Digital health education and training for undergraduate and graduate nursing students: A scoping review

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Abstract

Background: As technology will continue to play a pivotal role in modern-day healthcare and the potential impact on the nursing profession, it is vitally important to examine the types and features of digital health education in nursing so that graduates are better equipped with the necessary knowledge and skills needed for providing safe and quality nursing care and for them to keep abreast with the rapidly evolving technological revolution.

Objective: The scoping review aims to examine and report on available evidence about digital health education and training interventions for nursing students at the undergraduate and graduate levels.

Methods: The scoping review was conducted using the Joanna Briggs Institute methodological framework and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). A comprehensive search strategy was developed and applied to identified bibliographic databases including MEDLINE (Ovid; 1946–present), Embase (Ovid; 1974–present), CINAHL (EBSCOhost; 1936–present), ERIC (EBSCOhost; 1966–present), Education Research Complete (EBSCOhost; inception-present), and Scopus (1976–present). The initial search was conducted on March 03, 2022, and updated searches were completed on January 11, 2023, and October 31, 2023. Due to the volume of the included studies, a hand-search of the included studies could not be completed for additional studies. For grey literature sources, the websites of select professional organizations were searched to identify relevant digital health educational programs/courses available to support the health workforce development. Two reviewers screened and undertook the data extraction process. The review included studies focused on the digital health education of students at the undergraduate or graduate levels or both in a nursing program. Studies that discussed instructional strategies, delivery processes, pedagogical theory/frameworks, and evaluation strategies for digital health education, and applied quantitative, qualitative, mixed methods, and descriptive or discussion papers, with the exception of review studies, were included. Opinion pieces, editorials, and conference proceedings were excluded.

Results: A total of 100 records were included in this review. Out of these, 94 records were identified from database searches and six sources were from the gray literature. Despite improvements, there are significant gaps and limitations in the scope of digital health education at the undergraduate and graduate levels, consequently posing challenges for nursing students to develop competencies needed in modern-day nursing practice.

Conclusions: As the digital health ecosystem continues to evolve, nursing education and practice must evolve too. There is an urgent need to expand the understanding of digital health in the context of nursing education and practice and to better articulate its scope in nursing curricula and enforce its application across professional nursing practice roles at all levels and career trajectories. Further research is also needed to examine the impact of digital health education on improving patient outcomes, the quality of nursing care, and professional nursing role advancement. Clinical Trial: Review registration number: Open Science

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Review registration number: Open Science Framework osf.io/42eug.

Keywords: curriculum; digital health; health informatics; nursing education; nursing students; undergraduate; graduate

Abstract word count: 461/500

Introduction

The World Health Organization (WHO) emphasized the important role of information and communication technologies (ICTs) in facilitating ehealth services and urged health systems to embrace emerging technologies such as artificial intelligence (AI) and big data analytics considering their potential to radically change health outcomes. However, this requires intentional investments in people and processes as well as national-level strategies to realize the vision of a digitalized health sector [1]. Correspondingly, as the largest group of healthcare professionals, “there is an urgent need

for the nursing workforce to acquire the skills and competencies to deliver high-quality, safe, optimized person-centred care in a digital health environment and to lead and participate in digital health initiatives, decision-making, and evaluation" [2P.4].

Digital health is a new and evolving term that is often used interchangeably with other terms including ehealth, mhealth (mobile health), virtual care, and telehealth to name a few [3]. These terms have evolved over time and can be understood by examining the eras of the industrial revolution impacting society, including healthcare. During the periods 1950 – 1960 (Mainframe Computer Era) and 1970 – 2000 (Health IT Era) (1970 – 2000), technological development was in its infancy; as such healthcare systems focused on basic use of information technology (IT) systems to manage enterprise information and logistics. The eHealth Era (2000-2020) witnessed an expansive use of ICTs such as electronic health records (EHRs) and increased consumer engagement in decision making and self-care through digital technologies such as apps and personal health records [3]. In this period, terms such as mhealth and eHealth were popular. Services such as telehealth were also available but mostly as specialized and organization-based platforms. Telehealth refers to the "delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies. Examples of the technologies used in telehealth include but are not limited to live video conferencing, mobile health apps, 'store and forward' electronic transmission, and remote patient monitoring" [4]. The period between 2020 and beyond marked the Digital Health Era, which is anticipated to revamp healthcare as a result of the integration of more sophisticated technologies including AI, robotics, machine learning, the Internet of Things, virtual reality, and wearables. These advancements are shifting the focus of healthcare from the provider to a person-centred model and creating opportunities to improve health services modalities, system performance, therapeutics and treatments, and all aspects of healthcare [3]. During this period, the term virtual care emerged during the COVID-19 pandemic. Virtual health denotes the facilitation of the delivery of care services through any remote interactions between patients and healthcare providers, and between healthcare providers themselves, whether synchronous or asynchronous, using ICTs [5].

Although some progress has been achieved in increasing nurses' digital health capacity, the expanded and rapid integration of technological innovations in healthcare has created challenges for nursing educators and nursing programs to keep pace and ensure that nurses are well-prepared to lead the digital transformation impacting professional practice roles and patient care [6-9]. In addition, while the majority of nursing students have strong basic digital literacy skills, these skills don't necessarily translate into effective use of digital health technologies in the context of patient

care [8,10,11]. Sometimes, assumptions about the use of technology in the academic setting puts nursing students at a disadvantage, resulting in missed learning opportunities for students to develop competency in working with digital health technologies available in the clinical environment [8,12]. In Canadian nursing, approaches currently applied for preparing students at the undergraduate level in digital health mainly focused on integrating informatics within existing courses; however, this integration is mostly inconsistent and sporadic [8,13,14]. Similar to the Canadian context, in other countries the nursing informatics (NI) competencies, which should serve as a guiding framework for content integration in nursing curricula and as standards for professional practice requirements in the workplace, have limited to no focus on emerging technologies [15-17]. Further, the adoption of these NI competencies in the workplace and their impact on patient outcomes remains largely unknown [8,18].

Nursing education is a key pathway for preparing nurses to assume professional roles in diverse practice settings. Providing nurses and nursing students with a comprehensive education in digital health should be an urgent priority so they are better equipped with the necessary knowledge and skills needed for providing safe and quality nursing care and for them to keep abreast with the rapidly evolving technological revolution. This is also important so that nurses are better able to support patients and families as they navigate the health system and make decisions about using these technologies for health promotion and chronic disease management, and to ensure that digital health services and technologies brought into the healthcare system are equitable, bias-free, and accessible [2,9].

