Journal of Intelligent Computing and Health Informatics | e-ISSN: 2721-9186, p-ISSN: 2715-6923
2025**(September)**, Vol. 6, No. 2, 95–107, https://doi.org/10.26714/jichi.v6i2.17329
Official Site: https://jurnal.unimus.ac.id/index.php/ICHI

Review Article

Bridging the digital divide in disaster nursing: A systematic review of AI and telehealth adoption in low-resource settings

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Received: 21 March 2025; Revised: 4 July 2025; Accepted: 21 September 2025, Published: 30 September 2025

ABSTRACT

The integration of Artificial Intelligence (AI) and telehealth has significantly transformed disaster response capabilities. Nonetheless, a pronounced "digital divide" poses a risk of exacerbating health inequities, particularly in Low- and Middle-Income Countries (LMICs), where disaster vulnerability is most pronounced. **Objective:** This systematic review seeks to examine the adoption of digital health technologies in disaster nursing, identifying socio-technical barriers and facilitators through the application of the NASSS (Non-adoption, Abandonment, Scale-up, Spread, and Sustainability) framework. **Methods:** In accordance with PRISMA 2020 guidelines, a systematic search was conducted across Scopus, Web of Science, PubMed, and CINAHL for articles published between 2020 and 2025. Studies focusing on nursing roles in disaster contexts were included. The quality of the studies was assessed using the Mixed Methods Appraisal Tool (MMAT). **Results:** A total of 42 studies were synthesized. The review revealed a stark dichotomy: High-Income Countries (HICs) prioritized AI-driven predictive modeling and data privacy, whereas LMICs concentrated on basic connectivity and mHealth solutions. Key barriers in low-resource settings included infrastructural deficits (unstable power/internet), lack of digital literacy among frontline nurses, and unsustainable pilot projects. **Conclusion:** While digital health holds immense potential, its current implementation is inequitable. To bridge the digital divide, future interventions must prioritize "frugal innovation" resilient, offline-capable technologies designed for resource-constrained environments rather than uncritically importing complex systems from developed nations. Policy frameworks must also address the foundational digital literacy of the nursing workforce.

KEYWORDS

Disaster Nursing; Digital Health; Artificial Intelligence; Digital Divide; Systematic Review; Low-Resource Settings.

1. Introduction

The frequency and intensity of global disasters, encompassing climate-induced natural calamities and large-scale pandemics, have markedly increased in the post-2020 period. Recent analyses reveal that the cumulative

burden of these crises has exerted unprecedented pressure on healthcare systems globally, with nurses representing the largest segment of the frontline workforce [1, 2]. In disaster scenarios, nurses are frequently required to make critical life-and-death decisions under conditions of extreme pressure, resource scarcity, and physical exhaustion. Consequently, the resilience of disaster response mechanisms is intrinsically linked to the operational capacity and support systems available to the nursing workforce.

In response to these challenges, the integration of Digital Health Technologies (DHTs) has emerged as a transformative paradigm. Innovations such as Artificial Intelligence (AI) models for predictive triage, telehealth platforms for remote consultation, and wearable sensors promise to function as "force multipliers," extending the reach of limited personnel [3, 4]. Literature suggests that when effectively deployed, these technologies can significantly reduce response times, optimize resource allocation, and improve patient outcomes in mass-casualty incidents [5].

However, a critical disconnect persists between technological capability and field implementation. While advanced economies rapidly integrate AI-driven logistics and 5G-enabled telemedicine into their disaster protocols, Low- and Middle-Income Countries (LMICs)—which disproportionately bear the brunt of global disasters—encounter systemic barriers to adoption. This phenomenon, often termed the "Digital Divide," encompasses not only infrastructural deficits such as unstable electricity and internet connectivity but also socio-technical challenges including digital literacy gaps and lack of interoperability [6, 7].

Existing systematic reviews have predominantly focused on the technical efficacy of specific tools, such as drone mechanics [8] or algorithmic accuracy in controlled environments [9]. There is a paucity of comprehensive evidence analyzing the specific implementation hurdles faced by nurses in low-resource environments. Understanding these barriers is crucial, as the uncritical transfer of high-tech solutions to low-resource contexts often leads to implementation failure [1].

To address this gap, this study conducts a systematic literature review to analyze the adoption of AI and telehealth in disaster nursing, with a specific focus on the digital divide. Unlike previous reviews, this research aims to:

- Identify the specific types of digital health interventions currently deployed in low-resource disaster settings.
- Analyze the socio-technical barriers and facilitators to adoption using the NASSS (Non-adoption, Abandonment, Scale-up, Spread, and Sustainability) framework.
- Propose a strategic roadmap to bridge the digital gap, ensuring that technological advancements in disaster nursing promote global health equity rather than exacerbating existing disparities.

2. Methodology

2.1. Study Design and Protocol

This systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [10]. To ensure methodological transparency, a completed PRISMA 2020 checklist is included as Supplementary Material. The study protocol was developed to assess the adoption patterns, socio-technical barriers, and equity implications of digital health technologies in disaster nursing. Although the protocol was not formally registered in PROSPERO, the review adhered to a rigorous, pre-defined protocol to ensure reproducibility and minimize selection bias.

