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# Exploring digital health interventions to support community health workers in low-and-middle-income countries during the Covid-19 pandemic: a scoping review protocol.



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**Title of Scoping Review**

Exploring digital health interventions to support community health workers in low-and-middle-income countries during the Covid-19 pandemic: a scoping review protocol.

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## Abstract

***Introduction:*** Covid-19 has significantly affected community health workers' (CHWs) performance as they are expected to perform pandemic-related tasks along with routine essential healthcare services. A plausible way to optimize CHWs' functioning during this pandemic is to couple the efforts of CHWs with digital tools. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in LMICs amid the Covid-19 pandemic. The paper describes a protocol for a scoping review of primary research studies that aim to map evidence on the use of unique digital health interventions to support CHWs during Covid-19 in LMICs.

***Methods and Analysis:*** Our methodology has been adapted from scoping review guidelines provided by Arksey and O'Malley, Levac et al, and the Joanna Briggs Institute. Our search strategy has been developed for four main electronic databases: EMBASE, MEDLINE, Cochrane Central Register of Controlled Trials, and CINAHL. Google Scholar and reference tracking will be used for supplementary searches. Each article will be screened against eligibility criteria by 2 independent researchers at the title and abstract and full-text level. The review will include studies that targeted digital health interventions at CHWs' level to provide support in delivering Covid-19 related healthcare and other essential healthcare services. A date limit of December 31, 2019 to the present date will be placed on the search and English language articles will be included.

***Ethics and Dissemination:*** The immense physical, psychological, and emotional burden on CHWs during the Covid-19 pandemic has highlighted the urgent need to critically examine the use of digital health interventions to support CHWs. The results from our scoping review will provide valuable insight into the use of digital health interventions to optimize CHWs' functioning and will reveal current knowledge gaps in research. The results will be disseminated through journal publications and conference presentations.

**Strengths and limitations of this study**

- This will be the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic.
- This protocol outlines a rigorous design that includes an established research framework, a search strategy and a selection process.
- The search strategy includes four different databases with peer-reviewed literature as well as supplementary search from Google Scholar and reference tracking.
- Our review was limited in the ability to operationalize the term "community health workers" in our search since these are known by many different names in different countries.
- Our review will not include reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books, which will allow us to map original research on use of digital health interventions to support community health workers in low-middle-income countries.

## Background

Community health workers (CHWs) play an integral role in improving health outcomes at the community level due to their proximity to households, communities, and the primary healthcare system (1, 2). However, several CHW programs have failed in the past because of unrealistic expectations, poor planning, and an underestimation of the effort and input required to make them work. With the advent of Covid-19, maintaining the credibility of the CHW concept is even more daunting as healthcare systems across low-middle-income countries (LMICs) are overwhelmed due to the Covid-19 outbreak(3).

In the wake of Covid-19, the CHWs are playing a significant role in preventing the transmission of Covid-19 (4), through promoting physical distancing and other precautionary measures like hand washing, wearing making, contact tracing, recognizing early signs of Covid-19, referring individuals for testing, providing isolation and quarantine guidance, and Covid-19 vaccination (4) (5). With the prevention, detection, and management of Covid-19 cases, CHWs are also expected to deliver mental health services at the community level to address issues of stress, anxiety, anger, grief, and depression, which are rising because of pandemic(6). Despite being a vital part of the Covid-19 pandemic response, CHWs in LMICs are not well-supported and equipped with resources such as personal protective equipment to contain the spread of Covid-19. This has caused stress and anxiety among CHWs across LMICs. Some CHWs are apprehensive of becoming vectors of spreading Covid-19 in communities while others are concerned about contracting Covid-19 during household visits and transmitting it to their family members (7).

The pandemic has significantly affected the regular duties of CHWs which include the provision of antenatal and postnatal care, child immunization, and community case management of pneumonia, malaria, tuberculosis, and diarrhea. Assigning new Covid-19 related tasks to CHWs, within the scope of existing roles, pose the question of whether these Covid-19 related tasks will produce significant population health benefits and outweigh the risks posed to CHWs. Feroz et al. argue that public health departments, NGOs, and social enterprises operating CHW programs need to devise innovative solutions to strike the right balance, between Covid19 related tasks and other essential services (1) as it makes little sense to divert all CHWs for Covid-19 response and vaccination at the expense of other essential services.