To identify current approaches for digital health education at the undergraduate and graduate nursing education levels, a preliminary search of available literature was conducted to identify prior work on this topic, and several reviews were retrieved. Some reviews focused on NI and digital health competency frameworks and the integration of NI into nursing curricula [15,16,18,19]. Other reviews addressed the learning outcomes of digital learning interventions in higher education [20] and technological literacy in nursing education [21]. The remaining reviews examined the influence of AI on different domains of nursing [22] and the effectiveness of telehealth educational interventions in graduate nursing education [23]. Another search was conducted on December 1, 2023, to identify if new reviews have been published since the initial search was conducted on January 05, 2022, and a scoping review protocol was found in CINAHL plus database that focused on NI education in undergraduate nursing education [24].

Based on the evidence available on the digital health education for nursing students, the authors believe a gap exists in the literature, particularly assessing the current state with respect to how

nursing education at the undergraduate and graduate nursing levels addresses digital health education about existing and emerging technologies. Therefore, this scoping review aims to report on evidence available about digital health education and training interventions for nursing students at the undergraduate and graduate levels.

Review Question

The review aimed to answer the following question: What are the types and features of digital health education and training interventions currently available to guide teaching and curricular integration/ education about digital health for nursing students at the undergraduate and graduate levels? More specifically, this review analyzed and synthesized information on the following elements: 1) The definitions of digital health and learning objectives and/or topic content addressed in the digital health intervention; 2) the instructional strategies used and their delivery process; 3) the pedagogical theories or frameworks used; and 4) the outcomes measured, and evaluation/assessment strategies used for measuring them.

Inclusion criteria

Participants

The scoping review considered studies that included nursing students at the undergraduate or graduate levels admitted to public or private institutions. Furthermore, the review included students enrolled in undergraduate or graduate nursing programs, qualifying graduates for various nursing roles such as generalist entry-to-practice programs for Registered Nurses, Licensed Practical Nurses (LPNs) or Registered Practical Nurses (RPNs), Nurse Practitioners (NPs), Registered Psychiatric Nurses (RPNs). Empirical studies that reported on digital health education for qualified nurses working in practice settings or studies reporting on students in other health-related professions (e.g. medicine, pharmacy, physiotherapy) or allied health staff (e.g. Healthcare aids) were excluded because these professions are not the subject of interest in the review.

Concept

The primary concepts of significance to the review are education and training for nursing students about digital health. Other related concepts included are instructional strategies, delivery processes, pedagogical theory/frameworks and evaluation strategies. Since the use of different technologies in health professionals' education exists, the authors contend that the use of technologies for learning and teaching purposes differs from the use of digital health technologies for care delivery. Consequently, studies that focused on the use of instructional technologies, such as PowerPoint,

simulation and virtual reality for teaching/learning purposes in the classroom or laboratory or for learning about general clinical nursing skills, as opposed to education/learning/training for acquisition of digital health knowledge and competence were excluded. Studies that only examined an aspect of digital capabilities or NI competency, such as computer or information literacy and/or focused on NI competency without explicitly linking the concept to digital health were excluded. If studies focused on aspects of medical technologies, such as CT scans and in-vitro fertilization, such studies were also excluded.

Context

The review considered studies that examined digital health education for nursing students admitted to educational institutions (colleges or universities) at undergraduate and/or graduate programs or both. There was no limit on the geographical location of published studies, as the authors wanted to be comprehensive in their search and provide an in-depth analysis of the literature from multiple geographical locations.

Types of sources

The scoping review considered all methodological and theoretical papers, including quantitative, qualitative, and mixed methods study designs. Systematic, scoping, integrative, umbrella, and narrative review studies were excluded but used in the discussion section to provide further information. In addition, opinion pieces, editorials, and conference proceedings were also excluded due to the insufficient information these sources offer to contribute to the evidence available. Further, a hand search of reference lists of included studies to search for missing studies was planned but not completed due to the large volume of searches retrieved. A selected gray literature sources were searched for additional evidence and insights.

Methods

The scoping review was conducted following the Joanna Briggs Institute (JBI) methodology [25] and in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) [26]. The review followed a priori protocol [27].

Search Strategy

A health sciences librarian developed a comprehensive search strategy according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Searching (PRISMA-S) [28]. To ascertain the feasibility and testability of the search strategy, an initial search was conducted in CINAHL (EBSCOhost) as published in the study protocol [27]. All identified databases were

searched, and the search strategy was adapted as appropriate. The following bibliographic databases were searched from inception to present MEDLINE (Ovid; 1946–present), Embase (Ovid; 1974–present), CINAHL (EBSCOhost; 1936– present), ERIC (EBSCOhost; 1966–present), Education Research Complete (EBSCOhost; inception-present), and Scopus (1976–present) (Appendix I). The search used subject headings, wherever available, and appropriate keywords to capture relevant peer-reviewed literature. The search strategy was derived from 2 main concepts: 1) digital health, applying descriptors associated with the term, such as virtual, telehealth, or remote delivery, to capture the most relevant literature; and 2) nursing education, both undergraduate and graduate level, as well as competencies and curricula. A multi-database search was completed for ERIC and Education Research Complete as these databases were available on the same platform, and the search strategy for these databases did not include any subject headings.

Only studies published from 2012 to 2023 were included because the authors wanted to capture current and relevant articles. Also included were studies published in the English language, as authors speak only English. The non-peer-reviewed materials such as notes, editorials, letters, books, and book chapters were removed from the results as they had limited information to contribute to the findings and discussion. The initial database searches were conducted on March 03, 2022, and updated searches were completed on January 11, 2023, and October 31, 2023. The same search strategy was used for each updated search to ensure consistency and identify any recently published papers. For gray literature sources, select relevant organizational sources were identified and searched for information regarding digital health education being offered to gain insights on which topics are addressed and the target audiences for such education. Limiting this search to a few organizations was intentional, considering the volume of information that can be found on the Web.

Study/Source of Evidence Selection

Retrieved records were exported in complete batches into the Mendeley reference manager software to generate bibliographies and the Covidence software (Veritas Health Innovation) for deduplication and to enable the screening process. To increase the reliability of the screening process, two reviewers (SI, SA) independently determined the eligibility of articles against the inclusion and exclusion criteria using a two-stage screening process consisting of a title and abstract scan followed by a full-text review. All disagreements were resolved in consultation with other reviewers (MK, ED). The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) chart was used to document inclusion and exclusion decisions and ensure transparency and rigor in reporting (Figure 1). Where full-text articles were excluded, reasons were provided for the exclusion

(Appendix II).

