

Education

Simulation-based education within respiratory physiotherapy training: a scoping review

Stephanie K Mansell^{1,2}, Kate Grafton³, Emily Barnfield⁴, Georgina Eckersley⁵, Amy Bendall⁶, Gabriella Cork⁵, Agnieszka Lewko⁷, Amanda Thomas⁸, Una Jones⁶

¹ University College London, ² Royal Free London NHS Foundation Trust, ³ Leeds Beckett University, ⁴ Gloucestershire Hospitals NHS Foundation Trust, ⁵ University of Liverpool, ⁶ Cardiff University, ⁷ Coventry University, ⁸ Barts Health NHS Foundation Trust

Keywords: Simulation based education, Part task trainer, Pre-registration education, Post graduate education, Interprofessional learning

<https://doi.org/10.56792/KEPM1936>

Journal of the Association of Chartered Physiotherapists in Respiratory Care

Objective

The aim of this scoping review is to provide respiratory physiotherapists with guidance on the implementation of simulation-based education

Introduction

In recent years there has been a widespread rise in the adoption of simulation-based education. A scoping review was decided upon by the ACPRC Editorial Board to focus on any new evidence or guidance in the field.

Inclusion criteria

1) Studies investigating the use of simulation-based education within respiratory physiotherapy 2) Meta-analyses, systematic reviews, scoping reviews, randomised controlled trials and observational studies.

Methods

A literature search was developed and refined through testing. Nine databases were searched between 01/01/2014 and 31/10/2022. Data regarding study design, population, intervention, comparator and control were extracted into a data extraction table. Results were grouped by study design, intervention or context.

Results

141 sources were retrieved from the searches. After initial screening 27 sources were included and after full-text review, 25 were included. Sources included: meta-analyses and systematic review and studies considering pre-registration education, interprofessional learning, part-task trainers and postgraduate education.

Conclusion

There is increasing research output in the simulation-based education field for respiratory physiotherapy. The evidence continues to focus on learner experience. More resources and support are required to increase access to simulation-based education for respiratory physiotherapists.

INTRODUCTION

In recent years there has been an increase in the adoption of simulation-based education (SBE) in healthcare disciplines across both pre-registration and postgraduate environments, including physiotherapy. There are numerous definitions available for simulation used as a pedagogical approach but there is no universally agreed definition. Hawker et al¹ has perhaps the most comprehensive and recent explanation:

“Simulation is a learning tool that supports development through experiential learning by creating or replicating a particular set of conditions which resemble real life situations. It should provide a safe environment where participants can learn from their mistakes without any danger to patients, allowing individuals to analyse and respond to these realistic situations, with the aim of developing or enhancing their knowledge, skills, behaviour, and attitudes.”

The Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Editorial Board is comprised of respiratory physiotherapy clinicians and academics who lead scoping of latest evidence, commissioning, co-ordination

and delivery of all new ACPRC guidance documents and resources. The aim of this work is to facilitate knowledge sharing and drive improvements in the quality of care for respiratory patients.

The Editorial Board discussed potential areas for investigation and agreed that the area of SBE should be prioritised. A member of the Editorial Board (SKM) was nominated to lead the topic group and other respiratory physiotherapists were approached to be part of the team. A scoping review was the most appropriate method for exploring new evidence or guidance in the simulation-based education field.

AIMS/OBJECTIVES

The aim of this scoping review is to provide respiratory physiotherapists with guidance on the effectiveness of SBE in respiratory physiotherapy.

REVIEW QUESTION

How effective is simulation-based education as a pedagogical approach in both pre-registration and postgraduate respiratory physiotherapy?

METHODS

This scoping review was conducted in accordance with Joanna Briggs Institute Guidance for Conducting Scoping reviews² and has been reported in accordance with the PRISMA extension for Scoping Reviews.³ The scoping review was registered on Open Source Framework (reg number: ps8a7).

INCLUSION CRITERIA

The following were included in the scoping review: 1) studies investigating the use of SBE within respiratory physiotherapy, both at pre-registration and postgraduate level 2) Meta-analyses, systematic reviews, scoping reviews, randomised controlled trials (RCT), prospective and retrospective observational studies including case-controlled studies, cohort studies and cross-sectional studies. The following exclusion criteria were applied: 1) studies that were narrative reviews, non-research letters, abstracts, case reports, conference proceedings, theses and books; 2) studies involving non-human subjects; 3) studies that did not include respiratory physiotherapists and 4) studies not reported in English as there was no funding for translation.

TYPES OF PARTICIPANTS

Studies were included that considered the application of SBE within respiratory physiotherapy, both at pre-registration and postgraduate level.

CONCEPT

For the purpose of this scoping review, we considered SBE to be a broad umbrella term and included studies that used all SBE techniques including high fidelity simulation using mannequins, in-situ simulation, part task trainers, actors and team based/interprofessional simulation.

