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ORIGINAL RESEARCH

Bias in simulation training for healthcare professions: a scoping review

Selçuk Akturan[1], Amy Binns-Calvey[2], Christine Park[3]

[1]*Medical Education, Karadeniz Technical University, Trabzon, Turkey*
[2]*Medicine, University of Illinois at Chicago, Chicago, IL, USA*
[3]*Medical Education, University of Illinois at Chicago, Chicago, IL, USA*

Corresponding author: Amy Binns-Calvey, amybc@uic.edu

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ABSTRACT

Background
Bias potentially affects simulation-based training (SBT) for healthcare professions. The role bias plays in SBT design, presentations, and in the experiences of learners should be understood. Dual process theory is a well-accepted framework for understanding types of bias.

Methods
The authors performed a scoping review to map 'bias' in SBT of health professions in the literature. Search terms were developed for a query in the PubMed database. Researchers reviewed abstracts, met ten times to discuss which papers' full texts to read, and then analysed and categorized the articles. Researchers used the Arksey and O'Malley framework for scoping reviews.

Results
Three thousand six hundred and twenty abstracts were identified by a detailed query in the PubMed database of which, 115 full-text articles were identified for inclusion.

Discussion
Articles published about bias in SBT cover a broad range of topics, from addressing how bias affects patient care, to bias in raters' scoring of medical students on exams. Researchers found that the prevalence of articles on bias in SBT increased over time and focused primarily on implicit bias. Specific types of bias in some instances were difficult to identify, and several biases mentioned in papers were unique to this review. The results showed that many SBT methodologies (i.e. manikins, videos, etc.) were referenced in the papers. The type of simulation training most prevalent in the articles was simulated patient (SP) methodology. The results show that biases can be explored in any type of simulation method, indicating that simulationsists should be aware of bias in training during all types of training methodolgy.

Background

Simulation-based training (SBT) for healthcare professions is increasingly used as an educational strategy and to improve patient safety [1–4]. SBT is an effective strategy to improve skills in healthcare professions [5]. Many different methodologies have been developed in SBT, and those methodologies have helped achieve learning outcomes, which leads to clinical competency [6]. Patient or human simulation is a well-known methodology involving human role players interacting with health professions' education in a variety of experiential learning and assessment activities. The term simulated patient (SP) refers to a person trained to portray a role such as patients, clients, family members, healthcare professionals, etc. in realistic and repeatable method. The terms

standardized patient and simulated patient are often used synonymously [7].

SBT should be developed and implemented to ensure that clinical competencies including technical, communication, decision-making and team dynamics, etc. are achieved [3]. Because SBT involves decision-making where learners must weigh different options to provide patient care, the role that bias plays in SBT design, presentations and in the experiences of learners should be understood [8].

Scoping reviews are useful when authors want to explore certain concepts in papers, and in the mapping, reporting or discussion of these concepts [9]. There are scoping reviews on SBT of healthcare professions exploring the types of professions engaged in interprofessional education, characterization of the types of simulations, effects of new technologies on SBT, effects of different methodologies on clinical competencies of healthcare professions and barriers to utilization different methodologies [10–12]. We did not find any scoping reviews on the topic of bias in SBT of healthcare professions.

In this review, we sought to explore bias in SBT of healthcare to: 1) identify which types of biases affect SBT for healthcare professionals, 2) categorize the types of bias explored and 3) note the prevalence of articles published on this topic.

Methods

We performed a scoping review to map 'bias' in the literature on SBT of health professions. Scoping reviews are used to examine the range and nature of the research activities, to determine the value of conducting a complete systematic review, to summarize and disseminate research findings, or to detect gaps in existing literature [13].

Review strategy

We used the Arksey and O'Malley framework for scoping reviews [13] which was developed and refined by Levac and colleagues [14]. This approach involves five steps:

1. Identifying the research question
SA and CP met to identify the focus of the scoping review: '*How is the term "bias" in "simulation training" explored within the literature?*' After conducting background research, we discovered that the terms 'cognitive bias', 'implicit bias' and 'decision-making' are terms used in conjunction with 'bias', therefore it was decided to include these terms along with 'simulation' and 'bias' in the analysis.

Figure 1: Query for database search.

((((“simulation training”[Mesh] OR ((simulation[tw] OR simulating[tw] OR simulated[tw])

AND

(teaching[tw] OR training[tw] OR trainings[tw] OR education[tw])))))

AND

(((“Bias"[Mesh] OR "Observer Variation"[Mesh] OR “Prejudice”[Mesh] OR "Social Discrimination"[Mesh] OR "Social Stigma"[Mesh] OR "Dehumanization"[Mesh] OR "Discrimination, Psychological"[Mesh] OR "Attentional Bias"[Mesh] OR "Homophobia"[Mesh] OR "Racism"[Mesh] OR "Observer Variation"[Mesh] OR "Weight Prejudice"[Mesh] OR "Sexism"[Mesh] OR “Ageism”[Mesh] OR "Sexual and Gender Minorities"[Mesh] OR “Xenophobia”[Mesh] OR "Dehumanization"[Mesh] OR "Incivility"[Mesh] OR "Rejection, Psychology"[Mesh] OR “Scapegoating”[tw] OR “Sexual Harassment”[Mesh] OR “Shyness”[Mesh] OR "Social Dominance"[Mesh] OR "Dominance-Subordination"[Mesh] OR "Stereotyping"[Mesh] OR "Social Marginalization"[Mesh] OR "Social Isolation"[Mesh] OR "Social Desirability"[Mesh] OR "Help-Seeking Behavior"[Mesh] OR "Shame"[Mesh] OR ("Bias"[tw] OR “biases”[tw] OR “implicit bias”[tw] OR “implicit biases”[tw] OR “cognitive bias”[tw] OR “cognitive biases”[tw] OR “Prejudice”[tw] OR "Social Discrimination"[tw] OR "Social Stigma"[tw] OR "Dehumanization"[tw] OR "Discrimination, Psychological"[tw] OR "Attentional Bias"[tw] OR "Homophobia"[tw] OR "Racism"[tw] OR "Observer Variation"[tw] OR "Weight Prejudice"[tw] OR ((“obesity”[tw]

AND

(prejudice OR bias OR discrimination)) OR "Sexism"[tw] OR “Ageism”[tw] OR “Gender minorities"[tw] OR “Xenophobia”[tw] OR "Dehumanization"[tw] OR "Incivility"[tw] OR "Rejection, Psychology"[tw] OR “Scapegoating”[tw] OR “Sexual Harassment”[tw] OR “Shyness”[tw] OR "Social Dominance"[tw] OR "Dominance-Subordination"[tw] OR "Stereotyping"[tw] OR "Social Marginalization"[tw] OR "Social Isolation"[tw] OR "Social Desirability"[tw] OR "Help-Seeking Behavior"[tw] OR ((cognitive[tw] OR cognition[tw])

AND

(heuristic[tw] OR heuristics[tw])) OR assumptions[tw] OR “premature closure”[tw] OR fallacies[tw] OR fallacy[tw] OR truncation[tw] OR implicit[tw] OR experimental[tw] OR judgement[tw] OR covert[tw] OR “anti-homosexual”[tw] OR “anti-gay”[tw] OR ((“sex”[tw] OR “gender”[tw]) AND (minority OR minorities)) OR transgender[tw] OR LGBTQ[tw] OR discrimination[tw] OR discriminative[tw] OR racism[tw] OR “covert racism”[tw] OR shame[tw])))))

2. Identifying relevant studies
After determining the scoping review goals and receiving assistance from a University of Illinois at Chicago-affiliated librarian, we decided to use a detailed query which included all potential MeSH terms and keywords that might be related to 'simulation' and 'bias' for a database search (Figure 1).

We searched the PubMed, Medline and CINAHL databases with the same terms, and compared the results. The PubMed results were the most comprehensive and included the results from the other databases, so we decided to focus only on the PubMed database. We limited the results by publication language (English).

3. Selecting the studies
As a first step, researchers SA and ABC conducted a pilot study to determine the method for analyzing the papers for this scoping review. We reviewed the first 100 papers found by a search using the detailed query to determine which articles should be included in the review. We then compared notes on the abstracts and full texts of the papers. We decided to include only primary research articles as it was too difficult to evaluate review papers based on the aims of this scoping review. After this pilot, we decided to select articles for study inclusion based on the following criteria:

(a) studies that investigated bias in simulation training of any health professions' education program,
(b) studies that investigated the role of bias in simulation training,
(c) original articles, brief reports,
(d) studies in which outcomes/assessment focused on decision-making.

The following exclusion criteria were also defined as:

(a) any type of reviews,
(b) studies written in a language other than English,
(c) studies that did not include any simulation training, and
(d) studies including bias in simulation training, but, without any explanation for bias.

SA and ABC decided to analyze the papers' abstracts for first reading because it was determined that papers might be selected based on their abstracts (without reading the full text) using the inclusion criteria. SA and ABC independently reviewed all abstracts published up to August 31, 2020. We then discussed any discrepancies and reached a consensus on which articles to include for the full review (second stage of scoping review).

Classification of bias

We referred to the papers' descriptions of the type of bias they addressed, to identify if the bias was implicit or cognitive. In instances where the type of bias was not specified in the paper, we identified the type of bias from the content of the paper, including instances where both cognitive and implicit bias were explored. We then further classified the specific type of bias, again referring to the article's content. In cases where the bias was the same, but terminology differed between papers (i.e. one paper used the term 'race bias', while another referred to is as 'racial bias'), we standardized the naming of the bias by choosing one term for a similar type of bias.