Data Extraction

Two independent reviewers (SI, SA) extracted data from the included studies and recorded it into an open-access Google spreadsheet. The included studies were extracted based on the extraction table as published in the a priori protocol [27]. To enhance reliability, the independent reviewers piloted the extraction table on 10 records (qualitative, quantitative, and mixed method study designs) and after comparing results, no further modifications were made to the extraction table. For each record, the following information were extracted: record information (i.e., author[s], year of publication, study aim/purpose); population/sample (nursing students/level); context (country/program); concept (digital health existing and emerging technologies, the definition of digital health if provided, instructional strategy used and delivery process [e.g., lecture, video, case-based scenario, pedagogical theory/framework, outcomes measured [e.g., knowledge gain], assessment methods or approaches [e.g., instrument/tool, quizzes]); key findings; and recommendations. Any disagreements were resolved with other reviewers (MK, ED).

Data analysis and interpretation

Basic descriptive statistics (i.e., percentages/proportions) were applied to analyze and report key characteristics of studies included in the review. Using an iterative, descriptive approach, abstracted data from the included studies were examined for similarities and differences to identify patterns and facilitate thematic grouping of findings to answer the research questions. All members of the research team engaged in the discussion of the results and agreed upon the adequacy of the proposed thematic grouping. A tabular format was used where appropriate to provide a visual representation of the findings [25,29]. Appendices were used to provide access to information relevant to the conduct of this review and facilitate future research. Quality appraisal of included studies was not completed as it is not a requirement for scoping reviews.

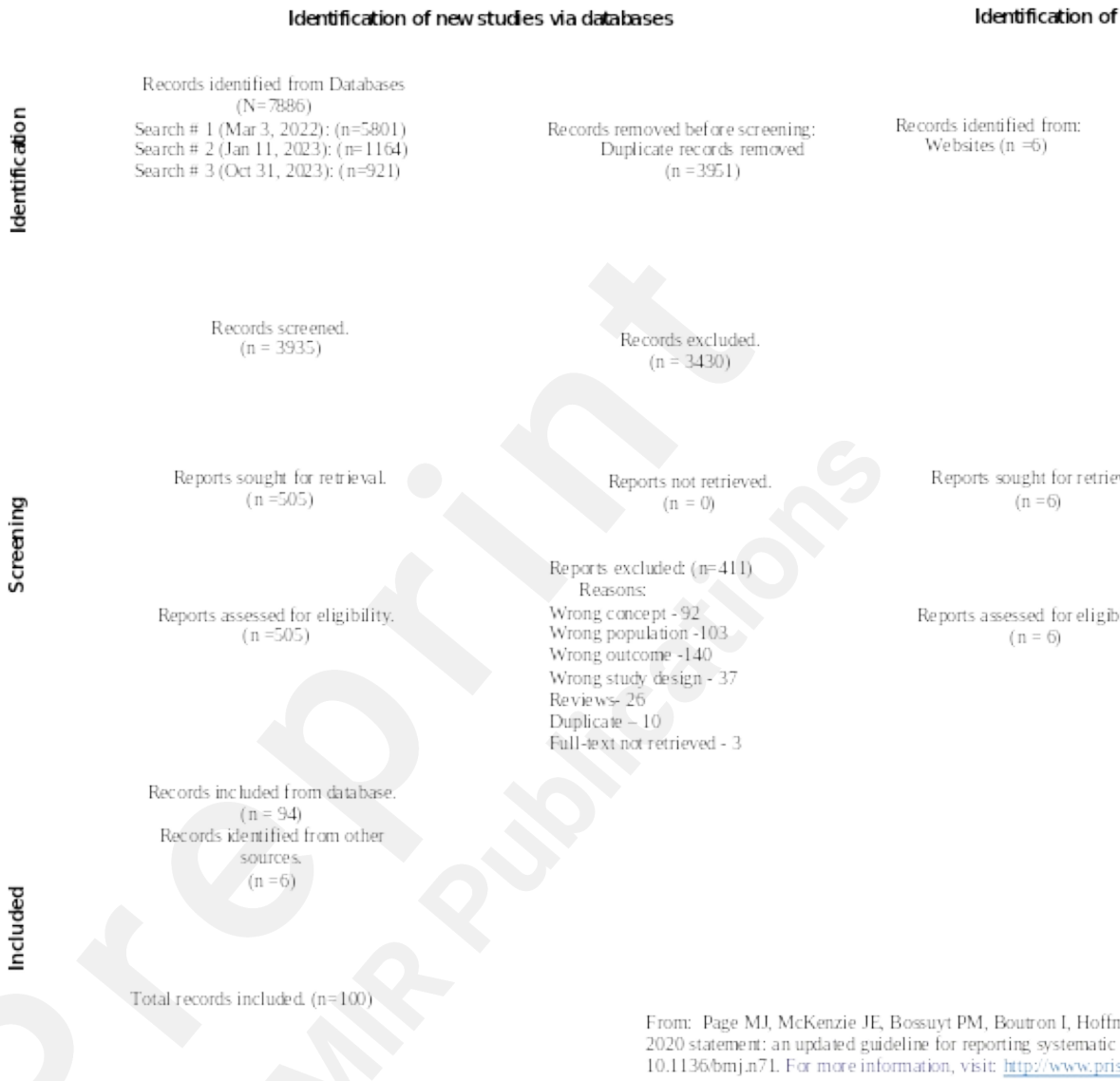
Results

Study Inclusion

As shown in the PRISMA chart (Fig.1), combining all three searches together, we identified a total of 7886 studies. After removing duplicates and completing first level and second-level screening, 94 records were included from the database searches. Six sources from the gray literature were included. These pertained to educational resources published on the websites of select organizations, including