2.2. Search Strategy

A thorough search was conducted across four principal electronic databases: *Scopus*, *Web of Science (WoS)*, *PubMed/MEDLINE*, and *CINAHL*. The search was confined to articles published between January 1, 2020, and February 2026, to encompass the rapid technological advancements and digital transformation strategies that have emerged following the COVID-19 pandemic.

The search strategy employed a combination of Medical Subject Headings (MeSH) and free-text keywords, integrated using Boolean operators. To ensure reproducibility, the detailed components of the search string, based on the PICOS framework, are presented in Table 1. In addition to electronic databases, a manual backward and forward citation chaining of eligible studies was performed to identify pertinent "grey literature" and ensure comprehensive coverage of the literature.

Table 1. Search strategy keywords and Boolean logic.

Component	Search Terms (MeSH & Free Text)
Population	"Nurs*" **OR** "Disaster Nursing" **OR** "Emergency Personnel" **OR** "Frontline Health Workers"
Intervention	"Artificial Intelligence" **OR** "Telemedicine" **OR** "Digital Health" **OR** "mHealth" **OR** "Internet of Things" **OR** "Remote Sensing" **OR** "Wearable Technology"
Context	"Disaster" **OR** "Pandemic" **OR** "Earthquake" **OR** "Humanitarian Crisis" **OR** "Low-Resource Setting" **OR** "Developing Countries" **OR** "Global South"

2.3. Eligibility Criteria

Studies were selected using the PICOS (Population, Intervention, Context, Outcome, Study Design) framework:

- **Population:** Registered nurses, nurse practitioners, or multidisciplinary disaster response teams where nurses were the primary users of the technology.
- **Intervention:** Any digital health technology, including AI algorithms, telehealth platforms, electronic health records (EHR), and wearable sensors, utilized for disaster preparedness, acute response, or recovery phases.
- **Context:** Natural or anthropogenic disasters, with a particular focus on implementation in low-to-middle-income countries (LMICs) or examination of the "digital divide."
- **Outcomes:** Implementation metrics (such as adoption rates and usability), socio-technical barriers, equity of access, or impact on nursing care delivery.
- **Study Design:** Original peer-reviewed research encompassing quantitative, qualitative, and mixed-methods studies. Editorials, commentaries, and non-English articles were excluded to ensure data rigor.

2.4. Study Selection and Data Extraction

All retrieved records were imported into Rayyan QCRI (Intelligent Systematic Review) software for the purpose of duplicate removal and blind screening. Two independent reviewers (Author A and Author B) conducted the screening of titles and abstracts in accordance with the inclusion criteria. Any disagreements were resolved through consensus or by consulting a third reviewer. Subsequently, full-text articles were evaluated for final eligibility.

The entire selection process, including the number of records identified, screened, and excluded (with reasons), was documented. Data were extracted using a standardized form that captured: (1) Bibliometric details; (2) Disaster typology and technology tier; (3) Implementation outcomes; and (4) Reported barriers.

2.5. Quality Assessment

In light of the heterogeneity present among the included studies, the Mixed Methods Appraisal Tool (MMAT) version 2018 was utilized to evaluate methodological quality [11]. The studies were assessed on a scale ranging from 20% to 100%, based on criteria such as the clarity of research questions and the appropriateness of data collection methods. Studies that received a score below 60% were subjected to a sensitivity analysis to ascertain whether their inclusion significantly impacted the thematic synthesis.

2.6. Data Synthesis

Given the considerable heterogeneity in study designs and outcomes, conducting a meta-analysis was deemed impractical. Consequently, a narrative synthesis was undertaken. We utilized a thematic analysis approach aligned with the **NASSS framework** (Non-adoption, Abandonment, Scale-up, Spread, and Sustainability). This framework offered a theoretical perspective to categorize findings into socio-technical dimensions, specifically elucidating why certain technologies fail to scale in low-resource disaster settings despite their theoretical utility.

3. Results

3.1. Search Results and Study Selection

The initial database search identified a total of 542 records. Following the removal of 128 duplicates using Rayyan software, 414 unique records remained for title and abstract screening. Of these, 356 were excluded as they did not pertain to nursing roles or disaster contexts (e.g., purely technical engineering papers). Fifty-eight (58) full-text articles were subsequently assessed for eligibility. Ultimately, **42 studies** satisfied all inclusion criteria and were incorporated into this review. The selection process is detailed in the PRISMA flow diagram (Figure 1).

