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SCOPING REVIEW

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The simulation design in health and nursing: A scoping review

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Abstract

Aims: The aims of this study were to map the components of the simulation design in health and nursing and to propose a classification based on their definitions to support the planning of simulation-based experiences.

Design: Scoping review.

Method: Searches were performed in the databases LILACS, Embase, MEDLINE/PubMed, SCOPUS, Web of Science, Google Scholar and ProQuest Thesis and Dissertation were performed, without time limitation, to identify studies about simulation design.

Results: This study mapped 19 components of the simulation design found in 26 studies included, which can contribute to the development of simulation-based experiences, classified into structural, methodological and theoretical–pedagogical components. The simulation design can be described according to its fundamental components: structural—define the basic formulation of a simulation in terms of infrastructure and conceptual framework; methodological—define the participants, roles and the instruction format; and theoretical–pedagogical—define the educational references used to support the simulation strategy.

KEYWORDS
education, health education, nursing, nursing education, simulation

1 | INTRODUCTION

Simulation is a teaching–learning strategy aligned with the perspective of an active methodology that, in the context of health and nursing education, enables students to develop skills and build knowledge in cognitive, procedural and attitudinal domains, preparing them for clinical practice (Kim et al., 2016; Lavoie et al., 2018; Onarici et al., 2021). It is associated with the development of skills necessary for nurses, which help in clinical judgement, decision-making and resolution of complex situations in health services, in addition to emotional skills that are fundamental for the work process and comprehensive care (Flynn et al., 2017).

It is also added that the simulation is recognized for promoting a safe space for learning in which the error does not cause harm to the patient. Moreover, are accompanied by facilitating professors who plan and implement the strategy similar to situations found in health

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services, problematizing important themes of the clinical practice in the light of scientific literature and reflection on the simulated context (Chiniara et al., 2013; INACSL Standards Committee, 2021d).

The main learning outcomes obtained through simulation are satisfaction, critical thinking, clinical judgement and self-confidence (O'Donnell et al., 2014), as well as teamwork, care and safety (Lavoie et al., 2018). These attributes reinforce the importance of applying this teaching–learning strategy in the education of qualified personnel for the health area, along with the best care practices.

In searches performed in the databases PROSPERO (International Prospective Register of Systematic Reviews), Cochrane Database of Systematic Reviews, CINAHL (Cumulative Index to Nursing and Allied Health Literature), JBI Database of Systematic Reviews and Implementation Reports and MEDLINE via PubMed (Medical Literature Analysis and Retrieval System Online), no proposals or complete systematic reviews were found focusing on mapping the components of the simulation design.

Considering that designing the simulation can impact better learning outcomes, identifying its components can provide subsidies for the elaboration of more assertive simulation-based experience (SBE) in health and nursing. In addition, identifying the simulation design components through this review can help SBE formulators to develop reliable simulation scenarios for clinical practice. Thus, this review was proposed with the purpose of assisting in the synthesis and establishment of standards for the elaboration of SBE in the pedagogical and research context, contributing to the existing knowledge by stimulating methodological rigour in the elaboration and implementation of simulation scenarios.

2 | BACKGROUND

Within the scope of simulation activities for nursing, there is a need to encourage students to develop the skills required in professional practice according to the standards of nursing education (Bryant et al., 2020). It is worth emphasizing that better results in education are achieved when the simulation planning follows a design, maintaining rigour through a scenario with clear goals, planned facilitation, theoretical referenced debriefing and run according to guidelines that support this strategy to achieve higher levels of quality (INACSL Standards Committee, 2021d), which in the context of strategies of teaching–learning, is called instructional design (Seel et al., 2017).

Instructional design is a systematic procedure of education design and implies in improving learning and influencing students with motivation for the teaching–learning process (Seel et al., 2017). From this perspective of motivation, instructional design is used to create assertive learning environments focused on the development of specific knowledge, practice skills and attitudes that reflect teamwork, leadership and other skills during interactions with others. These competencies are considered necessary for professional practice (Chiniara et al., 2013) and developed through active and innovative strategies based on grounded pedagogical theories (Jeffries et al., 2015; Libâneo, 1992; Moran, 2018). Thus, studies suggest that well-structured simulation promotes in student learning outcomes (de Melo et al., 2017; Fransen et al., 2018; Sagalowsky et al., 2018).

Therefore, structured simulation from the instructional design perspective includes how the pedagogical strategy will be applied, according to the most suitable guiding theory which will facilitate the learning process, the best available structure and the suitable methodology according to the educational goals previously defined (Chiniara et al., 2013). To elaborate SBE from the point of view of instructional design, it is essential to understand the fundamental components that will compose the simulation and its conduction. In the present study, we defined such constructs as components of the simulation design, understood by the authors as the fundamental characteristics necessary for the elaboration of SBE.

3 | AIMS

This study aimed to map the components of the simulation design in health and nursing and to propose a classification based on their definitions to support the planning of simulation-based experiences.

4 | METHODS

The scoping review methodology was adopted for this study, to obtain broad and comprehensive results in studies available in the literature, maintaining a systematic approach to research with the opportunity of replication (Arksey & O'Malley, 2005). Characterized by the opportunity of mapping the main concepts of a given area of knowledge, the scoping review allows the integration of results from studies of different designs, with the objective of summarizing the findings and identifying relevant gaps in the area of investigation (O'Brien et al., 2016).

Several studies address the simulation design, however, in the health and nursing areas the main standards for the elaboration of SBE present divergent or convergent concepts and different terms for similar concepts. Thus, considering that there is a diversity of published studies on the subject, with different types of methodological design, we chose the scoping review methodology because it contemplates such types of studies and allows mapping such concepts. Thus, this method helps us to map the main concepts and definitions about the simulation design and identify the fundamental components to elaborate SBE.

The recommendations of the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis (Peters, Godfrey, et al., 2020) were adopted in the present review, being developed in seven steps: (a) identifying the review questions; (b) inclusion criteria; (c) search strategies; (d) screening and selection of evidence; (e) data extraction; (f) data analysis; and (g) presentation of results. This study was reported from the recommendations of the PRISMA Extension for Scoping Reviews (PRISMA-ScR; Table A1; Tricco et al., 2018).