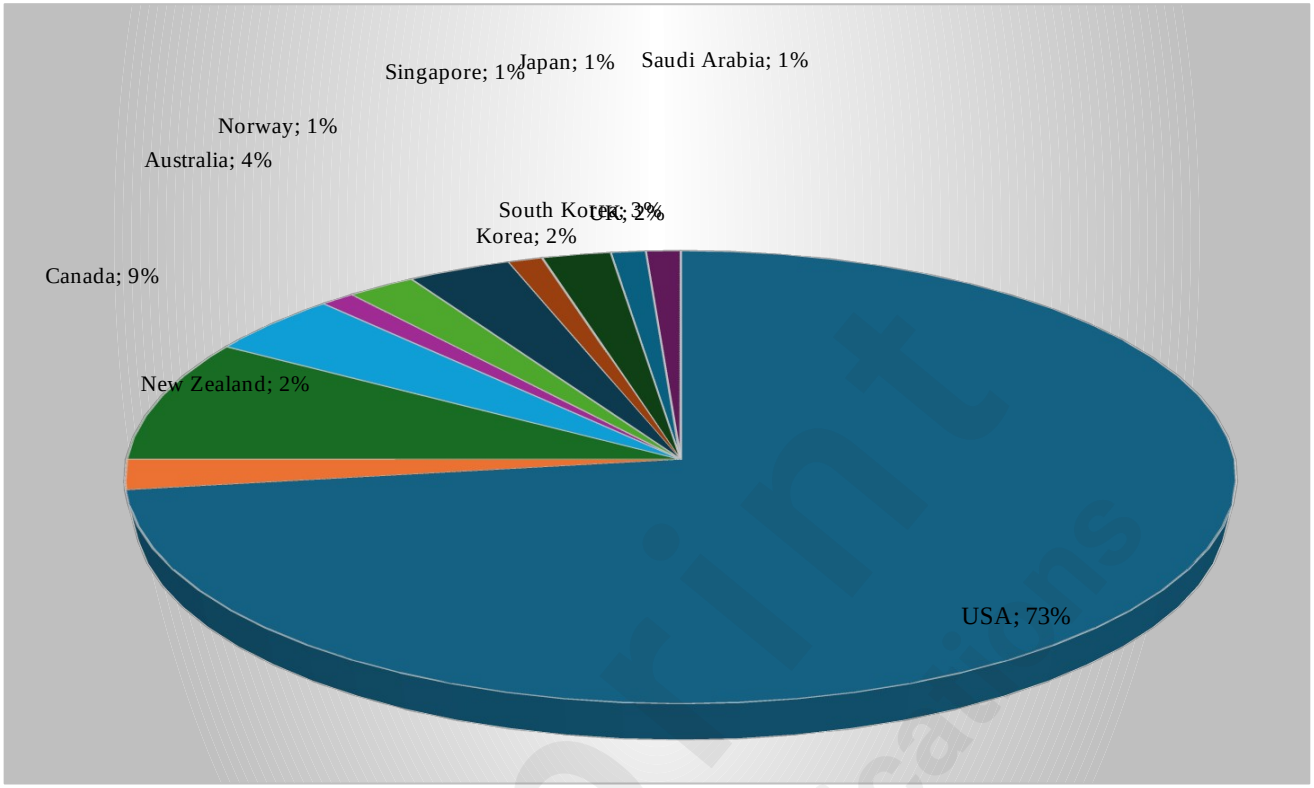
Digital Health Canada, Coursera, Healthcare Information and Management Systems Society (HIMSS), Canadian Nursing Informatics Association (CNIA), Canadian Association of Schools of Nursing (CASN), and the Open World Health Organization (Appendix III). In total, 100 records were included in this review.

Figure 1 PRISMA Chart



Characteristics of included studies.

Out of 94 included studies from databases, the majority (n=67, 71.2%) were published within the last five years (2019-2023). Studies were mainly conducted in the United States (n=69) followed by Canada (n = 8). The remaining were a few studies from New Zealand, the United Kingdom, Australia, South Korea, Japan, Singapore, Norway, Korea, and Saudi Arabia (Figure 2). The research populations in these studies included representations from nursing students at the undergraduate and graduate levels, and/or decision makers incharge of planning educational offerings. There were no studies involving LPN students or their educational preparation in digital health.



Review Findings

Table 1 provides a visual presentation of the range of studies included in this review classified according to the type and focus of the research study and the level of nursing education (undergraduate and graduate) in order to facilitate the reporting of the findings according to the review questions. Detailed abstraction tables of all included studies from databases are available in Appendix IV. The review of the six websites comprising the gray literature sources is also provided in Appendix III.

Table 1: Overview of the records included in the review.

Study Type		Level of Nursing Education	
Database Sources	Records	Undergraduate	Graduate
Interventional studies	61	Telehealth (n =11): [30-40]	Telehealth (n=30): [41-70]
		EHR training (n = 10): [71-80]	DH (n=2): [81,82]
		NI (n = 2): [83,84]	EHR (n =2): [85,86]
			NI (n = 4): [87-90]
Curriculum Status & Integration	14	[13,91-103]	
Proposed Strategies for Integration	19	[12,104-121]	
	94		

Gray literature Sources	6	
Total	100	

The included literature sources revealed a proliferation of educational offerings (Appendix IV) and these sources were examined to identify whether or not authors have included a definition of digital health. A few studies involving undergraduate level [13,102] and graduate level education [81,82] cited the definition by HIMSS, which defined digital health as healthcare delivery that "connects and empowers people and populations to manage health and wellness through technology. Care is augmented by accessible and supportive provider teams working within flexible, integrated, interoperable, and digitally enabled care environments that strategically leverage digital tools, technologies, and services to transform care delivery" [122p. 24]. The definition proposed by the WHO including the initial one in the draft of the global digital health strategy document published in 2019 or the one reported in final document, defines digital health as "the field of knowledge and practice associated with the development and use of digital technologies to improve health… Digital health expands the concept of eHealth to include digital consumers, with a wider range of smart and connected devices. It also encompasses other uses of digital technologies for health such as the Internet of Things, advanced computing, big data analytics, artificial intelligence including machine learning, and robotics" [1p. 11].

Digital Health and NI Educational Interventions at the Undergraduate Level

At the undergraduate level, the main focus of education delivered was on telehealth and/or telenursing [30-40] and developing competency in using the EHR through the simulated EHRs [71-80]. Two studies focused on NI education [83,84]. Of note, some of these interventions were implemented or developed in response to the COVID-19 pandemic [30-34,38].

Interventions focused on telehealth education. The scope of the telehealth theoretical education in the included studies varied but mainly focused on a pre-preparation for the telehealth simulation. In one study, a range of topics including telehealth etiquette, professionalism, peripherals, technologies, documentation, billing, collaboration, and history taking were taught, [31] using different teaching modalities to deliver the content such as online modules, [31] ebook and video [30]. One study reported the use of a telehealth clinical placement experience, [32] another study applied an online clinical experience, [34] but the

remaining studies applied a simulation methodology.

Integration of simulation experiences was mostly as a stand-alone intervention, a few studies reported integration as part of an existing course. These studies integrated the simulation experiences as part of a rotation practice [36], course assignment [31], and as part of a clinical course [35,38]. Simulation was delivered mainly via teleconferencing and online technologies such as Zoom and Google Hangouts [30,31,33,34,38-40]. A few studies utilized a telehealth robot [31] or a telepresence robot [36,37]. The simulation experiences varied in length from one hour to a few hours, facilitated by use of scenarios, standardized patients, briefing, and debriefing. Authors utilized different professional practice frameworks such as the American Association of Colleges of Nursing (AACN) Essentials [31,38], National Organization of Nurse Practitioner Faculties (NONPF) [31], QSEN [35], best practices and theoretical frameworks for conducting simulation such as the International Nursing Association of Clinical Simulation and Learning (INACSL) and Promoting Excellence and Reflective Learning through Simulation (PEARLS) method for debriefing [31,34,35].