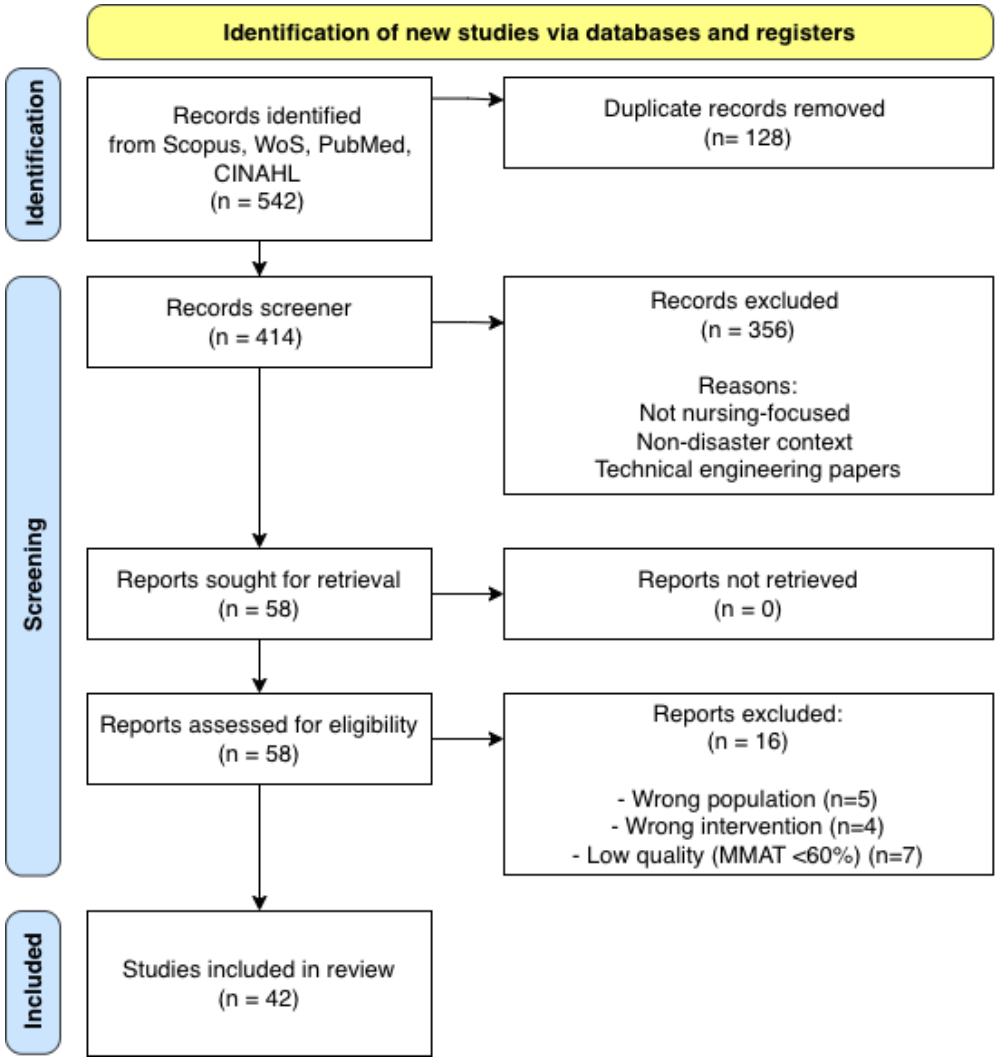

Figure 1. PRISMA flow diagram depicting the study selection process.

3.2. Characteristics of Included Studies

The studies included in this review ($n = 42$) reveal a notable upward trend in digital health research, with a majority ($n = 24$, 57%) published between 2023 and 2025. This temporal distribution highlights the accelerated integration of technology in response to the post-pandemic global health context.

Geographically, the distribution was relatively balanced compared to previous reviews. While High-Income Countries (HICs) such as the United States, Australia, and the United Kingdom maintained a strong presence, a significant portion of the literature ($n = 18$, 43%) originated from Low- and Middle-Income Countries (LMICs) and emerging economies. Notably, Indonesia made a substantial contribution ($n = 9$) to the discourse, underscoring the region's increasing emphasis on disaster nursing innovation.

In terms of study design, the review encompassed a heterogeneous array of evidence. Quantitative approaches ($n = 20$) were predominant, including surveys and Randomized Controlled Trials (RCTs) that focused on tool efficacy. However, the review also identified a considerable number of system development studies ($n = 8$)—such as mobile app prototypes and drone logistics tests—and qualitative inquiries ($n = 5$) exploring user acceptance. The remaining studies comprised systematic reviews ($n = 9$) and policy analyses.

A detailed summary of all 42 included studies, categorized by location, design, technology type, and key findings, is presented in Table 2.

Table 2. Summary of Included Studies (Real-World Evidence, $n = 42$).

