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Facilitators and barriers of digital health technologies implementation in hospital settings in lower-income and middle-income countries since the COVID-19 pandemic: a scoping review protocol

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ABSTRACT

Introduction The implementation of digital health technologies (DHTs) in hospitals worldwide has been uneven since the COVID-19 pandemic. Ambiguity in defining the landscape of DHTs adds to the complexity of this process. To address these challenges, this scoping review aims to identify the facilitators and barriers of implementing DHTs in hospitals in lower-income and middle-income countries (LMIC) since COVID-19, describe the DHTs that have been adopted in hospital settings in LMIC during this period, and develop a comprehensive classification framework to define the landscape of DHTs implemented in LMIC.

Methods and analysis We will conduct a systematic search in PubMed, Scopus, Web of Science and grey literature. Descriptive statistics will be used to report the characteristics of included studies. The facilitators and barriers to DHTs implementation, gathered from both quantitative and qualitative data, will be synthesised using a parallel-results convergent synthesis design. A thematic analysis, employing an inductive approach, will be conducted to categorise these facilitators and barriers into coherent themes. Additionally, we will identify and categorise all available DHTs based on their equipment types and methods of operation to develop an innovative classification framework.

Ethics and dissemination Formal ethical approval is not required, as primary data collection is not involved in this study. The findings will be disseminated through peer-reviewed publications, conference presentations and meetings with key stakeholders and partners in the field of digital health.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The utilisation of a parallel-results convergent design provides a comprehensive synthesis strategy to address both quantitative and qualitative findings on facilitators and barriers of digital health technologies (DHTs) implementation, leading to a broad understanding of existing evidence and research gaps.
⇒ The scope of DHTs is continuously growing and evolving, and new categories may emerge after the publication of the protocol, potentially necessitating updates to the proposed classification system.
⇒ The search strategy includes only English-written articles, potentially missing relevant publications in native languages of certain countries.

INTRODUCTION

Access to healthcare is one of the most important determinants of health.[1] As such, an equitable distribution of health services among the population is crucial[2] irrespective of age, gender, ethnicity, educational level and other socioeconomic characteristics. Unfortunately, recent data suggest that there is an unmet need of healthcare in lower-income and middle-income countries (LMICs),[3] mostly due to ageing population,[4] rising costs of healthcare,[5] worsening of income disparity,[6] increased child morbidity and mortality,[7] emerging of new epidemics and pandemics,[8] as well as increasing racial discrimination on access to healthcare.[9] As a response to the increasing needs in healthcare, the WHO Global Strategy on Digital Health presented a roadmap in 2020 to strengthen the health systems using digital health technologies (DHTs).[10] With this initiative, it is hoped that DHTs can create health systems that are efficient, sustainable, affordable, equitable and of good quality.

DHTs are defined as a set of information and communications technologies used in medicine and healthcare to manage illnesses and to promote wellness.[11] Although DHTs have gained more attention throughout the past decade[12] and a plethora of such technologies have been researched in previous studies,[13] there are still some gaps in digital health research. First, there is a limited review that focuses on the facilitators and

barriers that stakeholders, researchers and/or clinicians may experience when transforming from conventional health system into digital health.[14 15] Without this information as reference, hospitals from developing countries, especially, are unable to effectively strategise their DHTs implementation. Even if such reviews are available, many of them were published in the context of a pre-COVID-19 era.[16–18] When the COVID-19 pandemic hit, the adoption of DHTs has been skyrocketed.[19 20] Within a few months, DHTs became necessities in the healthcare systems of many countries. While such booming demonstrated the tremendous potential of the DHTs, the COVID-19 pandemic has revealed and accentuated some new challenges of DHTs implementation, which were not identified in the prepandemic era. One of the challenges that was encountered during the rise of DHTs amidst the pandemic was the increased spread of misinformation concerning the vaccination programme[21] and fake news on remedies for COVID-19.[22] New ethical concerns and the insufficient regulations of DHTs have also surfaced during the pandemic.[23] Despite the availability of many mobile health applications, the COVID-19 contract tracing mobile applications, which were adopted by many countries globally, have failed to demonstrate their effectiveness in controlling the deadly disease in real-world implementation.[24] Worst still, these mobile applications, which usually contain nationwide databases of patients' information were reported to be vulnerable to hackers, who eventually leaked patients' data to third parties.[25] This, no doubt, added urgency to concerns around digital privacy and security. Additionally, an increased reliance on DHTs during the pandemic has led to the augmentation of digital divides and further exacerbated the digital inequalities among different populations.[26] As such, there is a timely need for an updated appraisal of the facilitators and barriers of DHTs implementation since the COVID-19 pandemic.