A quantitative quasi-experimental design with a pre-posttest [30,31,36] or posttest only [37], and mixed method research [32] were mostly used to measure a variety of outcomes including knowledge, confidence, attitudes, communication, and overall experiences. Some studies also sought to determine usability of the telehealth robot [31,37] or feasibility of the telehealth experience [33,34]. In addition to using pre-posttest assessments, some authors used Objective Structured Clinical Examinations (OSCEs) [30,33], knowledge tests [31,38], reflection [32,34,39], and focus group interviews [32,35,40]. In spite of the inherent limitations of study designs used, interventions delivered yielded positive outcomes and students' experiences and feedback. Two studies [30,36] reported a statistically significant change in outcomes measured.

Interventions focused on EHR education. For studies involving EHR related education, authors applied a variety of research designs mainly to pilot academic EHRs including mixed methods [72,73,78], case study [75], correlational [79], surveys [71,74,76], Think aloud method [77], and focus groups [80]. Integration was mostly as a stand-alone intervention, a few studies reported integration as part of the first year nursing clinical course [71], a clinical course [74], or as part of a fundamentals of nursing course [79]. A key aspect of using the simulated EHRs focused on developing documentation skills [71-73,77,80]. Case scenarios were used in most interventions, some included an additional didactic content [71] or provided orientation through

videos, webinars and opportunities to practice [72,73,79,80]. A few studies related the intervention to required professional NI competencies or educational theories supporting simulation activities [73,78]. Outcomes of interest in these studies included knowledge, confidence, attitudes, satisfaction, experience, and perceived NI competency. Statistically significant findings were reported in some of these interventions [71,73,74]. Some studies also sought to evaluate the feasibility and suitability of the simulated record for use in a nursing program [72,73,76,77].

Interventions focused on NI education. Two studies addressed NI education [83,84]. Of these, one study applied a controlled-interventional design to measure knowledge gain, attitudes toward the EHR, and perceived confidence following completion of two learning modules on NI delivered via in-person lectures and online using vodcasts [84]. The other study used a one-group pre-post design following a 2-day online NI educational program and measuring perceived NI competency [83]. Both interventions were informed by professional practice standards/competencies and relevant educational theory yielding a statistically significant improvements in outcomes measured [83,84].

Digital Health and NI Educational Interventions at the Graduate Level

Out of thirty-eight studies identified, thirty of these focused on telehealth interventions [41-70], two addressed DH [81,82], two focused on EHRs [85,86], and four studies focused on NI education [87-90]. Of note, interventions focused on telehealth education were mostly delivered without situating this knowledge or skills within the broader digital health or NI context, despite some studies indicating the increased use of technology in the context of nursing practice. In addition, some of these studies were implemented or developed in response to the COVID-19 pandemic [41-43,45-47,49,51,53,55-57,69,81,82].

Most studies in all the interventions reported below enhanced the intervention design by incorporating theoretical and pedagogical frameworks such as Bandura's self-efficacy theory [64,68], Kolb's Cycle of Experiential Learning [47,70], Ericsson's and Smith Expertise theory [66], the Ottawa Model for Research [69], the Plan-Do-Study-Act (PDSA) cycle [64], the Technology Acceptance Model [58], Roy's Adaptation Model [57], Problem-based Learning [60], Bloom's Taxonomy [64,89], Adult Learning Theories [87], Nursing Education Healthcare Informatics Framework (NEHI) [90], Technology Informatics Guiding Education Reform

(TIGER) Competencies [90], and/or professional standards and competencies, telehealth competencies, and best practices for simulation-based research [41-43,45,47,49-51,53-57,59,61-63,65,70,81,82,89].

Interventions Focused on Telehealth Education. Integration was mostly as a stand-alone intervention, a good number of studies reported integration as part of an existing theory or clinical course [42,43,45,46,48,49,51,59-61,64,66,70]; theory courses included health policy, role transition course, advanced health assessment course, and Bio-physical and Integrated Clinical Diagnosis course. Of note, only a few studies engaged students in their final clinical practicum course in a telehealth clinical rotation experience [59]. Other students experienced telehealth during a clinical rotation [44] or as part of a clinical experience [67]. Telehealth education was delivered utilizing a variety of educational modalities or strategies including: didactic education (online modules and lectures, reading materials, videos, narrated lectures, self-directed modules) with simulation scenarios and standardized patients [41-43,45,47,49,50,53,55,56,60-62,65-68,70]; asynchronous and synchronous simulation using teleconferencing tools and interactivities with or without didactic education [49,50,56,57,61,63,69]; telehealth self-paced learning with discussion [46]; guest speaker lectures with self-paced modules, lectures, and video conferencing demos [64,123]; simulation with a telehealth robot with an iPad and or a telehealth cart [52,53,62]; simulation with students acting as patients or providers [52,53,56,58]; telehealth as a clinical rotation [44,70]; telehealth OSCEs and clinical exams [45,61,63,65]; telehealth curriculum with supporting competencies [54]; telehealth focused on specific skills (e.g., consultation, e-visit, triage, etc.) [48,52,53,58,62,63,66]; and partnership with clinical organizations [59,67].

The duration of telehealth simulation intervention varied from a few hours to days. Regarding topics covered in telehealth education, some studies reported on topics included, such as a broad overview of telehealth, technologies used in delivering telehealth, ways to engage with patients, telehealth competencies, laws and regulations related to telehealth practice, digital professionalism, and licensure requirements [54-56,62,64-70].

Researchers designed the interventional studies using different methods including mixed methods [41,53], pre/post design [69], descriptive design [52], quasi-experimental design [42,48], formative and summative evaluation introduced as educational activities [43,46,49,51], program evaluations [44,45,47,54,61,63,67], pilot studies [41,50,53,55,57,58,60,62,65,66], and

quality improvement projects [56,64,69]. Some studies applied pre/posttest or pre/post surveys to measure a variety of outcomes including knowledge, beliefs, confidence and comfort level, interest in telehealth, attitudes, preparedness, and satisfaction with the learning [42-46,48,50,54,62,64,66,70], proficiency and competence in performing skills, clinical decision making, working collaboratively with members of the health team, communication, providing care virtually, opinions, and experience of learning. In addition, some researchers evaluated the usability of telehealth technologies applied in simulation and/or simulation effectiveness [53]. Majority of these studies reported improvements post the intervention and positive student feedback; however, these measurements were either limited by the study design applied and or the small sample size—due to the heterogeneity of designs used. See supplemental data (Appendix IV) for more details.