4.1 | Identifying the review questions and inclusion criteria

To determine the research question, the PCC acronym was used (Peters, Marnie, et al., 2020), in which P (Population) is equivalent to health education in different professional categories (nursing, medicine, dentistry, pharmacy and health professions), C (Concept) is equivalent to instructional design, and C (Context) is equivalent to simulation. Thus, the following research questions were defined:

- What is known from the existing literature about the instructional design in the development of SBE in health and nursing education?
- What are the main components of the simulation design needed for the elaboration of SBE?

Although nursing has a rich theoretical framework for the elaboration and implementation of SBE, understanding the simulation design from the perspective not only of nursing education, but also of other areas such as medicine, pharmacy and dentistry can provide evidence for the elaboration of effective simulations for learning in the health area and also in an interprofessional way.

Thus, were included in this scoping review primary studies, systematic reviews, meta-analyses, integrative and narrative reviews, guidelines and standards that discuss instructional design elements in the development of SBE, published in English, Spanish and Portuguese, without time limitation. In this study, we considered simulations with different types of modality, fidelity and clinical context, considering that the purpose of this study is to map the available designs for SBE. To map such concepts, studies with different methodological designs were included, in order to include the largest number of studies that discussed the theme. Books, event proceedings and clinical trial registries were excluded.

4.2 | Search strategies

The searches were performed in September 2021 and updated in April 2022. For the searches, we considered studies available in the electronic databases Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Excerpta Medica dataBASE (Embase), Medical Literature Analysis and Retrieval System Online (MEDLINE), SCOPUS (Elsevier) and Web of Science. Considering that scoping reviews propose to carry out an extensive mapping of the literature, free searches and grey literature searches were performed on Google Scholar, and ProQuest Thesis and Dissertations databases—considering the 200 most relevant references (Bramer et al., 2017).

Search strategies included standardized descriptors identified in the MeSH (Medical Subject Headings) and Emtree Terms: "Nursing," "Nursing Education," "Medicine," "Medical Education," "Dentistry," "Dental Education," "Pharmacy," "Pharmacy Education," "Health Occupations," "Health Education," "Simulation Training"; and non-standardized descriptors: "Simulation," "Simulation-Based Experiences," "Simulation-Based Training," "Instructional Design," "Design Features," "Design Characteristics." Those were developed search strategies for each database (Appendix S1).

To exemplify the search, the strategy adopted in the MEDLINE via PubMed database was as follows: ("Nursing" [Mesh] OR "Education, Nursing" [Mesh] OR "Medicine" [Mesh] OR "Education, Medical" [Mesh] OR "Dentistry" [Mesh] OR "Education, Dental" [Mesh] OR "Pharmacy" [Mesh] OR "Education, Pharmacy" [Mesh] OR "Health Occupations" [Mesh] OR "Health Education" [Mesh]) AND ("Simulation Training" [Mesh] OR "Simulation" [Title/Abstract] OR "Simulation-Based Experiences" [Title/Abstract] OR "Simulation-Based Training" [Title/Abstract]) AND ("Instructional Design" [Title/Abstract] OR "Design Features" [Title/Abstract] OR "Design Characteristics" [Title/Abstract]). In the searches, the terms included were identified in the titles and abstracts of the studies about the subject.

4.3 | Screening and selection of evidence

The stage of selection of the sources of evidence was carried out in four stages: (a) after carrying out the searches in the databases, a database was created with all the records using the software EndNote X9; (b) the database was exported to the software used to manage systematic and scope reviews, Covidence (Veritas Health Innovation, 2022), which, after import, were identified and excluded the duplicate references; (c) the selection of studies was carried out in an initial stage of screening the studies, in which titles and abstracts were evaluated; and (d) the selection confirmation step took place after reading the full texts, identifying more precisely the relevant studies and excluding those that did not meet the inclusion criteria. The screening and confirmation steps were performed independently by two reviewers. A third reviewer resolved any disagreements that arose.

4.4 | Data extraction

Based on the JBI model, a data extraction form was developed to analyse the scope and record the characteristics of each study. The form was tested by the authors and transferred to the Covidence software, where the data were extracted and imported to a Microsoft Office Excel worksheet. Information such as authors, title, objective, sample (if applicable), methodological design, study group and variables that relate to the simulation design were recorded. One reviewer performed data extraction, which was independently confirmed by a second reviewer.

4.5 | Data analysis and presentation of the results

The synthesis of the identified results was performed by mapping the simulation design components and grouping them into three main categories, namely structural, methodological and theoretical–pedagogical components. To designate each study included in this review, we selected the term "Study," described by the letter "S" followed by an Arabic numeral according to the order of presentation in the results. The results were descriptively mapped and analysed according to divergences and commonalities of concepts and characteristics of the instructional design adopted for the elaboration of SBE. Data were presented following the Methodology for JBI Scoping Reviews' recommendations (Peters, Godfrey, et al., 2020), in table format considering the occurrence of the simulation design components identified in each study.

5 | RESULTS

Searches in the databases resulted in 875 records, of which 350 were duplicates. A total of 595 studies were evaluated for titles and abstracts, of which 488 were excluded because they did not address the simulation design. Thus, 37 studies were evaluated and, after reading the full text, it was identified that 11 did not answer the research questions. Therefore, 26 studies were submitted for consideration of this scope, as evidenced in the study selection flowchart (PRISMA; Figure 1).

5.1 | Characteristics of the included studies

Of the 26 studies included, 12 (46.2%) were conducted in the USA, 2 (7.7%) in Brazil, 2 (7.7%) in Canada, 2 (7.7%) in South Korea, 1 (3.8%) in Australia, 1 (3.8%) in Colombia, 1 (3.8%) in Egypt, 1 (3.8%) in the Netherlands and 4 (15.5%) in collaboration with different countries. Regarding the design of the included studies, discussion papers ($n = 6$; 23.1%), followed by cross-sectional studies ($n = 3$; 11.5%), intervention studies ($n = 3$; 11.5%), methodological studies ($n = 3$; 11.5%), theoretical studies ($n = 3$; 11.5%), literature reviews ($n = 3$; 11.5%), systematic reviews ($n = 2$; 7.7%), Delphi study ($n = 1$; 3.9%), Q-methodology study ($n = 1$; 3.9%) and a standard for clinical simulation ($n = 1$; 3.9%). The primary studies sampled simulation experts, nursing professors, medical residents, undergraduate students in nursing, medicine, nutrition, exercise physiology, pharmacy and social work students.