CONTEXT

The authors identified that previous scoping review, systematic reviews and meta-analyses had limited their context to pre-registration education or included respiratory physiotherapists within a broader context. This scoping review therefore sought to limit the context to respiratory physiotherapists but to include both pre-registration and postgraduate education.

SEARCH STRATEGY

The literature search was developed and refined through piloting, during which the search criteria was used to test if known papers were identified with the search strategy. The search terms included: high fidelity simulation, physio*, resp*, physical therapy and simulation

Nine databases were searched between 01/01/2014 and 31/10/2022: AMED, BNI, CINAHL, EMBASE, HEALTH BUSINESS ELITE, HMC, MEDLINE, PsycINFO and PubMed. These databases were chosen as they are the most commonly used in the physiotherapy field. The search strategy was limited to the dates given as previously reported work was published prior to 2014. Database searches were supplemented by screening reference lists and hand searching. ResearchRabbit (www.researchrabbit.ai) was used to identify additional references. ResearchRabbit is an innovative citation-based literature mapping tool available online which optimises time compared to hand searching.

SOURCE OF EVIDENCE SELECTION

References were imported into Rayyan.⁴ Duplicates were removed. Two authors (SKM and KG) independently screened the title and abstract for inclusion. Discrepancies were resolved through discussion. Full text sources were retrieved and assessed against the inclusion criteria.

DATA EXTRACTION AND SYNTHESIS

Data regarding study design, population, intervention, comparator and control were extracted into a data extraction table. Results were grouped by study design, intervention or context. Quality assessments were not undertaken as this was not the intention of this scoping review.

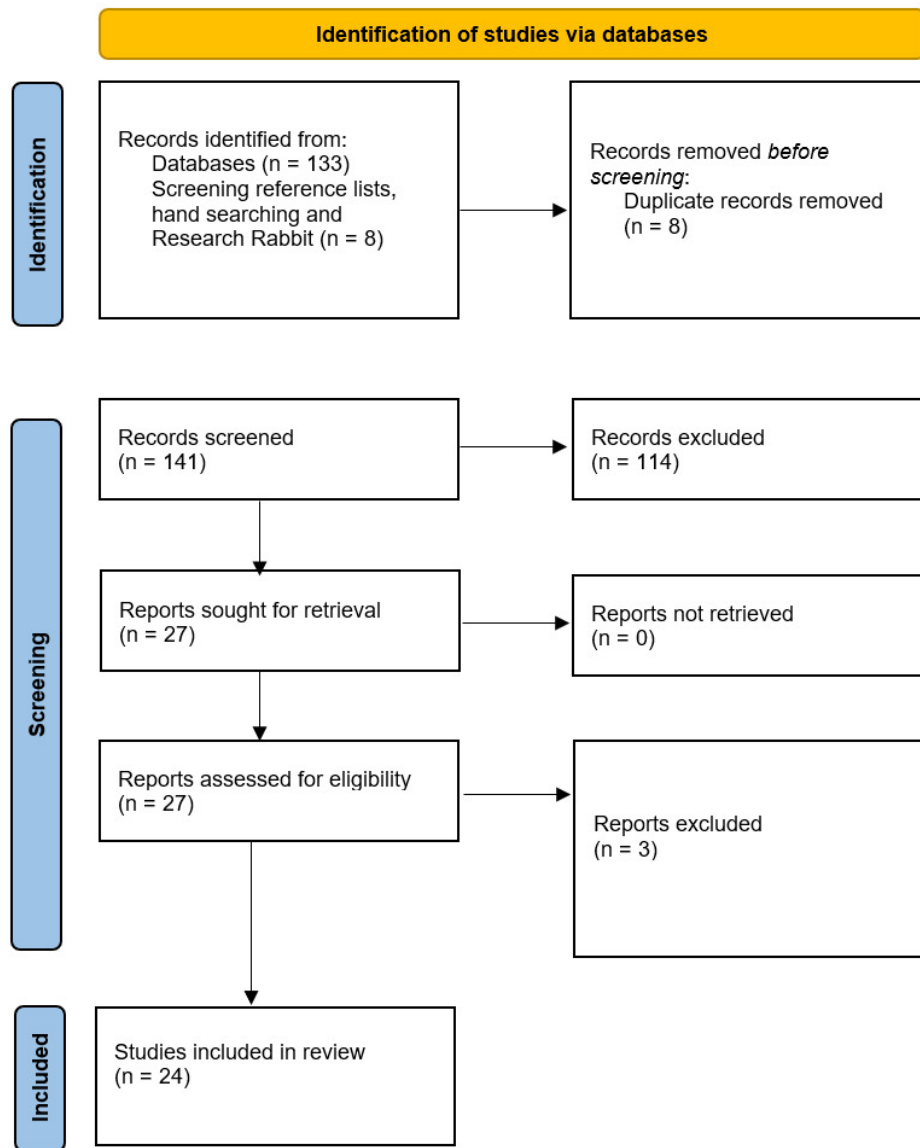


Figure 1

RESULTS

141 sources were retrieved from the searches. As per [figure 1](#), 24 studies were included.