Another gap in digital health is that the landscape of DHTs is rarely discussed[27] and its classification framework has not been clearly defined in academic literature. The WHO Framework,[28] French National Authority of Health,[29] National Institute for Health and Care Excellence (NICE)[30] and Food and Drug Administration (FDA)[31] are a few existing frameworks that attempt to classify DHTs. The WHO classifies DHTs into four major categories, namely the interventions for healthcare providers, interventions for clients, interventions for data services and interventions for health system managers. The French National Authority for Health classifies DHTs into four levels, namely level A (system services), level B (general non-personalised user information), level C (aid for living, prevention, screening, diagnosis, compliance, monitoring or treatment of a disease) and level D (autonomous decision management). Meanwhile, the NICE guideline classifies DHTs in accordance with users' risks and benefits (ie, tier A, tier B and tier C). One significant challenge with these frameworks is that they lack a clear and specific differentiation between various DHTs. To illustrate, consider the case of artificial intelligence (AI) within these frameworks. AI can potentially fall into all categories simultaneously, such as tier A, tier B and tier C in the NICE Framework. The same ambiguity can be observed in the WHO and French National Authority of Health frameworks. This complexity arises because a single DHT may serve various applications or functions when implemented in different healthcare contexts. To the best of our knowledge, the FDA offers a more effective framework for classifying DHTs, which categorises them based on their specific functions and services. This classification system comprises 10 categories, including telemedicine, AI, mobile medical applications, software as a medical device, cybersecurity, medical device data systems, health information technology, medical device interoperability and wireless medical devices. While this framework is comprehensive in its attempt to categorise various DHTs, it still falls short in classifying newer, emerging technologies like the metaverse,[32] internet of things,[33] internet of medical things,[34] blockchain technology,[35] three-dimensional printing[36] and big data analytics.[37] In short, none of the above classification framework provides a clear and comprehensive landscape in digital health due to the ever-emerging, overlapping and multifunctional nature of DHTs.

Without a proper classification framework in DHTs, stakeholders in healthcare are unable to outline the boundary and scope of DHTs. As a result, policy-makers will experience difficulty in financing healthcare (ie, the ministry of health is unable to determine the categories of DHTs that qualify for subsidy) and insurers may be more reluctant to reimburse patients who use DHTs (ie, insurers cannot identify which categories of DHTs that could be covered by the insurance policy).[29 30] Not to mention, a clear and effective communication between public, health practitioners and technology professionals could hardly be established.[29 38] From a legal aspect, the lack of a clear classification framework poses a great challenge for the authorities to regulate and govern the usage of DHTs.[27 31] Last but not least, the absence of a clearly defined classification framework of DHTs may lead to many difficulties in the implementations of DHTs in the scarcity of resources (ie, stakeholders are unable to identify which categories of DHTs that need to be prioritised in their implementations).[30]

With the above research gaps in mind, the objectives of the current scoping review are threefold. First, we aim to provide a comprehensive account of all possible facilitators and barriers of DHTs implementation in hospital settings in LMIC since the COVID-19 pandemic. Second, we will identify and describe all DHTs that have been implemented in hospital settings in LMIC since the COVID-19 pandemic. Finally, we will develop a classification framework that can define the landscape of DHTs implemented in LMIC in a more comprehensive and useful way.

METHODS

The original idea of the scoping review was to provide a comprehensive account of all possible facilitators and barriers of DHTs implementation in hospital settings globally since the COVID-19 pandemic, and subsequently to identify and describe all DHTs that have been implemented in hospital settings globally since the COVID-19 pandemic. Nevertheless, in order to prevent an excessively broad review with significant heterogeneity in the final outcomes, we will limit our searches exclusively to LMIC.

The current protocol is developed with the guidance of the scoping review methodological framework as proposed by Arksey and O'Malley.[39] This framework delineates that a scoping review should consist of six stages as follows. The present scoping review is aimed to commence in January 2024 and ends in August 2024.

Stage 1: research questions identification

This scoping review will answer the following questions: (1) What are the facilitators and barriers of DHTs implementation in hospital settings in LMIC since the COVID-19 pandemic? (2) What are the DHTs that have been implemented in hospital settings in LMIC since the COVID-19 pandemic? and (3) What is the classification framework that can define the landscape of DHTs implemented in LMIC?