Among the theoretical studies analysed, we found different classifications that address concepts and characteristics of instruction design used in the elaboration of SBE in health and nursing education. They consist in an extensive reference on which professors and instructors can rely on to design and structure SBE (Table 1). Some of the included studies were based on theories and frameworks used to carry out the instructional design of the simulation. Among these, we highlight the cognitive load theory, the experiential learning theory, the ADDIE instructional design model (analysis, design, development, implementation and evaluation), the instructional design features defined in a BEME (best evidence in medical education) systematic review, the NLN/Jeffries Simulation Framework and the INACSL Healthcare Simulation Standards of Best Practice™.

5.2 | Components of the simulation design

After exploratory reading, the main concepts, definitions and fundamental characteristics of the simulation design were identified and listed for each study included in this review. After listing, similar concepts with different nomenclature were grouped into a single nomenclature.

Thus, were mapped 19 essentials simulation design components to elaborate SBE: scenario structure and duration, modality, fidelity, simulator type, scenario, script for contextualizing the scenario, composition of participants and roles, definition of learning objectives, instruction and pre-briefing, list of expected actions, learning assessment, use of support materials, debriefing, curriculum integration, facilitation, problem-solving, theoretical–conceptual structure, potential for interdisciplinarity and flexibility for interprofessional application.

Based on this theoretical basis, the present study proposes a categorization of simulation design components, which was performed by grouping of similar components qualitatively according to how each component would contribute to the elaboration of SBE, highlighting the main groups of simulation design components for the elaboration of SBE: structural, methodological and theoretical–pedagogical components.

The *structural components* define the structural characteristics of the simulation, such as the structure itself and the duration of the simulation, the simulation modality, the types and levels of fidelity, type of simulator to be used and the characteristics of the simulated scenario in terms of the clinical context and scenario validation. They help in the identification of the environmental structure available to carry out the simulation and in the definition of which types of components will be adopted.

The *methodological components* integrate the methodological approach adopted by the teacher in the mediation of simulation activities, characterized in the composition of participants, composition of instructors/facilitators, type of instruction, facilitation (types of pre-briefing and debriefing), problem-solving, opportunity of repetition and feedback provided. They help to define the strategies that will be used to conduct the simulation.

The *theoretical–pedagogical components* comprise the characteristics associated with the theoretical–pedagogical structuring of the simulation with a view to achieving greater learning results, characterized by the curricular integration of the simulation, prior planning with the establishment of learning objectives, theoretical and/or conceptual structure guiding and evaluation of learning. They define the theoretical basis used to prepare and conduct the simulation. Table 2 presents the simulation design according to this classification and mention the source according to the literature review.

6 | DISCUSSION

This study enabled the identification of the aspects involved in the simulation design and proposed a classification to support

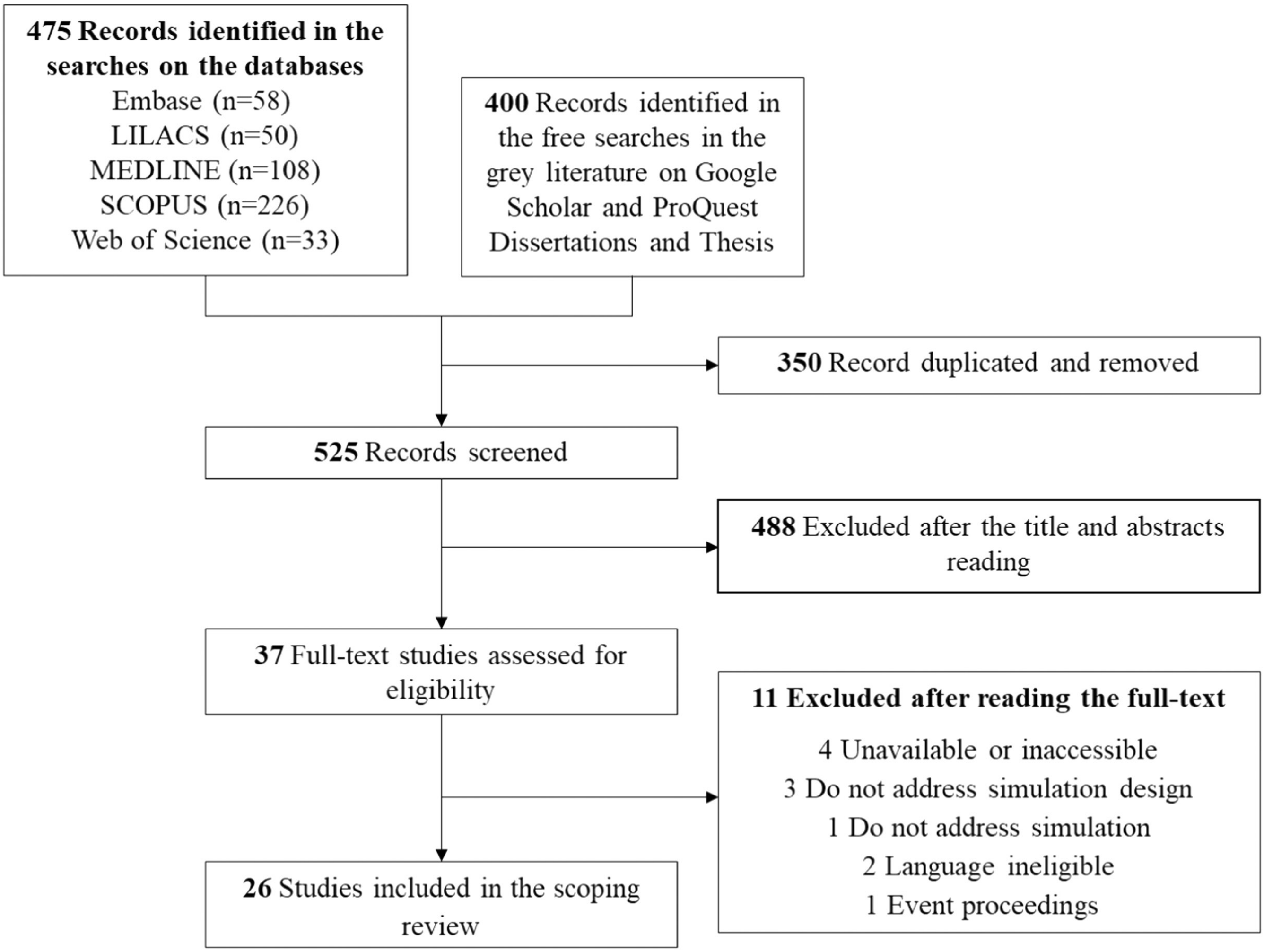

FIGURE 1 Flowchart of the included studies in the scoping review (PRISMA-ScR Flowchart)