A plausible way to optimize CHWs' functioning during this pandemic is to couple the efforts of CHWs with digital tools. Evidence suggests that CHWs equipped with digital tools can serve as a valuable lifeline in the Covid-19 response for information sharing, communication, training, surveillance, and decision support. In LMICs, CHWs reportedly used a range of digital health interventions for remote data collection and health assessments, health education through short message service (SMS) and voice message, behavior change through the use of digital megaphones, and digital contract tracing using mobile-based tracking systems (8). Numerous digital tools have been operationalized to optimize CHWs' functioning for Covid-19 related tasks and other essential health services including Living Goods' Smart Health app, DiMagi's CommCare, mHero, and Medic Mobile's Community Health Toolkit (9-11).

Bhaumik et al. conducted a rapid evidence synthesis on CHWs for pandemic response in response to a request from National Health Systems Resource Centre, a public agency in India (8). The review identified 36 articles, mainly from LMICs, which highlighted that CHW roles and tasks have been changed substantially during the pandemic and the most common additional activities were community awareness, engagement, and sensitization. CHW roles and tasks also changed considerably for countering stigma and contact tracing (8). However, the review did not mention the use of digital health interventions to support CHWs' functioning during Covid-19. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in LMIC during the Covid-19 pandemic. This gap highlights the need to explore unique digital health interventions to support CHWs in LMICs during pandemic response. This review aims to systematically explore the available literature on the use of digital health interventions to improve CHWs' performance during Covid-19.

## Methods

A scoping review method was selected as a method to outline different types of evidence on the use of digital health interventions for supporting CHWs during the pandemic and to fill in the gaps for further research. Our scoping review will use "Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews " to guide the design and reporting of results (12). The review has been registered in the Open Science Framework - Center for Open Science on May 19, 2021 (Registration link: https://osf.io/eu5yb/). The review will be guided by the methodological framework by Levac et al. (13), Arksey et al (14), and the Joanna Briggs Institute Tricco et al. (15) to examine studies describing the use of digital health interventions to support CHWs in LMICs amid pandemic. Following five steps will be followed in this scoping review: (i) identifying the research question, (ii) identifying relevant studies, (iii) selection of eligible studies, (iv) charting the data, and (v) collating and summarizing the results. Since this review aims to explore the general scope of research conducted on the area of interest, quality appraisal of studies will not be conducted.

### *Step 1: Identifying the Research Question*

The main research question for this scoping review is:

What is known in the literature about digital health interventions that have been used to support CHWs in LMICs during the Covid-19 pandemic response?

The research sub-questions are as follows:

What types of digital health interventions have been used by CHWs at the community level for providing essential health services and Covid-19 additional tasks?

What are the barriers and facilitators associated with the use of new digital health interventions for providing essential health services and Covid-19 additional tasks?

How the use of digital health interventions supported CHWs, in terms of improving their performance and reducing workload, in LMICs during the pandemic?

### *Step 2: Identifying Relevant Studies*

To identify relevant studies that would inform our research questions, we first operationalized the following 2 key concepts within our study: CHWs and digital health interventions. We then outlined the search strategy and decided on the types of studies that would be the most relevant to include in our scoping review.

Operational Definitions

For this scoping review, we used widely accepted definition of CHWs which was proposed by the World Health Organization: 'Community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers' (16).

This review will focus on all kinds of digital health interventions that supported CHWs for providing essential health services and carrying out additional Covid-19 tasks. In particular, the review will include original papers that focused on the use of digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision

support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions(17). For this review, the digital health interventions will include wearable devices, predictive models operationalized through clinical applications, health information technologies, health management systems, and other innovations related to mobile health, telehealth, and telemedicine that can guide diagnosis, monitoring, and treatment(18).

Search Strategy Development

We developed comprehensive search strategies with the assistance of an expert librarian specializing in health services research at the Aga Khan University. The search strategies were developed for the following four main electronic databases: Excerpta Medica Database (EMBASE), Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane Central Register of Controlled Trials, and Cumulated Index to Nursing and Allied Health Literature (CINAHL). The databases were selected based on subject area coverage and functionality. Additionally, guidelines provided by Goosen et al (19) and Bramer et al (20) were applied to inform the database selection. A date limit of December 31, 2019, to the present date will be placed on the search given that the first case of Covid was reported from Wuhan, China, on 31 December 2019. The search strategy including four main concepts of interest: target population (CHWs), disease condition (Covid-19), intervention (digital health interventions), and settings (LMICs). The search strategies used a combination of text words, keywords, and subject headings such as MeSH, and Emtree for each concept (Appendix 1: Search strategy for the MEDLINE database). Before importing results into Covidence for screening, a systematic review software program that supports the screening and management of citations by multiple reviewers (21), all citations from the databases will be exported into EndNote X9 (Clarivate Analytics) for deduplication (20).