4. Charting the data
We used Arksey and O'Malley's 'descriptive-analysis' approach to data extraction, summarizing information from the selected articles and recording the data [13]. We also applied Levac and et al.'s recommendations for the data charting process and used an Excel sheet to analyze the selected articles [14]. By using this approach, the key information from the selected papers was charted under the headings: article name, author, journal, year, country, article type, population, details of simulation training and details of bias.

Results

5. Collating, summarizing and reporting the results
Three thousand six hundred and twenty abstracts were identified from PubMed. The first reading was conducted by SA and ABC from May 4, 2020 to August 31, 2020. During this first reading, we met 10 times to discuss which papers should be added for the second step (reading full texts). We reviewed 238 selected papers for the second step, and 125 full-text articles were selected to be analysed from October 23, 2020 to January 12, 2021. We independently read and reviewed the included articles, and reconvened at six online meetings to discuss individual findings (Figure 2).

From 1985 until 2020, the number of articles published on the topic of bias in simulation in medical professional training increased dramatically (Figure 3).

We completed a review of articles published on bias in SBT for healthcare professionals. The articles reviewed cover a broad range of topics, from addressing how bias affects patient care, to bias in raters' scoring of medical students on exams. We did not assess the methodological quality of the articles, but categorized them into four general themes: the type of healthcare profession, the method of simulation, whether the bias was cognitive or implicit, and the specific bias mentioned (Table 1).

Discussion

The exploration of types of biases and dual theory

Dual process theory is a well-accepted framework for understanding decision-making processes and bias. This theory explains our thinking processes as either type 1 or type 2. Type 1 thinking is a fast, intuitive, pattern recognition-focused problem-solving method that creates a low cognitive burden on the user and enables quick decisions. Type 2 thinking is a slower, more methodical, thoughtful process. Therefore, an optimal balance of type 1 and type 2 processes is required to prevent biases for optimal clinical practice [15].

In dual process theory, type 2 thinking can bring a higher cognitive strain on the user but allows them to evaluate data more critically and look beyond patterns, and may potentially be more appropriate for complex problem solving. The current opinion among psychologists is that we spend approximately 95% of our time in type 1 thinking [16].

Figure 2: Results of search strategy and process of paper selection.

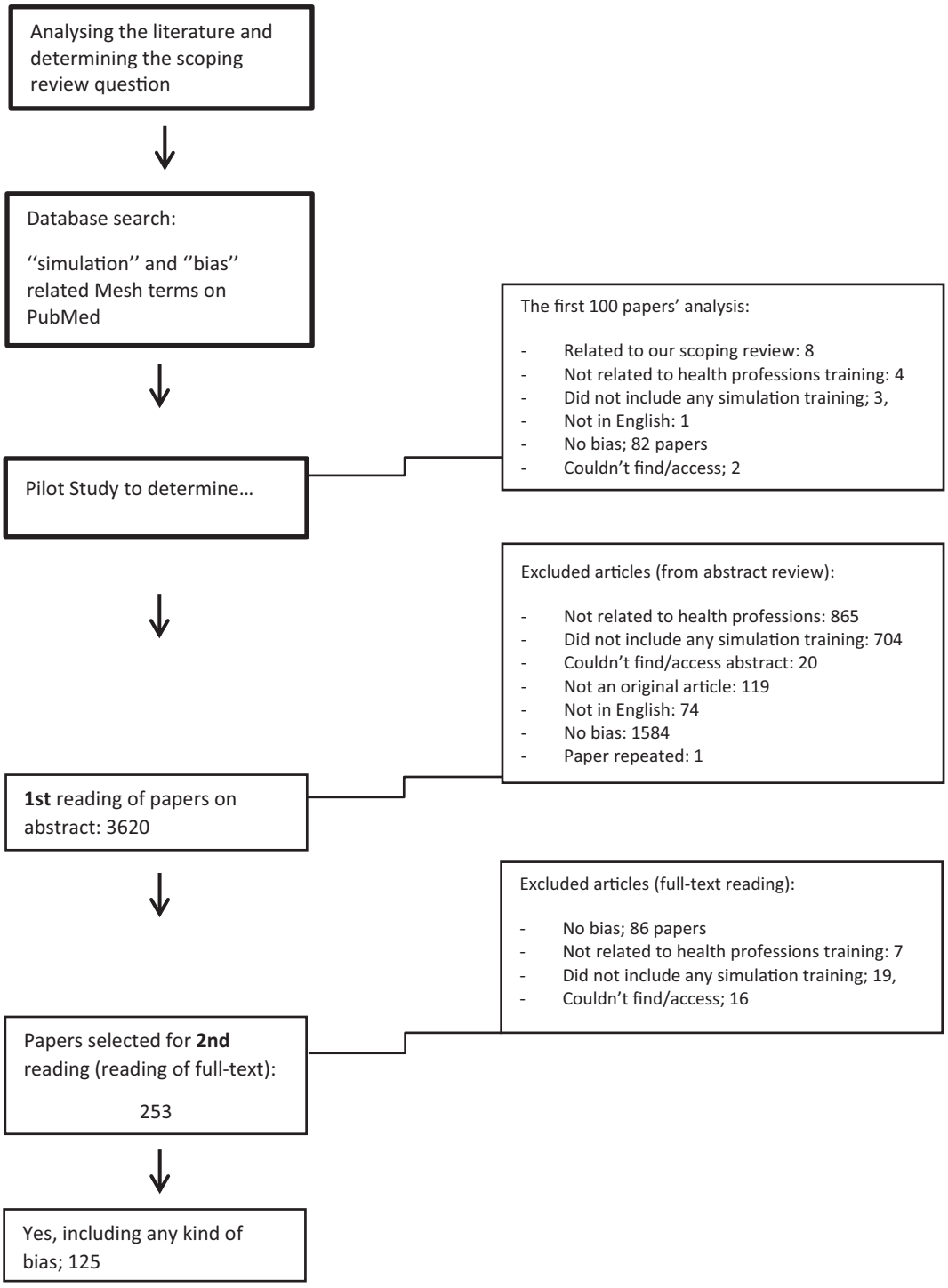
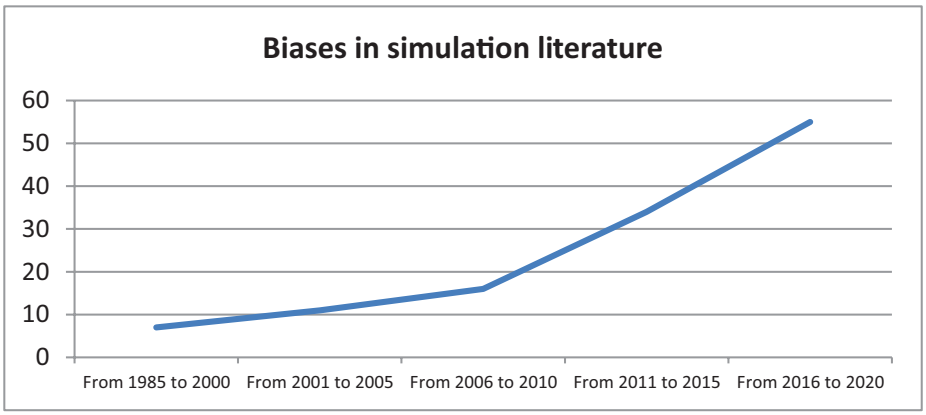


Figure 3: Classification by year.



From 2016 to 2020; 55 papers

From 2010 to 2015; 36 papers

From 2006 to 2010; 16 papers

From 2001 to 2005; 11 papers

From 1985 to 2000; 7 papers

Table 1: The characteristics of papers decided at the end of the scoping review

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Adamson, K. [70]	Nursing education perspectives	2016	USA	Simulation participant-raters (nurse)	Video-recorded simulations	Implicit bias	Race, ethnicity bias
Al-Moteri, M. [71]	Australian Critical Care	2019	Australia	Final-year undergraduate nurses, nurses enrolled in Masters or PhD programs.	Screen-based simulated scenario	Cognitive Bias	Perceptual, attention, confirmation biases
Altabbaa, G. [72]	Diagnosis	2019	Canada	Medical students, post-graduate year (PGY) 1 IM residents,	Simulated clinical environment	Cognitive Bias	Momentum, confirmation, playing-the-odds, order-effect biases
Arber, S. [17]	Social Science & Medicine	2006	USA	Primary care doctors	Video vignette	Implicit bias	Gender, age, SES, race biases
Barnato, A. [55]	Crit Care Med.	2011	USA	Emergency physicians, hospitalists, and intensivists	SPs	Implicit bias	Race bias
Barnato, A. [73]	Med Decis Making	2014	USA	EM physicians	Video-encounters	Implicit bias	Race bias
Bennett, P. [74]	Clin Teach	2016	Australia	Medical, nursing, allied health students	Immersive/wearable simulation	Implicit bias	Age bias
Berg, K. [18]	Acad Med	2015	USA	Medical students	OSCEs	Implicit bias	Gender, race and ethnicity biases
Boada, L. [19]	Comput Methods Programs Biomed	2018	Spain	Undergraduate nursing students	High fidelity simulators	Implicit bias	Gender bias
Bond, W. [75]	Acad Med	2004	USA	Emergency medicine residents	High fidelity simulators	Cognitive bias	Decision-making
Boulet, J. [20]	Adv Health Sci Educ Theory Pract	2005	USA	Medical students (CSA candidates)/physician note raters	SPs	Implicit and Cognitive Biases	Gender and rater bias
Braun, L. [76]	Diagnosis	2019	Germany	Medical students	Electronic case simulation platform	Cognitive Bias	Premature closure bias
Brown, S. [77]	Community Ment Health J	2010	USA	Undergraduate medical students	Simulation of auditory hallucinations	Implicit bias	Illness stigma
Brown, SA. [78]	Community Ment Health J	2010	USA	Undergraduate students	Simulation of auditory hallucinations	Implicit bias	Mental illness stigma
Bucknall, T. [79]	J Adv Nurs	2016	Australia	Nursing students (final year)	SPs	Cognitive bias	Premature closure and confirmation biases
Burgess, D. [80]	Soc Sci Med	2008	USA	Internal medicine physicians	Video vignettes	Implicit bias	Race bias
Cavalcanti, R. [56]	Acad Med	2014	Canada	Residents in internal medicine	OSCEs and High fidelity simulators	Cognitive bias	Not specified
Chen, A. [81]	Am J Pharm Educ	2011	USA	Pharmacy students	Geriatric medication game and SPs	Implicit bias	Age bias