researchers and educators to organize the SBE based on structural, methodological and theoretical–pedagogical components.

To ensure that a given activity is called simulation, it must follow the format suggested by guidelines and recognized researchers in the theme (Cook et al., 2013; Groom et al., 2014; INACSL Standards Committee, 2021b, 2021d), and the strategy must necessarily consist of the following steps: pre-briefing, simulated scenario itself and debriefing (McDermott et al., 2017, 2021). The duration of each stage varies, but each one must be carefully prepared by the professor and to achieve the planned learning objectives (INACSL Standards Committee, 2021b; Issenberg et al., 2005).

The structural components define the basics to set the scenario: duration of each stage or the scenario in one whole stage, simulation modality, types and levels of fidelity, the type of simulator, scenario realism, infrastructure and script for contextualizing the scenario.

Regarding the modalities, literature describes opportunities for application in health service settings (in situ simulation); computer-based simulation that can be enhanced according to the available technology, such as virtual reality that requires specific programming with 3D devices; procedural simulation, which consists of simulating procedures such as passing a urinary catheter or treating wounds; hybrid simulation, which consists in combination with different modalities; and immersive clinical simulation, which includes scenarios as close as possible to reality. Whose choice depends on the purpose of the activity developed by the professor in the larger context of training (Chiniara et al., 2013; INACSL Standards Committee, 2021d).

Some studies described the combination of different simulation modalities to support the same theme from multiple perspectives (Fonseca et al., 2016; Goldsworthy et al., 2019) and simulation with other teaching strategies to enhance the student's experience (Cook et al., 2013; Issenberg et al., 2005). The choice is defined by pedagogical criteria established by the educator aiming the best-learning results.

Besides it, fidelity is an element of the simulation design that determines the proximity of SBE to real clinical practice (Arthur et al., 2013; Groom et al., 2014). More than the level of technological resources and human simulators functions that imitate human beings (which certainly add realism), the fidelity involves other aspects (environment, concept and psychology) and follows a categorization in levels: high, medium or low fidelity—escalating according to its similarity with reality (Dieckmann et al., 2007).

TABLE 1 Studies about simulation design included in the scoping review

ID	Author (year)	Country	Title	Objective	Design and sample	Instructional design characteristics
1	Andersen et al. (2021)	Australia, New Zeeland	Designing tag team patient safety simulation: An instructional design approach	Translates the principles of learning and instruction that apply to TTPSS materials, activities, resources and evaluation and provides direction to those seeking to design effective educational simulations using the TTPSS methodology	Discussion paper	Learning outcomes; scenario; cue cards; antagonist cards; intermission and debrief; what if questions; evaluation; knowledge test
2	Anderson et al. (2008)	USA	Instructional design dogma: Creating planned learning experiences in simulation	To portray simulation as an educational strategy in the context of a curriculum, to describe experiential learning theory, deliberate practice and reflective practice as they apply in simulation-based training and to explore additional educational theories useful in improving and refining our educational processes in simulation	Discussion paper	Step 1: problem identification, learning needs and targeted learners; Step 2: overarching educational goals and specific measurable learning objectives; Step 3: select curriculum content and the educational strategies; Step 4: assessment of learning outcomes, curriculum evaluation and revision
3	Arthur et al. (2013)	Australia, North America, Europe and Hong Kong	Quality indicators for the design and implementation of simulation experiences: A Delphi study	Develop a set of quality indicator statements that are internationally applicable and can be used to guide the development, implementation and evaluation of simulation experiences in undergraduate nursing curricula	Delphi Study; 32 simulation experts	Pedagogical principles; fidelity; student preparation and guidance; preparation and training of instructors; debriefing
4	Burke (2010)	USA	A simulation case study from an instructional design framework	Applies the principles of instructional design to the development and evaluation of simulation instruction for entry-level nursing students	Discussion paper	1. drill and practice, 2. advance organizers, 3. problem-solving activities, 4. case-based reasoning and 5. collaborative groups
5	Chauvin (2015)	USA	Applying educational theory to simulation-based training and assessment in surgery	To describe considerations for selecting appropriate forms of simulation and relevant educational theories of learning	Theoretical study	Simulators and simulation; educational theories and models of learning; taxonomies of learning and thinking; ADDIE model for curriculum and instructional design; assessment principles; validity and reliability

(Continues)

TABLE 1 (Continued)