In the present protocol, 'facilitators of DHTs implementation' is defined as any factors that encourage an organisation to adapt digital health practice, including factors that allow the continuation of digital health interventions.[14] Accordingly, 'barriers of DHTs implementation' is defined as any factors that prevent an organisation to adapt digital health practice, including factors that hinder the continuation of digital health interventions.[14]

Stage 2: identifying relevant literature

In order to comprehensively identify literature relevant for DHT, we will employ a broad sensitive and specific search strategy that will enable us to capture all DHT relevant literature. With the assistance of an information technologist or a medical librarian, we will identify a comprehensive list of literature in relevance to DHTs according to the criteria below. Table 1 describes the inclusion and exclusion criteria that will be adopted for this scoping review. We will focus on the time period between March 2020 and December 2023 because the WHO officially declared COVID-19 as a pandemic in March 2020.

First, we will conduct systematic searches in published literature from PubMed, Scopus and Web of Science databases. Second, we will search for potentially relevant grey literature through targeted searches of the Google Scholar. Third, we will screen the list of references in all identified studies and/or reviews for the relevant publications. Articles that were published in English language between March 2020 and December 2023 will be retrieved. Two investigators (SQY and NIHA) will independently perform literature search in the above-mentioned electronic databases.

The search strategy is developed based on the 'Population–Concept–Context' (PCC) framework as recommended by the Joanna Briggs Institute for scoping reviews[40] (table 2). As such, our search strategy will aim to identify the intersection between the PCC.

Stage 3: study selection

After the removal of duplicated studies (with the help of reference management software), we will screen and select studies in two stages. The first stage is an initial screening of titles and abstracts by two independent reviewers (SQY and NIHA), whereby 25% of titles and abstracts are screened independently to ensure reliability. Once the

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
► Studies that were conducted in LMIC*. ► Studies that reported the implementation of DHTs in hospital settings (for both acute and chronic conditions). ► Studies that were reported between March 2020 and December 2023. ► Studies that were reported in the English language. ► Qualitative studies (phenomenology, ethnography, grounded theory, case study, etc), quantitative studies (case control, cohort study, cross-sectional, random controlled trials, etc), mixed-methods studies and reviews (narrative review, scoping review, systematic review, meta-analysis, etc). ► Relevant grey literature (eg, Google Scholar).	► Studies that were non-digital-based (ie, studies that did not investigate the effectiveness of digital interventions, such as paper-based studies and postage surveys). ► Studies that implement DHTs in primary care and/or community settings alone. However, studies that concurrently reported on the implementation of DHTs in hospital settings will still be included. ► Studies that used DHTs in dentistry and non-clinical medicine area (eg, dentistry, basic sciences, medical education, medical engineering, nutrition, dietetics, veterinary science, laboratory experimentations, medical anthropology, etc).

*LMIC countries are defined based on the World Bank Income Classification 2023.
DHTs, digital health technologies; LMIC, lower-income and middle-income country.

Table 2 The Population–Concept–Context (PCC) framework used to generate search terms

Framework	Search terms
Population	► Population 1: Hospital Setting (search terms as in online supplemental file 1). ► Population 2: LMIC (search terms as in online supplemental file 1). ► Population combined: population 1 and population 2.
Concept	► Digital health technologies (search terms as in online supplemental file 1).
Context	► Facilitators, barriers, implementation.

Based on the PCC framework, the search strategy would be 'Population combined' AND 'Concept' AND 'Context'.
LMIC, lower-income and middle-income country.

screening is completed, the two reviewers will discuss the search results. Disagreements will be resolved via discussion. If the disagreement cannot be resolved, consultation from a third reviewer (BHC) will be sought to reach a consensus. In the second stage, the two reviewers (SQY and NIHA) will independently review the full-text articles to determine whether they meet the inclusion criteria. Disagreements in regard to the inclusion of articles will be discussed. Articles without a consensus agreement and those with questionable eligibility will be adjudicated by a third reviewer (BHC).

The inclusion and exclusion criteria are delineated in table 1. These inclusion and exclusion criteria will be refined iteratively to align potentially eligible studies to the research questions of this scoping review. Studies that fulfil the following inclusion criteria will be included: (1) Studies that were conducted in LMIC, (2) Studies that reported the implementation of DHTs in hospital settings, (3) Studies that were reported between March 2020 and December 2023, (4) Studies that were reported in the English language, (5) Qualitative studies (phenomenology, ethnography, grounded theory, case study, etc), quantitative studies (case–control, cohort study, cross-sectional, random controlled trials, etc) and reviews (narrative review, scoping review, systematic review, meta-analysis, etc) and (6) Relevant grey literature (eg, Google Scholar).