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Choi, H. [82]	Nurse Educ Today	2016	Korea	Undergraduate nursing students	SPs	Implicit bias	Mental illness stigma
Chugh, U. [83]	Med Teach	1993	Canada	Physicians/immigrant patients	SPs	Implicit bias	Race and Ethnicity bias
Cicero, M. [84]	Prehosp Emerg Care	2014	USA	SPs, high-fidelity manikins, and low-fidelity manikins	Disaster simulation scenarios using SPs, high-fidelity manikins, and low-fidelity manikins	Cognitive bias	Bias towards a specific pediatric disaster triage strategy
Claramita, M. [85]	Nurse Educ Today	2016	Indonesia	Nursing students	OSCE with SPs	Cognitive bias	SES bias
Clark, C.M. [86]	Nurse Educ	2019	USA	Undergraduate nursing students	Role play	Implicit bias	Uncivil behavior bias
Crapanzano, K. [87]	J Gen Intern Med	2018	USA	Internal medicine residents	SPs	Implicit bias	Mental illness stigma
Dearing, K. [88]	J Nurs Educ	2008	USA	Nursing students	Voice simulation mimics auditory hallucinations	Implicit bias	Mental illness stigma
Dedy, N. [45]	Surgery	2015	Canada	Surgery residents	OSCE	Implicit bias	Rater bias
Denney, M. [21]	Educ Prim Care	2016	UK	GPs	OSCE	Implicit bias	Ethnicity and gender bias
Doyle, K. [46]	J Grad Med Educ	2014	Canada	Faculties and residents of family medicine programs	Simulated a tri-college, on-site ER for internal review (IR) process	Implicit bias	Rater/reviewer bias
Eisenberg, E. [22]	J Gen Intern Med	2019	USA	First-year residents in the Internal Med-Residency Program	Simulation scenarios included interactions with SPs	Implicit bias	Race, ethnicity, nationality, religion, gender, sexual orientation, disability, physical appearance, SES biases
Eva, K. [89]	Acad Med	2010	Canada	Primary care physicians	Videotaped vignette	Cognitive bias	Confirmation, and premature closure bias
Evans. J. [90]	Issues Ment Health Nurs	2015	Australia	2nd year nursing students	Simulated auditory hallucinations for schizophrenics	Implicit bias	Mental illness stigma
Feldman, H. [23]	Health Serv Res	1997	USA	Physicians	Simulated scenarios on videotapes by professional actors	Implicit bias	Age, gender, race, and SES biases
Fitzgerald, S. [91]	MedEdPORTAL	2018	USA	Health professions students from multiple disciplines	SPs	Implicit bias	Ethnicity bias
Fletcher, G. [47]	Br J Anaesth	2003	UK	Anesthetists	SPs	Cognitive bias	Rater bias
Floyd, K. [92]	J Physician Assist Educ	2015	USA	Physician assistant students/2nd yr of MS degree and SPs	SPs	Cognitive bias	Inflation bias

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Foster, K. [93]	Oral Surg Oral Med Oral Pathol Oral Radiol Endod	2008	USA	1st year dental students	Role play practice	Cognitive bias	Presentation bias
Galletly, C. [94]	Aust N Z J Psychiatry	2011	Australia/ New Zealand	Medical students (final year)	Video presentation/ Simulated auditory hallucinations	Implicit bias	Mental illness stigma
Gispert, R. [24]	Med Educ	1999	Spain	Undergraduate medical students	SPs	Implicit bias	Gender bias
Goddard, L. [95]	J Neurosci Nurs	1998	USA	Nursing students	Role play	Implicit bias	Disability bias
Gostlow, H. [96]	Ann Surg	2018	Australia	Surgical trainees and consultant surgeons	Video of operating theater sim – SPs	Implicit bias	Hierarchy bias
Gotlieb, R. [97]	Gynecologic Oncology Reports	2019	Canada	Medical doctors (staffs and residents)	Software (computer) simulation scenarios.	Cognitive Bias	Gender effects on cognition
Greene, R.E. [25]	Med Educ	2014	USA	Medicine residents	SPs	Implicit bias	Gender bias
Greene, R.E. [26]	J Grad Med Educ	2017	USA	Medicine students	SPs	Implicit bias	Gender bias
Hahn, T. [98]	J Man Manip Ther	2014	USA	Physical therapists	Video vignettes of SPs	Cognitive bias	Confirmation bias/ and training bias
Hales, C. [99]	Ostomy Wound Manage	2018	USA	Health care staff	Immersive/wearable simulation	Implicit bias	Weight bias
Haliko, S. [100]	Med Decis Making	2018	USA	Physicians	High fidelity simulator and SPs	Cognitive bias	Preference and comfort bias
Hanson, M. [101]	Acad Psychiatry	2008	Canada	Adolescent standardized patients	SPs	Implicit bias	Mental illness stigma
Hareli, S. [102]	Int J Psychol	2013	Israel	Undergraduate medical students	Video on computer screen simulation	Implicit bias	SES bias
Hermann-Werner, A. [103]	BMJ Open	2019	Germany	Medical students	SPs and immersive/ wearable simulation	Cognitive Bias	Weight bias
Hillbrand, M. [104]	Psychiatr Rehabil	2008	USA	Nurses, psychiatric technicians, psychologists and social workers, rehabilitation therapist.	Role play	Implicit bias	Bias against prisoners
Hirsh, A. [27]	J Pain	2010	USA	Nurses	Virtual human (VH) videos	Implicit bias	Gender, race, age bias
Hu, Y. [105]	Adv Health Sci Educ Theory Pract	2015	USA	Undergraduate medical students	Simulation-based suturing task	Cognitive bias	Overestimation bias
Huber, M. [106]	J Adv Nurs	1992	USA	Healthcare care personnel	Simulated handicaps	Implicit bias	Age bias

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Hunter, J. [107]	Nurse Educ Today	2018	UK	Nursing Students	Immersive/wearable simulation	Implicit bias	Weight bias
Jaeken, M. [108]	Front Psychol	2017	Belgium	Undergraduate psychology students	Role play	Cognitive bias	Self-enhancement bias
Jaworsky, D. [109]	AIDS Care	2017	Canada	Medical Students	SPs	Implicit bias	HIV stigma
Jensen, K. [48]	Surg Endosc	2019	Multi-centered	Medical students	Virtual reality simulator	Cognitive bias	Self-enhancement and self-diminishment bias
Junnola, T. [110]	J Clin Nurs	2002	Finland	Nurses	Screen-based computer simulated case	Cognitive bias	Confirmation bias
Kales, H. [28]	Psychiatr Serv	2005	USA	Psychiatrists	Video vignettes of SPs	Implicit bias	Race and gender bias
Kennedy, D. [29]	Nurse Educ Today	2020	Qatar	Male nursing students	Role-play, moderate and high fidelity simulators, SPs, simulated maternity clinic	Implicit bias	Gender bias
Khazadian-Figueroa, M. [111]	J Nurs Staff Dev	1997	USA	CNAs (certified nursing aids)	Simulation game	Implicit bias	Age bias
Kidd, L. [112]	Issues Ment Health Nurs	2015	USA	Undergraduate psychiatric nursing students	Hearing Distressing Voices Audio Simulation	Implicit bias	Mental illness stigma
Kim, M. [30]	Comput Inform Nurs	2016	Korea	Nursing students	Simulation-based learning/ hybrid SP and Noelle human simulator	Implicit bias	Gender bias
Kumagai, A. [31]	Med Teach	2007	USA	Faculty	'Forum Theater' techniques; simulated classroom discussion	Implicit bias	Race, gender, sexual orientation, SES bias
Kushner, R. [113]	BMC Med Educ	2014	USA	Medical students	SPs	Implicit bias	Weight bias
LaRoche, K. [114]	Contraception	2015	Canada	Postabortion support team	Unannounced standardized patient	Implicit bias	Abortion stigma
Levett-Jones. T. [115]	Nurse Educ Pract	2011	Australia	Nursing Students	Videos w/SPs to train assessors	Implicit and Cognitive biases	Rater/Assessor bias Decision-making
Lewis, C. [116]	BMC Palliat Care	2016	UK	Nursing and medical students	High fidelity simlulator and SP	Implicit bias	Attitudes towards death
Li, L. [117]	Int J Epidemiol	2014	China	Hospital service providers	Unannounced standardized patient	Implicit bias	HIV stigma
Lockeman, K.S. [118]	Nurse Educ Today	2017	USA	Nursing and medical students	high fidelity – mannequins and SPs	Implicit Bias	Provider stereotypes
Lohman, P. [119]	Percept Mot Skills	2008	USA	Graduate students majoring in communications disorders	Peer role play	Implicit bias	Attitudes towards stutterers