ID	Author (year)	Country	Title	Objective	Design and sample	Instructional design characteristics
6	Chiniara et al. (2013)	Canada	Simulation in healthcare: A taxonomy and a conceptual framework for instructional design and media selection	To propose a conceptual framework for the instructional design of educational activities using simulation in the health area	Theoretical study	Instructional medium; simulation mode; instructional method; presentation
7	Cook et al. (2013)	Canada, USA	Comparative effectiveness of instructional design features in simulation-based education: Systematic review and meta-analysis	Evaluate the effectiveness of instructional design features through a systematic review of studies comparing different simulation-based interventions	Systematic review and meta-analysis; 289 studies included/18,971 participants	Evaluation of satisfaction, knowledge, time and non-time skills, behaviours and patient effects outcomes through the varying the key design features of simulation (clinical variation; cognitive interactivity; curricular integration; distributed practice; feedback; group practice [vs. individual]; individualized learning; learning by domain; multiple learning strategies; range of task difficulty; repetitive practice)
8	Craft et al. (2014)	USA	Instructional design affects the efficacy of simulation-based training in central venous catheterization	To compare 2 instructional design models, Experiential Learning Theory (ELT) and Guided Experiential Learning (GEL), to determine which is more effective for training the central venous catheterization procedure	Quasi-experimental randomized block design; 32 medical students (ELT group = 16; GEL group = 16)	Better results with the GEL model: learning objective; reason; overview; concepts, process and principles; demonstration of procedure; practice the procedure; review practice and give feedback
9	de Melo et al. (2017)	Brazil	The use of instructional design guidelines to increase effectiveness of postpartum haemorrhage simulation training	To compare learning outcomes of postpartum haemorrhage (PPH) simulation training based on either instructional design guidelines or best practice	Pre-test–posttest non-equivalent groups study; 54 obstetrics and gynaecology residents (Instructional design group = 36; Best practice group = 16)	The instructional design group format comprised eight steps, including three training scenarios with increasing levels of complexity. The best practice group received the PPH guideline before undergoing a three-step training format, one of which was a training scenario. Better results found in instructional design group.
10	de Melo et al. (2018)	Brazil	Perspectives on the use of instructional design guidelines for health simulation: A literature review	To present a brief summary of introductory cognitive concepts on learning and instruction for simulation, including instructional design guidelines; and provide an overview of the current available evidence on the instructional perspectives on healthcare simulation training effectiveness, in particular with regards to simulation formats, fidelity and simulation site	Literature review; 66 studies included	Authenticity, increasing complexity, appropriate training location, debriefing, opportunity for self-assessment, other forms of assessment, fidelity and simulation location.

TABLE 1 (Continued)

ID	Author (year)	Country	Title	Objective	Design and sample	Instructional design characteristics
11	Dobbs et al. (2006)	USA	Testing simulation design features using an insulin management simulation in nursing education	To test the simulation design features and selected outcomes outlined in the model with 60 students from a large Midwest university enrolled in a required medical/surgical course	Cross-sectional study; 60 nursing studies	High scores on the factors of the Simulation Design Scale: Objective/information; support; problem-solving; feedback; fidelity
12	Fransen et al. (2018)	The Netherlands	Assessment tool for the instructional design of simulation-based team training courses: The ID-SIM	To develop an evidence-based and objective assessment tool for the evaluation of the instructional design of simulation-based team training courses	Validation study; 10 raters (experts)	Tool created through a Visual Analogue Scale based on the 10 instructional design features defined by Issenberg et al. (2005), in a BEME (Best Evidence in Medical Education) systematic review (feedback, clinical variation, repetitive practice, controlled environment, curriculum integration, defined outcomes, difficulty range, individualized learning, learning strategies and simulation fidelity)
13	Fraser et al. (2015)	Australia, Canada	Cognitive load theory for the design of medical simulations	To describe cognitive load theory, its grounding in our current understanding of cognitive architecture and the evidence supporting it	Discussion paper	Cognitive load principles and instructional design recommendations: all (consider the expertise reversal effect); pre-requisite knowledge (segmentation and pre-training); briefing (pre-training, manage emotion); scenario (avoid split attention, avoid redundancy, use dual modality, avoid transient information, provide partially completed or full worked examples, manage emotion and stress, collective working memory effect); debriefing (manage emotion)
14	Gamboa et al. (2019)	Colombia	Instructional design model applied to a virtual guide in clinical simulation	To create a virtual clinical simulation guide for nursing students to have autonomous learning of a clinical-care procedure, through the application of an instructional design model	Methodological study; 159 nursing students	Development of a virtual simulation through the ADDIE instructional design model: analysis, design, development, implementation and evaluation
15	Groom et al. (2014)	USA	National League for Nursing/Jeffries Simulation Framework State of the science project: Simulation design characteristics	Report findings from the review in the state of the art for the simulation design features construct	Literature review	Objectives; fidelity; problem-solving; student support; debriefing

(Continues)

TABLE 1 (Continued)

ID	Author (year)	Country	Title	Objective	Design and sample	Instructional design characteristics
16	Guimond et al. (2011)	USA	Getting ready for simulation-based training: A checklist for nurse educators	To provide an overview of the relevant seminal literature from the science of training, proposes an evidence-based framework for pre-training analysis and presents a handy pre-training checklist to facilitate the use of PS	Discussion paper	Pre-training checklist elements: individual (assess the learner); organization (analyse the college or university's resources, assess gaps of clinical practice environment); task (meet with subject matter experts, identify tasks for training, prioritize task, complete cognitive task analysis); team (assess the team relevant to the task); instructional strategies (perform and evaluate organizational, individual and task analysis, match training with strategy, incorporate concepts, Embed KSA, create opportunity for practice and feedback)
17	Harder et al. (2019)	Canada	Using simulation design characteristics in a non-manikin learning activity to teach prioritization skills to undergraduate nursing students	To discuss the application of simulation design characteristics to a non-manikin-based simulation with a focus on developing prioritization skills.	Discussion paper	Simulation development based on the INACSL Standards of Best Practice: Simulation.
18	INACSL Standards Committee (2021d)	USA	Standards of best practice: Simulation standard IX: Simulation design	Introduce simulation design best practice patterns	Standard	Needs assessment; measurable goals; simulation format; clinical scenario or case; fidelity; facilitator/facilitating approach; pre-briefing; debriefing and/or feedback; evaluation; participant preparation; design test
19	Issenberg et al. (2005)	USA	Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review	Review and synthesize existing evidence in education science that addresses the question, “What are the features and uses of high-fidelity medical simulations that lead to more effective learning?”	Systematic review; 109 studies included	Clinical variation; cognitive interactivity; curricular integration; distributed practice; feedback; group practice (vs. individual); individualized learning; learning by domain; multiple learning strategies; range of task difficulty; repetitive practice
20	O'Shea et al. (2021)	Australia	Key design characteristics of interprofessional simulation-based learning experiences as rated by allied health and nursing students	To report the first non-nursing application of the Jeffries Simulation Design Scale (SDS) tool in dietetics education to assess design features of two interprofessional simulation activities for perceived learner importance	Cross-sectional study; 334 nursing, nutrition, exercise physiology, pharmacy and social work students	High scores on the factors of the Simulation Design Scale: information; support; problem-solving; feedback; fidelity