META-ANALYSIS AND SYSTEMATIC REVIEWS

Five meta-analyses and systematic reviews⁵⁻⁹ were sourced.

PRE-REGISTRATION USE OF SBE

Ten studies¹⁰⁻¹⁹ were sourced investigating SBE in pre-registration respiratory physiotherapy pedagogy.

INTERPROFESSIONAL LEARNING (PRE-REGISTRATION)

Five studies²⁰⁻²⁴ were sourced investigating SBE in inter-professional learning.

PART TASK TRAINERS

One study²⁵ investigated the use of part task trainers.

POSTGRADUATE USE OF SBE

Three studies²⁶⁻²⁸ were sourced that investigated SBE in postgraduate respiratory physiotherapy pedagogy.

DISCUSSION

This scoping review provides an overview of the current knowledge base for the use of SBE within pre-registration and postgraduate respiratory physiotherapy training. Kirkpatrick's evaluation framework classifies training outcomes into 4 levels of reaction or satisfaction, learning or knowledge, behaviour or practice change and results or impacts.²⁹⁻³¹ There has been an increase in publication of SBE evidence within the last 10 years, however the evidence base continues to focus on learner experience (Kirkpatrick

Table 1. Summary of meta-analyses and systematic reviews included in the scoping review

AUTHOR, YEAR, COUNTRY	STUDY DESIGN	PARTICIPANTS	INTERVENTION	COMPARISON	KEY FINDINGS
Brown, 2021, Australia	Mixed-Methods Systematic Review	11 papers • RCT (n=5) • Observational study (n=1) • Cross sectional study (n=5) Participants • Graduate entry level (n = 612) • Undergraduate physiotherapy students (n=64) • Practicing physical therapists (n=10)	Studies that used high-fidelity simulation defined as “full-body computerized mannequins that are capable of real time physiological parameters”	Studies that did not use high-fidelity simulation Minimal information regarding comparisons from individual studies included.	The quantitative findings suggest high fidelity simulation improves students’ preparedness. However negligible to small and not statistically significant improvements in clinical performance were reported. Qualitative data found students perceived they were able to become more familiar and learn better in a simulated environment. As a result, they were more safety conscious with their patients, and expressed a higher level of confidence and self-efficacy.
Heuer, 2022, Canada	Systematic literature review	33 papers • Paramedics (n=22) • Respiratory Therapists (n=6) (Respiratory Therapists participant total = 286) 1 survey, 5 observational studies	Studies that used SBE in Allied Health Professionals (AHPs) training. Minimal information regarding inclusion of what SBE encompasses.	Minimal information regarding comparisons from individual studies included.	Unable to extract only respiratory therapist data. The most used modalities of simulation were: • Manikins (37%) • Combination of manikins and simulated patient/actor (33%) • Simulated patients (15%) • Other (9%) • Not stated (6%) Setting for performing SBE: • Stationary simulation centres (34%) • Prehospital/ ambulance (21%) • Mobile simulation unit (18%) • Healthcare environment (12%) Six (18%) of studies described a sustained impact on objective or subjective measures, ranging from 4 weeks to 1 year after the SBT intervention. This project demonstrated that there are many SBT applications employed in skill-building. However, there appears to be relative unevenness in terms of the professions which report

AUTHOR, YEAR, COUNTRY	STUDY DESIGN	PARTICIPANTS	INTERVENTION	COMPARISON	KEY FINDINGS
					their use, the common features of SBT, and the perceived and actual impact on practice.
Mori, 2015, Canada	Systematic literature search	23 papers No further information given.	Studies that used simulated learning environments (SLEs) in physical therapy, in which the learner had the opportunity to interact with the simulated clinical scenario.	Minimal information regarding comparisons from individual studies included.	Studies do seem to indicate using simulators to provide feedback during learning confers an advantage in skill development; and appears to improve learners confidence and decrease anxiety. SLEs have the potential to replace up to 25% of a clinical internship. However, current research does not review long term follow up and benefits are associated with a cost.
Rezayi, 2022, Iran	Qualitative Systematic Review	16 papers published between 2008-2022. Country published: USA 43% Australia 25% Sweden 18% No further detail provided.	Studies that used technology-based simulated training settings as an intervention to train physiotherapy students.	Comparing physiotherapy students who underwent training by technology-based simulated tools with other training tools.	Physiotherapy students reported the positive effect of computerized simulation methods on improving basic knowledge, clinical reasoning, and practical and interprofessional communication skills. Suggests computer simulation could be a suitable method to replace the traditional simulation method.
Stockert, 2022, Canada/ USA	Scoping review	182 papers No further information provided.	Studies that involved the use of SBE with student physical Therapists (Simulation was defined to include the use of manikins, standardized patients, part task trainers, virtual reality applications and/or virtual patient cases)	Minimal information regarding comparisons from individual studies included.	This literature suggests that SBE in physical therapist education can be used to address numerous learning objectives. 4 common content areas: • orthopedics (n = 64) • neurological (n = 40), • cardiovascular (n = 37) • general medicine (n = 35) Patient communication skills were the most commonly reported objectives for simulation with 53% reporting it as a learning objective. 31% included task/skill training as an objective and 47% included clinical reasoning. The review identified substantial limitations in the reporting of Standards of Best Practice (SOBP) related to SBE.