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Lorenzo, A. [120]	Fam Pract	2015	France	Practicing providers	SPs	Cognitive bias	Desirability bias/Hawthorne bias
Magpantay-Monroe, E. [121]	Nurse Educ Today	2017	USA	Nursing students	SPs	Implicit bias	Military and veteran bias
Marceau, L. [32]	J Eval Clin Pract	2011	USA	Primary care physicians	Video simulation	Implicit bias	Age, race, gender, SES biases
March, C. [122]	J Grad Med Educ	2018	USA	Pediatric residents	SPs	Implicit bias	Age, race and ethnicity stigma
Margolis, M. [33]	Acad Med	2002	USA	Medical doctors	Computer-based case simulation	Implicit bias	Gender and language bias
Maruca, A.T. [123]	Nurse Educ Perspect	2018	USA	Nursing students	High fidelity (manikin) simulation	Implicit bias	Gender bias
Maupome, G. [124]	Eur J Dent Educ	2002	Mexico	Senior dental students	SPs	Implicit bias	SES bias
McCave, E. [34]	MedEdPORTAL	2019	USA	Students' of different health professions	SPs	Implicit bias	Gender bias
McGrath, J. [49]	West J Emerg Med	2015	USA	EM residents	High fidelity and virtual reality simulators	Implicit bias	Rater/observer bias
McNiel, P.L. [35]	J Nurse Educ	2018	USA	Nursing students	Role play	Implicit bias	Gender biases
Minehart, R. [125]	Anesthesiology	2014	USA	Anesthesia faculty	Role play/videos/SPs	Cognitive bias	Not specified
Mirza, A. [126]	MedEdPORTAL	2018	USA	Pediatric interns, upper-level residents (PGY-2 and PGY-3), and six fellows.	SPs	Cognitive Bias	Premature closure bias
Mohan, D. [127]	BMC Emerg Med	2016	USA	Emergency physicians	Virtual video games simulation	Cognitive bias	Poorly-calibrated heuristics
Nerup, N. [50]	Gastrointest Endosc	2015	Denmark	Physicians (10 experienced endoscopists and 11 trainees)	High fidelity simulator	Implicit bias	Rater/observer bias
Nicolai, J. [36]	Patient Educ Couns	2007	Germany	General practitioners	SPs	Implicit bias	Gender bias
Norman, R. [128]	J Nurs Educ	2001	Australia	RNs (nurses)	Simulation game, peer role playing	Implicit bias	Bias against illicit drug users
O'Lynn, C. [129]	J Nurse Educ	2014	USA	Male nursing students	Video and practice on manikins/debriefing	Implicit bias	Gender bias
Padilha, J. [57]	J Med Internet Res	2019	Portugal	Nursing students	Virtual reality simulator	Cognitive bias	Bias in clinical reasoning
Paige, J. [130]	J Surg Educ	2019	USA	General surgery residents/ emergency medicine residents/senior undergraduate nursing students	High fidelity simulation	Implicit bias	Hierarchy bias

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Park, C. [58]	Simul Healthc	2014	USA	Residents, Anesthesiology (PG2)	Simulated operating room/ simulated scenario	Cognitive bias	Not specified
Patterson, F. [131]	Med Educ	2018	UK	Medical students	High fidelity simulator	Implicit bias	Ethnicity bias
Pennaforte, T. [132]	JMIR Res Protoc	2016	Canada	General Pediatrics and Neonatal-Perinatal Medicine residents.	Simulation scenario and standardized health professionals	Cognitive bias	Not specified
Persky, S. [133]	Ann Behav Med	2011	USA	Undergraduate medical students	Immersive virtual environment/computer generated	Implicit bias	Weight bias
Prakash, S. [134]	BMC Med Educ	2017	Australia	Interns (medical students)	High-fidelity simulator and SPs	Cognitive bias	Search satisfying, premature closure, and anchoring bias
Raemer, D.B. [37]	Acad Med	2016	USA	Anesthesiologist	Simulated scenarios	Implicit bias	Hierarchy, gender and stereotypes bias
Richey Smith, C. [135]	Am J Pharm Educ	2016	USA	Pharmacy students	Simulation game	Implicit bias	SES bias
Richmond, A. [136]	MedEdPORTAL	2017	USA	Students/medicine, nurse, pharmacy	SPs	Implicit bias	Hierarchy bias
Ruparel, R. [137]	J Surg Educ	2014	USA	27 urology residents	Virtual reality simulator	Cognitive	Internal bias (experience w/ simulator not translating to surgery affecting confidence)
Rutledge, C. [138]	Contemp Nurse	2008	USA	Nurses	Computer generated virtual learning platform, high performance simulators (HPS).	Implicit bias	Cultural bias
Sargeant, S. [38]	Adv Health Sci Educ Theory Pract	2017	Australia	Medical students/SPs	SPs	Implicit bias	Culture, age, gender biases
Schuler, S. [139]	Stud Fam Plann	1985	USA/Nepal	Family planning staff	SPs	Implicit bias	Hierarchy bias
Sidi, A. [140]	J Patient Saf	2017	USA	Residents	High fidelity simulator	Cognitive bias	Anchoring, availability bias, premature closer and confirmation bias
Siegelman, J.N. [39]	J Grad Med Educ	2018	USA	Emergency medicine residents	Simulated cases – SPs, nurses, and simulation operators	Implicit bias	Gender bias
Silverman, A.M. [141]	Disabil Rehabil	2018	USA	Masters of occupational therapy (1st year)	Impairment simulation (role play)	Implicit bias	Anti-disability and discriminatory bias
Stockmann, C. [40]	J Nurse Educ	2017	USA	Nursing students	Manikin	Implicit bias	Gender bias

(*Continued*)

Table 1: Continued

Lead Author	Journal	Year	Country	Population (healthcare professions)	Method(s) of simulation mentioned in article	Bias types	Description of bias
Svendsen, M. [51]	World J Gastrointest Endosc	2014	Denmark	Ten consultants experienced in endoscopy (gastroenterologists, n = 2; colorectal surgeons, n = 8) and eleven fellows	Virtual reality simulator	Implicit and Cognitive biases	Rater/observer bias Decision-making
Theodossiades, J. [142]	Ophthalmic Physiol Opt	2012	UK	Optometrists	Unannounced standardized patients	Cognitive	Self-reporting bias
Thompson, C. [143]	J Adv Nurs	2012	UK	Nursing students, nurses	Low and high fidelity/ paper cases and human simulation (manikins not actors)	Cognitive	Judgment bias
Tollison, A.C. [41]	J Nurse Educ	2018	USA	Male nursing students	Online simulation	Implicit bias	Gender bias
Underman, K. [42]	MedEdPORTAL	2016	USA	Undergraduate medical students	SPs	Implicit bias	Gender bias
Varas-Diaz, N. [144]	J Gay Lesbian Soc Serv	2019	USA	Physicians in training	SPs	Implicit bias	Gender and sexual orientation bias
Watson, M. C. [145]	Pharm World Sci	2004	UK	Emergency medicine residents	Simulation lab scenario/ high fidelity simulation	Cognitive bias	Selection bias
Welch, L. [43]	J Health Sco Behav	2012	UK	Primary care physicians	Video vignettes of SPs	Implicit bias	Gender bias
Wijnen-Meijer, M. [52]	Adv Health Sci Educ Theory Pract	2013	Netherlands/ Germany	Physicians	SPs	Cognitive bias	Rater bias Decision-making
Wiskin, C. [44]	Med Educ	2004	UK	Medical students	Role-play	Implicit bias	Gender bias
Woda, A. [146]	Nurs Educ Perspect	2019	USA	Nursing students	Simulated clinical environment	Cognitive bias	Bias in clinical reasoning
Worth-Dickstein, H. [147]	Teach Learn Med	2005	USA	Medical Students	SPs	Implicit bias	SP scoring, personal, race, ethnic, and age bias
Wu, B. [148]	BMC Med Educ	2016	Hong Kong	Medical students	Simulated cases – cognitive mapping	Cognitive bias	Bias in clinical reasoning
Yeates, P. [149]	BMC Med	2017	UK	Undergraduate medical students	SPs	Implicit bias and Cognitive bias	Race, ethnicity, and examiner, recollection bias
Yu, C. [150]	J Am Geriatr Soc	2012	Taiwan	Nursing assistants	SPs	Implicit bias	Age bias
Yuan, M. [151]	Interact J Med Res	2013	USA	Nurse evaluators	SPs	Cognitive bias	Premature closure, anchoring, confirmation, and framing bias
Yudkowsky, R. [152]	Acad Med	2015	USA	Medical students	SPs	Cognitive bias	Confirmation bias
Yule, S. [153]	World J Surg	2008	Scotland	Surgeons	Videos of SPs and High fidelity simulator	Cognitive bias	Competency bias
Zottmann, J.M. [154]	GMS J Med Educ	2018	Germany	Medical students	High fidelity simulator	Cognitive bias	Competency bias

Cognitive bias (and the resulting errors) are more likely during the type 1 process [15].

Optimal diagnostic approaches are likely to use both type 1 and type 2 thinking at appropriate times. Non-analytical (type 1) reasoning has been shown to be just as effective as reflective reasoning to diagnose routine clinical cases. Furthermore, not all biases are caused by type 1 processing, but it is believed that when bias occurs, it can only be solved by activating type 2 processing. The articles we reviewed showed that the biases explored in articles on SBT were related to both cognitive and implicit biases, both of which can be associated with the two types of dual theory.

Bias types in simulation training

In this scoping review, we looked for all types of cognitive and implicit biases in SBT of health professions. Implicit biases were explored more than cognitive biases (Figure 5). The most researched implicit bias in health professions' SBT is 'gender bias' [17–44]. Gender bias was also explored in different types of health professions and with different levels of experience: residents, primary care physicians, medical students, nursing students, etc. The most researched cognitive bias in literature is 'decision-making (premature closure)' [20,45–52]. We noted some biases that were not found in other reviews: uncivil behavior bias; poorly calibrated heuristics; and selection bias of patient participants [53–56]. In several papers, the type of bias was not specified and in those instances, we classified the biases based on the article's content [20,47,51,52]. We were unable to further classify the types of bias explored in a couple of papers [57,58]. Our review indicates the prevalence of undefined bias in simulation training, which supports the importance of educators' awareness of bias. All biases explored were classified under cognitive and implicit biases.