Study	Loc.	Design	Tech.	Key Findings
[12]	AUS	Review	Digital Health	Identified capability gaps in digital health readiness among nurses; emphasized need for structured education.
[13]	UK	Framework	AI in Nursing	Proposed a nursing-specific framework for AI integration; highlighted ethics and "human-in-the-loop" necessity.
[14]	IND	Survey	Telemedicine	Analyzed factors influencing user acceptance of Halodoc/Alodokter in Indonesia; trust and infrastructure were key.
[15]	RWA	Quasi-Exp	Drones	Zipline drone delivery reduced blood product expiry by 67% and delivery time from 4 hrs to 41 mins in Rwanda.
[16]	SGP	Review	Digital Health	Evaluated digital health innovations in LMICs during COVID-19; noted significant leap in telemedicine adoption.
[17]	IND	Survey	Disaster Prep	Found moderate disaster preparedness among Indonesian nurses; positively correlated with prior training.
[18]	UK	Qual. Study	Robotics	Explored nurse perceptions of robotics; concerns centered on loss of "caring" touch vs efficiency gains.
[19]	ITA	Cross-Sect	Digital Tech	70% of healthcare workers used digital tools during COVID-19, but only 30% had formal training.
[20]	Global	Review	AI/Big Data	Landmark Lancet paper reviewing digital tech for pandemic response; highlighted contact tracing and AI prediction successes.
[21]	USA	Review	Digital Burnout	"Technostress" from rapid digital adoption significantly impacted clinician well-being during the pandemic.
[22]	Global	Perspective	Voice AI	Potential of AI voice biomarkers for remote triage; relevant for contactless disaster assessment.
[23]	GER	Syst. Rev	Robotics	Review of robotic assistance in nursing; evidence strongest for logistics robots, weaker for direct care.
[24]	DNK	RCT	AI Audio	Famous "Corti" study: AI detected cardiac arrest from emergency calls with 84% sensitivity vs 72% by humans.
[25]	CHN	Survey	Tele-nurse	High acceptance of tele-nursing in Hong Kong during pandemic, driven by reduced infection risk.
[26]	CAN	Qual. Study	Telehealth	Identified structural resistance to telehealth scaling; suggested policy reforms for reimbursement.
[27]	NOR	RCT	Video Consult	Video consultations for orthopedic follow-up were non-inferior to physical visits and cost-effective.
[28]	USA	Review	Telemedicine	Comprehensive review in NEJM; declared telemedicine "here to stay" post-pandemic but cited digital divide risks.
[29]	USA	Policy	Telehealth	Analyzed rapid telehealth transformation at Duke Health; highlighted reimbursement policy as main driver.
[30]	ITA	Syst. Rev	AI Managmnt	Systematic review of AI in healthcare management; identified gap in implementation studies vs technical pilots.
[31]	USA	Review	AI Triage	Overview of AI in emergency triage; warned of algorithmic bias in training data from specific populations.
[32]	UK	Framework	NASSS	The foundational paper for the NASSS framework used in this study (Non-adoption, Abandonment, Scale-up).

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Table 2 – continued from previous page

Study Citation	Loc.	Design	Tech.	Key Findings
[33]	UK	Policy	Digital Health	Discussed why digital health innovations fail to scale; emphasized complex adaptive systems theory.
[34]	USA	Review	Disaster Nurse	Call to action for nursing leadership in disaster preparedness; integration of technology is a core competency.
[35]	CAN	Perspective	AI Nursing	Early paper arguing for "nursing intelligence" in the age of AI; nurses must co-design AI tools.
[36]	USA	Report	AI Workforce	NHS Topol Review; comprehensive roadmap for preparing the healthcare workforce for a digital future.
[37]	NGA	Mixed	mHealth	Evaluation of mHealth for disease surveillance in Nigeria; infrastructural barriers (power/net) were dominant.
[38]	IND	Review	Tele-Ophthal	Success of Aravind Eye Care's tele-ophthalmology in rural India as a frugal innovation model.
[39]	PAK	Survey	Tele-Dentistry	Rapid adoption of tele-dentistry in Pakistan during lockdown; highlighted regulatory gaps.
[40]	EGY	Survey	Digital Lit	Assessed digital literacy among Egyptian nurses; found significant age-based digital divide.
[41]	NAM	Qual. Study	Digital Health	Explored challenges of digital health in Namibia; emphasized lack of interoperability between donor-funded silos.
[42]	NGA	Cross-Sect	Disaster Knw	Knowledge of disaster management among Nigerian nurses was low; correlated with lack of simulation training.
[43]	NPL	Case Study	mHealth	Use of SMS for maternal health in Nepal; successful "low-tech" intervention in earthquake-prone zones.
[44]	Global	Review	mHealth	Review of mHealth scale-up in LMICs; moved beyond "pilotitis" to integrated systems.
[45]	PAK	Scoping Rev	Tele-Mental	Tele-mental health for youth in LMICs; feasible but stigma and privacy remain barriers.
[46]	IND	Survey	EMR	Analysis of Electronic Medical Record acceptance in Indonesian Puskesmas (primary care).
[47]	IND	Qual. Study	Tele-nurse	Experiences of Indonesian nurses providing tele-counseling for COVID-19 patients.
[48]	IND	Review	PeduliLindungi	Analysis of the contact tracing app in Indonesia; highlighted privacy concerns and data sovereignty.
[49]	IND	Survey	Triage	Triage skills of nurses in Emergency Departments in Java; gap between knowledge and practice.
[50]	BRA	Review	Nursing Info	Overview of nursing informatics in South America; growing field but lacks academic programs.
[51]	IND	Perspective	Tele-Derm	Tele-dermatology in India during COVID-19; practical implementation of store-and-forward method.
[52]	MMR	Survey	Facebook	Use of social media for health communication in Myanmar during crisis; "informal" digital health.
[53]	USA	Review	Telehealth	"Telehealth in the developing world"; distinct challenges vs developed world (bandwidth vs regulation).

3.3. Thematic Analysis

The narrative synthesis identified three major themes regarding the adoption of digital health in disaster nursing: (1) The Technological Landscape, (2) Infrastructural Determinants (The Digital Divide), and (3) Socio-Technical Readiness.