TABLE 1 (Continued)

ID	Author (year)	Country	Title	Objective	Design and sample	Instructional design characteristics
21	Paige and Morin (2015)	USA	Using Q-methodology to reveal nurse educators' perspectives about simulation design	Discover nursing educators' perspectives (thinking patterns) on simulation design	Study based on Q-methodology; 35 nursing educators	Discovery facilitation; role assignment; student support; interruption and repetition of simulations
22	Rim and Shin (2021)	South Korea	Effective instructional design template for virtual simulations in nursing education	Effective instructional design template for virtual simulations in nursing education	Methodological study; 16 nursing students	Scenario title; scenario target; learning objectives; evaluation; course flow; associated knowledge and skill; feedback strategy; space setting; scenario background; protocols (evidence-based practice guidelines); nursing intervention; storyboard with scenario algorithm; documentation form; mechanical support; scenario characters (characteristics, details of characteristics; items (accessary, equipment); debriefing components
23	Robinson and Dearmon (2013)	USA	Evidence-based nursing education: Effective use of instructional design and simulated learning environments to enhance knowledge transfer in undergraduate nursing students	To detail the application of the ADDIE (analysis, design, development, implementation, evaluation) model of instructional design to the use of simulation in nursing education in an effort to facilitate improved clinical performance in new graduate nurses	Theoretical study	ADDIE instructional design model: analysis, design, development, implementation and evaluation
24	Roh et al. (2021)	South Korea	Nursing students' perceptions of simulation design features and learning outcomes: The mediating effect of psychological safety	To determine whether psychological safety mediates the relationship between students' perceptions of simulation design features and learning outcomes.	Cross-sectional study; 194 nursing students	High scores on the factors of the Simulation Design Scale: objectives and information; support; problem-solving; feedback; fidelity
25	Schaefer et al. (2011)	USA	Literature review: Instructional design and pedagogy science in healthcare simulation	To provide the beginnings of an assessment of these three aspects of the science that support the use of simulation in healthcare education as revealed in a review of the published literature	Literature review; 221 studies included	I. Validation of simulator; II. validation of performance evaluation; III. design of educational intervention; IV. analysis of translational impact
26	Wasfy et al. (2021)	Egypt	Effectiveness of instructional design framework based on cognitive load theory for clinical skills training	To design an instructional framework to optimize the total cognitive load imposed on the medical students during their clinical skills training in the clinical skills laboratory	Quasi-experimental posttest design; 104 medical students (Intervention group = 52; Control group = 52)	Segmentation and pre-training; manage emotions and avoid split attention; manage emotions and pre-training; pre-training and segmenting; activation of learners' prior knowledge; worked examples; worked examples—dual modality; self-explanation

TABLE 2 Mapping of simulation design components and their classification according to structural, methodological and theoretical–pedagogical components

Simulation design components	Studies 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	*N*
Structural																											
Scenario structure and duration	✓												✓				✓	✓								✓	5
Modality						✓											✓	✓									3
Fidelity			✓		✓					✓	✓	✓			✓		✓	✓		✓				✓			10
Simulator type					✓	✓																			✓		3
Scenario	✓			✓	✓	✓							✓	✓			✓	✓				✓	✓			✓	11
Script for contextualizing the scenario																	✓	✓									2
Methodological																											
Composition of participants and roles				✓		✓	✓					✓				✓			✓		✓	✓					8
Definition of learning objectives		✓	✓	✓	✓			✓		✓	✓			✓	✓		✓	✓		✓		✓	✓	✓			15
Instruction and pre-briefing			✓		✓	✓							✓													✓	5
List of expected actions									✓								✓	✓									3
Learning assessment	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		21
Use of support materials	✓							✓	✓								✓	✓									5
Debriefing	✓		✓					✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓		✓		✓		✓	16
Theoretical–pedagogical																											
Curriculum integration		✓	✓	✓	✓		✓	✓				✓							✓								8
Facilitation	✓		✓		✓		✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓			✓		✓	17
Problem-solving				✓			✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓		✓	16
Theoretical–conceptual structure	✓	✓			✓			✓						✓		✓	✓	✓					✓				9
Potential for interdisciplinarity						✓										✓	✓	✓									4
Flexibility for interprofessional application						✓											✓	✓									3

In the environmental, conceptual and psychological aspects of fidelity, we exemplify: (a) environmental—referring to available resources, such as laboratory and mannequin; (b) conceptual—related to the execution of the strategy and how it should make sense from a pedagogical point of view; and (c) psychological—related to the extent to which the synergy between the three aspects will reach the participant, immersing him or her in this context capable of problematizing reality (INACSL Standards Committee, 2021c).

Numerous studies compare the impact of fidelity levels on learning domains and on emotions experienced in simulated environments (Kim et al., 2016; La Cerra et al., 2019), suggesting that high levels of fidelity are related to positive students' outcomes. However, for the most part, studies only address simulator fidelity, with the effect of different fidelity aspects on learning outcomes obtained in SBE being an important gap. We suggest a special attention to the psychological level of fidelity because the immersion is core to simulation success and it is a strategy that can be applied in different places, with various levels of resources (Massoth et al., 2019).

To improve realism and to create opportunities for different SBE, there is a diverse range of strategies which can be used, such as the performance of actors or standardized patients, the use of computers, body parts simulators or complete mannequins and virtual patients (using different technological resources, including virtual reality; Chiniara et al., 2013; INACSL Standards Committee, 2021d).

The choice of the best simulator or strategy that simulates a human interaction in the health context depends both on the defined learning objectives and on the available resources. It considers the limitations of using technologically advanced simulators that are closer to reality, due to the high cost of obtaining and maintaining these resources (Al-Ghareeb & Cooper, 2016; Lapkin & Levett-Jones, 2011). In this sense, low-fidelity simulators continue to be widely used in SBE, and with creativity to increase the level of realism of the activity (in terms of conceptual and psychological external scenario to the simulator), they can achieve satisfactory results in learning outcomes (Massoth et al., 2019).