Table 2. Summary of included studies that investigated SBE in preregistration respiratory physiotherapy pedagogy

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
Bednarek, 2014, USA	Cohort	To illustrate how a physical therapist education program at a small university, previously without access to HFS, was able to partner with a local simulation center	n=28 4 th year physical therapy students	3 simulation scenarios	Self-assessed confidence and interest in treating patients in an acute care setting	Nil	Increased confidence levels and interest in acute care

Table 3. Summary of included studies that investigated SBE in interprofessional learning

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
King, J., B, 2016, Canada	Quasi-experimental pre-post intervention study design.	Compare two different methods of patient simulation in improving competencies for students in Registered nursing, Physical Therapy and Respiratory Therapy programs.	13 Students (4 Respiratory Therapists, 5 Registered Nurses, 4 Physical Therapists) 2013 and 2014 43 students (19 Respiratory Therapists, 15 Registered Nurses and 9 Physical Therapists) from 3 institutions.	3 hour facilitated workshops covering topics that included hip fracture / COPD and difficulty in breathing treatment. All facilitated workshops included a debrief.	Standardised patients and mannequins	Standardised patients	Simulation improves competence (shown in conflict resolution $p < 0.001$ and roles / responsibilities $p = 0.03$) as judged by the Interprofessional Collaborative Competencies Attainment Scale (ICCAS) pre-post. No significant differences noted between conditions in communication, collaboration, patient/family-centred approach and team functioning.
Lefebvre, 2015, USA	Experimental Study	Examine the changes in Physical Therapy and Nursing student beliefs and attitudes toward learning from and collaborating with each other after an opportunity to engage professionally around a learning simulation involving a patient simulator and problem-solving patient code scenario.	2nd year Physical Therapy students plus volunteer 4 th Year nursing students. Mean age 25 yrs. 56% female 67% white 36% no Interprofessional	Students interacted with a high-fidelity manikin, that was undergoing a cardiac arrest during a Physical Therapy treatment session in a simulated intensive care	Compared attitudes toward Interprofessional collaboration (IPC), Interprofessional Learning (IPL) and teamwork pre and post simulation.		Interdisciplinary education perception scale used. (Competence and autonomy $p = 0.032$) Readiness for Interprofessional Learning scale used. (Teamwork and

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
			Education exposure 56% no previous Interprofessional Collaboration for providing direct patient care.	unit.			collaboration $p=0.033$) Attitudes toward healthcare teams' scales used. (Team value and Admin / MD role showed significant p-values) Teams Skills scale used (showed highly significant results).
Rossler, 2016, USA	Mixed Methods Research Study.	Four research questions which were 1. Do perceptions of readiness to learn among pre-licensure students enrolled in a health professions program of study change following an interprofessional education simulation experience? 2. Are these difference among health profession pre-licensure students in perceptions of readiness to learn and collaboration following an interprofessional education simulation experience? 3. What are the pre-licensure health professions student participants perceptions of the interprofessional education simulation experience? 4. To what extent do the quantitative and qualitative results converge?	An interprofessional sample (n=53) pre-licensure health professions students. T 50% nursing students.	A high-fidelity patient simulation scenario translated from a geriatric role play case study.	Collected demographic data, two self-report instruments; revised Readiness for Interprofessional Learning Scale (RIPLS) and the Health Professional Collaboration Scale (HPCS).		Significant differences in RIPLS subscale of negative professional identity ($p=0.01$) and health professional collaboration scale ($p=0.01$). Qualitative data explored three themes that included 'exposure to experimental learning,' 'Acquisition of interactional relationships' and 'presence of chronology in role preparation.'
Thomas,	Quasi	Examined the impact of an Intensive Care	2 nd Year	Intensive Care	Confidence and		87% of clinical