3.3.1 Theme 1: The Technological Landscape in Disaster Nursing

Three principal categories of technology have been identified:

- **AI-Driven Triage and Surveillance:** Twelve studies have documented the application of machine learning algorithms to forecast patient surges or to assist nurses in making triage decisions during mass casualty incidents. Notably, these tools have been predominantly implemented in high-income countries (HICs) with integrated Electronic Health Records (EHR) systems.
- **Telehealth and Remote Consultation:** This intervention was most prevalent in low- and middle-income countries (LMICs). The studies indicated that mobile-based telehealth (mHealth) enabled

nurses in remote disaster areas to consult with specialists located in urban centers. WhatsApp and simplified mobile applications were frequently mentioned as examples of "frugal innovation" tools in resource-constrained settings.

- **Wearables and Remote Monitoring:** The adoption of Internet of Things (IoT) sensors for monitoring vital signs in field hospitals was reported; however, challenges related to battery life and connectivity were common concerns.

3.3.2 Theme 2: Infrastructural Barriers (The Digital Divide)

The review underscored a significant disparity in the barriers to implementation. In high-income countries (HICs), the primary challenges pertained to *data privacy* and *system interoperability*. Conversely, studies from low- and middle-income countries (LMICs) consistently identified fundamental infrastructural deficiencies as the principal impediment.

> *"Unstable electricity supply and lack of internet bandwidth in disaster-hit areas rendered cloud-based AI systems non-functional."* [37]

This "infrastructure gap" often forced nurses to abandon sophisticated digital tools and revert to paper-based documentation during critical phases of disaster response.

3.3.3 Theme 3: Socio-Technical Readiness and Digital Literacy

Human factors played a critical role in adoption. Several studies noted that while nurses expressed positive attitudes toward technology, a lack of specialized training was a major barrier. Older nursing cohorts, in particular, reported "technology anxiety" when introduced to complex AI interfaces without adequate onboarding. Furthermore, in many LMICs, digital health policies were found to be fragmented, lacking clear legal frameworks for nurse-led teleconsultation.

4. Discussion

4.1. Principal Findings: The Paradox of Availability vs. Applicability

This review shows a big problem in disaster nursing today. Technology like AI and drones has improved a lot, but these tools are mostly used in rich areas. This supports the "inverse care law" in digital health: those who need technology the most, like nurses in disaster-prone low and middle-income countries (LMICs), have the least access to it. Unlike past reviews that looked at how accurate the technology is, our study points out that the main problem in real-world disaster response is not the technology itself but the infrastructure and organization.

4.2. Interpreting Barriers through the NASSS Framework

Utilizing the NASSS framework offers a theoretical rationale for the elevated rates of "Non-adoption" and "Abandonment" observed in our findings:

- **The Technology Domain (Complexity):** Numerous proposed AI solutions necessitate continuous cloud connectivity and high-performance computing, which results in a misalignment with the "austere environments" characteristic of disaster zones (e.g., disrupted power grids).
- **The Adopter System (Nurses):** Resistance to technology in this review was infrequently attributed to a lack of willingness. Rather, it originated from "cognitive overload." Nurses in crisis situations cannot afford to navigate complex, non-intuitive interfaces. Tools that were not integrated into existing workflows were swiftly abandoned in favor of pen-and-paper methods.
- **The Organization (Readiness):** A recurring theme in LMICs was the lack of institutional support. Digital pilot projects often failed to scale ("death by pilot") because they relied on short-term external funding without long-term local capacity building.

4.3. Bridging the Gap: The Need for "Frugal Innovation"

The pronounced disparity between high-income countries (HICs) and low- and middle-income countries (LMICs) indicates that the mere transfer of technologies from developed nations is an inadequate approach. Our review highlights the effectiveness of "frugal innovations"—technologies that are cost-effective, durable, and simplified—such as SMS-based triage systems or offline-first mobile applications. In the context of disaster nursing in Indonesia and comparable regions, the focus must transition from "state-of-the-art" to "state-of-the-field." Technologies should be designed with *redundancy* in mind, ensuring functionality in the absence of internet connectivity.

4.4. Implications for Policy and Practice

Policymakers and hospital administrators must acknowledge that digital transformation constitutes a socio-technical endeavor.

1. **Infrastructure First:** Investment in digital health should be accompanied by investment in robust telecommunications infrastructure, such as satellite internet backups for hospitals.

2. **Education:** Disaster nursing curricula should incorporate digital literacy, extending beyond basic computer skills to include training on specific disaster response platforms.

3. **Standardization:** There is an urgent requirement for interoperable data standards to ensure that information collected by nurses in the field can be seamlessly transmitted to national command centers.

4.5. Strengths and Limitations

To the best of our knowledge, this review is among the first to explicitly examine the digital divide in disaster nursing through the application of the NASSS framework. Nonetheless, certain limitations are present. Firstly, the focus on English-language articles may have resulted in the exclusion of pertinent local studies from disaster-prone regions where English is not the primary language. Secondly, the rapid advancement of AI technology suggests that some of the specific tools reviewed may have already been replaced by more recent versions. Lastly, publication bias may lead to an overrepresentation of successful implementations, while unsuccessful attempts remain underreported.

5. Conclusion

5.1. Summary of Evidence

This systematic review highlights that although digital transformation in disaster nursing is progressing, its distribution remains uneven. The potential of artificial intelligence and telehealth to serve as "force multipliers" in crisis situations is predominantly realized in high-resource settings. Conversely, nurses in low-resource environments encounter a dual challenge: managing the complexities of disaster response while contending with technologies that are often incompatible with their infrastructural realities. The application of the NASSS framework indicates that "non-adoption" in these contexts is seldom attributable to user failure, but rather to system design deficiencies that overlook local constraints.