Interventions Focused on Digital Health. Only two studies [81,82] have actually utilized the term digital health and intentionally developed educational strategies to deliver such education to Doctor of Nursing Practice level students [81]. Of these studies, one study reported on developing an elective course on digital health comprised of 5 units [81], and the second study incorporated mind maps within a practicum experience to expose students to digital health technologies used in practice [82]. In this same study, the authors also reported that prior NI courses existed in the curriculum.

Interventions Focused on EHR Education. Two studies published by the same authors [85,86] reported on EHR related learning by exposing students to simulated electronic records using an assignment strategy with case scenarios integrated within health IT/NI courses and assessing perceived NI competency. The initial evaluation [85] included an assessment of NI competence within the same group following the intervention; however, the second evaluation incorporated a control group [86].

Interventions Focused on NI Education. Four studies [87-90] reported on NI education. One of these studies provided didactic education in the form of an online learning module [87], one study developed a 4-week clinical practicum experience for using the electronic medical record [88], and two studies reported on developing online courses in NI, [89,90] but these were conducted in 2013 and 2014.

Studies Reporting on Status of Curricular Integration

Fourteen studies [13,91-103] focused on determining the status of digital health and/or NI integration in undergraduate and graduate nursing curricula using mainly survey designs [92,94,95,98,99,101,103]. Four studies focused on telehealth integration [91-94]. Of these, two studies included NP curricula [91,93], one applying an evaluation of a web-based telehealth (module-based) course [91] and the other reported on program evaluation [93] following curriculum mapping, integration, and obtaining students' feedback through comparing pre-post surveys. The remaining two studies [92,94] used cross-sectional surveys of nursing programs involving both undergraduate and graduate level students, and both studies revealed variable levels of integration.

Nine studies examined NI integration in nursing curricula using different methods including Delphi survey [95], Internet search [96,98,101], case study [97], questionnaires [99], curriculum review [100], mixed methods examining both NI and digital health [13,102], and one study examined the status of academic EHRs utilization [103]. Variability was noted across these studies, but overall, some studies that have implemented NI or digital health have noted improvement in students' learning outcomes post integration [91,93,96,97].

Proposed Strategies for Enhancing Digital Health and NI Education

Fourteen studies [12,104-121] provided a discussion of strategies that could be used by nurse educators or nursing programs to strengthen undergraduate and graduate nursing education including AI competencies to inform undergraduate and graduate education [104], role of clinical preceptors in helping students learn about digital health [12], guidelines for health informatics [105], different telehealth educational strategies including how to incorporate/level telehealth competencies in the curriculum [106-110], strategies for NI education or curricular leveling [111-118], and EHR simulations [119,120]. One study focused on digital health and technology competency [121].

Gray literature Findings

A review of the websites of 6 organizations revealed an increase in the offering of educational programs and courses related to digital health, with some of them focused on emerging technologies. An overview of these findings is available in Appendix III.

Discussion

The purpose of this review was to map the literature on digital health education, training courses, or other pedagogical interventions used for undergraduate and graduate nursing students and to inform the development of future educational interventions. Despite improvements, there are significant gaps and limitations in the scope of digital health education at the undergraduate and graduate levels, consequently posing challenges for nursing students to develop competencies needed in modern-day nursing practice.

In defining digital health, a few studies used the term digital health and/or provided educational strategies and content that capture the broad focus of digital health in nursing education. Several studies included in this evolved in the wake of the COVID-19 pandemic. The increased use of virtual care and telehealth practice mainly occurred at the graduate NP practice level, and both modalities are subsumed under digital health. Yet, the authors of these studies did not situate this education within the broader area of digital health or ehealth. Furthermore, the current educational approaches regarding digital health education are primarily focused on developing dimensions of NI competencies, i.e., skills for using digital health technologies such as EHRs and telehealth.

According to the 2022 Nurse Practitioner Role Core Competencies in the U.S, Domain 8: Technology and Information Literacy, this domain includes five indicators focused on the application of ICTs [124]. These are also aligned to the AACN Essentials/Advanced-level Nursing Education, which emphasize ICTs and informatics processes under domain 8 and provides five indicators, for example, indicator [8.4f: “employ electronic health, mobile, health, and telehealth systems to enable quality, ethical, and efficient patient care”] may explain the focus on telehealth education at the NP education level within the included studies [124]. These guidelines also do not use the terminology of digital health. In Canada, the Canadian Nurse Practitioner Core Competency Framework, published in 2010, has an indicator [1.10: “Adheres to federal and provincial/territorial legislation, policies, and standards related to privacy, documentation, and information management (this also applies to verbal, written or electronic records)”] [125], but also no reference to digital health nor NI.

Only a few studies focused on digital health as a concept to teach nursing students, with an increasing volume of studies on telehealth education. Contrary to the findings of this review, the review by Foster and Adams [126] indicated inadequate research studies on telehealth education.

The disparity in the findings could partly be due to the difference in the search periods, as our review included studies conducted before, during, and after the COVID-19 pandemic when the use of telehealth began to increase. Despite the difference in the findings, both reviews address the importance of timing and indicate the attention and relevance of telehealth education within nursing. Although the majority of the educational interventions about digital health at the graduate level addressed telehealth, the integration and education about telehealth is still inadequate as identified in this review and prior reviews [127]. Additionally, a recent national survey conducted by Eckoff et al. [92], which examined the telehealth education in both prelicensure and graduate nursing education, also revealed inconsistency and limited education about telehealth.

No studies indicated teaching NI or digital health as unique course within the nursing curriculum. In addition, despite the increased attention to the potential impact of AI in nursing education and practice, no interventional studies that addressed AI education at the undergraduate or graduate levels were found. Only one study identified AI competencies to guide nursing education in Canada despite urgent calls for providing formal training and education of healthcare providers and nurses at the basic and advanced levels in AI. The proliferation of AI technologies in nursing education and clinical practice shows the need for proactive measures to integrate AI education and its related competencies in nursing education [22,128].