The scenario can favour the development of critical thinking, clinical reasoning and decision-making, aspects that are constantly required in clinical practice (Chiniara et al., 2013; INACSL Standards Committee, 2021d). It must promote an authentic experience of an active role in the participants; be reproducible and reliable, with outcomes consistent with reality.

In its execution, there must be elements that allow the students a certain level of control over the situation and count on the students' autonomy to carry out the activity (process planned by the professor beforehand; INACSL Standards Committee, 2021b). To this end, it is necessary to take care of the complexity level of the task, being consistent with the training stage (Groom et al., 2014).

Another determining aspect is the validation of the scenario (INACSL Standards Committee, 2021d), which is a less commonly explored factor in simulation studies, as well as it is fundamental to guarantee realism and evidence-based practice. In this sense, the scenarios must be carried out based on the best evidence and validated by experts in the field (O'Brien et al., 2015). The constant updating of the information in the health area demands periodic reviews to guarantee the quality of the scenario over time, the engagement and the learning of the participants.

In the simulation scenario, the students' roles determine the development of individual and collective learning (Bates et al., 2019; Scherer et al., 2013). Scholars have discussed learning from the point of view of the simulation observer, not identifying differences compared with the participants that effectively interfere in the scenario (Bates et al., 2019; Norman, 2018). However, it is still necessary to verify the difference between the roles of observer and participant in relation to the cognitive, attitudinal and procedural domains of learning. In addition, it is required to analyse the different forms of observation: in the same space or watched by video/videoconference.

Although well defined in the literature, it is worth highlighting that theatre or staging is not a simulation. For the simulation to take place, the students who participate in it do not receive a script of speeches or step-by-step actions, as they do not receive this prescription in clinical practice. SBE require that the students play an active role in solving the presented problem, didactically prepared, to develop knowledge mediated by the facilitator (INACSL Standards Committee, 2021a). The idea is to provide the emotion of being the responsible to make decisions, to think critically using clinical reasoning, and mobilize skills and knowledge. It would not occur if the scripts were pre-defined, because there would not exist autonomy of the participants to decide and to implement their interventions, rather than follow a prescribed action.

The composition of facilitators is defined by the type of instruction, which can be instructor-based or self-instruction (Chiniara et al., 2013; INACSL Standards Committee, 2021a). In the context of health education, the presence of professors/instructors is highly widespread with different types of intervention depending on the established learning objectives and simulation outcomes (Mills et al., 2016). Yet, it is necessary that in the development and implementation of SBE, the team works in an integrated way with the curriculum aligned to the objectives and the performance of the students (Weis et al., 2018; Zheng et al., 2020).

Regarding the structure, it is essential that professors prepare a guiding document, both to guarantee the systematic planning of the activity and to enable its reuse in teaching–learning situations that have the same learning objectives, maintaining rigour and the design step. This activity is already carried out in teaching practice in the elaboration of lesson plans, which facilitates the recognition of its importance by the professor (INACSL Standards Committee, 2021b; Kaneko & Lopes, 2019; Lunde et al., 2021). Through the definition of the structure, the operational step is proposed a priori and must ensure alignment with the methodological proposal.

The methodological components define the following composition: participants and instructors/facilitators; the roles that will be used in the scenario; the instruction; the facilitation framework adopted in the pre-briefing and debriefing; the list of actions expected from the student; and the professor intervention plan in the simulated scenario.

The literature points out three types of pre-briefing: model case, reverse case and case report (Page-Cutrara, 2015). The first one consists of the presentation of the simulated scenario and its theme, with the information given by the facilitators, such as guidance on the simulator, the establishment of a safe environment for the participants and time for planning the actions. In the reverse case, the objectives and information are not presented to the participants, without active facilitation before or during the simulation. The case report is in line with the standards recommended by INACSL (McDermott et al., 2021). It consists of a case presentation immediately before the simulation, with the presentation of the learning objectives, but without the opportunity to anticipate or plan care (Page-Cutrara, 2015).

The preparatory activities must evoke knowledge, skills and attitudes that will be required from the participants. According to INACSL Standards Committee (2021a), “prior reading, concept map, assignments, didactic sessions, answering specific questions of the simulation, watching audiovisual material, pre-test, review of documents of health record, review and practice of activities.” In addition to the issues related to learning already mentioned, pre-briefing reduces anxiety and increases participant performance, according to the perception of facilitators/professors (McDermott, 2016).

Debriefing is an inherent step in the simulation (INACSL Standards Committee, 2021e), conducted to promote a guided reflection on important points of discussion, with active participation by all the members involved, primarily listening to those who acted directly in solving the scenario's problems, under facilitator guidance. The dialogue is structured in phases that will promote the summarization of knowledge, with the opportunity of using educational techniques and strategies to increase the impact on learning. The guided reflection in the debriefing can be structured in different ways, in three or more phases, depending on the framework used (Sawyer et al., 2016).

Studies have evaluated the impact of different debriefing modalities on the learning of nursing students (Alhaj Ali et al., 2020; Lee et al., 2020; Zhang et al., 2020); however, there are still few studies that evaluate the impact of pre-briefing (Chamberlain, 2017; Roh et al., 2018) in the teaching–learning process, especially comparing the types of pre-briefing model case, reverse case and case report (Page-Cutrara, 2015).

Learning assessment is a well-known element of teaching planning and is also present in the simulation strategy. By doing so, the professor must clearly define the learning objectives, whose recommendation for the simulation is that they follow the acronym SMART (Specific, Measurable, Achievable, Realistic and Timephased; Bjerke & Renger, 2017).

The assessment of learning in the context of simulation is established in the strategy design phase (INACSL Standards Committee, 2021a). It can be carried out individually or collectively, as well as being used for student progression in simulation activities associated with deliberate practice (Issenberg et al., 2005; Paige & Morin, 2015). It should include the perspective of participants, observers, facilitators and professors, in order to guarantee the quality of the experience (INACSL Standards Committee, 2021a).

Furthermore, simulation can be used in both formative and summative evaluation (INACSL Standards Committee, 2021e), providing information to students about their development competence level and clarity about the next steps of learning. However, it is theorized that because they are being evaluated, students may feel vulnerable, which can bring some barriers in participating in simulation activities and requires further investigation.

