randomized control trial	Nursing	Intervention group N=44 Control group N=43	Examine the effect of SPs on students' blood pressure measurement and administration of subcutaneous injections skills and self-confidence	SPs Manikin	Lectures and hands-on training Intervention group practiced on SPs and control group practiced on manikin	Blood pressure measurement and administration of subcutaneous injections performance form SPs-students interaction assessment form
Siebeck et al (2011)[54]	Germany	Posttest	Medicine (3rd and 4th year students)	Study 1: N=41 Study 2: N=188	Study 1: identify the effect of LFS and HFS on knowledge and inhibition on doing rectal examination. Study 2: explore the effect of different sequencing between LFS and HFS	Manikin (Model 4660100, Polyco GmbH, Beimerstetten, Germany) as LFS SPs as HFS	Students participated in two 30-minute simulation sessions	Surveys of knowledge and inhibition In study 1: students answered two questions Study 2: students rated their experience on a scale developed by authors
Stayt et al (2015)[30]	United Kingdom	Randomized control trail	Nursing (1st year students)	Intervention group N=48 Control group N=50	Evaluate students' skills and confidence of recognize and manage an adult deteriorating patient	Manikin (Laerdal's ALS Simulator)	Assessment of eligibility-enrollment stage Experimental group received simulation intervention Control group received lectures	OSCE pre- and post-intervention General Perceived Self-Efficacy Scale (GPSEC)

Thomas & Mackey (2012)[32]	United States	Pretest posttest with control group	Nursing (Bachelor students)	Intervention group N=14 Control group N=10	Explore whether students' level of confidence change after HFS compared with traditional clinical training	Manikin	Experimental group enrolled in the HFS course including debriefing. Control group enrolled in the traditional clinical training	Faculty assessed students' performance A 12-item clinical decision-making self-confidence scale
Westberg et al (2006)[55]	United States	Pretest posttest	Pharmacy, Nursing, and Medicine*	N= 26 pharmacy students N= not given for nursing and medical students	Describe the effect of implementation of IPE activities using SPs on students' communication skills and cooperation with other healthcare students	SPs	Encounter with different scenarios performed by SPs. Group and one-on-one discussion with faculty members. Short and long care plan assignment	Pre- and post-simulation survey. Direct observation and evaluation by faculty
Zhang et al (2015)[56]	China	Posttest with control group	Medicine	Intervention group N=140 Control group N=63	Improve students' clinical operating capacity	Manikins	Intervention group received simulation Control group received traditional training	OSCE 16 stations of clinical skills competency

Note. N= sample size; SPs= standardized patients; HFS= high fidelity simulation; LFS= low fidelity simulation; KA= knowledge assessment; SCA= self-confidence assessment; IPE= interprfoessional education; PBL= problem-based learning; CAM= complementary and alternative medicine; PSS= Perceived Stress Scale; STAI= State-trait anxiety inventory for adults, CSAF= communication skills assessment form; SBAR= situation, background, assessment, and recommendation; MCQ= multiple-choice questionnaire; ECG= electrocardiograph; IV= intravenous, NG= nasogastric; OSCE= objective structured clinical examination. *IPE/IPP components were included.

Level of evidence, strength of evidence, and outcomes of the included studies

The level of evidence based on the JBI Model of Healthcare paradigm, strength of evidence ratings, and outcomes (i.e., knowledge, skills, self-confidence, anxiety, and satisfaction) are shown by study in Table 4. One study examined student preferences for high fidelity versus low-fidelity simulation.[37] Two of the studies were rated as level 1.c with high strength of evidence,[29,30] two studies were rated as level 2.c with moderate strength of evidence,[31,32] three studies qualified as level 3.e with low strength of evidence,[33-35] and the remaining studies met level 2.d design criteria with low or moderate strength of evidence. Six studies included control groups with traditional clinical training, lectures, or hands-on training in lieu of simulation training.[30-32,48,53,56] Overall, statistical and/ or clinical improvements in knowledge, skills, and self-confidence after the simulation training were reported.