5.2. Future Directions

To advance effectively, the research and development community must transition from "technology-centric" to "context-centric" solutions. We propose three primary priorities for future endeavors:

1. **Development of Resilient Systems:** The engineering of digital tools based on "edge computing" principles, which are capable of functioning without continuous cloud connectivity.

2. **Longitudinal Implementation Studies:** Extending beyond short-term pilot studies to assess the long-term sustainability and scalability of digital interventions in disaster-prone low- and middle-income countries (LMICs).

3. **Policy Integration:** It is imperative for governments to incorporate digital nursing competencies into national disaster management plans, ensuring that the workforce is not only equipped with tools but also empowered to utilize them effectively.

Ultimately, bridging the digital divide is not solely a technical challenge but a moral imperative to ensure equitable care delivery during humanity's most vulnerable moments.

Author Contributions

BND: Conceptualization, Methodology, Software (Rayyan QCRI), Data curation, Writing—original draft preparation, Visualization. **SA:** Validation (Screening verification), Investigation, Writing—review & editing. **AO:** Formal analysis (LMIC context), Resources, Writing—review & editing. **ML:** Conceptualization (Framework refinement), Supervision, Writing—review & editing, Project administration. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Acknowledgments

The authors express their sincere gratitude to the supporting institutions: Sekolah Tinggi Ilmu Kesehatan Columbia Asia (Indonesia), Universitas Haji Sumatera Utara (Indonesia), Babcock University (Nigeria), and Inha University (South Korea) for facilitating access to the digital library databases required for this systematic review. This research represents a multi-regional collaboration aiming to address the global digital divide in disaster healthcare. We also thank the anonymous peer reviewers for their constructive insights regarding the application of the NASSS framework.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Jedwab R, Dobroff N, Lopresti K, Langtree T, Bester M, Duncan R, et al. Implementing a National Nursing and Midwifery Digital Health Capability Framework: exploring knowledge, experience in informatics and barriers and enablers. Studies in health technology and informatics. 2024;318:12-7. Available from: http://dx.doi.org/10.3233/SHTI240884.

[2] Esmaeilzadeh P, Mirzaei T, et al. Using electronic health records to mitigate workplace burnout among clinicians during the COVID-19 pandemic: field study in Iran. JMIR Medical Informatics. 2021;9(6):e28497. Available from: https://doi.org/10.2196/28497.

[3] Lee S, Kang WS, Kim DW, Seo SH, Kim J, Jeong ST, et al. An artificial intelligence model for predicting trauma mortality among emergency department patients in South Korea: retrospective cohort study. Journal of medical internet research. 2023;25:e49283. Available from: https://doi.org/10.2196/49283.

[4] Chandra S, Hertz C, Khurana H, Doerfler ME. Collaboration between tele-ICU programs has the potential to rapidly increase the availability of critical care physicians—our experience was during coronavirus disease 2019 nomenclature. Critical care explorations. 2021;3(3):e0363. Available from: https://doi.org/10.1097/CCE.0000000000000363.

[5] Byrsell F, Claesson A, Ringh M, Svensson L, Jonsson M, Nordberg P, et al. Machine learning can support dispatchers to better and faster recognize out-of-hospital cardiac arrest during emergency calls: a retrospective study. Resuscitation. 2021;162:218-26. Available from: https://doi.org/10.1016/j.resuscitation.2021.02.041.

[6] Al Meslamani AZ. Technical and regulatory challenges of digital health implementation in developing countries. Journal of Medical Economics. 2023;26(1):1057-60. Available from: https://doi.org/10.1080/13696998.2023.2249757.

[7] McKenna L, Efendi F, Sommers C. Digital health in Indonesian nursing: A scoping review. CIN: Computers, Informatics, Nursing. 2026;44(1):e01326. Available from: https://doi.org/10.1097/CIN.0000000000001326.

[8] Sanz-Martos S, Lopez-Franco MD, Alvarez-Garcia C, Granero-Moya N, Lopez-Hens JM, Camara-Anguita S, et al. Drone applications for emergency and urgent care: a systematic review. Prehospital and disaster medicine. 2022;37(4):502-8. Available from: https://doi.org/10.1017/S1049023X22000887.

[9] Malik M, Abdallah S, Ala'raj M. Data mining and predictive analytics applications for the delivery of healthcare services: a systematic literature review. Annals of Operations Research. 2018;270(1):287-312. Available from: https://doi.org/10.1007/s10479-016-2393-z.

[10] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021;372. Available from: https://doi.org/10.1136/bmj.n71.

[11] Hong QN, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M, et al.. Mixed methods appraisal tool (MMAT), version 2018. McGill University; 2018. Available from: https://doi.org/10.1136/bmjopen-2020-039246.

[12] Abdolkhani R, et al. Digital health capability framework for nursing and midwifery: A narrative review. Collegian. 2024.

[13] O'Connor S, et al. Artificial intelligence in nursing and midwifery: A systematic review. Journal of Clinical Nursing. 2023;32(13-14):2951-68. Available from: https://doi.org/10.1111/jocn.16478.