Type of Studies

Since we aim to summarize a comprehensive and diverse collection of literature on the use of digital health interventions to support CHWs during the pandemic, it will primarily include original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. All types of reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books will be excluded.

Supplementary Searching

To enhance our search, a supplementary search will be conducted using the first seven pages of Google Scholar to identify relevant peer-reviewed literature on the use of digital health interventions to support CHWs during the Covid-19 pandemic. The supplementary search will help identify relevant studies that were not acknowledged during the database searches. The reference lists of relevant systematic reviews and final included articles will also be hand-searched to find pertinent studies. Potentially relevant articles will be selected and sent for abstract and full-text screening.

***Step 3: Selection of Eligible Studies***

The inclusion and exclusion criteria for study selection (Table 1: Eligibility Criteria) were developed iteratively by the research team based on the previously mentioned operational definitions and search strategy.

Table 1: Eligibility Criteria

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| **Inclusion criteria for study selection.**<br><br>**Types of participants**<br>• Primary research studies involving community health workers at which digital health interventions were targeted for improving functioning of community health workers during Covid-19 pandemic.<br>**Concept**<br>• Primary research studies on use of digital health interventions to support community health workers in low-middle-income countries during Covid-19 pandemic.<br>• Original papers focused on digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions.<br>**Context**<br>• All health system settings in low-middle-income countries.<br>**Types of evidence**<br>• Original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. |
| **Exclusion criteria for study selection.**<br><br>**Types of participants**<br>• Original studies that describe the use of digital health interventions to support clinicians and other healthcare providers at the secondary and tertiary hospital levels instead of community health workers as described within our inclusion criteria.<br>**Concept**<br>• Original studies that do not explicitly focus on the use of digital health interventions to support community health workers during Covid-19 pandemic.<br>**Context**<br>• Studies focused on high-income countries.<br>**Types of evidence**<br>• Literature reviews, including systematic reviews, meta-analyses, scoping reviews, realist reviews, and critical interpretive syntheses.<br>• Opinion papers, commentaries, editorial reviews, and letters to the editor, Conference abstracts/proceedings. |

A pre-defined screening guide has been developed by the primary author (ASF) with feedback from the research team, which will be used to determine if the eligibility criteria have been met. A total of four researchers (ASF, KV, SK, HK) will independently perform the pilot testing of the screening guide with a test sample of 100 abstracts to ensure the inter-rater reliability of screened articles. Based on the pilot test, results will be discussed, and modifications to the screening form will be made. The research team will also be provided with an example of an included and an excluded study.

A two-stage screening process will be implemented, once the screening guide is formulated a pilot-testing is completed. The first stage of study selection will require two reviewers (SK and HK) to independently screen each article by title and abstract using Covidence Software. Reviewers will meet regularly to discuss any challenges related to study selection and refine the inclusion and exclusion criteria as needed. Any disagreement between the 2 reviewers will be resolved by a third reviewer (KV) in a consensus meeting or

through a group discussion. The second stage of study selection will involve the screening of the full-text articles, shortlisted in the first stage of study selection, to determine their eligibility for inclusion. All the full-text articles will be reviewed independently by the two reviewers (SK, HK) to their eligibility for inclusion. In case of disagreement between two reviewers, a third reviewer (KV) will be involved to resolve conflict through discussion with the research team. At each stage of study selection, a strong justification for article exclusion will be provided by each reviewer. The study selection procedure will be recorded according to the "Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)" flow diagram (Figure 1: PRISMA Flow Diagram for Database Search of Studies).

***Step 4: Charting the Data***

A customized data extraction sheet has been developed by the primary author (ASF), which will be pilot-tested on 2 eligible studies by the four reviewers (ASF, KV, SK, HK) to evaluate the consistency and comprehensiveness of the data extraction form in capturing relevant data (Appendix 2: Data Extraction Form). Subsequently, modifications will be made to the form through team discussions after comparing pilot test results. Previously published articles on this research area have been reviewed to decide items of the data extraction form.