Cognitive bias

Cognitive bias is defined as unconscious and automatically developed mental processing strategies. These strategies are developed as adaptive mechanisms to simplify the complex inflow of information ultimately leading to biased judgments and inferences [59].

Cognitive bias and its impact are an important parameter on decision-making processes [60,61]. Cognitive bias, also known as 'heuristics', are cognitive shortcuts to help us make decisions [62]. It is increasingly accepted that significant diagnostic error can result from cognitive bias [63]. Clinical decision-makers have a risk of error due to biases that are not associated with intelligence or any other measure of cognitive ability [64]. In addition, individuals lack awareness of how these biases can affect their perceptions as they are

Figure 4: Types of biases.

Main bias types	Biases	n*
Cognitive bias = 33.6% (42)	Decision making (premature closure)	8
	Confirmation bias	8
	Clinical reasoning	3
	Anchoring bias	3
	Rater bias	2
	Competency bias	2
	Self-enhancement bias	2
	Not specified cognitive biases	4
	Other types of cognitive biases	22
Implicit bias = 64.8 % (81)	Gender	29
	Racial/ethnicity bias	15
	Different types of stigma	12
	Age	11
	Social-Economical-Status (SES) bias	8
	Hierarchy bias	5
	Rater bias	5
	Obesity/weight bias	4
	Sexual orientation	3
	Diasbilities	3
	Cultural bias	3
	Bias towards military veterans	1
	Bias against illicit drug users	1
	Bias towards stutterers	1
	Language	1
	Challenging patient	1
	Bias against non-native learners	1
	Provider preference/comfort bias	1
	Uncivil behavior	1
	Others	4
Both = 1.6% (2)	Race, ethnicity, and examiner, recollection bias	1
	Rater/observer/assessor bias and decision making bias	3

* Several papers included more than one type of bias, therefore, the number of biases total more than the number of papers reviewed.

Figure 5: Simulation training methods.

Scenarios portayed by Standardised and simulated patients (SPs)	41
Video/vignette based scenarios (including auditory records)	19
Hybrid models (SPs + high fidelity simulators (6), SPs + Videos (2), role play +videos (1), simulated game + SPs (or role playing) (2); HFS + mannikin (2); HFS +VR (2))	15
OSCEs (including: OSCEs implementing with HFS, mannikins; simulated clinical environment)	12
High fidelity simulator	10
Role plays	10
Screen-based simulated scenario	6
Mannikin	5
Virtual reality	5
Simulation games	2

unaware that their judgments are biased. The doctors who describe themselves as 'excellent' decision-makers and 'free from bias', often lack insight into their own bias [65].

We explored papers on the effects of different simulation methodologies on clinical reasoning and decision-making, and we explored which types of biases affect clinical reasoning and decision-making in SBT.

Implicit bias

The natural tendency of the mind is to rely on type 1 thinking, interpret data through heuristic scanning, and establish quick connections with data and experiences already available. Beyond cognitive bias, which affects clinicians' interpretation of clinical data, there are intuitive screening and systematic biases on how we perceive other people, including patients. The ways we perceive and classify other individuals based on their characteristics (i.e. social and cultural biases) are most likely shaped by the experiences we have been exposed to. In clinicians, these biases appear in parallel with the general population [66]. Implicit bias (sometimes called unconscious bias) affects interpersonal interactions in ways that we are not consciously aware of. The health and behavioral effects of these implicit attitudes can be important. Implicit bias has many dimensions. Some examples of implicit biases are: race or ethnicity, gender, age, weight, sexual orientation, education and socioeconomic status [67].

Meanwhile, experimental studies have repeatedly shown that these biases measurably affect clinical assessments and treatment decision-making [68]. This effect seems particularly significant in challenging or ambiguous situations, or under heavier cognitive loads.

In addition, we noted that the number of articles published on the topic of bias in simulation in healthcare professional training increased dramatically from 1985 until 2020. This increase could reflect the increasing attention paid to decision-making processes and bias in general. It could also be a snowball effect – the more papers published on a topic, the more authors become inspired to explore new data on biases in SBT.

Biases exposed in different simulation training methods

Biases were explored using different simulation methods (Figure 4). Most of the articles exploring biases in simulation training involved SP methodology. This may reflect the importance of SP methodology as a training approach, its prevalence, or the particular need for well-designed scenarios in SP methodology. While SP methodology was the modality most often referred to in the articles, other modalities were also present (i.e. manikins, videos, etc.)

All trainings can be subject to bias. SBT has enhanced learning, however, trainers and learners can benefit from understanding that biases might be present in SBT [58,69]. The results also show that biases can be explored in any type of training methods in simulation, indicating that simulationsists should be aware of bias in training during all types of training.

Limitations

One limitation of our review is that we only reviewed articles available in English. Additionally, there is no comprehensive classification guide for biases, especially implicit biases, so, we had some difficulties defining or naming some types of bias mentioned in the papers.

Another limitation is that we only reviewed articles found in one database, it is possible that some articles on bias in simulation training of healthcare professionals are included in a database other than PubMed. We also focused on peer-reviewed literature and therefore did not include literature produced outside of traditional academic publishing.

Conclusion

Understanding how bias affects SBT for healthcare professionals is important, as it affects not only how future providers are educated and develop their clinical decision-making skills, but also because of its impact on patient care and health outcomes. This review not only showed the depth of the types of bias examined in the literature, but also found some biases that had not been previously classified.

In future, researchers might explore how biases affect clinical reasoning and decision-making in SBT. Researchers might also explore how to avoid bias in simulation by looking at instructional design of SBT.

There are many opportunities for researchers to explore bias and its impact on SBT. Once SBT trainers become aware

of the possible presence of bias in their methodology, they may adjust existing instructional design, better follow established best practices and create new best practices to help identify and address these biases.

Declarations

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Authors' contributions

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Disclaimer

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References

1. Issenberg SB, McGaghie WC, Petrusa ER, Gordon DL, Scalese RJ. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Medical Teacher. 2005 Jan;27(1):10–28.
2. McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003–2009. Medical Education. 2010 Jan;44(1):50–63.
3. Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. Medical Teacher. 2013 Oct;35(10):e1511–e1530.
4. Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA. 2011 Sep;306(9):978–988.
5. Hegland PA, Aarlie H, Strømme H, Jamtvedt G. Simulationbased training for nurses: systematic review and metaanalysis. Nurse Education Today. 2017 Jul;54:6–20.
6. Foronda CL, Fernandez-Burgos M, Nadeau C, Kelley CN, Henry MN. Virtual simulation in nursing education: a systematic review spanning 1996 to 2018. Simulation in Healthcare. 2020 Feb;15(1):46–54.
7. Lewis KL, Bohnert CA, Gammon WL, et al. The Association of standardized patient educators (ASPE) standards of best practice (SOBP). Advances in Simulation (London). 2017 Jun;2(1):10.
8. Satish U, Streufert S. Value of a cognitive simulation in medicine: towards optimizing decision making performance of healthcare personnel. Quality & Safety in Health Care. 2002 Jun;11(2):163–167.
9. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Medical Research Methodology. 2018 Nov;18(1):143.
10. Lee CA, Pais K, Kelling S, Anderson OS. A scoping review to understand simulation used in interprofessional education. Journal of Interprofessional Education & Practice. 2018 Dec;13:15–23.
11. Williams B, Song JJY. Are simulated patients effective in facilitating development of clinical competence for healthcare students? A scoping review. Advances in Simulation (London). 2016 Feb;1(1):6.
12. Qiao J, Xu J, Li L, Ouyang Y-Q. The integration of immersive virtual reality simulation in interprofessional education: a scoping review. Nurse Education Today. 2021 Mar;98:104773.
13. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005 Feb;8(1):19–32.
14. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation Science. 2010 Sep;5(1):69.
15. Evans JSBT. Dual-processing accounts of reasoning, judgment, and social cognition. Annual Review of Psychology. 2008 Jan;59(1):255–278.
16. O'Sullivan ED, Schofield SJ. Cognitive bias in clinical medicine. The Journal of the Royal College of Physicians of Edinburgh. 2018 Sep;48(3):225–232.
17. Arber S, McKinlay J, Adams A, Marceau L, Link C, O'Donnell A. Patient characteristics and inequalities in doctors' diagnostic and management strategies relating to CHD: a video-simulation experiment. Social Science & Medicine (1982). 2006 Jan;62(1):103–115.
18. Berg K, Blatt B, Lopreiato J, et al. Standardized patient assessment of medical student empathy: ethnicity and gender effects in a multi-institutional study. Academic Medicine. 2015 Jan;90(1):105–111.
19. Boada I, Rodriguez-Benitez A, Thió-Henestrosa S, Olivet J, Soler J. How the gender of a victim character in a virtual scenario created to learn CPR protocol affects student nurses' performance. Computer Methods and Programs in Biomedicine. 2018 Aug;162:233–241.
20. Boulet JR, McKinley DW. Investigating gender-related construct-irrelevant components of scores on the written assessment exercise of a high-stakes certification assessment. Advances in Health Sciences Education: Theory and Practice. 2005 Mar;10(1):53–63.
21. Denney M, Wakeford R. Do role-players affect the outcome of a high-stakes postgraduate OSCE, in terms of candidate sex or ethnicity? Results from an analysis of the 52,702 anonymised case scores from one year of the MRCGP clinical skills assessment. Education for Prim Care. 2016 Jan;27(1):39–43.