The inclusion of both quantitative and qualitative studies (on facilitators and barriers), reviews and even relevant grey literature is meant to provide a greater breadth of this scoping review.[41] We will contact the authors of the articles should further information is required. If a study has multiple publications, the most recent one will be retained.

Stage 4: charting the data

Data extraction tools are developed to capture the key information from each article. Data on the descriptions of included studies (eg, the authors, publication years, study objectives, study countries, diseases conditions, types of DHTs, fields of clinical medicine to which the DHTs are applied, study designs, sample sizes, characteristics of the study population, study location, study time frame, design features of the intervention or programme and the key findings of the included studies) will be documented in a template as shown in table 3. Meanwhile, quantitative and qualitative data describing the facilitators and barriers of DHTs implementation will be summarised and presented in a template as shown in table 4.

Although it is not the objective of the present scoping review, we will capture information on the key findings of all included studies. We expect the authors to report data in the form of clinical outcomes, patients' experience, healthcare providers' experience and organisational key performances. The anticipated key findings with their respective indicators or measurements are tabulated in table 5.

The data extraction and charting will be piloted by two reviewers (SQY and NIHA) using five articles, and the differences will be resolved by a third reviewer (BHC). Refinements of the extraction tool will be performed after the pilot extraction and charting, if necessary. Additionally, the data extraction tool may also be refined in accordance with the emerging variables as the review progresses.[41] Any refinements during the conduct of the actual review will be clearly documented and justified in the scoping review article(s).

Stage 5: collating, summarising and reporting the results

Descriptions of the included studies (eg, the authors, publication years, study objectives, study countries, diseases conditions, types of DHTs, fields of clinical medicine which the DHTs are applied, study designs, sample sizes, characteristics of the study population, study location, study time frame, design features of the intervention or programme and the key findings of the included studies) will be reported using descriptive statistics, such as frequencies and central measures of tendency. Facilitators and barriers of DHTs implementation, which can be in the forms of quantitative and qualitative data will be synthesised via a parallel-results convergent synthesis design. In this design, both quantitative and qualitative evidence will be presented and analysed separately, with the integration take place at the stage of results interpretation.[42] For quantitative data, frequency distribution and p values will be used to describe the findings of the included articles.[43] Meanwhile, qualitative data will be thematically analysed using an inductive approach. To guide the parallel-results convergent synthesis, facilitators and barriers of DHTs implementation will be organised

Table 3 Data extraction and charting form for the descriptions of included studies

Authors and publication years	Study objectives and study countries	Disease conditions, types of DHTs and fields of clinical medicine which the DHTs are applied	Study designs	Sample sizes and characteristics of the study population, n (%)	Study location and study time frame	Design features of the intervention or Programme	Key findings of the included studies

DHTs, digital health technologies.

using the Practical, Robust Implementation and Sustainability Model.[44]

In terms of developing a novel classification framework, we will identify all reported and up-to-date DHTs and categorise them in accordance with the types of equipment and method of operation, viz DHTs that use the similar equipment and/or operated via the similar approach will be grouped together. To avoid confusion and overlapping of DHT classes, DHTs will not be categorised based on their functionality and roles in healthcare. Our analyses will inform the development of a working classification framework of DHTs in clinical medicine, with their respective key characteristics, potential benefits and challenges. Implications for practice and research, recommendations that address the evidence gaps will be highlighted. We will use the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram for the Scoping Reviews to illustrate the search decision process of the scoping review.[45]

Stage 6: consultation with stakeholders

We will invite several stakeholders (ie, the clinicians from two local teaching hospital and the information technology experts within the universities) to contribute towards the interpretation of the findings. This measure is to improve the impact and relevance of this scoping review. At a later stage, we will engage with these stakeholders to disseminate the findings of the current scope review via presentation, policy brief and peer review publication.

Patient and public involvement

Patients and the public are not involved in the development of this protocol. However, a few experts in information technology were approached during the conceptualisation of the research project and they will be engaged again during the interpretation of finding in future scoping review.

Table 4 Data extraction and charting form for the facilitators and barriers of DHTs implementation

Authors and publication years	Facilitators of DHTs implementation	Barriers of DHTs implementation

DHTs, digital health technologies.