Identification of the fields for the extraction is grounded on the articles used for developing a search strategy. Extraction fields include (1) review identifiers ( article title, authors, date of publication, country of origin, type of study, study objectives); (2) Type of digital intervention used by the CHWs; (3) Study population and setting (the demographic characteristics of the study participants and the geographical setting where the intervention was implemented); (4) key study outcome (improvement in the CHW performance working in the LMIC); (5) barriers encountered during implementation and adoption of digital health interventions; and (6) the reported strategies for improving implementation of digital health interventions.

To ensure the inter-rater reliability of the identified key findings, a sample (20%) of the included studies will be reviewed and compared. Discrepancies will be discussed till consensus is attained or through the involvement of the third reviewer, if required.

***Step 5: Collating, Summarizing, and Reporting the Results***

Our review will synthesize the gathered data narratively using a qualitative descriptive approach. We will identify common features of the included studies to descriptively analyze study characteristics including, study type, objectives, study setting, participants, sampling technique, sample size, study methodology, data analysis technique, key study outcome. In keeping with established scoping review guidelines, our review will not conduct a quality appraisal of the included studies. Two of the team members will independently read each included article. An exploratory and inductive analysis approach will be considered as a critical process to thematically organize and summarize the results from the included articles to explore our research question. The extracted results from each article were read several times to identify similarities, recurring patterns, differences, and group-related results. The focus of the emergent concepts will revolve around the use of digital health interventions to support CHWs in providing Covid-19 related and routine health services in LMIC. Major themes and subthemes arising from the included studies will be summarized with a focus on the type of digital health intervention, the role of CHW in the study, improvement in CHWs performance, barriers encountered in implementation and adoption of digital health interventions at the level of CHWs amid Covid-19 and associated strategies. All the reviewers will discuss the results and agree upon the final groupings of the results.

On the other hand, sub-group analysis will be carried out for the quantitative studies under the different categories of digital health interventions. Measures of associations for example relative risk, odds ratios,

and prevalence ratios will be calculated for associations between digital interventions and CHWs Performance. This study will also state confounder or effect modifiers adjusted in quantitative studies to highlight the significance of independent digital intervention to improve the CHWs' performance during the pandemic.

***Patient and public involvement***

As digital health interventions are essential to improve CHWs' functioning during the Covid-19 pandemic, CHWs and the primary healthcare system will eventually benefit from the body of knowledge this review contributes to. However, specific interests of CHWs have not been examined. CHWs have not been involved in the design nor the conduct of the study. As this concerns a review, this study has no participants.

**Results**

Our scoping review is currently in the protocol development phase. The study selection phase will begin on June 01, 2021. The electronic database searches will be completed on June 30, 2021. All database searches will undergo title and abstract screening to identify relevant studies meeting the eligibility criteria. The final included studies will undergo a full-text review which will be followed by data synthesis. The authors anticipate that the results of this study will be submitted for publication in December 2021.

**Discussion**

*Protocol Overview*

To the best of our knowledge, this is the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic. By identifying the unique digital health interventions and their associated barriers and facilitators for use and adoption among CHWs, our findings will offer providers, health system leaders, and policymakers evidence-informed recommendations on how to support CHWs in carrying out Covid-19 related and other routine healthcare services in LMICs.

*Limitations*

A potential limitation of this study is the lack of quality assessment for included studies. Although a quality appraisal of included studies is not required in scoping reviews (14, 15, 22), we hope to improve the quality and rigor of our approach by limiting our search to original and primary research studies with well-established methodologies (randomized controlled trials, quasi-experimental studies, cohort, case-control, cross-sectional, qualitative studies, and study protocols). We recognize that our focus on primary research studies may exclude relevant review-level evidence. However, since the review-level evidence on the use of digital health interventions to support CHWs during the pandemic is limited, our focus on primary studies will allow us to capture the range of digital health interventions and their associated barriers for adoption and use among CHWs in LMICs. In addition, operationalizing the term "CHWs" in our search was challenging since CHWs are known by many different names in different countries. Bhattacharyya et al. and Gilroy & Winch list altogether 36 different terms by which CHWs are known in different countries, which is not exhaustive (23, 24).

