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Simulation-Based Learning for Pain Medicine: A Scoping Review of Undergraduate Education

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Abstract

Background: Pain medicine is under-represented in medical curricula worldwide, potentially contributing to barriers to best practice in acute and chronic pain management. Simulation-based education (SBE) is an established educational tool, though its utility has not been fully explored in relation to pain medicine. We undertook a scoping review to identify how SBE has featured in pain management undergraduate education. We wanted to know how SBE affects undergraduate medical students' knowledge, skills, and attitudes in pain medicine.

Methods: We searched Medline, EMBASE, PubMed and PsychInfo databases. Key terms in the search string were simulation-based education AND medical student AND pain medicine AND education OR confidence. We applied Arksey and O'Malley's framework for analysis. We additionally recorded whether included studies reported learning according to Kirkpatrick's modified four levels of learning.

Findings: Twelve studies were included in the review. Both acute and chronic pain were addressed. The most common form of SBE reported in the included studies was learning with standardised patients. Key results from across the included studies were: SBE improves medical students' knowledge, skills and attitudes in pain medicine; SBE informs student attitudes and confidence to manage patient pain effectively; and SBE can be effective for reducing stigmatisation of patients with chronic pain. Student satisfaction with the reported SBE interventions was high. Eleven studies (92%) only collected data on learner satisfaction, equating to a Kirkpatrick Level 1 educational outcome. However, nine studies (75%) also evaluated the simulation intervention's effect on participant learning, equating to a Kirkpatrick Level 2 educational outcome (learning).

Conclusion: SBE can be an effective method of undergraduate medical education in pain medicine. Further research should examine the way SBE can affect medical students' attitudes towards patients with chronic pain.

I INTRODUCTION

Pain medicine is a discipline that is concerned with the prevention, evaluation, treatment, and rehabilitation of patients in pain [1]. Pain is a common symptom yet both acute and chronic pain are often poorly managed. A recent study reported that one week following surgery, 47% of patients are still experiencing moderate to severe pain [2]. This matters not only because pain is an unpleasant sensory and emotional experience, but also because inadequate postoperative pain control may result in delayed ambulation, prolonged hospital stays and increased patient distress [3–5]. Healthcare-related pain burden is not limited to acute pain. Australian epidemiological research suggests 20-25% of adults experience moderate-to-severe chronic pain in their daily lives [6]. Best-practice pain management could be achieved through improved medical training, starting in the undergraduate level [7–9]. The problem is, a recent review of pain medicine education in Australasia concluded that medical schools do not have established, comprehensive curricula to reflect the complexity and importance of effective pain management [10]. The review was focused on medication, which is only one aspect of pain management. Never-the-less, its messages reflect an international pattern of inadequate undergraduate preparation to meet the healthcare needs of patients with acute and chronic pain [11].

Shipton et al., recently reviewed undergraduate pain medicine curricula within medical schools across multiple countries. They report that an incredible “Ninety-six percent of medical schools in the UK and USA, and nearly 80% of medical schools in Europe had no compulsory dedicated teaching in pain medicine" [12 (p139)]. While simulation-based education (SBE) was reportedly used infrequently, Shipton and colleagues suggest that future pain medicine education should steer away from didactic teaching methods and towards SBE.

SBE has been widely utilised in undergraduate medical curricula to provide a safe and realistic environment for learners to gain knowledge and reinforce skills [13]. Simulation is defined as a “person, device, or set of conditions which attempts to present education and evaluation problems authentically” [14]. Simulation of a clinical environment can be achieved using mannequins, part-task trainers, standardised patients (SPs), or virtual reality [15]. It can be very engaging to students and (if well prepared) very realistic [16], preparing learners for real-life situations [17]. While the utility of SBE has been established in activities such as crisis management, procedural skills training and interprofessional training, its potential utility in developing pain management skills has not been fully explored [18–20]. Shipton et al. demonstrated that while all medical schools in Australasia used didactic teaching methods to deliver their pain medicine curriculum, only 42% of schools adopted case-based learning, with only 2% utilising simulation [10].