22. Eisenberg EH, Kieffer KA. Use of simulated patient encounters to teach residents to respond to patients who discriminate against health care workers. Journal of General Internal Medicine. 2019 May;34(5):764–768.
23. Feldman HA, McKinlay JB, Potter DA, et al. Nonmedical influences on medical decision making: an experimental technique using videotapes, factorial design, and survey sampling. Health Services Research. 1997 Aug;32(3):343–366.
24. Gispert R, Rué M, Roma J, Martinez-Carretero JM. Gender, sequence of cases and day effects on clinical skills assessment with standardized patients. Medical Education. 1999 Jul;33(7):499–503.
25. Greene RE, Garment AR, Avery A, Fullerton C. Transgender history taking through simulation activity. Medical Education. 2014 May;48(5):531–532.
26. Greene RE, Hanley K, Cook TE, Gillespie C, Zabar S. Meeting the primary care needs of transgender patients through simulation. Journal of Graduate Medical Education. 2017 Jun;9(3):380–381.
27. Hirsh AT, Jensen MP, Robinson ME. Evaluation of nurses' selfinsight into their pain assessment and treatment decisions. Journal of Pain. 2010 May;11(5):454–461.
28. Kales HC, Neighbors HW, Blow FC, et al. Race, gender, and psychiatrists' diagnosis and treatment of major depression among elderly patients. Psychiatric Services. 2005 Jun;56(6):721–728.
29. Kennedy DM, Jewell JJ, Hickey JE. Male nursing students' experiences of simulation used to replace maternalchild clinical learning in Qatar. Nurse Education Today. 2020 Jan;84:104235.
30. Kim M, Shin M. Development and evaluation of simulationproblem–based learning for sex education. Computers, Informatics, Nursing. 2016 Jan;34(1):17–25.
31. Kumagai AK, White CB, Ross PT, Purkiss JA, O'Neal CM, Steiger JA. Use of interactive theater for faculty development in multicultural medical education. Medical Teacher. 2007 May;29(4):335–340.
32. Marceau L, McKinlay J, Shackelton R, Link C. The relative contribution of patient, provider and organizational influences to the appropriate diagnosis and management of diabetes mellitus. Journal of Evaluation in Clinical Practice. 2011 Dec;17(6):1122–1128.
33. Margolis MJ, Clauser BE, Harik P, Guernsey MJ. Examining subgroup differences on the computer-based casesimulation component of USMLE Step 3. Academic Medicine. 2002 Oct;77(10 Suppl):S83–S5.
34. McCave EL, Aptaker D, Hartmann KD, Zucconi R. Promoting affirmative transgender health care practice within hospitals: an IPE standardized patient simulation for graduate health care learners. MedEdPORTAL. 2019 Dec;15(1):10861.
35. McNiel PL, Elertson KM. Advocacy and awareness:integrating LGBTQ health education into the prelicensure curriculum. The Journal of Nursing Education. 2018 May;57(5):312–314.
36. Nicolai J, Demmel R. The impact of gender stereotypes on the evaluation of general practitioners' communication skills: an experimental study using transcripts of physician–patient encounters. Patient Education and Counseling. 2007 Dec;69(1):200–205.
37. Raemer DB, Kolbe M, Minehart RD, Rudolph JW, Pian-Smith MCM. Improving anesthesiologists' ability to speak up in the operating room: a randomized controlled experiment of a simulation-based intervention and a qualitative analysis of hurdles and enablers. Academic Medicine. 2016 Apr;91(4):530–539.
38. Sargeant S, McLean M, Green P, Johnson P. Applying positioning theory to examine interactions between simulated patients and medical students: a narrative analysis. Advances in Health Sciences Education: Theory and Practice. 2017 Mar;22(1):187–196.
39. Siegelman JN, Lall M, Lee L, Moran TP, Wallenstein J, Shah B. Gender bias in simulation-based assessments of emergency medicine residents. Journal of Graduate Medical Education. 2018 Aug;10(4):411–415.
40. Stockmann C, Diaz DA. Students' perceptions of the psychological well-being of a transgender client through simulation. The Journal of Nursing Education. 2017 Dec;56(12):741–744.
41. Tollison AC. Stereotype threat in male nurse-patient interactions. The Journal of Nursing Education. 2018 Oct;57(10):614–619.
42. Underman K, Giffort D, Hyderi A, Hirshfield LE. Transgender health: a standardized patient case for advanced clerkship students. MedEdPORTAL. 2016 Dec;12(1):10518.
43. Welch LC, Lutfey KE, Gerstenberger E, Grace M. Gendered uncertainty and variation in physicians' decisions for coronary heart disease: the double-edged sword of 'atypical symptoms'. Journal of Health and Social Behavior. 2012 Sep;53(3):313–328.
44. Wiskin CM, Allan TF, Skelton JR. Gender as a variable in the assessment of final year degree-level communication skills. Medical Education. 2004 Feb;38(2):129–137.
45. Dedy NJMD, Szasz PMD, Louridas MMD, Bonrath EMMD, Husslein HMD, Grantcharov TPMDPF. Objective structured assessment of nontechnical skills: Reliability of a global rating scale for the in-training assessment in the operating room. Surgery. 2015 Jun;157(6):1002–1013.
46. Doyle K, Young M, Meterissian S. Evaluation of residency programs: a novel approach using simulation. Journal of Graduate Medical Education. 2014 Mar;6(1):55–60.
47. Fletcher G, Flin R, McGeorge P, Glavin R, Maran N, Patey R. Anaesthetists' non-technical skills (ANTS): evaluation of a behavioural marker system. British Journal of Anaesthesia. 2003 May;90(5):580–588.
48. Jensen K, Hansen HJ, Petersen RH, et al. Evaluating competency in video-assisted thoracoscopic surgery (VATS) lobectomy performance using a novel assessment tool and virtual reality simulation. Surgical Endoscopy. 2019 May;33(5):1465–1473.
49. McGrath J, Kman N, Danforth D, et al. Virtual alternative to the oral examination for emergency medicine residents. The Western Journal of Emergency Medicine. 2015 Mar;16(2):336–343.
50. Nerup NMD, Preisler LMD, Svendsen MBSM, Svendsen LBMDD, Konge LMDP. Assessment of colonoscopy by use of magnetic endoscopic imaging: design and validation of an automated tool. Gastrointestinal Endoscopy. 2015 Mar;81(3):548–554.
51. Svendsen MB, Preisler L, Hillingsoe JG, Svendsen LB, Konge L. Using motion capture to assess colonoscopy experience level. World Journal of Gastrointestinal Endoscopy. 2014 May;6(5):193–199.