Table 4. Level of evidence, strength of evidence, and outcomes

Reference	Level of Evidence	Strength of Evidence	Knowledge*	Skills*	Self-Confidence*	Anxiety	Satisfaction*
Alanazi et al (2016)[3]	2.d	Moderate	Increased	Increased	Increased	Not reported	Increased

Ander et al (2009)[36]	2.d	Moderate	Not reported	Increased	Increased	Not reported	Not reported
Baska et al (2015)[37]	2.d	Low	Not reported	Not reported	Increased in HFSG more than LFSG	Not reported	Increased in HFSG more than LFSG
Bearnson & Wiker (2005)[33]	3.e	Low	Increased	Increased	Increased	Not reported	Not reported
Bloomfield et al (2015)[38]	2.d	Moderate	Not reported	Increased	Increased	Increased when talking with dying patients and families	Not reported
Brown & Chronister (2009)[31]	2.c	Moderate	Not reported	Equal for Critical thinking skills IG and CG	Increased in IG more than CG	Not reported	Not reported
Catling et al (2016)[39]	2.d	Moderate	Increased	Increased	Increased	Not reported	Increased
Copper et al (2010)[40]	2.d	Moderate	Increased	Increased	Not reported	Decreased	Not reported
Curtis et al (2016)[41]	2.d	Low	Not reported	Increased	Increased	Not reported	Increased
Dearmon et al (2013)[8]	2.d	Moderate	Increased	Increased	Increased	Decreased	Increased
Guvenc et al (2016)[42]	2.d	Low	Increased in terms of use another language	Not reported	Not reported	Reported for participants before simulation	Not reported
Halm et al (2011)[43]	2.d	Moderate	Increased	Not reported	Increased	Not reported	Not reported
Hoellein et al (2009)[44]	2.d	Low	Increased	Increased	Not reported	Not reported	Not reported
Hunag et al (2015)[45]	2.d	Low	Not reported	The SPs gender influenced communicatio n skills	Not reported	Not reported	Not reported
Isenberg et al (2015)[46]	2.d	Low	Not reported	Not reported	Increased	Not reported	Not reported
Kaplan & Ura (2010)[47]	2.d	Moderate	Not reported	Increased	Increased	Not reported	Not reported
Kim & Kim (2015)[48]	2.d	Moderate	Increased in IG more than CG	Increased in IG more than CG	Equal for IG and CG	Not reported	Not reported
Koo et al (2014)[34]	3.e	Low	Not reported	Increased	Not reported	Not reported	Not reported
Langen et al (2011)[49]	2.d	Low	Not reported	Increased	Increased	Not reported	Not reported
Mackey et al (2014)[35]	3.e	Low	Increased	Increased	Not reported	Not reported	Not reported

Nimalkar et al (2015)[29]	1.c	High	Increased in HFSG and LFSG	Increased in HFSG and LFSG	Increased in HFSG and LFSG	Not reported	Not reported
Ohtake et al (2013)[50]	2.d	Moderate	Not reported	Not reported	Increased	Not reported	Increased
Rickles et al (2009)[51]	2.d	Low	Not reported	Increased	Not reported	Not reported	Not reported
Roh et al (2014)[52]	2.d	Moderate	Increased	Increased	Increased	Not reported	Not reported
Sarmasoglu et al (2016)[53]	2.d	Moderate	Not reported	One skill Increased in IG more than CG	Increased among some IG students	Decreased among some IG students	Not reported
Siebeck et al (2011)[54]	2.d	Low	Increased	Not reported	Not reported	Inhibition decreased	Not reported
Stayt et al (2015)[30]	1.c	High	Not reported	Increased in IG more than CG	Increased in IG and CG	Not reported	IG more satisfied than CG
Thomas & Mackey (2012)[32]	2.c	Moderate	Not reported	Not reported	Increased in IG more than CG	Not reported	Not reported
Westberg et al (2006)[55]	2.d	Moderate	Increased	Not reported	Not reported	Not reported	Not reported
Zhang et al (2015)[56]	2.d	Moderate	Not reported	Increased in IG more than CG	Not reported	Not reported	Not reported

Note. 1=level one; 1.c= randomized control trial; 2= level two; 2.c= quasi-experimental prospectively controlled study; 2.d= pre-test post-test or historic/retrospective control group study; 3= level three; 3.e= observational study without a control group; HFSG= high fidelity simulation group; LFSG= low fidelity simulation group; SPs= standardized patients; IG= intervention group; CG= control group; * Increases where noted were statistically and/or clinically significant.