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
2017, USA	experimental design. Pre and Post measures used.	simulation lab using a patient simulator and standardised patients on students' perceptions of their confidence and preparedness to work in acute care settings.	Doctoral Physical Therapy students (n=105) with 51 clinical instructors; 2 nd year Occupational Therapists (MSc) (n=127). Mean age 25 years, majority of participants were white and female. Data collected over 3 years for DPT and 2 years for Clinical Instructors and Master of Occupational Therapy.	simulation lab using a patient simulator and standardised patients	Preparedness Surveys developed by investigators prior to and following the ICU lab. Using 5-point Likert scale and open-ended questions.		instructors found students were either prepared or very prepared for the acute setting in the first 2 weeks. Those not taught skills prior to simulations felt less prepared than those who did. Pressure situations were seen as valuable by a few students and 67% of students felt more prepared to practice in an ICU setting, with increased feelings of confidence and competence.
Wellmon, 2017, USA	Pre and Post Experimental Design.	To examine changes in nursing and physical therapy students' attitudes towards Interprofessional learning and interprofessional collaboration following an opportunity to engage in a simulated cardiac arrest scenario using high fidelity simulation.	2 nd year students enrolled on a 3-year full time, entry level DPT program (n=41) at 1 institution and from the same institution 4 th year UG BSc in nursing (n=33). Learning	90 mins Interprofessional learning experience using high fidelity simulation that was designed to address gaps in student knowledge on teamworking.	Interprofessional Education Perception Scale (IEPS), Readiness for Interprofessional Learning Scale (RIPLS) and Attitudes toward Health Care Teams Scale (ATHCTS).	Control Group (n=74) which did not have the opportunity to participate in the Interprofessional Learning experience was also included in data analysis.	Supports the effectiveness of high-fidelity simulation experience toward interprofessional learning and interprofessional collaboration. Nurses demonstrated the evidence was

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
			Intervention group (n=77) vs Control Group (n=74).				valued and positively perceived the simulation activity.

Table 4. Summary of included studies that investigated part task trainers

AUTHOR, YEAR, COUNTRY	STUDY DESIGN	PARTICIPANTS	INTERVENTION	COMPARISON	KEY FINDINGS
Hassam 2003, Hong Kong	Observational study, used a within-subject, repeated measures design with a follow-up questionnaire	37 subjects (14 males and 23 females. mean age, 21.35 ± 2.18 years) Final year physiotherapy students.	A 20-minute education session using a part-task trainer (Adapted paediatric model)	Percussion technique pre-education session conducted 2 days prior to intervention.	The findings show a clear difference between overall acceptable technique between pre- and post-education sessions (3% vs 97%) was evident Significant improvement in overall technique following the education session (p = 0.05). The inclusion of active practice, combined with new specific theoretical knowledge, resulted in more specific and longer retention of key components than provision of specific theoretical knowledge alone.

Table 5. Summary of included studies that investigated SBE in postgraduate respiratory physiotherapy pedagogy

Author(s), Year, Country	Study design	AIMS	Population	Intervention	Comparison	Control	Key findings
Gough, 2012, UK	Survey	Investigate the application and extent of SBE being utilised in post-graduate (in-service) cardiorespiratory physiotherapy training.	280 NHS trusts 155 responses were received (55%)	NA	N/A	N/A	SBE being used in a variety of competency and on-call training, skills development, refreshers and on-call training however there was an inconsistent approach across the UK.

level 1 and 2) and does not consider translation into clinical practice (Kirkpatrick level 3), patient outcomes or patient safety (Kirkpatrick level 4). Therefore, it remains challenging for some to justify the need for SBE.

META-ANALYSES AND SYSTEMATIC REVIEWS

There was heterogeneity within the studies included in the meta-analyses and systematic reviews in the populations included, the modality of SBE and the outcome measures utilised. It is clear that a range of SBE modalities have been deployed in educating respiratory physiotherapists. The optimal duration and frequency of SBE is unclear. There was a trend in all meta-analyses towards an improvement in confidence and self-efficacy as a result of SBE.

PRE-REGISTRATION

It is recognised that there is a shortage of clinical placements to meet the current demands of pre-registration physiotherapy education, and this is especially apparent in acute respiratory settings.³² The evidence base presented in this scoping review suggests it might be possible to replace up to 25% of traditional clinical time with SBE without a detrimental impact on student attainment.¹¹ However, SBE is resource intense in terms of equipment, time to prepare and faculty to deliver the training. Cost-effectiveness of SBE in this model of education has not been considered and may be one of the limitations to implementing this pedagogical approach successfully.

INTERPROFESSIONAL LEARNING

Studies sourced for this scoping review revealed that the current evidence specifically for interprofessional learning SBE is limited to pre-registration in the respiratory physiotherapy field. There was a suggestion that interprofessional learning SBE improved aspects of teamwork. Uni-professional SBE may be considered appropriate when introducing SBE to a profession, or when developing specific skills.

However, current educational theories encourage SBE to be delivered in multi-professional ways, which more closely represent the clinical environment.³³⁻³⁵ Anecdotally, the deployment of multi-professional SBE is being incentivised, for example via funding routes.