Five years after Shipton et al.’s recommendations, we wondered whether SBE has been taken up in pain medicine and whether we could identify studies using SBE for pain medicine education. We also wondered whether evidence exists linking SBE for pain medicine to specific types or levels of learning. We used Kirkpatrick’s modified four levels of learning, which include: (1) Participation; learner’s views on the educational experience, (2) Modification; evidence of change in attitudes, knowledge, or skills, (3) Behavioural change; evidence of transfer of learning to the workplace, and (4) Change in practice or benefit to patients; improvement in patient wellbeing because of the intervention [21]. We undertook a scoping review to explore the ways in which SBE is being used to teach best practice pain management, and how SBE affects undergraduate medical students’ knowledge, skills, and attitudes in pain medicine.

II METHODS

We conducted a scoping review using the methodological framework proposed by Arksey and O’Malley [22]. The aim of a scoping review is to identify all relevant literature regardless of study

design, in order to appreciate the extent, range, and nature of evidence. A scoping review does not explicitly aim to examine research quality but can identify gaps in the existing literature. We followed the scoping review framework outlined by Arksey and O'Malley, which describes five required stages: (1) Identifying the research question, (2) Identifying relevant studies, (3) Study selection, (4) Charting data and (5) Collating, summarising and reporting results. Their model also suggests a sixth stage – consultation and collaboration with stakeholders – that may be helpful. We did not complete stage six. Nor did we pre-register the a priori protocol.

A *Research Question*

Our research question was outlined as: What is known from the existing literature about the influence of SBE on undergraduate medical students' knowledge, skills, and attitudes in pain medicine? Of included literature, we additionally wanted to know which Kirkpatrick levels they addressed.