With respect to the scope of educational strategies currently being used, these included didactic approaches such as training sessions/webinars, online modules, pre-recorded lectures, PowerPoint presentations, video clips; experiential mostly applying simulation encounters along with debriefing, guided exercises, and opportunities for question/answer; or a combination of both. To enhance students' experiential learning, the educational strategies were delivered through online and/or face-to-face means [129]. The choice of these strategies was largely based on the objectives of the study and the interventional design applied. More advanced educational strategies, such as virtual and augmented reality are limited in teaching nursing students about digital health and NI. As these technologies become more mainstream, it is anticipated that future research will shed light on the value and effectiveness of these strategies in nursing education, specifically in the digital health education [8,9]. It is promising to see that educators and scholars have shared their expertise and the strategies that they have applied in their programs for integrating digital health and NI, this could serve to encourage educators to consider applying

these strategies within their programs or day-to-day teaching in order to improve graduate outcomes and increase their capacity for optimal practice in digital healthcare environments.

It is noted that the theoretical education about digital health and NI as core concepts in the nursing curricula remains variable and is mostly focused on the skills component as opposed to providing comprehensive and foundational knowledge that would help students understand the full picture of the digital health revolution. This was also corroborated by the findings from studies that examined the status of NI and digital health integration in nursing curricula, demonstrating variable levels of integration at both the undergraduate and graduate levels. These findings suggest that digital health and NI are not yet a priority in nursing education; however, studies reviewed were mostly survey studies examining the state of education at a point in time.

Several papers in the included studies have incorporated theoretical, conceptual, pedagogical, and professional standards in designing their interventions. Using such frameworks is highly recommended because it provides an evidence-based approach for planning, implementation, and evaluation of the educational intervention [130]. It also enables researchers to expand on the body of knowledge available to inform nursing education and practice based on best practices for knowledge generation. Incorporating theory in the intervention design also increases the intervention fidelity; however, the effectiveness of these interventions can be limited by a small sample size and or the lack of experimental control in measuring the outcomes of interest.

The evaluative strategies used in these studies depended on the study design and the expected outcomes. Although not all the included studies assessed an intervention, some authors used a single, multiple or a combination of assessment strategies or tools to undertake summative and/or formative assessment to determine the effectiveness of the intervention. Therefore, the assessment served as the measurement of the intervention done or the process instituted. Similar to the findings of Hui et al. [129], these authors also identified multiple and written assessment tasks as evaluative strategies used in assessing telehealth education implemented in a health curriculum. Of note is that some studies that used theoretical frameworks for the intervention also developed their assessment strategies using frameworks.

Concerning the outcome measures examined, the outcome measure for undergraduate and graduate levels had some similarities and differences. Regarding the similarities, students at the undergraduate and graduate levels were assessed on their levels of competencies related to an educational intervention. However, at the graduate level, in addition to the competencies

identified at the undergraduate level, the expectations and outcomes measured were more complex and advanced. After completing graduate-level education, graduate students are expected to assume leadership with the delivery and implementation of telehealth; hence, the education and training at the graduate level on telehealth is more comprehensive, and the educational interventions were often designed in alignment with advanced practice standards and competencies as well as frameworks such as the telehealth competence framework [131].

With respect to results from the gray literature, it is interesting to note that different organizations in the U.S and Canada provided a wide range of courses in different areas of practice related to digital health (Appendix III). This may reflect an increased interest in digital health and/or a demand among healthcare professionals or their employers for such information. This is encouraging and can be used as a guidepost for nursing educational programs with respect to the importance and scope of content that can be incorporated into formal nursing education at the undergraduate and graduate levels. While these educational offerings primarily target healthcare professionals in practice, they can also be used by students particularly at the graduate level. It can also serve as a resource for nurse educators or practitioners to pursue continuing education or increase their knowledge in areas that are evolving pretty rapidly in healthcare, such as AI; for example, the WHO course about ‘Ethics and Governance of AI for Health’ is one example.

The limitations in the scope of the digital health education both at the undergraduate and graduate levels could be attributed, in part, to the fact that digital health as a field is still evolving. The definition of digital health may not necessarily be known or utilized by nursing scholars, and the term is also new and will likely further evolve as technology advances in the years to come. Although this may pose challenges for nurse educators and programs to clearly articulate the scope of digital health education in nursing curricula, standardization in either the definition or the dimensions of digital health education should not be perceived as a barrier for nursing programs and educators to begin teaching their students about digital health.

Nursing education programs and educators are encouraged to integrate what is known about digital health as it applies to nursing in their curricula and to keep abreast with developments in this field so that nurses are not left behind. In addition, upgrading existing NI competency standards to account for developments in the field of digital health, particularly, at the entry-level to practice and providing resources for nurse educators on how to operationalize these indicators

in their day-to-day teaching is needed to expedite this process of integration. As the field will continue to evolve, periodic revisions of the NI competency standards should also be considered.

Implications

The dynamic nature of the healthcare system continuously evolving as a result of technological advancement demands that nursing students have opportunities to develop a baseline knowledge and competency in digital health and to cultivate this knowledge through continuing education upon becoming independent practitioners. From an equity perspective, all nursing students should have the opportunity to receive comprehensive digital health education because they represent the future healthcare workforce that is already faced with significant challenges to overcome including aging population, technological disruption, globalization, population displacement, and climate change to name a few [2]. As such, digital health education should not be a side topic in the nursing curriculum nor should it be taught on a need-to-know basis, but rather it should be comprehensively embedded throughout all levels of nursing education and nursing career trajectories.

This scoping review provided important insights into the current state of digital health education and the modalities available for teaching nursing students. In light of the gaps and limitations identified in this review, enhancing the digital health education for nurses and nursing students should be a policy priority. A comprehensive education about digital health should provide foundational knowledge in core concepts relative to existing and new digital healthcare technologies and create opportunities for learners to continuously reflect on their practice as well as be able to identify areas for growth and development as the digital health ecosystem evolves. Upgrading nursing education by introducing new strategies, such as virtual and augmented reality and AI generative platforms to deliver and augment learning, allows nursing students to think critically about these technologies, and, by extension, other similar applications that will eventually make their way into clinical practice [122,132]. Follow-up studies may also be beneficial to determine the impact of digital health and informatics education in the workplace.

Conclusion

As the digital health ecosystem continues to evolve, nursing education and practice must evolve too. There is an urgent need to expand the understanding of digital health in the context of

nursing education and practice and to better articulate its scope in nursing curricula and enforce its application across professional nursing practice roles at all levels and career trajectories. Further research is also needed to examine the impact of digital health education on improving patient outcomes, the quality of nursing care, and professional nursing role advancement.

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Multimedia Appendices

- Multimedia Appendix: Figure 1
- Multimedia Appendix: Figure 2
- Multimedia Appendix: Search Strategy
- Multimedia Appendix: List of excluded studies
- Multimedia Appendix: Abstraction tables
- Multimedia Appendix: Organizations providing digital health education.