PART TASK TRAINERS

Part task trainers are physical replicas of a body part used to help train specific skills. Part task trainers in SBE have been most widely used as a surgical pedagogical intervention. Studies included within this scoping review have indicated that part task trainers are used within respiratory physiotherapy education. They are most commonly deployed to allow the repetition of a specific skill and are most useful to allow the learner to increase proficiency and confidence in specific tasks that are invasive.³⁶ Part task trainers allow the learner to make mistakes in a safe environment.³⁷ The impact of part task trainers is limited to one study, which demonstrated improved competence. Measuring the impact on patient safety and outcomes could prove an ethically challenging methodology for many of the invasive interventions conducted by respiratory physiotherapists. Part task trainers can be costly to establish and maintain, perhaps one way to increase access would be for collaboration across organisations and geographical locations.

POSTGRADUATE

Whilst there has been an increase in research outputs in the respiratory physiotherapy arena, these are disproportionately in pre-registration contexts. This suggests there are still barriers to respiratory physiotherapists accessing SBE in the workplace. Barriers might include a lack of trained faculty (educators trained specifically in SBE to deliver it safely and effectively), access to facilities and equipment and perceived cost.²⁶ As SBE pedagogical approaches adapt to suit the needs of the workforce, innovations such as in-

situation scenarios, virtual/augmented reality and 360 degree videos may help to increase access to SBE. Application of these innovations has progressed rapidly in response to the COVID-19 pandemic, however they are still in their infancy. Whilst increased access to equipment is potentially on the horizon, without faculty adequately trained to deliver SBE access will remain poor. The sources presented in this scoping review have demonstrated SBE increases confidence and self-efficacy. There is a known association between confidence, self-efficacy, stress and competence but not attainment.^{13,38-41} Where staff are more stressed there is a perceived need for more support, it is feasible therefore that SBE could result in reduced need for support, thus reducing pressure on senior staff.

LIMITATIONS

It was outside of the aims of this scoping review to undertake a quality assessment of the included studies. There is heterogeneity within the included studies with regards to the populations recruited, the design of the simulation based education and the outcome measures used, thus making it challenging to synthesize the results and draw conclusions. This scoping review provides an overview of the current literature and has not included the depth of analysis that a meta-analysis would provide.

FUTURE RESEARCH

None of the studies included in this scoping review have considered evolving modalities of SBE such as virtual reality, 360 degree video or gamification. The studies conducted continue to focus outcomes on learner experience. There continues to be paucity of evidence demonstrating translation of knowledge or skills learnt in SBE into clinical practice. Similarly, the impact on patient outcomes and safety specifically within the respiratory physiotherapy field has not been examined or reported. Regardless the benefits of SBE on patient safety is well documented in other fields, and whilst research in this area is encouraged this should not be considered a limitation or barrier to the further development and deployment of SBE for respiratory physiotherapists. The optimal modality and frequency of SBE remains unclear. There is increased emphasis on inter-professional education and there have been no studies considering this in a post graduate setting.

CONCLUSION

There is an increasing research output in the SBE field for respiratory physiotherapy. The evidence continues to focus on learner experience with paucity of evidence exploring impact on translation into clinical practice or patient safety. There is an increasing focus on Inter professional learning and the benefits this pedagogical approach has on teamwork. More resources and support are required to increase access to SBE for respiratory physiotherapists.

Key points

- There is an increasing research output in the simulation-based education field for respiratory physiotherapy
- The evidence continues to focus on learner experience with paucity of evidence exploring impact on translation into clinical practice or patient safety
- There is an increasing focus on inter-professional learning and the benefits this pedagogical approach has on teamwork
- There are very few research outputs considering simulation-based education in postgraduate respiratory physiotherapy training

DECLARATION OF INTEREST

Nil to declare.

FUNDING

This work was unfunded.

ACKNOWLEDGEMENTS

Association of Chartered Physiotherapists in Respiratory Care Editorial Board.