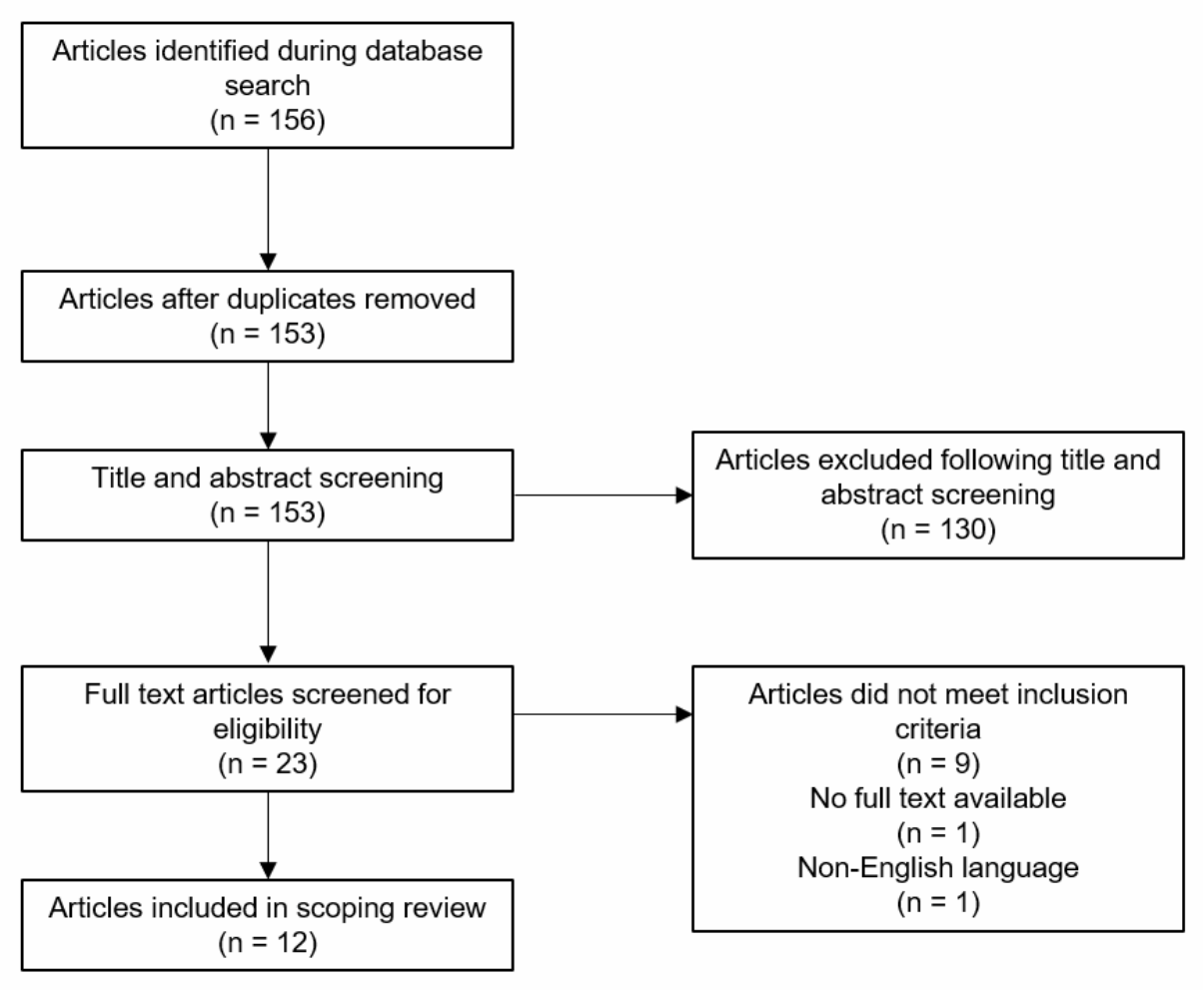
B *Search Strategy*

The search was conducted using the following electronic databases: MEDLINE, Embase, PsychInfo, and PubMed. The specific search terms (and derivatives) used in the search were developed through input from the research team. The search strategy in PubMed was: simulation-based education AND (medical student OR medical undergraduate OR trainee intern) AND pain medicine AND (education OR confidence OR knowledge OR readiness OR preparedness). Both medical subject headings (MeSH) and free text terms were used. A manual reference list search was also conducted to identify any relevant studies. Final searches were executed by one of the research team members (AS), exported to a reference manager software and duplicates removed.

C *Study Selection*

Studies included in the review reflected quantitative, qualitative, and mixed methods designs. We included studies that: involved a form of simulation activity; commented on any educational outcomes of a simulation intervention; focused on undergraduate medical students (but could also include interprofessional learning); and concerned attitudes, knowledge, or skills relevant to managing a person in pain. There were no restrictions placed on publication date. Only English language papers were included due to the cost and time involved in translating material. Two research team members (AS and CC) screened and applied the inclusion criteria to article abstracts independently in duplicate. This was subsequently reviewed by a third research team member (TJ). The research team engaged in iterative discussions when questions regarding inclusion or exclusion arose until consensus was reached. Methodological quality criteria were not used during study selection. A total of 12 articles were included for full review. The literature search and article identification flow chart are depicted in Figure 1.

Figure 1
Search Strategy Flow Chart



D *Charting the Data*

Through iterative discussions, the research team developed a data abstraction form. We tested the form using five studies and then reached consensus through discussion on necessary changes to the form. One team member (AS) revised the form and the other two research team members (CC and TJ) checked and agreed to the changes made. The final form included information on: (1) study profile (e.g., year of publication, country of origin, cohort characteristics); (2) study design or aim; (3) simulation modality; (4) educational outcomes; (5) focus on acute or chronic pain or both; (6) Kirkpatrick level/s of educational outcomes; (7) student satisfaction or acceptability. The Kirkpatrick model was used as it is widely cited in educational literature and was developed to evaluate the efficacy of educational interventions in various environments [23].

E *Collating, Summarising, and Reporting Findings*

Data compiled to the final abstraction form was initially analysed using quantitative frequency analysis. Qualitative data was mentioned when present. The report of findings was conducted by one research team member (AS), in a deductive way (i.e., driven by a specific research question)

at a semantic or explicit level. It was then reviewed by two other research team members (CC and TJ) using the 6-step approach of reflexive thematic analysis as described by Braun and Clarke (i.e., familiarisation with the dataset, generation of initial codes, generation of initial themes, revision and development of themes, definition and naming of themes, and writing of report) [24].

F *Positionality*

Author AS is a trainee in anaesthesiology and has completed a postgraduate qualification in medical education. CC and TJ are experienced in qualitative and clinical education research. Our clinical and educational experiences have informed our interpretation of the review findings.

III RESULTS

A total of 12 articles were included in the final review [25–36]. A summary of the articles included in the review is presented in Table 1 (Appendix A).