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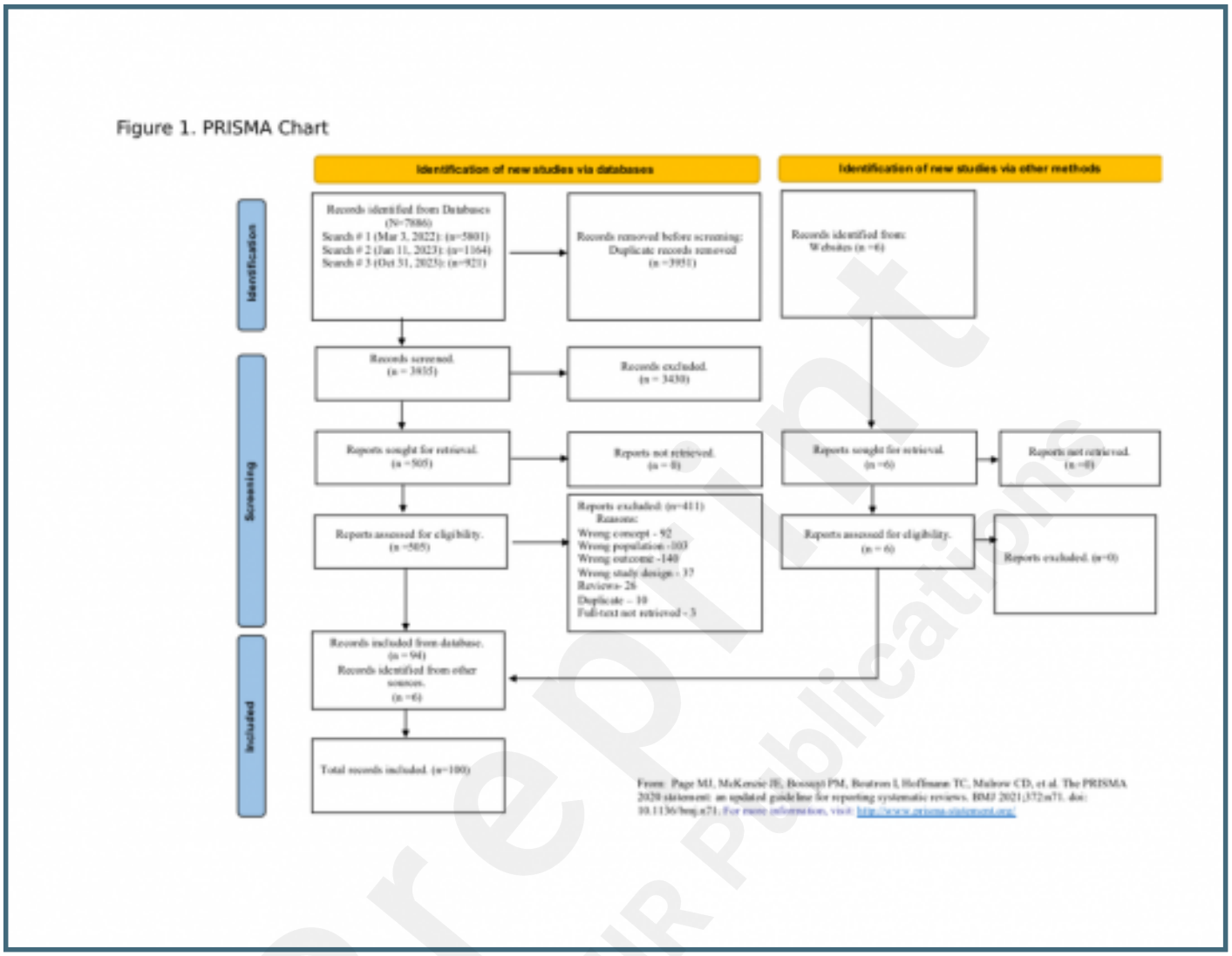
Supplementary Files

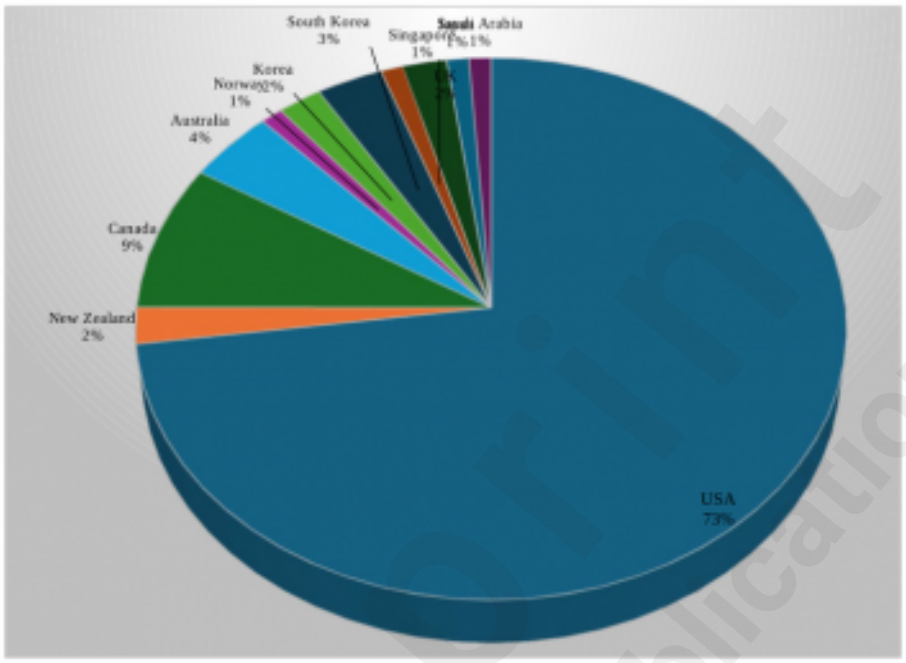
Figures

Prisma.



Distribution of studies.

Figure 2. Geographic distribution of included Studies



Multimedia Appendixes

Search strategy.
URL: http://asset.jmir.pub/assets/2bfa3518dd2b4657b7d8aae530efc9b9.docx

List of excluded studies.
URL: http://asset.jmir.pub/assets/4b9edcbe8be91cef4f09689c5f71b662.docx

Organizations providing digital health education.
URL: http://asset.jmir.pub/assets/1cab927c0061a3c45f50aaf7f56d89e8.docx

Abstraction tables.
URL: http://asset.jmir.pub/assets/c8082c3e35034e0b7274447755e80391.docx