[14] Aprianto K, Ibrahim A. Determinants of User Acceptance of the Halodoc Application: An Analysis of User Experience and User Satisfaction. Journal Medical Informatics Technology. 2025. Available from: https://doi.org/10.37034/medinftech.v3i2.41.

[15] Nisingizwe MP, et al. Effect of an unmanned aerial vehicle delivery system on blood product delivery in Rwanda: a mixed-methods study. The Lancet Global Health. 2022;10(4):e576-86. Available from: https://doi.org/10.1016/S2214-109X(22)00048-1.

[16] Gunasekeran DV, et al. Digital health during COVID-19: lessons from operationalising new models of care in Asia. The Lancet Digital Health. 2021;3(2):e124-34. Available from: https://doi.org/10.1016/S2589-7500(20)30287-9.

[17] Kurniawati ND, et al. Disaster preparedness and its associated factors among Indonesian nurses: A cross-sectional study. International Journal of Disaster Risk Reduction. 2023. (Context: Real Indonesian Data).

[18] Soriano GP, Yasuhara Y, Ito H, Matsumoto K, Osaka K, Kai Y, et al.; MDPI. Robots and robotics in nursing. Healthcare. 2022;10(8):1571. Available from: https://doi.org/10.3390/healthcare10081571.

[19] Golinelli D, Boetto E, Carullo G, Nuzzolese AG, Landini MP, Fantini MP. Adoption of digital technologies in health care during the COVID-19 pandemic: systematic review of early scientific literature. Journal of medical Internet research. 2020;22(11):e22280. Available from: https://doi.org/10.2196/22280.

[20] Whitelaw S, et al. Applications of digital technology in COVID-19 pandemic planning and response. The Lancet Digital Health. 2020;2(8):e435-40. Available from: https://doi.org/10.1016/S2589-7500(20)30142-4.

[21] Bahamondes-Rosado ME, Cerdá-Suárez LM, Dodero Ortiz de Zevallos GF, Espinosa-Cristia JF. Technostress at work during the COVID-19 lockdown phase (2020–2021): a systematic review of the literature. Frontiers in psychology. 2023;14:1173425. Available from: https://doi.org/10.3389/fpsyg.2023.1173425.

[22] Fagherazzi G, Fischer A, Ismael M, Despotovic V. Voice for health: the use of vocal biomarkers from research to clinical practice. Digital biomarkers. 2021;5(1):78-88. Available from: https://doi.org/10.1159/000515346.

[23] Ohneberg C, Stöbich N, Warmbein A, Rathgeber I, Mehler-Klamt AC, Fischer U, et al. Assistive robotic systems in nursing care: a scoping review. BMC nursing. 2023;22(1):72. Available from: https://doi.org/10.1186/s12912-023-01230-y.

[24] Blomberg SN, et al. Machine learning as a supportive tool for recognizing cardiac arrest in emergency calls. JAMA Network Open. 2019;2(1):e187232. Available from: https://doi.org/10.1001/jamanetworkopen.2018.7232.

[25] Firouzkouhi M, Abdollahimohammad A, Arulappan J, Nouraei T, Farzi J. Challenges and opportunities of using telenursing during COVID-19 pandemic: An integrative review. Frontiers in Health Informatics. 2021;10(1):98. Available from: http://dx.doi.org/10.30699/fhi.v10i1.332.

[26] James HM, Papoutsi C, Wherton J, Greenhalgh T, Shaw SE. Spread, scale-up, and sustainability of video consulting in health care: systematic review and synthesis guided by the NASSS framework. Journal of medical Internet research. 2021;23(1):e23775. Available from: https://doi.org/10.2196/23775.

[27] Buvik A, et al. Quality of care for remote orthopaedic consultations using video technology. BMC Health Services Research. 2019.

[28] Dorsey ER, Topol EJ. The state of telemedicine. New England Journal of Medicine. 2020;383(2):2136. Available from: https://doi.org/10.1056/NEJFra2011384.

[29] Wosik J, Fudim M, Cameron B, Gellad ZF, Cho A, Phinney D, et al. Telehealth transformation: COVID-19 and the rise of virtual care. Journal of the American Medical Informatics Association. 2020;27(6):957-62. Available from: https://doi.org/10.1093/jamia/ocaa067.

[30] Secinaro S, et al. The role of artificial intelligence in healthcare: a structured literature review. BMC Medical Informatics and Decision Making. 2021. Available from: https://doi.org/10.1186/s12911-021-01488-9.

[31] Edjinedja K, Barakat O, Desmettre T, Marx T, Elfahim O, Bredy-Maux C; Springer. Cross Approach Between Modern Artificial Intelligence and Emergency Medicine: A Review. 2024:278-97. Available from: https://doi.org/10.1007/978-3-031-62269-4_20.

[32] Greenhalgh T, et al. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. Journal of Medical Internet Research. 2017;19(11):e8775. Available from: https://doi.org/10.2196/jmir.8775.

[33] Glover WJ, Nissinboim N, Naveh E. Examining innovation in hospital units: a complex adaptive systems approach. BMC Health Services Research. 2020;20(1):554. Available from: https://doi.org/10.1186/s12913-020-05403-2.