A *Description of Included Studies*

Studies originated from four countries, with 75% of studies describing experiences in the United States of America (nine studies). The remaining studies were based in the United Kingdom (one study), Germany (one study) and Hong Kong (one study). Six studies (50%) were pre-post interventions, three (25%) were randomised control trials, one (8.3%) was a prospective randomised cross-over study, one (8.3%) was a pilot intervention study, and one (8.3%) was a quasi-experimental mixed method study. Eight studies (67%) utilised the standardised patient simulation modality. Regarding simulation modalities, two studies (17%) utilised an anatomical model or skill trainer. One study (8%) utilised a medium fidelity mannikin and one study (8%) utilised a virtual patient simulation. Four studies (33%) focused on the management of acute pain [26,28,31,32], while three studies (25%) focused on chronic pain [25,29,35]. Three studies (25%) focused on end-of-life care or cancer [27,30,36]. One study focused on procedural skills using ultrasound [34] and one study focused on opioid misuse [33]. Eleven studies (92%) only collected data on learner satisfaction, equating to a Kirkpatrick Level 1 educational outcome. However, nine studies (75%) also evaluated the simulation intervention's effect on participant learning, equating to a Kirkpatrick Level 2 educational outcome. Nine studies (75%) reported on student satisfaction with the simulation provided, with an overall trend to rate simulations highly with respect to utility and effectiveness of information or skill delivery. Those studies reporting on satisfaction found students rated the interventions at least ≥80% out of 100 using their respective scoring instruments, however many only recorded ratings qualitatively with positive descriptors [25,26,29–35]. Three studies (25%) did not explicitly comment on learner satisfaction or the acceptability of the simulation intervention. None of the studies included in the review explicitly reported on Level 3 or 4 Kirkpatrick educational outcomes.

B *Themes*

1 *Theme One: SBE Improves Students' Factual Knowledge, Clinical and Procedural Skills*

Ten of the included studies (83%) examined the effect of simulation interventions on students' factual knowledge, clinical and specific procedural skills. Factual knowledge related to pain medicine included topics such as appropriate opioid prescription, dosing, and adverse effects. It also included knowledge of regional anaesthesia techniques, as well as a focus on non-opioid analgesia in the context of chronic pain. Monteiro et al. investigated opioid misuse or overdose management, with students demonstrating an improved score in a written assessment regarding

the identification of a patient experiencing opioid related side effects due to misuse and the appropriate use of naloxone [33]. This was the only included study that explored opioid misuse. Students participating in the interprofessional workshop containing SBE achieved an improvement in scores in the Opioid Overdose Knowledge Scale 12 weeks post intervention (pre-test mean score of 40.84 compared to 47.94 out of 54, p <0.001) [33]. The authors found this to be evidence of "significant and sustained increase in knowledge, attitudes, and skills" [33]. Overall, students participating in SBE achieved statistically significant higher marks in written and clinical examinations of factual knowledge such as MCQs, mini-Clinical Evaluation Exercises (Mini-CEX) and Objective Structured Clinical Examinations (OSCEs), when compared to themselves (pre/post tests) or control groups (which underwent other educational interventions) [26,31–36]. This points to the positive effect SBE has on factual knowledge of pain medicine for medical students. For example, Leung et al. found that pain management case studies of virtual (computer-simulated) patients enhanced student performance in both the short term (Module MCQ scores 85% compared to control of 66%, p = 0.004) and the long term (End-of-Year Modified Easy Question scores 54% compared to 48%, p = 0.01) [32]. Likewise, Sloan et al. demonstrated a long-term knowledge retention as evidenced by improved scores in the pain management components of an OSCE (namely, pain history taking, physical examination, analgesic management, and communication of opioid myths) four months post instruction with standardised patients (mean score 30.9 compared to 16.2 in control group – with no formal cancer pain education – , p <0.05) [36]. This was evidence of "durable learning of cancer pain management principles" [36].

Two included studies demonstrated SBE improved student knowledge of the theory underpinning procedural skills (performance of regional anaesthesia) [26,34]. Both studies utilised a skills trainer or anatomical model as the simulation modality. Hanna et al. assessed performance using an OSCE, examining the students' knowledge of interscalene blocks by demonstrating proper patient positioning, appropriate local anaesthetic choice and anatomical landmarks [26]. Situ-LaCasse et al. assessed procedural competency with a live model and nerve block phantom in conjunction with a written assessment [34]. This study demonstrated a significant change between pre- and post-SBE intervention written assessment scores (68.4% (95% CI = 65.4 – 71.4) compared to 92.8% (95% CI = 90.8 – 94.8)) [34]. Overall, teaching regional anaesthesia as part of procedural skills was uncommon, possibly reflecting the scope of the undergraduate anaesthesia curriculum.