52. Wijnen-Meijer M, Van der Schaaf M, Booij E, et al. An argument-based approach to the validation of UHTRUST: can we measure how recent graduates can be trusted with unfamiliar tasks? Advances in Health Sciences Education: Theory and Practice. 2013 Dec;18(5):1009–1027.
53. Blumenthal-Barby JS, Krieger H. Cognitive biases and heuristics in medical decision making: a critical review using a systematic search strategy. Medical Decision Making. 2015 May;35(4):539–557.
54. Gopal DP, Chetty U, O'Donnell P, Gajria C, Blackadder-Weinstein J. Implicit bias in healthcare: clinical practice, research and decision making. Future Healthcare Journal. 2021 Mar;8(1):40–48.
55. Barnato AE, Mohan D, Downs J, Bryce CL, Angus DC, Arnold RM. A randomized trial of the effect of patient race on physicians' intensive care unit and life-sustaining treatment decisions for an acutely unstable elder with end-stage cancer. Critical Care Medicine. 2011 Jul;39(7):1663–1669.
56. Cavalcanti RB, Sibbald M. Am i right when i am sure? Data consistency influences the relationship between diagnostic accuracy and certainty. Academic Medicine. 2014 Jan;89(1):107–113.
57. Padilha JM, Machado PP, Ribeiro A, Ramos J, Costa P. Clinical virtual simulation in nursing education: randomized controlled trial. Journal of Medical Internet Research. 2019 Mar;21(3):e11529.
58. Park CS, Stojiljkovic L, Milicic B, Lin BF, Dror IE. Training induces cognitive bias: the case of a simulation-based emergency airway curriculum. Simulation in Healthcare. 2014 Apr;9(2):85–93.
59. Fischhoff B, Gonzalez RM, Lerner JS, Small DA. Evolving judgments of terror risks: foresight, hindsight, and emotion: a reanalysis. Journal of Experimental Psychology Applied. 2012 Jun;18(2):e1–e16.
60. Croskerry P. A universal model of diagnostic reasoning. Academic Medicine. 2009 Aug;84(8):1022–1028.
61. Croskerry P. From mindless to mindful practice – cognitive bias and clinical decision making. The New England Journal of Medicine. 2013 Jun;368(26):2445–2448.
62. Detmer DE, Fryback DG, Gassner K. Heuristics and biases in medical decision-making. Journal of Medical Education. 1978 Aug;53(8): 682-683.
63. Redelmeier DA. The cognitive psychology of missed diagnoses. Annals of Internal Medicine. 2005 Jan;142(2):115–120.
64. Stanovich KE, West RF. On the relative independence of thinking biases and cognitive ability. Journal of Personality and Social Psychology. 2008 Apr;94(4):672–695.
65. Klein JG. Five pitfalls in decisions about diagnosis and prescribing. BMJ. 2005 Apr;330(7494):781–783.
66. Zestcott CA, Blair IV, Stone J. Examining the presence, consequences, and reduction of implicit bias in health care: a narrative review. Group Processes & Intergroup Relations. 2016 Jul;19(4):528–542.
67. Balakrishnan KMDMPH, Arjmand EMMDMMMP. The impact of cognitive and implicit bias on patient safety and quality. Otolaryngologic Clinics of North America. 2018 Feb;52(1):35–46.
68. FitzGerald C, Hurst S. Implicit bias in healthcare professionals: a systematic review. BMC Medical Ethics. 2017 Mar;18(1):19.
69. Technology Enhanced Learning: The good, the bad, and the ugly. Pragmatics & Cognition. 2008 Jan;16(2):215–223.
70. Adamson K. Rater bias in simulation performance assessment: examining the effect of participant race/ethnicity. Nursing Education Perspectives. 2016 Mar-Apr;37(2):78–82.
71. Al-Moteri M, Cooper S, Symmons M, Plummer V. Nurses' cognitive and perceptual bias in the identification of clinical deterioration cues. Australian Critical Care. 2020 Jul;33(4):333–342.
72. Altabbaa G, Raven AD, Laberge J. A simulation-based approach to training in heuristic clinical decision-making. Diagnosis (Berl). 2019 Jun;6(2):91–99.
73. Barnato AE, Mohan D, Lane RK, et al. Advance care planning norms may contribute to hospital variation in end-of-life ICU use: a simulation study. Medical Decision Making. 2014 May;34(4):473–484.
74. Bennett P, Moore M, Wenham J. The PAUL Suit©: an experience of ageing. The Clinical Teacher. 2016 Apr;13(2):107–111.
75. Bond WF, Deitrick LM, Arnold DC, et al. Using simulation to instruct emergency medicine residents in cognitive forcing strategies. Academic Medicine. 2004 May;79(5):438–446.
76. Braun LT, Borrmann KF, Lottspeich C, et al. Scaffolding clinical reasoning of medical students with virtual patients: effects on diagnostic accuracy, efficiency, and errors. Diagnosis (Berl). 2019 Jun;6(2):137–149.
77. Brown SA, Evans Y, Espenschade K, O'Connor M. An examination of two brief stigma reduction strategies: filmed personal contact and hallucination simulations. Community Mental Health Journal. 2010 Oct;46(5):494–499.
78. Brown SA. Implementing a brief hallucination simulation as a mental illness stigma reduction strategy. Community Mental Health Journal. 2010 Oct;46(5):500–504.
79. Bucknall TK, Forbes H, Phillips NM, Hewitt NA, Cooper S, Bogossian F. An analysis of nursing students' decision-making in teams during simulations of acute patient deterioration. Journal of Advanced Nursing. 2016 Oct;72(10):2482–2494.
80. Burgess DJ, Crowley-Matoka M, Phelan S, et al. Patient race and physicians' decisions to prescribe opioids for chronic low back pain. Social Science & Medicine (1982). 2008 Dec;67(11):1852–1860.
81. Chen AMH, Plake KS, Yehle KS, Kiersma ME. Impact of the geriatric medication game on pharmacy students' attitudes toward older adults. American Journal of Pharmaceutical Education. 2011 Oct;75(8):158.
82. Choi H, Hwang B, Kim S, Ko H, Kim S, Kim C. Clinical education in psychiatric mental health nursing: overcoming current challenges. Nurse Education Today. 2016 Apr;39:109–115.
83. Chugh U, Dillmann E, Kurtz SM, Lockyer J, Parboosingh J. Multicultural issues in medical curriculum: implications for Canadian physicians. Medical Teacher. 1993 Jul;15(1):83–91.
84. Cicero MX, Brown L, Overly F, et al. Creation and Delphimethod refinement of pediatric disaster triage simulations. Prehosp Emerg Care. 2014 Apr-Jun;18(2):282–289.
85. Claramita M, Tuah R, Riskione P, Prabandari YS, Effendy C. Comparison of communication skills between trained and

untrained students using a culturally sensitive nurse–client communication guideline in Indonesia. Nurse Education Today. 2016 Jan;36:236–241.
86. Clark CM, Gorton KL. Cognitive rehearsal, HeartMath, and simulation: an intervention to build resilience and address incivility. The Journal of nursing Education. 2019 Dec;58(12):690–697.
87. Crapanzano K, Fisher D, Hammarlund R, Hsieh EP, May W. Internal medicine residents' attitudes toward simulated depressed cardiac patients during an objective structured clinical examination: a randomized study. Journal of General Internal medicine: JGIM. 2018 Jun;33(6):886–891.
88. Dearing KS, Steadman S. Challenging stereotyping and bias: a voice simulation study. The Journal of Nursing Education. 2008 Feb;47(2):59–65.
89. Eva KW, Link CL, Lutfey KE, McKinlay JB. Swapping horses midstream: factors related to physicians' changing their minds about a diagnosis. Academic Medicine. 2010 Jun;85(7):1112–1117.
90. Evans J, Webster S, Gallagher S, Brown P, Sinclair J. Simulation in nursing education: iPod as a teaching tool for undergraduate nurses. Issues in Mental Health Nursing. 2015 Jul;36(7):505–512.
91. Fitzgerald SN, Leslie KF, Simpson R, Jones VF, Barnes ET. Culturally effective care for refugee populations: interprofessional, interactive case studies. MedEdPORTAL. 2018 Jan;14(1):10668.
92. Floyd K, Generous MA, Clark L, Simon A, McLeod I. Empathy between physician assistant students and standardized patients: evidence of an inflation bias. The Journal of Physician Assistant Education. 2015 Jun;26(2):94–98.
93. Foster KHDMD, Harrison EDMDRPH. Effect of presentation bias on selection of treatment option for failed endodontic therapy. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics. 2008 Nov;106(5):e36–e9.
94. Galletly C, Burton C. Improving medical student attitudes towards people with schizophrenia. Australian and New Zealand Journal of Psychiatry. 2011 Jun;45(6):473–476.
95. Goddard L, Jordan L. Changing attitudes about persons with disabilities: effects of simulation. The Journal of Neuroscience Nursing. 1998 Oct;30(5):307–313.
96. Gostlow H, Vega CV, Marlow N, Babidge W, Maddern G. Do Surgeons React?: a retrospective analysis of surgeons' response to harassment of a colleague during simulated operating theatre scenarios. Annals of Surgery. 2018 Aug;268(2):277–281.
97. Gotlieb R, Abitbol J, How JA, et al. Gender differences in how physicians access and process information. Gynecologic Oncology Reports. 2019 Jan;27:50–53.
98. Hahn T, Kelly C, Murphy E, Whissel P, Brown M, Schenk R. Clinical decision-making in the management of cervical spine derangement: a case study survey using a patient vignette. The Journal of Manual & Manipulative Therapy. 2014 Nov;22(4):213–219.
99. Hales C, Gray L, Russell L, MacDonald C. A qualitative study to explore the impact of simulating extreme obesity on health care professionals' attitudes and perceptions. Ostomy/ Wound Management. 2018 Jan;64(1):18–24.
100. Haliko S, Downs J, Mohan D, Arnold R, Barnato AE. Hospital-based physicians' intubation decisions and associated mental models when managing a critically and terminally ill older patient. Medical Decision Making. 2018 Apr;38(3):344–354.
101. Hanson MD, Johnson S, Niec A, et al. Does mental illness stigma contribute to adolescent standardized patients' discomfort with simulations of mental illness and adverse psychosocial experiences? Academic Psychiatry. 2008 Mar-Apr;32(2):98–103.
102. Hareli S, Berkovitch N, Livnat L, David S. Anger and shame as determinants of perceived competence. International Journal of Psychology. 2013 Dec;48(6):1080–1089.
103. Herrmann-Werner A, Loda T, Wiesner LM, Erschens RS, Junne F, Zipfel S. Is an obesity simulation suit in an undergraduate medical communication class a valuable teaching tool? A cross-sectional proof of concept study. BMJ Open. 2019 Aug;9(8):e029738.
104. Hillbrand M, Hawkins D, Howe DM, Stayner D. Through the eyes of another: improving the skills of forensic providers using a consumer-informed role-play procedure. Psychiatric Rehabilitation Journal. 2008 Winter;31(3):239–242.
105. Hu Y, Kim H, Mahmutovic A, Choi J, Le I, Rasmussen S. Verification of accurate technical insight: a prerequisite for self-directed surgical training. Advances in Health Sciences Education: Theory and Practice. 2015 Mar;20(1):181–191.
106. Huber M, Reno B, McKenney J. Long-term care personnel assess their attitudes and knowledge of the older adult. Journal of Advanced Nursing. 1992 Sep;17(9):1114–1121.
107. Hunter J, Rawlings-Anderson K, Lindsay T, Bowden T, Aitken LM. Exploring student nurses' attitudes towards those who are obese and whether these attitudes change following a simulated activity. Nurse Education Today. 2018 Jun;65:225–231.
108. Jaeken M, Zech E, Brison C, Verhofstadt LL, Van Broeck N, Mikolajczak M. Helpers' self-assessment biases before and after helping skills training. Frontiers in Psychology. 2017 Aug;8:1377.
109. Jaworsky D, Gardner S, Thorne JG, et al. The role of people living with HIV as patient instructors – reducing stigma and improving interest around HIV care among medical students. AIDS Care. 2017 Apr;29(4):524–531.
110. Junnola T, Eriksson E, SalanterÄ S, Lauri S. Nurses' decisionmaking in collecting information for the assessment of patients' nursing problems. Journal of Clinical Nursing. 2002 Mar;11(2):186–196.
111. Khazadian-Figueroa MR, Johnson E. Simulation game: a tool for staff development and its effects on staff behavioral outcomes. Journal of Nursing Staff Development. 1997 Jul-Aug;13(4):223–226.
112. Kidd LI, Tusaie KR, Morgan KI, Preebe L, Garrett M. Mindful teaching practice: lessons learned through a hearing voices simulation. Issues in Mental Health Nursing. 2015 Feb;36(2):112–117.
113. Kushner RF, Zeiss DM, Feinglass JM, Yelen M. An obesity educational intervention for medical students addressing weight bias and communication skills using standardized patients. BMC Medical Education. 2014 Mar;14(1):53.