As for the theoretical–pedagogical components of the simulation design, facilitation stands out—a fundamental aspect of this teaching–learning strategy. Professor facilitation is mainly influenced by their pedagogical perspective that guides teaching practice. Simulation is a teaching–learning strategy with active methodology, didactically prepared and organized with methodological rigour, that provides student autonomy and value their previous knowledge during the education process. This description can connect SBE to meaningful learning theory, postulated by Ausubel (1968).

According to Ausubel, there are two conditions for students to learn meaningfully: (a) Student motivation per se and (b) Potentially meaningful content to be learned—logical, considering the nature of the content, and psychological, regarding each person previous experience and knowledge and how it connects with the new learning (Agra et al., 2019).

They are aligned as well with emancipatory education, especially in the role of facilitators, overcoming the traditional role of faculty as the only holder of knowledge that aims to transfer it to students who must passively absorb (Freire, 2016).

Within the scope of learning theories (Ostermann & Cavalcanti, 2011), as well as the problematization contained in the emancipatory education framework, constructivism and sociocultural theories are aligned with simulation, which deals with learning through cognitive assimilation stimulated by a challenge that is actively faced in the learner's cognitive processes, and mediated by other people—colleagues and facilitators.

Once the facilitators recognize themselves pedagogically, they must ensure the recognition of fundamental aspects of the simulation of scenario organization, psychological safety, confidentiality and rules. Providing or not the student with clues for solving the simulated scenario, as well as the facilitation of learning provided by the discussion among participants in debriefing, motivating observers to participate and reflect on action (Arthur et al., 2013; Groom et al., 2014; INACSL Standards Committee, 2021a).

Summing up to facilitation, other theoretical–pedagogical characteristics are fundamental for the success of the strategy in nursing and health education, such as the integration of simulation with the curriculum, ensuring that it makes sense in an expanded context of education; the definition of the guiding theoretical–conceptual framework, potential for interdisciplinarity and flexibility for interprofessional application (Bryant et al., 2020; Starkweather & Kardong-Edgren, 2008).

Since problem-solving is key in SBE, it concerns the elaboration of simulation activities with a focus on providing an opportunity to solve real clinical situations in a simulated environment.

The level of complexity may vary depending on the objectives established by the professor (Groom et al., 2014), considering students' needs for learning and phase of the course, and if the level is perceived as higher when running the scenario, it is possible to provide clues to help participants to progress in the simulated scenario and achieve the goals (Cook et al., 2013; Groom et al., 2014; Paige & Morin, 2015).

An aspect that appeared in two analysed studies and was not included as a component in the proposal of the present work is the opportunity or not of repetition of the simulated scenario (Cook et al., 2013; Issenberg et al., 2005). This aspect, in the context of the simulation, is called deliberate practice and is usually associated with feedback provided during scenario development (Chiniara et al., 2013). Some studies have addressed the effect of deliberate practice and pointed out to positive results in the opportunity of students performing their activities more than once, especially focusing on actions based on mistakes and successes (Li et al., 2019; McKendrick-Calder et al., 2019).

It was not included as a component in this proposal of simulation design classification, because it is optional, and it is not part of the fundamental method. Additionally, it must be further studied to understand whether students will feel motivated during the repetition and whether repetition plays a different role from debriefing in the meaningful learning perspective.

In terms of repetition being feasible, the virtual simulation guarantees reproducibility, given its computational nature, allowing the students to access it as many times as they want, improving their skills over time, following their pace and time availability, until reaching the desired level of proficiency (Foronda et al., 2020; Padilha et al., 2018). For laboratory simulation, it requires new intervention by all involved and it must be carefully planned to ensure that it is an interesting, purposeful and motivating action.

Finally, in the scope of theoretical–pedagogical components, the inclusion of SBE in the undergraduate curriculum is a way to improve learning outcomes through the integration between disciplines, the use of different teaching methods and achievement of measurable results established by the professor (Zheng et al., 2020). However, the impact of this curricular integration in the transposition of competences to clinical practice, which is still scarcely explored by studies and, when explored, the assessment is carried out only in a simulated environment (Choi et al., 2020; Tan et al., 2017), representing an important gap for future research.

This review presented a limitation due to not going into the design details of the different forms of simulation, for example the convergences and divergences between the laboratory simulation, virtual simulation and tele simulation approaches, topics for future research.

7 | CONCLUSION

Based on the findings of this review, we identified that the simulation design components can be categorized as structural, methodological and theoretical–pedagogical. The proposed summarization and description contained in this work can contribute to the improvement of the planning and systematization of SBE, improving the application of this strategy in the educational context. Although nursing has an important theoretical framework on simulation, the mapping carried out in this review on the components of simulation design in different areas can help consolidate the elaboration of interprofessional simulation scenarios and advance the study of simulation. It is recommended future research to assess the influence of different simulation designs on the domains of learning, training skills and the emotional aspects of students.

AUTHOR CONTRIBUTION

George Oliveira Silva: Conceptualization, methodology, investigation, data curation, writing—original draft, writing—review and editing, supervision and project administration. **Luciana Mara Monti Fonseca, Karina Machado Siqueira, Fernanda dos Santos Nogueira de Góes and Laiane Medeiros Ribeiro**: Methodology and writing—review and editing. **Natália Del' Angelo Aredes**: Conceptualization, methodology, data curation, writing—original draft, writing—review and editing, supervision and project administration.

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]:

- substantial contributions to conception and design, acquisition of data or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX 1

TABLE A1 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	1
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	1-3
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.	Title page
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	4
Information sources[a]	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	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated	4; Supplementary File 1
Selection of sources of evidence[b]	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review	5
Data charting process[c]	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 use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made	5
Critical appraisal of individual sources of evidence[d]	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	5
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
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations	6-7
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12)	NA

(Continues)

TABLE A1 (Continued)

Section	Item	PRISMA-ScR checklist item	Reported on page #
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	Table 1
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives	6-7; Table 2
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	7-13
Limitations	20	Discuss the limitations of the scoping review process	13
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	13-14
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	14

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

From: Tricco et al., 2018.

[a]Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

[b]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).

[c]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.

[d]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).