SBE improved student clinical skills. Through SBE, students interviewing patient partners with chronic back pain were able to improve their skills in eliciting appropriate clinical information [29]. Medical students who learned via SBE scored higher than control groups in domains such as empathy, communication skills and rapport building when examining patients with acute and chronic pain [31,36]. Notably, simulations involving standardised patients were found to be of particular benefit, because students were able to receive immediate feedback from the standardised patient, which reinforced their learning [31]. One included study reported that SBE enabled them to identify and build on student poor communication skills regarding opioids[36]. One study showed, through qualitative analysis, that interprofessional students in a recorded OSCE interview station particularly struggled to communicate with a standardised patient who had a history of chronic pain and opioid misuse [25].

In their pilot hybrid-simulation experience, Hayley et al. showed that students particularly struggled to communicate with a standardised actor who was a relative of a dying patient. Some students in the study informed the standardised actor relative incorrectly that the pain medicines may contribute to their relative's death [27]. Teaching staff provided students with video recordings of their simulation scenario and then ran group debriefing to support key learning.

2 *Theme Two: SBE Informs Student Attitudes and Confidence to Manage Patient Pain Effectively*

Seven of the included studies (58%) evaluated changes in medical students' attitudes towards managing patients with acute and chronic pain following SBE activities [27–30,34–36]. All seven studies observed learner attitudes were positively informed by SBE. In the included studies, attitudes were often assessed with reference to student comfort and confidence. Five included studies used students self-rated questionnaires to assess student confidence with acute pain management after SBE. They all demonstrated SBE was associated with increased student self-confidence for effective pain management [28–30,34,35].

3 *Theme Three: SBE to Reduce Stigmatisation of Patients with Chronic Pain*

Student attitudes were prioritised in three included studies (12%) [25,33,35]. One study addressed the potential for simulation to encourage destigmatisation of patients with opioid misuse, however there was no conclusive evidence that it had done so [33]. Two studies specifically mentioned the effects of SBE on medical students' attitudes towards patients with chronic non-malignant pain [25,35]. Vargovich et al. utilised a "comfort/attitude"-based questionnaire to determine the changes in attitudes pre- and post- simulation workshop, however the contents of the questionnaire were not included in the article. The authors found a statistically significant change in the mean total scores of students' attitudes towards pain management [35]. In contrast, Barreveld et al. found that students interviewing a standardised patient with acute or chronic non-malignant pain and previous opioid misuse often made stigmatising remarks and lacked patient collaboration [25]. For example, students "focussed on addressing opioid misuse prior to obtaining a history that supported the need to do so" [25]. Other stigmatising comments included "Would you like to…be off the oxycodone at some point? Because it carries certain side effects that may be dangerous" and "She could be selling her medication" [25].

IV DISCUSSION

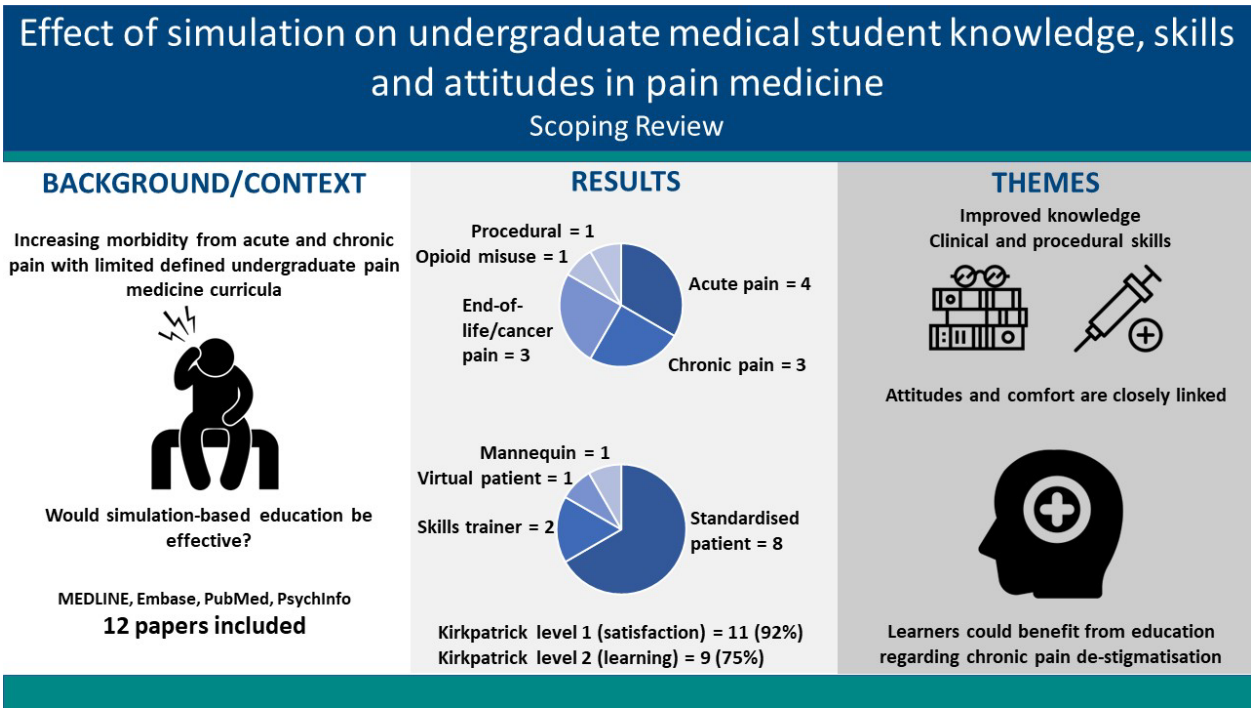
This review identified only 12 articles published between 2001 and 2021 concerning the effects of SBE on undergraduate skills, knowledge, and attitudes in pain medicine. SBE was broadly identified as effective in developing undergraduate medical students' knowledge, skills, and attitudes in the discipline of pain medicine, with evidence of longer-term factual knowledge retainment (see Figure 2). Findings were consistent with those previously observed regarding the effectiveness of SBE in undergraduate medical student learning and development [13,37,38].