Several in-depth discussions and a careful review of the literature were performed to inform our operational definition of "CHWs". We hope that our choice of search terms is purposefully broad enough to identify relevant digital health interventions being used to support CHWs in different LMICs during the pandemic. Future research should be considered to assess the effectiveness of these digital health interventions being implemented to support CHWs in carrying out assigned tasks in LMICs during the Covid-19 and beyond the pandemic period.

**Conclusion**

The immense physical, psychological, and emotional burden on CHWs during the Covid-19 pandemic has highlighted the urgent need to critically examine the use of digital health interventions to support CHWs in delivering their assigned tasks. Although technology-driven innovations in health care generally aim to improve access, quality, and health outcomes, it is also possible for these interventions to benefit CHWs via remote data collection and health assessments, contract tracing, and health education using short message service, voice message, digital megaphones, and digital tracking systems. The results from our scoping review of primary research studies will provide valuable insight for the use of digital health interventions to optimize CHWs' functioning for the delivery of Covid-19 related tasks and other essential healthcare services at the community level and will reveal current knowledge gaps in research.

Figure 1: PRISMA Flow Diagram for Database Search of Studies

Contributors Design of protocol: ASF. Draft of manuscript: ASF, KV, HK, SK. Final approval of manuscript: ASF, KV, HK, SK.

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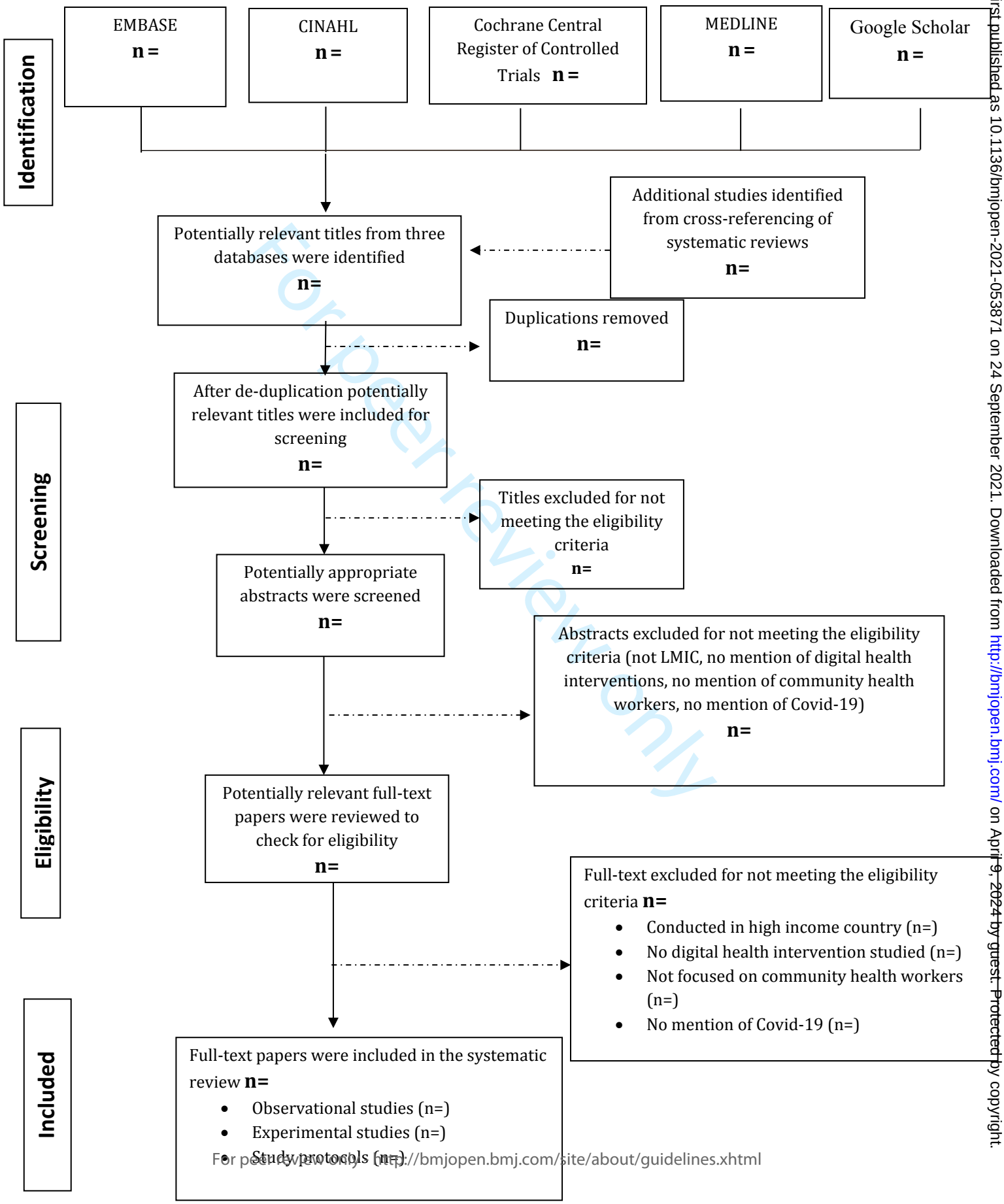
Figure 1: PRISMA flow diagram for database search of studies