114. LaRoche KJ, Foster AM. Toll free but not judgment free: evaluating postabortion support services in Ontario. Contraception (Stoneham). 2015 Nov;92(5):469–474.
115. Levett-Jones T, Gersbach J, Arthur C, Roche J. Implementing a clinical competency assessment model that promotes critical reflection and ensures nursing graduates' readiness for professional practice. Nurse Education in Practice. 2011 Jan;11(1):64–69.
116. Lewis C, Reid J, McLernon Z, Ingham R, Traynor M. The impact of a simulated intervention on attitudes of undergraduate nursing and medical students towards end of life care provision. BMC Palliative Care. 2016 Aug;15(1):67.
117. Li L, Lin C, Guan J. Using standardized patients to evaluate hospital-based intervention outcomes. International Journal of Epidemiology. 2014 Jun;43(3):897–903.
118. Lockeman KS, Appelbaum NP, Dow AW, et al. The effect of an interprofessional simulation-based education program on perceptions and stereotypes of nursing and medical students: a quasi-experimental study. Nurse Education Today. 2017 Nov;58:32–37.
119. Lohman P. Students' perceptions of face-to-face pseudostuttering experience. Perceptual and Motor Skills. 2008 Dec;107(3):951–962.
120. Lorenzo A, Schildt P, Lorenzo M, Falcoff H, Noel F. Acute low back pain management in primary care: a simulated patient approach. Family Practice. 2015 Aug;32(4):436–441.
121. Magpantay-Monroe ER. Integration of military and veteran health in a psychiatric mental health BSN curriculum: a mindful analysis. Nurse Education Today. 2017 Jan;48:111–113.
122. March C, Walker LW, Toto RL, Choi S, Reis EC, Dewar S. Experiential communications curriculum to improve resident preparedness when responding to discriminatory comments in the workplace. Journal of Graduate Medical Education. 2018 Jun;10(3):306–310.
123. Maruca AT, Diaz DA, Stockmann C, Gonzalez L. Usingsimulation with nursing students to promote affirmative practice toward the lesbian, gay, bisexual, and transgender population: a multisite study. Nursing Education Perspectives. 2018 Jul-Aug;39(4):225–229.
124. Maupome G, Sheiham A. Explanatory models in the interpretations of clinical features of dental patients within a university dental education setting: explanatory models of clinical features in dental patients. European Journal of Dental Education. 2002 Feb;6(1):2–8.
125. Minehart RD, Rudolph J, Pian-Smith MCM, Raemer DB. Improving faculty feedback to resident trainees during a simulated case: a randomized, controlled trial of an educational intervention. Anesthesiology (Philadelphia). 2014 Jan;120(1):160–171.
126. Mirza A, Winer J, Garber M, Makker K, Maraqa N, Alissa R. Primer in patient safety concepts: simulation case-based training for pediatric residents and fellows. MedEdPORTAL. 2018 Apr;14(1):10711.
127. Mohan D, Rosengart MR, Fischhoff B, et al. Testing a videogame intervention to recalibrate physician heuristics in trauma triage: study protocol for a randomized controlled trial. BMC Emergency Medicine. 2016 Nov;16(1):44.
128. Norman R. Experiential learning in drug and alcohol education. The Journal of Nursing Education. 2001;40(8):371.
129. O'Lynn C, Krautscheid L. Evaluating the effects of intimate touch instruction: facilitating professional and respectful touch by male nursing students. The Journal of Nursing Education. 2014 Mar;53(3):126–135.
130. Paige J, Garbee D, Yu Q, Kiselov V, Rusnak V, Detiege P. Moving along: team training for emergency room trauma transfers (T2ERT2). Journal of Surgical Education. 2019 Sep-Oct;76(5):1402–1412.
131. Patterson F, Tiffin PA, Lopes S, Zibarras L. Unpacking the dark variance of differential attainment on examinations in overseas graduates. Medical Education. 2018 Jul;52(7):736–746.
132. Pennaforte T, Moussa A, Loye N, Charlin B, Audétat M-C. Exploring a new simulation approach to improve clinical reasoning teaching and assessment: randomized trial protocol. JMIR Research Protocols. 2016 Feb;5(1):e26-e.
133. Persky S, Eccleston CP. Impact of genetic causal information on medical students' clinical encounters with an obese virtual patient: health promotion and social stigma. Annals of behavioral medicine. 2011 Jun;41(3):363–372.
134. Prakash S, Bihari S, Need P, Sprick C, Schuwirth L. Immersive high fidelity simulation of critically ill patients to study cognitive errors: a pilot study. BMC Medical Education. 2017 Feb;17(1):36.
135. Richey Smith CE, Ryder P, Bilodeau A, Schultz M. Use of an online game to evaluate health professions students' attitudes toward people in poverty. American Journal of Pharmaceutical Education. 2016 Oct;80(8):139.
136. Richmond A, Burgner A, Green J, et al. Discharging Mrs. Fox: a team-based interprofessional collaborative standardized patient encounter. MedEdPORTAL. 2017 Feb;13(1):10539.
137. Ruparel RKMD, Taylor ASMD, Patel JBS, et al. Assessment of virtual reality robotic simulation performance by urology resident trainees. Journal of Surgical Education. 2014 May-Jun;71(3):302–308.
138. Rutledge CM, Barham P, Wiles L, Benjamin RS, Eaton P, Palmer K. Integrative simulation: a novel approach to educating culturally competent nurses. Contemporary Nurse. 2008 Apr;28(1–2):119–128.
139. Schuler SR, McIntosh EN, Goldstein MC, Pande BR. Barriers to effective family planning in Nepal. Studies in Family Planning. 1985 Sep- Oct;16(5):260–270.
140. Sidi A, Gravenstein N, Vasilopoulos T, Lampotang S. Simulation-based assessment identifies longitudinal changes in cognitive skills in an anesthesiology residency training program. Journal of Patient Safety. 2021 Sep 1;17(6):e490-e496.
141. Silverman AM, Pitonyak JS, Nelson IK, Matsuda PN, Kartin D, Molton IR. Instilling positive beliefs about disabilities: pilot testing a novel experiential learning activity for rehabilitation students. Disability and Rehabilitation. 2018 May;40(9):1108–1113.
142. Theodossiades J, Myint J, Murdoch IE, Edgar DF, Lawrenson JG. Does optometrists' self-reported practice in glaucoma detection predict actual practice as determined by standardised patients? Ophthalmic & Physiological Optics. 2012 May;32(3):234–241.
143. Thompson C, Yang H, Crouch S. Clinical simulation fidelity and nurses' identification of critical event risk: a signal detection analysis. Journal of Advanced Nursing. 2012 Nov;68(11):2477–2485.
144. Varas-Díaz N, Rivera-Segarra E, Neilands TB, et al. HIV/AIDS stigma manifestations during clinical interactions

with MSM in Puerto Rico. Journal of Gay & Lesbian Social Services. 2019;31(2):141–152.
145. Watson MC, Skelton JR, Bond CM, et al. Simulated patients in the community pharmacy setting. Using simulated patients to measure practice in the community pharmacy setting. Pharmacy World and Science. 2004 Feb;26(1):32–37.
146. Woda A, Schnable T, Alt-Gehrman P, Bratt MM, Garnier-Villarreal M. Innovation in clinical course delivery and impact on students' clinical decision-making and competence. Nursing Education Perspectives. 2019 Jul-Aug;40(4):241–243.
147. Worth-Dickstein H, Pangaro LN, MacMillan MK, Klass DJ, Shatzer JH. Use of 'standardized examinees' to screen for standardized-patient scoring bias in a clinical skills examination. Teaching and Learning in Medicine. 2005 Jun;17(1):9–13.
148. Wu B, Wang M, Grotzer TA, Liu J, Johnson JM. Visualizing complex processes using a cognitive-mapping tool to support the learning of clinical reasoning. BMC Medical Education. 2016 Aug;16(1):216.
149. Yeates P, Woolf K, Benbow E, Davies B, Boohan M, Eva K. A randomised trial of the influence of racial stereotype bias on examiners' scores, feedback and recollections in undergraduate clinical exams. BMC Medicine. 2017 Oct;15(1):179.
150. Yu CY, Chen KM. Experiencing simulated aging improves knowledge of and attitudes toward aging. Journal of the American Geriatrics Society. 2012 May;60(5):957–561.
151. Yuan MJ, Finley GM, Long J, Mills C, Johnson RK. Evaluation of user interface and workflow design of a bedside nursing clinical decision support system. Interactive Journal of Medical Research. 2013 Jan;2(1):e4.
152. Yudkowsky R, Park YS, Hyderi A, Bordage G. Characteristics and implications of diagnostic justification scores based on the new patient note format of the USMLE step 2 CS exam. Academic Medicine. 2015 Nov;90(11 Suppl):S56–S62.
153. Yule S, Flin R, Mar an N, Rowley D, Youngson G, Paterson-Brown S. Surgeons' non-technical skills in the operating room: reliability testing of the NOTSS behavior rating system. World Journal of Surgery. 2008 Apr;32(4):548–556.
154. Zottmann JM, Dieckmann P, Taraszow T, Rall M, Fischer F. Just watching is not enough: fostering simulation-based learning with collaboration scripts. GMS Journal of Medical Education. 2018 Aug;35(3):1–18.