Of the included studies, significant heterogeneity was observed in study design, and the learning that was measured reaches Kirkpatrick levels one and two. Levels three and four are notoriously more difficult to achieve, measure and demonstrate. Behaviour change and patient outcomes is mainly where SBE and research need to be focused. The findings of this review are disappointing in this regard. For educators interested in attaining those higher Kirkpatrick levels, one avenue might be to evaluate the effect of a new pain medicine curriculum on patient pain outcomes using a proxy measure such as opioid prescribing on discharge following surgery. Another suggestion for those medical institutions outlining regional anaesthesia as a required competency is to use a workplace-based assessment such as a Direct Observation of Procedural Skills (DOPS) for assessing skill acquisition and behavioural change.

In our study, we found that SBE informed positively on student attitudes towards pain management. Attitudes are complex processes that influence the way individuals process information and attitudes motivate behaviour [39]. In the wider medical education literature, learner attitudes are often closely interlinked with their intrinsic comfort or confidence regarding a certain task or interaction [40], which is concordant with our findings. Attitudes are also informed by early learning experiences (of which SBE can be one modality), habits, and individual beliefs [41].

The strength of the included studies is that they demonstrate SBE to be especially useful in providing learning around soft/core skills and the practical side of patient care. This is often poorly catered for in other aspects of pain curricula where an emphasis tends to be on biomedical aspects of pain. There have been concerns expressed about the lack of humanism and empathy in healthcare, often attributed to the focus of undergraduate medical curricula on the biomedical model [42,43]. SBE using standardised patients and patient partners are able to bridge that gap by sharing their lived experiences and providing immediate feedback to students in a safe learning environment.

Figure 2
Visual Abstract. Effect of Simulation on Undergraduate Medical Student Knowledge, Skills, and Attitudes in Pain Medicine.



A *Attitudes Towards Patients with Chronic Pain*

A particularly interesting finding of this review was the observation of stigmatising comments and attitudes towards patients with a history of opioid abuse and chronic pain by Barreveld et al [25]. This observation tends to reflect perceptions of stigma frequently reported by patients with chronic pain symptoms [44–47]. Patients with chronic non-malignant pain often receive stigmatising reactions from healthcare providers, thought to be as a consequence of a deviation from the traditional biomedical model of pain physiology [48]. In a study of people with chronic pain, 38% of respondents "endorsed the experience of internalised stigma" [49]. The effect of stigma on patients is far-reaching. Waugh et al. describe internalised stigma as having a "negative relationship with self-esteem and pain self-efficacy", with a greater catastrophising reactions and a "reduced sense of personal control" over pain [49]. Often, stigmatising reactions stem from the development of attitudes over time that are informed by the hidden curriculum of healthcare [40]. Rajput et al. comment that "attitudes are communicated, silently or otherwise, down the hierarchical chain" [50].