DISCUSSION AND SUMMARY

The use of simulation has become a routine part of education and training for health professionals in many health education facilities. Evidence supports simulation training for clinical knowledge and skills improvement as an educational methodology. The primary purpose of this study was to review the current best available evidence for the use of simulation in improving clinical skills, knowledge, and self-confidence among healthcare students and to rate the level and quality of research on simulation training.

Reviewed studies

Results and analysis of the 30 studies included in this systematic review demonstrate and support the use of high and/or low fidelity simulation training as an educational methodology evidenced by enhanced scores on students' knowledge, skills, self-confidence, and satisfaction. Moreover, simulation significantly decreased anxiety and inhibition levels in those studies where they were examined. The reviewed studies showed a great variability in terms of design, intervention, measurement, and simulation type and use. The majority of studies qualified as level 2 and only two studies qualified as level 1.[29-30] The findings of the reviewed studies are highlighted by study location, health professions represented, level of evidence, sample size, sample characteristics, type of simulation, study purpose and intervention, and outcome measures and outcomes.

Study location

In this systematic review, the majority of studies were conducted in the United States (16 of 30 studies).[3,8,31-34,36,37,43,44,46,47,49-51,55] This result is similar to the systematic reviews in the literature. Cant and Cooper found that most of the reviewed studies (11 of 12 studies) were conducted in the United States.[57] Another systematic review by Gamble et al revealed that five of 15 reviewed studies were conducted in the United States.[58] The remaining studies in the current review were conducted in Australia, United Kingdom, Turkey, South Korea, Germany, Singapore, Taiwan, India, and China.

Health profession represented

Most of the reviewed studies (26 studies) were conducted in nursing and medicine, [8,29-48,52-56] and only three studies included IPE/IPP with the use of SPs.[34,38,55] The literature shows that internal medicine, family medicine, psychiatry, and other medical specialties use SPs to assess students' clinical knowledge and skills in approximately 50% or more of the clinical rotations.[59] The healthcare simulation literature includes numerous studies from nursing and medicine; however, the use of simulation in other healthcare professions, such as audiology, is scant.

Level of evidence (study design)

Validity and reliability of study results are two key features upon which decisions regarding the strength and quality of evidence are based. In general, validity is an assessment of the degree to which an evaluation tool measures what it is supposed to measure, whereas reliability refers to the concept that repeated measurement would result in similar findings. While the simulation literature has studies with several levels of evidence and designs, such as RCTs, quasi-experimental, and qualitative designs, the validity of studies included in this systematic review was threatened by several factors, such as choice of study design and psychometric properties of the assessment tools. The majority of the reviewed studies (76%) were designated as level 2.d (posttest or pre/post-test quasi-experimental design), which is the most commonly used design in the healthcare simulation studies. One reason may be the ethical quandary of having a control group with no benefits of the simulation training that could potentially reduce the students' performance and achievement in the related courses.[60]

Sample size

Sample size can affect the generalizability of outcomes. The sample size varies greatly across studies in the simulation literature. For example, Cant and Cooper reviewed 12 studies of which one study had 23 participants and another study had 798 participants.[57] The range of the number of participants in reviewed nursing and medical studies was 18 to 146 participants.[61] In the present systematic review, the range number of participants was 14 to 509 students. The small number of participating students in some studies may have occurred because of low numbers of students enrolled in the program or assigned for clinical practice simulation, the dropout rate, and/or technical issues with audio/video taping analysis. In one reviewed study, the number of included students was 115 in the initial training, but the completed data sets were available on only 104 students.[36] In another study, 637 nursing students were invited to complete a 16-item 6-point Likert scale questionnaire after the simulation experience, but only 509 students responded.[41] This loss of participants or data can threaten the internal validity and affect the efficacy of simulation research.