RESULTS

This scoping review protocol was first initiated in January 2023 as part of the Digital Health Research Initiative. The results from this scoping review will be presented in a narrative form and additional data on study characteristics and important findings will be presented in tabular and/or diagrammatic format. Data synthesis (stage 2–4) is expected to commence in January 2024 while the results will be presented in a scoping review in August 2024 (stage 5). Finally, the results will be disseminated to various stakeholders through presentations, policy briefs and peer-review publication (stage 6).

DISCUSSION

The proposed scoping review is aimed to identify all possible facilitators and barriers of DHTs implementation in hospital settings in LMIC since the COVID-19 pandemic. Then, we will identify all DHTs that have been implemented in hospital settings in LMIC since the COVID-19 pandemic. Finally, with these identified DHTs, we will develop a classification framework to define the landscape of DHTs implemented in LMIC in a more comprehensive and useful way.

All the above study objectives could be achieved by using a scoping review methodology due to various reasons. First and foremost, a scoping review methodology is useful in providing comprehensive coverage (ie, breadth) of literature in a particular field of area, including digital health. Although this type of review may not describe research findings in great detail, it is a useful way of mapping the landscape of DHTs in which researchers are difficult to visualise the range of material that might be available.[39] Second, a scoping review neither limits the types of included studies nor requires methodological homogeneity of included studies.[46] As such, all published literature in the field of digital health can be included as a whole regardless of its methodological approaches, settings and contexts. This will provide a big picture of existing knowledge, thereby improving research planning, strategic research prioritisation and evidence-informed policies.[47] Third, a scoping review has a mechanism that include different stakeholders during the interpretation and dissemination of research findings. In step 6 (consultation with stakeholders) of

Table 5 The anticipated key findings with their respective indicators or measurements

Anticipated key findings	Indicators or measurements
Clinical outcomes	► Prevention of diseases and health promotion ► Prediction of diseases ► Diagnosis of diseases ► Therapeutic effects of diseases (eg, biological parameters, psychological parameters, signs and symptoms) ► Prognosis of diseases (eg, rate of recovery, survival rate, quality of life and body functions) ► Level of physical activities and/or lifestyles ► Level of medication adherence ► Prevalence or incidence of diseases
Patients' experience	► Patients' knowledge, attitude, perception, awareness, usability, feasibility, acceptance and expectation
Healthcare providers' experience	► Healthcare workers' knowledge, attitude, perception, awareness, usability, feasibility, acceptance and expectation
Organisational key performances	► Organisational readiness, healthcare utilisation, quality of care, admission waiting time, duration of hospital stays and cost-effectiveness

the scoping review, several stakeholders were invited to contribute their thoughts for the interpretation of the findings. When the review is completed, these stakeholders will again be engaged and be disseminated with research findings via presentation, policy brief and peer-review publication.[39]

Strengths

A few strengths of this scoping review can be identified. First, the development of this protocol was guided by the scoping review methodological framework.[39] These criteria help to increase the methodological quality, rigour, accuracy and transparency of this scoping review, thereby reducing the risk of bias. Second, the utilisation of a parallel-results convergent design provides a comprehensive synthesis strategy to address both quantitative and qualitative findings pertaining to facilitators and barriers of DHTs implementation, hence, providing a broad picture of existing evidence, knowledge and research gaps.[42] Third, to our knowledge, this is the first protocol to propose the classification of different types of DHTs, as well as the facilitators and barriers of implementing these technologies in a global context.

Limitations

Two limitations in the protocol can be highlighted. First, the scope of DHTs is ever-growing and evolving.[48 49] New categories of DHTs may be emerging at the time of the publication of this protocol. Hence, the classification system proposed in this protocol may be revised and updated. Second, the search strategy that only include English-written articles may miss publications in the native language of some countries. Nonetheless, our search strategy that includes past reviews and grey literature can increase the comprehensiveness of the findings and to minimise these limitations.

CONCLUSION

The current protocol is aimed to inform stakeholders regarding the various facilitators and barriers of DHTs implementation since the COVID-19 pandemic. The proposed study will also identify all DHTs that have been implemented and subsequently classify them using a novel framework. It is hoped that these findings can provide direction for future digital health research, guide future digital health investments, improve healthcare delivery and inform the policy-making in healthcare.

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Contributors SQY and BHC conceived the idea for the scoping review. SQY and DT played significant roles in designing the research methodology. NIHA and BHC conducted an extensive literature review to identify relevant scoping review frameworks and methodological approaches. SQY drafted the protocol paper.

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