Appendix 1: Medical Literature Analysis and Retrieval System Online search strategy

1. Community Health Workers/
2. Community Health Worker.mp.
3. Health Worker, Community.tw.
4. Health Workers, Community.tw.
5. Worker, Community Health.tw.
6. Workers, Community Health.tw.
7. Community Health Aides.tw.
8. Aide, Community Health.tw.
9. Aides, Community Health.tw.
10. Community Health Aide.tw.
11. Health Aide, Community.tw.
12. Health Aides, Community.tw.
13. Family Planning Personnel.tw.
14. Personnel, Family Planning.tw.
15. Planning Personnel, Family.tw.
16. Village Health Workers.tw.
17. Health Worker, Village.tw.
18. Health Workers, Village.tw.
19. Worker, Village Health.tw.
20. Workers, Village Health.tw.
21. Village Health Worker.tw.
22. Barefoot Doctors.tw.
23. Barefoot Doctor.tw.
24. Doctor, Barefoot.tw.
25. Doctors, Barefoot.tw.
26. Case Work Aide.tw.
27. Community Care Coordinator.tw.
28. Community Health Advisor.tw.
29. Community Health Educator.tw.
30. Community Health Promoter.tw.
31. Community Health Representative.tw.
32. Community Outreach Worker.tw.
33. Family Service Worker.tw.
34. Lay Health Advisor.tw.
35. Neighborhood Health Advisor.tw.
36. Outreach Specialist.tw.
37. Patient Navigator.tw.
38. Peer Educator.tw.
39. Public Health Aide.tw.
40. or/1-38
41. Telemedicine/
42. Medical informatics/
43. Digital health.mp.
44. mHealth app.mp.
45. predictive model.mp.
46. informatics/
47. exp Telecommunications/
48. Monitoring, Ambulatory/
49. exp Telemetry/
50. Monitoring, Physiologic/
51. exp Computer Communication Networks/
52. Mobile Applications/
53. Smartphone/
54. Cell Phone/

55. (tele-monitor* or telemonitor* or telemed* or tele-med* or teleinterpret* or tele-interpret* or telecomm* or tele-comm* or telemetry).tw,kw.
56. (mhealth* or m-health* or ehealth* or e-health* or telehealth* or tele-health*).tw,kw.
57. (mobile adj3 (health* or technolog* or app* or solution* or phone* or communicat*)).tw,kw.
58. (remote* adj3 (transmi* or transfer* or tele* or monitor* or consult* or follow-up or program* or connect* or web-base* or "web base*" or term)).tw,kw.
59. (monitor* adj3 (home or remote or distan* or ambulatory or tele* or online or on-line or "on line" or phone or digital* or Skype or electronic* or implant* or wireless* or web-base* or "web base*")).tw,kw.
60. (interven* adj3 (remote* or distan* or tele* or online or on-line or "on line" or phone* or digital* or Skype or electronic* or wireless*)).tw,kw.
61. (smartphone* or "smart phone*" or bluetooth* or Internet* or phone* or text messag*).tw,kw.
62. ((app or apps or application*) adj3 (mobile or electronic or software)).tw,kw.
63. ((digital* or electronic* or online* or on-line* or "on line" or Internet) adj3 (health* or solution* or transmit* or transmiss* or transfer* or device* or connect*)).tw,kw.
64. (broadband adj3 (device* or capab*)).tw,kw.
65. (multi-media* or multimedia*).tw,kw.
66. (self monitor* or self-monitor*).tw,kw.
67. or/40-65
68. 40 and 67
69. developing countries/
70. low-and-middle-income countries.mp.
71. LMICs
72. Honduras/
73. Angola/
74. Papua New Guinea/
75. Algeria/
76. India/
77. Philippines/
78. Bangladesh/
79. Kenya/
80. Sao Tome and Principe.mp.
81. Benin/
82. Kiribati.mp.
83. Senegal/
84. Bhutan/
85. Kyrgyzstan/
86. Solomon Islands.mp.
87. Bolivia/
88. Laos/
89. Sri Lanka/
90. Cabo Verde/
91. Lesotho/
92. Tanzania/
93. Cambodia/
94. Mauritania/
95. Timor-Leste/
96. Cameroon/
97. Micronesia/
98. Tunisia/
99. Comoros/
100. Moldova/
101. Ukraine/
102. "Democratic Republic of the Congo"/
103. Mongolia/
104. Uzbekistan
105. Cote d'Ivoire/