CORRESPONDING AUTHOR

Stephanie Mansell, stephanie.mansell1@nhs.net,

REFERENCES

1. Hawker C, Jones B, Cooke SC, et al. Developing an All-Wales definition of Simulation-Based Education. *International Journal of Healthcare Simulation*. 2022;2(1):A40-A41. doi:10.54531/inhm4618
2. Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *JBIM Evidence Implementation*. 2015;13(3):141-146. doi:10.1097/xeb.0000000000000050
3. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169(7):467-473. doi:10.7326/m18-0850
4. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1). doi:10.1186/s13643-016-0384-4
5. Brown L, Ilhan E, Pacey V, Hau W, Van Der Kooi V, Dale M. The Effect of High-Fidelity Simulation-Based Learning in Acute Cardiorespiratory Physical Therapy—A Mixed-Methods Systematic Review. *Journal of Physical Therapy Education*. 2021;35(2):146-158. doi:10.1097/jte.0000000000000183
6. Heuer A, Bienstock J, Zhang Y. Simulation-based training within selected allied health professions: an evidence-based systematic review. *Journal of Allied Health*. 2022;51(1):59-71.
7. Mori B, Carnahan H, Herold J. Use of Simulation Learning Experiences in Physical Therapy Entry-to-Practice Curricula: A Systematic Review. *Physiother Can*. 2015;67(2):194-202. doi:10.3138/ptc.2014-40e
8. Rezayi S, Shahmoradi L, Ghotbi N, et al. Computerized Simulation Education on Physiotherapy Students' Skills and Knowledge: A Systematic Review. *Biomed Res Int*. 2022;2022:4552974. doi:10.1155/2022/4552974
9. Stockert B, Silberman N, Rucker J, et al. Simulation-Based Education in Physical Therapist Professional Education: A Scoping Review. *Physical Therapy*. 2022;102(12). doi:10.1093/ptj/pzac133
10. Bednarek M, Downey P, Williamson A, Ennulat C. The use of human simulation to teach acute care skills in a cardiopulmonary course: a case report. *Journal of Physical Therapy Education*. 2014;28(3):27-34. doi:10.1097/00001416-201407000-00005
11. Blackstock FC, Watson KM, Morris NR, et al. Simulation can contribute a part of cardiorespiratory physiotherapy clinical education: two randomized trials. *Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare*. 2013;8(1):32-42. doi:10.1097/sih.0b013e318273101a
12. Jones A, Sheppard L. Use of a human patient simulator to improve physiotherapy cardiorespiratory clinical skills in undergraduate physiotherapy students: A randomised controlled trial. *Internet Journal of Allied Health Sciences and Practice*. 2011;9(1):1-11. doi:10.46743/1540-580x/2011.1338
13. Jones A, Sheppard L. Self-efficacy and clinical performance: A physiotherapy example. *Advances in Physiotherapy*. 2011;13(2):79-84. doi:10.3109/14038196.2011.565072
14. Nithman RW, Spiegel JJ, Lorello D. Effect of High-Fidelity ICU Simulation on a Physical Therapy Student's Perceived Readiness for Clinical Education. *Journal of Acute Care Physical Therapy*. 2016;7(1):16-24. doi:10.1097/jat.0000000000000022
15. Ohtake PJ, Lazarus M, Schillo R, Rosen M. Simulation experience enhances physical therapist student confidence in managing a patient in the critical care environment. *Physical therapy*. 2013;93(2):216-228. doi:10.2522/ptj.20110463
16. Roos R, van Aswegen H, Casteleijn D, Thurling CH. Perceptions of students and educators regarding a once-off pre-clinical ICU simulation activity. *S Afr J Physiother*. 2022;78(1):1830. doi:10.4102/sajp.v78i1.1830
17. Silberman NJ, Panzarella KJ, Melzer BA. Using human simulation to prepare physical therapy students for acute care clinical practice. *Journal of Allied Health*. 2013;42(1):25-32.
18. Silberman NJ, Litwin B, Panzarella KJ, Fernandez-Fernandez A. High Fidelity Human Simulation Improves Physical Therapist Student Self-Efficacy for Acute Care Clinical Practice. *Journal of Physical Therapy Education*. 2016;30(1):14-24. doi:10.1097/00001416-201630010-00003
19. Wright A, Moss P, Dennis DM, et al. The influence of a full-time, immersive simulation-based clinical placement on physiotherapy student confidence during the transition to clinical practice. *Adv Simul*. 2018;3(1):3. doi:10.1186/s41077-018-0062-9