Sample characteristics

The sample characteristics were reported in the majority of reviewed studies, including gender, age and racial groups, and varied clinical experience. It is necessary to pay attention to the differences among student participants as internal validity may be threatened because of such differences. For example, one of the reviewed studies stated that females are more likely to underestimate their performance on technical skills compared to males, and male students tend to overestimate their communication and interpersonal skills.[46] Moreover, students who achieved honors were more likely to overestimate their self-rated scores than students who just passed the course.[46] IPE was identified as an emerging population sample variable.

Types of simulation

This review focused on two types of simulation: manikins and SPs for the following reasons. Manikins have advanced capabilities and outputs such as physiological changes, so they have greater effects on the learner.[62] Manikins have been successfully used in both learning and assessment of clinical skills.[63] The SPs assessment is one of the most common forms of physical examination and communication skills assessments in medical education.[64] Evaluation of students via the use of SPs is more accurate and reliable in comparison to traditional testing formats.[65] This review shows that SPs and manikins are the most common simulation types used in medical education. Use and outcomes of these simulation types was varied among studies in this systematic review. Two studies reported that the use of high fidelity simulation increased students' knowledge, skills, self-confidence, and/or satisfaction compared to low fidelity simulation.[29,37] Only six reviewed studies used hybrid simulation (i.e., the use of two or more simulation types at the same simulation experience).[3,33,39,46,53,54] The combined use of different types of simulation could lead to better learning outcomes than the use of either alone.[66] Nevertheless, no study in this review examined the effectiveness of using one type of simulation compared to two or more types.

Study purpose and intervention characteristics
The reviewed studies aimed to measure the effect of simulation on professional competencies including knowledge, skills, self-confidence, anxiety and comfort level, and the cooperation with and between healthcare students. The effect of using high fidelity simulation versus low fidelity simulation and the effect of the integration of simulation in the curriculum were identified as goals of the simulation training in some studies. Pre-simulation orientation to familiarize students with the simulation learning environment was reported. Lectures, online training, workshops, small learning groups, training on manikins, PBL cases, and a learning course were used in the pre-simulation orientation.[34,36,43,44,51] The limited use of debriefing and carry-over effect of learned knowledge and skills was noticed among the reviewed studies. Only nine studies reported the implementation of debriefing or group discussion after the simulation experiences.[3,8,34,39,40,43,47,50,55] The majority of these studies did not describe the debriefing session and how the session was conducted. Only two studies assessed the retention of the learned knowledge and skills three months and more than one year after the completion of simulation experience.[29,36] These studies revealed that the retention or carry-over effect of learned skills decreased over time.

Outcome measures and outcomes
The use of non-validated outcome measures has been reported in the studies included in the current review. This may influence the outcomes and bias the results. Only seven reviewed studies used validated assessment instruments. This is not the only issue, as the validity of self-assessment as a measure of learning is also debatable. For instance, one study showed the self-assessment is valid and reliable in specific skills but not across all skills learned in the simulation training.[46] Instrumentation can also be another threat to internal validity "in which changes in the calibration of a measuring instrument or changes in the observer or scores used may produce changes in the obtained measurements."[67] In one of the reviewed studies, Rickles et al chose to remove 21 sets of the recorded SPs group training from analysis due to audiovisual difficulties.[51] Cant and Copper reported that simulation outcomes using self-reported instruments are less reliable than the other objective simulation outcome assessments, such as examiners evaluation and interview. [57] On the other hand, Gosen and Washbush demonstrated that objective measures are inadequate measures of learning.[68] Therefore, student learning and performance in simulation experiences may not readily be assessed by objective measures. Regarding the outcomes, the healthcare simulation literature includes a great deal of studies that explore the effect of simulation on knowledge, skills, self-confidence, and other technical and non-technical skills. For example, self-assessment skills and behavior can improve with self-assessment practice.[69] Thus, learning is the core outcome of simulation training. However, knowledge acquisition through simulation training alone has not previously been well established.[70] Results of this systematic review revealed statistical and/or clinical improvements in knowledge, skills, self-confidence, and/or satisfaction after the simulation training.