They provide an example of a house officer “communicating his callous and judgmental feelings about a chronic pain patient in a variety of ways” to those junior to him, emphasising the way in which negative attitudes can be modelled to students [50]. None of the studies included in this review approached this topic, which is a major gap in the literature. Patients with pain whose symptoms are discounted by medical professionals experience poorer psychological and physical wellbeing [51,52]. Targeting negative attitudes at an early learning stage may allow for improved patient interactions during independent practice in the future [53]. Further research could examine the effects of simulation on the de-stigmatisation of patients with chronic pain. Indeed, we recommend SBE programs actively highlight stigmatisation within standardised patient scripts and as part of effective debriefs.

B *Limitations*

Given the exclusion of non-English articles, this study carries a bias for a traditionally Western attitude towards pain, modelling of medical curricula and patient demographics. Attitudes were variable, and often poorly defined in their respective studies. The translatability of medical student simulation to robust improvement in pain prescription and management is limited, especially considering most interventions were one-off activities (rather than longitudinal curricula), mostly focused on opioid management rather than a more holistic view of pain management. Furthermore, the relative impact of introducing at times costly, labour-intensive (to execute and train faculty to doing it) SBE into already saturated medical curricula was left unexplored and beyond the scope of this review but carries significant weight in determining its efficacy. We also note the interprofessional contexts in which pain management usually occurs is not reflected in our paper, which only focuses on undergraduate medical students.

V CONCLUSION

SBE is an effective educational strategy to improve undergraduate medical students’ knowledge, skills and attitudes in the discipline of pain medicine. Pain medicine is under-represented in medical curricula worldwide, the consequences of which are contributing to barriers to best practice in acute and chronic pain management. While there is evidence of improvement in student confidence and comfort following simulation, it is unclear how – or indeed, if – this translates to robust mid to long term improvements in those outcomes. Importantly, the efficacy of SBE in addressing the stigmatising attitudes towards patients with chronic pain has been left largely unexplored. Many skills, attitudes, and competencies relevant to pain medicine are well-suited to SBE. Our scoping review has revealed ways in which simulation could be incorporated into medical curricula.

DECLARATIONS

Ethics Approval and Consent to Participate
Not applicable.

Consent for Publication
Not applicable.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

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Availability of Data and Materials
The data abstraction form utilised for this review has been included as Table 1.

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APPENDIX A

Table 1
Summary of articles included in the review. MS, medical students; IP, interprofessional; NS, nursing students; PTS, physiotherapy students; SWS, social work students; PS, pharmacy students; DS, dental students; SP, standardised patient; VP, virtual patient; ST, skills trainer; A, acute pain; C, chronic pain.

Included Studies are Presented Chronologically

Authors	Year of publication	Context	Study design and aim	Sample/cohort	Simulation modality	Pain category and duration	Key findings	Kirkpatrick level/s	Student satisfaction
Kahn et al. [30]	2001	Louisiana, USA	Pre-post intervention study evaluating the effectiveness of standardised patients in teaching end-of-life skills	44 3rd year MS	SP	End-of-life/cancer A	Students had a positive opinion on the intervention and self-reported improved perceived abilities to deal with end-of-life patients.	Level 1	Participants believed standardised patients were "effective"
Sloan et al. [36]	2004	Kentucky, USA	Prospective randomised study evaluating efficacy of SBE on cancer pain management	192 3rd year MS	SP	End-of-life/cancer A and C	Intervention group participants outperformed control group ones at 4 months post instruction.	Level 2	No evaluation
Hanna et al. [26]	2005	Maryland, USA	Comparison study evaluating whether simulation in regional anaesthesia improves knowledge and skills in peripheral nerve blocks	40 4th year MS divided into study and control groups	ST using cadaver prosections	Acute pain (peri-operative) A	Intervention group performed better on all OSCE items and on the total performance scores All students rated the course positively.	Level 2	Score 4.5 +/- 0.5 out of 5 for overall effectiveness
Haq et al. [29]	2006	London, United Kingdom	Pre-post intervention study evaluating the effect of patient partner simulation on student confidence and performance in examinations relating to back pain	60 3rd year MS	SP – patient partner	Chronic pain C	Intervention group performed significantly better in summative OSCE, but no difference was seen in single station assessing history-taking skills.	Level 1, Level 2	Median student rating of overall utility = 4 ("useful")
Leung et al. [32]	2014	Shatin, Hong Kong	Prospective randomised cross over study evaluating efficacy of virtual patients	130 final year MS	VP	Acute pain A	Virtual patients were found to enhanced student performance in all three examinations, and were well liked by the students.	Level 1, Level 2	Rated "highly" as a learning tool