20. King J, Beanlands S, Fiset V, et al. Using interprofessional simulation to improve collaborative competences for nursing, physiotherapy, and respiratory therapy students. *J Interprof Care*. 2016;30(5):599-605. [doi:10.1080/13561820.2016.1189887](https://doi.org/10.1080/13561820.2016.1189887)
21. Lefebvre K, Wellmon R, Ferry D. Changes in Attitudes Toward Interprofessional Learning and Collaboration Among Physical Therapy Students Following a Patient Code Simulation Scenario. *Cardiopulmonary Physical Therapy Journal*. 2015;26(1):8-14. [doi:10.1097/cpt.0000000000000003](https://doi.org/10.1097/cpt.0000000000000003)
22. Rossler KL, Kimble LP. Capturing readiness to learn and collaboration as explored with an interprofessional simulation scenario: A mixed-methods research study. *Nurse Educ Today*. 2016;36:348-353. [doi:10.1016/j.nedt.2015.08.018](https://doi.org/10.1016/j.nedt.2015.08.018)
23. Thomas EM, Rybski MF, Apke TL, Kegelmeyer DA, Kloos AD. An acute interprofessional simulation experience for occupational and physical therapy students: Key findings from a survey study. *J Interprof Care*. 2017;31(3):317-324. [doi:10.1080/13561820.2017.1280006](https://doi.org/10.1080/13561820.2017.1280006)
24. Wellmon R, Lefebvre KM, Ferry D. Effects of High-Fidelity Simulation on Physical Therapy and Nursing Students' Attitudes Toward Interprofessional Learning and Collaboration. *J Nurs Educ*. 2017;56(8):456-465. [doi:10.3928/01484834-20170712-03](https://doi.org/10.3928/01484834-20170712-03)
25. Hassam M, Williams M. Education via simulation: teaching safe chest percussion for pre-term infants. *Hong Kong Physiotherapy Journal*. 2003;21(1):22-28. [doi:10.1016/s1013-7025\(09\)70036-3](https://doi.org/10.1016/s1013-7025(09)70036-3)
26. Gough S, Yohannes AM, Thomas C, Sixsmith J. Simulation-based education (SBE) within postgraduate emergency on-call physiotherapy in the United Kingdom. *Nurse Education Today*. 2013;33(8):778-784. [doi:10.1016/j.nedt.2012.03.015](https://doi.org/10.1016/j.nedt.2012.03.015)
27. Mansell SK, Harvey A, Thomas A. An exploratory study considering the potential impacts of high-fidelity simulation based education on self-evaluated confidence of non-respiratory physiotherapists providing an on-call respiratory physiotherapy service: a mixed methods study. *BMJ Simulation and Technology Enhanced Learning*. 2019;6(4):199-205. [doi:10.1136/bmjstel-2019-000444](https://doi.org/10.1136/bmjstel-2019-000444)
28. Thackray D, Roberts L. Exploring the clinical decision-making used by experienced cardiorespiratory physiotherapists: A mixed method qualitative design of simulation, video recording and think aloud techniques. *Nurse Education Today*. 2017;49:96-105. [doi:10.1016/j.nedt.2016.11.003](https://doi.org/10.1016/j.nedt.2016.11.003)
29. La Duke P. How to evaluate training: using the Kirkpatrick model. *Professional safety*. 2017;62(8):20.
30. Tamkin P, Yarnall J, Kerrin M. *Kirkpatrick and Beyond: A Review of Models of Training Evaluation*. Institute for Employment Studies Brighton, England; 2002.
31. Kirkpatrick J. *An Introduction to the New World Kirkpatrick Model*. Kirkpatrick Partners; 2015:2019.
32. Lowe CM, Heneghan N, Herbrand A, Atkinson K, Beeton K. *PROJECT REPORT FOR THE CHARTERED SOCIETY OF PHYSIOTHERAPY.*; 2022.
33. Rossler K, Molloy MA, Pastva AM, Brown M, Xavier N. Healthcare Simulation Standards of Best Practice™ Simulation-Enhanced Interprofessional Education. *Clinical Simulation in Nursing*. 2021;58:49-53. [doi:10.1016/j.ecns.2021.08.015](https://doi.org/10.1016/j.ecns.2021.08.015)
34. Sezgin MG, Bektas H. Effectiveness of interprofessional simulation-based education programs to improve teamwork and communication for students in the healthcare profession: A systematic review and meta-analysis of randomized controlled trials. *Nurse Education Today*. 2023;120:105619. [doi:10.1016/j.nedt.2022.105619](https://doi.org/10.1016/j.nedt.2022.105619)
35. Robertson J, Bandali K. Bridging the gap: Enhancing interprofessional education using simulation. *Journal of Interprofessional Care*. 2008;22(5):499-508. [doi:10.1080/13561820802303656](https://doi.org/10.1080/13561820802303656)
36. Krishnan DG, Kelothe AV, Ubedulla S. Pros and cons of simulation in medical education: A review. *Education*. 2017;3(6):84-87.
37. Gaba DM. The future vision of simulation in health care. *Quality and Safety in Health Care*. 2004;13(suppl_1):i2-i10. [doi:10.1136/qshc.2004.009878](https://doi.org/10.1136/qshc.2004.009878)
38. Dunford F, Reeve J, Larner P. Determining differences between novice and expert physiotherapists in undertaking emergency on-call duties. *New Zealand Journal of Physiotherapy*. 2011;39(1):20-29.
39. Yerkes RM, Dodson JD. The relation of strength of stimulus to rapidity of habit-formation. *J Comp Neurol Psychol*. 1908;18(5):459-482. [doi:10.1002/cn.920180503](https://doi.org/10.1002/cn.920180503)
40. Kruger J, Dunning D. Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*. 1999;77(6):1121-1134. [doi:10.1037/0022-3514.77.6.1121](https://doi.org/10.1037/0022-3514.77.6.1121)

41. Stewart J, O'Halloran C, Barton JR, Singleton SJ, Harrigan P, Spencer J. Clarifying the concepts of confidence and competence to produce appropriate self-evaluation measurement scales. *Medical Education*. 2000;34(11):903-909. [doi:10.1046/j.1365-2923.2000.00728.x](https://doi.org/10.1046/j.1365-2923.2000.00728.x)