IMPLICATIONS
The reviewed studies consisted of high, mid, and low strength (or quality) of evidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. These practices include 1) study design, 2) debriefing, 3) integration of IPE values, 4) outcome measures, and 5) student satisfaction and information retention.

Study Design
Reviewed studies included qualitative, quantitative, and/or mixed methods research designs. In general, the validity of simulation studies is often threatened by several factors, one of which is the study design. Campbell and Stanley identified several designs in the educational research that might affect both internal and external validity.[67] Quantitative simulation research includes three common study designs: the posttest design, the one group pretest-posttest design, and the non-equivalent control group pretest/posttest design. The posttest design is the simplest and weakest quasi-experimental design, which is also known as "the one-shot case study." In this design, a single group is observed one time after it has been exposed to the simulation. These studies do not have reference points for comparison (i.e., pretest scores or control group). Therefore, the effect of simulation cannot be evaluated because there is no basis for comparison of professional competency development (e.g., knowledge, skills, and/or confidence level). The other design observed is known as "one-group pretest-posttest design" in which a single group is pretested before the simulation and posttested after the simulation. This design is more commonly found in the simulation literature and shows some improvements over the posttest design. However, a threat to this design can appear if the pretest increased students' ability to perform better on the posttest or if pretest and posttest are not equivalent, particularly when the outcome is measured by an observer (i.e., faculty members or SPs).

The third design is the non-equivalent control group pretest/posttest design. It is also called "nonequivalent control-group design" in which one group is pretested before the simulation training and posttested after, while the other group is pretested, not exposed to the simulation training, and posttested. This design is stronger than the previous designs because it includes a control group. One of the threats to the internal validity of this design is the student-selection factor. This means that the selection of students in each group (i.e., the experimental group and control group) has been based on accessibility or convenience rather than on randomization. Therefore, without randomization, unknown confounders and unmeasured differences between groups can bias the results. The stronger and best study design would be to include three groups: an experimental group with (simulation training), an experimental group with (traditional training), and a control group with (no training).[60] This design will provide high levels of evidence; however, it is hard to employ because having a group or two with no benefits of the simulation experience may hinder students from getting the benefits of the simulation training, so students' performances on related academic courses could be affected.[60] Therefore, the most common simulation study design, which is usually pretest, posttest design, does not include a control group. That said, when a simulation study design includes a control group, a traditional training can be provided firstly to this group and followed by simulation training after the completion of simulation event so learners in this group benefit of the simulation experience.[60]

Debriefing

This practice is universally accepted as an evidence-based process in 1) facilitating a high level of learning, 2) assisting the participants to clearly understand and integrate the simulation experience, and 3) connecting it with previous knowledge and future real practices.[43] The role of debriefing in simulation education has been eloquently described by Phrampus and O'Donnell.[71] The lack of the debriefing component has been reported in literature.[13,72] This systematic review included nine studies that implemented debriefing or group discussion after the simulation experiences. Eight of these studies reported insufficient details about how the debriefing sessions were organized, how the debriefing methods were used, and how time was allocated to these debriefing sessions. Only one study provided sufficient details about debriefing and how it was used in the simulation experience.[3] This study used the Promoting Excellence and Reflective Learning in Simulation (PEARLS) model. This model specifies four distinct phases of the debriefing process: 1) reactions, 2) description, 3) analysis, and 4) summary. This model focuses on identifying positive aspects of the experience (what went well), negative aspects (what could have gone better), and changes if learners were given another opportunity.[73] There are several debriefing models to organize the structure of the debriefing session. Some authors divided the debriefing conversational structures into two types: "three-phase debriefing structure" and "multiphase debriefing structure."[74] The "Debriefing with Good Judgment" is an example of the three-phase debriefing structure type. It is an evidence-based framework of observation and reflection to change behaviors in the learning process.[75] The PEARLS debriefing is an example of the multiphase debriefing structure type.[73] Debriefing helps learners to clearly understand and integrate the simulation experience and connect it with previous knowledge. Students who engage in academic discussions with peers may benefit motivationally, academically, and socially.[76] Students are expected to discuss and analyze the experience to enhance their learning.[77] Cognitive theory supports this as evidence-based practice due to research presenting findings about multi-sensory input/output as a strategy for information retention.[78] Also, debriefing time is critical. The reviewed studies support previously published literature about the length of time for debriefing. Debriefing time is estimated at 15 minutes for each objective or twice the time of the simulation activity.[79]