Authors	Year of publication	Context	Study design and aim	Sample/cohort	Simulation modality	Pain category and duration	Key findings	Kirkpatrick level/s	Student satisfaction
Salam et al.[28]	2015	Delaware, USA	Pre-post pilot intervention study to measure changes in confidence in assessing and managing acute pain	12 3rd year NS and 12 3rd year MS	SP	Acute pain A and C	There was a significant positive shift in the confidence of the learners' ability to assess and manage acute pain. Participants' attitudes regarding education to enhance interprofessional collaboration improved after the simulation experience.	Level 1	No evaluation
Monteiro et al.[33]	2017	Rhode Island, USA	Pre-post intervention study evaluating the utility of an interprofessional workshop on increasing student knowledge of opioid misuse	IP group of 2nd year MS (n = 120), 4th year NS (n = 209), 2nd year PTS (n = 33), 1st year SWS (n = 60), 2nd year PS (n = 118)	SP	Opioid misuse C	Medical students scored more in a pre/posttest analysis at 12-week follow-up, Interprofessional students satisfaction data revealed a high degree of satisfaction	Level 1, Level 2	"Very high satisfaction" with overall quality of the intervention
Hayley et al.[27]	2018	Kansas, USA	Pilot intervention of medium fidelity simulation to teach end-of-life skills	83 4th year MS and 22 1st year residents	Medium fidelity mannekin (Laerdal SimMan 3G) and SP	End of life/cancer A	All learners demonstrated professional activity working with the nurse, and most medical students gave opioids appropriately for pain. Only 19% of the medical students and 50% of residents appropriately disclosed the patient's status to the wife using the words *death* and/or *dying*,	Level 1	No evaluation
Situ-LaCasse et al.[34]	2019	Arizona, USA	Cross-sectional study evaluating the efficacy of a simulation workshop on peripheral nerve block skills	94 3rd year MS	ST – nerve block phantom	Procedural A	The average post-test score was significantly higher compared to the pre-test. All students were satisfied with the educational session. Most students felt confident with their skills after the session. The majority agreed that the session will change how they manage patients' acute pain in their future medical practice	Level 1, Level 2	Mean student evaluation score 84.4%

Authors	Year of publication	Context	Study design and aim	Sample/cohort	Simulation modality	Pain category and duration	Key findings	Kirkpatrick level/s	Student satisfaction
Vargovich et al.[35]	2019	New York, USA	Pre-post intervention study examining the utility of a simulation workshop designed to improve knowledge and skills in chronic pain management	108 3rd year MS	SP	Chronic pain C	Test and survey results indicated improvements in knowledge, attitudes, and confidence in treating chronic pain. Students were satisfied with the experience.	Level 1, Level 2	More than 90% of students ranked quality and effectiveness as "above average" or "excellent"
Barreveld et al.[25]	2021	Massachusetts, USA	Mixed-methods study evaluating effect of case-based studies on interprofessional student performance in a team OSCE	60 IP students comprising of MS, DS, PS	SP	Chronic pain A and C	Demographics, OSCE learning scores, Interprofessional Attitudes Scale scores, and pain management plans did not differ between groups. All students evaluated the activity highly. Qualitative analysis identified similar themes between groups: students missed opportunities to establish patient-provider rapport and educate across disciplines; opioid use disorder was assumed with chronic opioid therapy; team discussions improved treatment plans; moderators variably influenced team discussion.	Level 1, Level 2	Students evaluated the activity “highly”
Kurz et al.[31]	2021	Mainz, Germany	Prospective randomised study evaluating the effect of simulation on clinical skills in pain medicine	35 final year MS during elective	SP	Acute pain A and C	The quality of the simulation was evaluated highly by the students. Intervention group was significantly better in the final examination. The following skills were significantly better after the course: taking responsibility, expert knowledge, empathy, relationship building and communication.	Level 1, Level 2	Mean student rating of course 1.1 ("very good")

Appendix B

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2-3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	-
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6-7
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their	7

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	7
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	6-7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	8
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	8-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	8-12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	12-14
Limitations	20	Discuss the limitations of the scoping review process.	14-15
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	15
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	15

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.