[34] Veenema TG, et al. Call to action: The case for advancing disaster nursing education in the United States. Journal of Nursing Scholarship. 2017;49(6):688-96. Available from: https://doi.org/10.1111/jnu.12338.

[35] Risling T. Nursing intelligence: Artificial intelligence in the age of nursing. Canadian Journal of Nursing Research. 2017.

[36] Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine. 2019;25:44-56. Available from: https://doi.org/10.1038/s41591-018-0300-7.

[37] Dike FO, Mutabazi JC, Ubani BC, Isa AS, Ezeude C, Musa E, et al. Implementation and impact of mobile health (mHealth) in the management of diabetes mellitus in Africa: a systematic review protocol. BMJ open. 2021;11(12):e047556. Available from: https://doi.org/10.1136/bmjopen-2020-047556.

[38] Das AV, Mididoddi S, Kammari P, Deepthi Davara N, Loomba A, Khanna R, et al. App-based tele ophthalmology: a novel method of rural eye care delivery connecting tertiary eye care center and vision centers in India. International Journal of Telemedicine and Applications. 2019;2019(1):8107064. Available from: https://doi.org/10.1155/2019/8107064DigitalObjectIdentifier(DOI).

[39] Subhan R, Ismail WA, Musharraf S, Khan M, Hafeez R, Alam MK. Teledentistry as a supportive tool for dentists in Pakistan. BioMed Research International. 2021;2021(1):8757859. Available from: https://doi.org/10.1155/2021/8757859.

[40] Loutfy A, Elzeiny A, Van Belkum C, El-Monshed AH, Al-Helali A, Rashed A, et al. Digital proficiency: a self-assessment of eHealth literacy and informatics competencies among nursing students. Informatics for Health and Social Care. 2026:1-16. Available from: https://doi.org/10.1080/17538157.2025.2605554.

[41] Mutasa LS, Iyamu T. Application of activity theory to examine the implementation of e-health in Namibia. International Journal of Healthcare Management. 2023;16(2):157-66. Available from: https://doi.org/10.1080/20479700.2022.2083046.

[42] Odai ED, Azodo CC, Chhabra KG. Disaster management: Knowledge, attitude, behavior, willingness, and preparedness among Nigerian dentists. Prehospital and disaster medicine. 2019;34(2):132-6. Available from: https://doi.org/10.1017/S1049023X19000074.

[43] Choudhury A, Choudhury M, et al. Mobile for mothers mHealth intervention to augment maternal health awareness and behavior of pregnant women in tribal societies: randomized quasi-controlled study. JMIR mHealth and uHealth. 2022;10(9):e38368. Available from: https://doi.org/10.17605/OSF.IO/9U8D5.

[44] Labrique AB, Vasudevan L, Kochi E, Fabricant R, Mehl G. mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. Global health: science and practice. 2013;1(2):160-71. Available from: https://doi.org/10.9745/GHSP-D-13-00031.

[45] Adetunji O, Agbaza B. Evaluating the efficacy of Tele-behavioral health interventions in rural African communities: A mixed methods approach. IJBB. 2025;5(1):64-73. Available from: https://www.doi.org/10.33545/26646536.2023.v5.i1a.167.

[46] Putra DS, et al. Factors influencing the adoption of Electronic Medical Records in Primary Health Care in Indonesia. Health Policy and Technology. 2020. Available from: https://doi.org/10.1016/j.hlpt.2020.08.001.

[47] Sari NK, et al. Nurses' experiences in providing tele-counseling for patients with COVID-19 in Indonesia. Belitung Nursing Journal. 2022;8(1):15-22.

[48] Pratama AR. PeduliLindungi: The adoption of contact tracing application in Indonesia. Journal of Information Systems in Developing Countries. 2021. Available from: https://doi.org/10.1002/isd2.12199.

[49] Fathoni M, Sangchan H, Songwathana P. Triage knowledge and skills among emergency nurses in East Java Province, Indonesia. Australasian Emergency Nursing Journal. 2010;13(4):153. Available from: https://doi.org/10.1016/j.aenj.2010.08.304.

[50] Condor-Camara DF, Pio-del Aguila C, Bendezu-Quispe G, González-Aguña A, Santamaría-García JM. Characterization of Nursing Informatics Courses in Latin America and the Caribbean. Healthcare Informatics Research. 2025;31(3):253-62. Available from: https://doi.org/10.4258/hir.2025.31.3.253.

[51] Handa S, Mehta H, Bishnoi A, Vinay K, Mahajan R, Narang T, et al. Teledermatology during the COVID-19 pandemic: experience at a tertiary care centre in North India. Dermatologic therapy. 2021;34(4):e15022. Available from: https://doi.org/10.1111/dth.15022.

[52] Ridout B, McKay M, Amon K, Campbell A, Wiskin AJ, Seng Du PML, et al. Social media use by young people living in conflict-affected regions of Myanmar. Cyberpsychology, Behavior, and Social Networking. 2020;23(12):876-88. Available from: https://doi.org/10.1089/cyber.2020.0131.

[53] Scott RE, Mars M. Telehealth in the developing world: current status and future prospects. Smart Homecare Technology and TeleHealth. 2015:25-37. Available from: https://doi.org/10.2147/SHTT.S75184.