Interprofessional Education and Practice

The core goal of IPE is to prepare all health profession students to work together. Therefore, students can experience working with other professions and obtain knowledge and skills about other professions, in addition to their own profession, to enhance their effectiveness as professionals once they enter clinical practice.[80] Consequently, healthcare quality and patient safety is achieved.[80] IPE is more effective if used appropriately with consideration of context, goals, and approach.[81] The Interprofessional Education Collaborative Expert Panel proposed four major interprofessional collaborative practice competencies: 1) values and ethics, 2) roles and responsibilities, 3) interprofessional communication, and 4) teams and teamwork.[80] There are several tools used to assess IPE learners in the educational settings. For example, Thannhauser, Russell-Mayhew, and Scott identified 23 assessment tools.[82] The Readiness for Interprofessional Learning Scale (RIPLS) and Interdisciplinary Education Perception Scale (IEPS) were the two primary measures reviewed of the 23 measures because both measures were easily accessible, commonly used, and validated, while limited information existed for the remaining measures.[82] Simulation offers good opportunity for training students from different health professions, and it is associated with improving students' IPP, teamwork and collaboration, and communication skills.[83] To achieve professional competency and patient safety as a result, many practicing healthcare professionals need training to achieve these competencies. The researchers should implement and assess IPE. However, two main barriers to IPE include 1) healthcare professionals are not well trained in interprofessional environments, and 2) there is a lack of sufficient connection with other healthcare providers to build collaboration among healthcare teams.[80,84]

Outcome Measures

Knowledge and skills learned in simulation are usually connected to the cognitive domain levels of Bloom's taxonomy and Kolb's experiential learning cycle.[78] These learned knowledge and skills acquired in the simulation training are built on prior knowledge and skills.[78] Therefore, the use of an appropriate scale to measure the impact of a simulation exercise on learning is important. Silvia suggested that the use of self-rating surveys to obtain the impact of the simulation on students' learning is the most appropriate approach.[85] Rating scales allow participants to rate their attitudes and perceptions.[86] Issenberg et al warned that using pretest and immediate posttest is ineffective to investigate the retention (or carry-over) effect.[87] Therefore, researchers should use valid and proper scales consistent with their learning objectives.

Satisfaction and Retention after Simulation

The level of satisfaction among participants in simulation is critical in terms of repeating the training sessions. Participants' satisfaction may have correlations with performance and may help to build self-confidence, which in turn helps students develop skills and acquire knowledge.[88] Repetitive practice is one of the key features of simulation that best facilitates learning, and the level of satisfaction is also related to repeating the simulation training.[89-91] The researchers should use valid and reliable instrument to measure satisfaction after the simulation experience, such as the Satisfaction with Simulation Experience (SSE).[70] Besides the repetitive nature of simulation training, it is important to understand how long learning is sustained after the simulation experience. Little is known about the impact of the simulated learning over the long term. The test of retention is important to make sure that the learned knowledge and skills are generalized and continued after the simulation training.[91] Therefore, the researchers should test the retention of learned knowledge and skills within 3 to 12 months after the simulation experience according to the type of the learned knowledge and skills in the simulation activity.

LIMITATIONS

Efforts were made to minimize study limitations, though some were unavoidable. Potentially useful databases for this project, such as EMBASE, were not searched as a result of a lack of access, so only four databases were searched for eligible studies. However, additional sources were searched to identify any papers that were missed by the original search strategy. Furthermore, reviewed studies were limited to those available electronically and to those published in English. The inclusion criteria were open to all JBI levels of evidence to include many studies for review. This may have been an advantage of the review; however, a great deal of the reviewed studies had weak designs. The other limitation was that the inclusion criteria for this study were restricted to student populations and it is possible that some studies were excluded because of the target population.

FUTURE RESEARCH

There is need for a quality improvement framework on how to design and implement simulation training in health education utilizing strong study designs. Further research is warranted to establish guidelines for designing and writing simulation studies. Students may benefit from serving as SPs; however, caution should be taken when recruiting students as SPs to train and evaluate their peers. There is ample evidence to support the use of reflection as a tool to support student learning and the development of critical thinking skills.[92] The use of structured debriefing sessions should be included in all simulated training and learning experiences. The use of validated outcome measures, when appropriate, is important to avoid any potential bias. Simulation is a valuable teaching and learning methodology to accomplish IPE objectives and to prepare all healthcare students to work together in safe IPP environments, suggesting the need for additional IPE/IPP simulation research.

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APPENDIX A

Search Terms, Databases, and Search Strings

Search Terms	Database	Search Strings
- Health occupation students: health occupations, medical sciences, health sciences - Simulation types: simulators/simulation, standardized patients, manikins - Outcomes: education, knowledge, skill, confidence, satisfaction - Assessment tools: evaluation, educational measurement, questionnaire, survey	The PubMed and CINAHL® database searches consisted of the MeSH term/CINAHL	Heading Students, Health Occupations as a major topic combined (OR) with the terms simulation OR "standardized patient" OR "standardized patients". The citations retrieved from this search were further narrowed using the terms confidence OR skill OR skills OR knowledge combined with AND to the terms tool OR instrument OR survey OR questionnaire* OR "student evaluation" OR "student evaluations" OR "student satisfaction" OR (student*[tiab] AND (narrative OR reflect*)) OR educational measurement. The results were limited to English language; they were not limited by publication date.
	PsycINFO, ProQuest- Social Science Journals, ProQuest- Psychological journals, ProQuest- Career and Technical Education: Health & Medicine	These databases were searched using only text words. As an example, the ProQuest collections were searched as shown below: all(simulation OR "standardized patient?") AND all(confidence OR skill OR skills OR knowledge) AND all(tool OR instrument OR survey OR questionnaire* OR "student evaluation" OR "student evaluations" OR "student satisfaction" OR (student AND (narrative OR reflect*))) AND all(student? AND (medical OR nursing OR pharmacy OR psychology OR "social work"))

Note. CINAHL = Cumulative Index to Nursing and Allied Health Literature; PsychINFO= Psychological Information; MeSH= Medical Subject Headings; tiab= Title/abstract.

APPENDIX B

Simulation Studies Review Form

Study title: ____
Database: __________________Study Number_________Reviewer_________________

(1) Study Screen Details

Screening Decision			Screening Conclusion		
Study Passes Screens	Yes	No	Eligible for Review	Yes	No

(2) Study Design Details

Rating: High Moderate Low

Study Design: Randomized control trial One group pretest posttest design

Pretest posttest design with a control group Posttest design Mixed Research

Qualitative Other ____________________________________

(3) Study Characteristics

Study Population Graduate Students Undergraduate Students

Participants' Profession Audiology Speech-language pathology Physical Therapy Nursing
Medical Students Physician Assistant Pharmacy Optometry
Other___________________________________

Demographics Sample size________ Gender: M F
Year in the program _______________________

Primary Outcome Knowledge Skills Confidence Satisfaction Other
____

Secondary Outcome Self-Efficacy Stress Anxiety N/A
Other: __________________________________

Primary Outcome Measure Direct Observation Direct Assessment Self-Reported Written Exam
Clinical Exam Other: ______________________

Type of Simulation Manikins Standardized Patients Virtual Patient
Other:__________________________________

Type of Standardized Patients Real Actors Students Faculty N/A
Other:__________________________________

Simulation Settings Hospital Simulation Center University
Other: __________________________________

Interprofessional education/practice Yes No
Debriefing Yes No