106. Morocco/
107. Vanuatu/
108. Djibouti/
109. Myanmar/
110. Vietnam/
111. Egypt/
112. Nepal/
113. West Bank and Gaza.mp.
114. El Salvador/
115. Nicaragua/
116. Zambia/
117. Eswatini/
118. Nigeria/
119. Zimbabwe/
120. Ghana/
121. Pakistan/
122. (Angola or Honduras or Papua New Guinea or Algeria or India or Philippines or Bangladesh or Kenya or Sao Tome and Principe or Benin or Kiribati or Senegal or Bhutan or Kyrgyz Republic or Solomon Islands or Bolivia or Lao PDR or Sri Lanka or Cabo Verde or Lesotho or Tanzania or Cambodia or Mauritania or Timor-Leste or Cameroon or Micronesia or Tunisia or Comoros or Moldova or Ukraine or Democratic Republic of the Congo or Mongolia or Uzbekistan or Cote d'Ivoire or Morocco or Vanuatu or Djibouti or Myanmar or Vietnam or Egypt or Nepal or West Bank and Gaza or El Salvador or Nicaragua or Zambia or Eswatini or Nigeria or Zimbabwe or Ghana or Pakistan).tw,kw.
123. or/68-121
124. 68 and 123
125. COVID-19/
126. Covid-19.mp.
127. Coronavirus/
128. CORONAVIRUS.mp.
129. Or/124-127
130. 124 and 129
131. exp animals/ not humans.sh.
132. 130 not 131
133. remove duplicates from 132

Appendix 2: Draft Data Extraction Form

General

| | |
|---|---|
| Extractor Name/ID | |
| Title of Article | |
| Author(s) | |
| Publication Year | |

Methods

| | Descriptions as stated in text |
|---|---|
| Study Type | ☐ Experimental studies (e.g., randomized controlled trials, quasi-experimental studies)<br>☐ Observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies)<br>☐ Study protocols |
| Study Objectives | |
| Study Setting | |
| Study Participants | |
| Sampling Technique and Sample number | |
| Data Collection Methods | |
| Data Analysis Technique | |
| Key outcomes | |

Digital Health Intervention

| | Descriptions as stated in text |
|---|---|
| Description of technology used | |
| Categorization of technology | ☐ Telephone communication<br>☐ Digital Megaphones<br>☐ Video communication<br>☐ Text messaging (asynchronous)<br>☐ Email messaging (asynchronous)<br>☐ Patient portals, app etc. for data collection<br>☐ Digital Contract Tracing<br>☐ Patient portals, app etc. for health education<br>☐ Patient portals, app etc. for remote monitoring<br>☐ Predictive models operationalized through clinical applications |
| Notes | |

Community Health Workers

| | Descriptions as stated in text |
|---|---|
| Describe characteristics of study population (i.e. what makes them community health worker in their setting) | |
| Duties of community health worker outlined in the paper | |
| Notes | |

Covid-19

| | |
|---|---|
| Is Covid-19 explicitly stated? (Y/N) | ☐ Yes ☐ No |

Findings:

| Improvement in Community Health Worker Performance | Notes | Description as stated in text |
|---|---|---|
| Barriers encountered during implementation and adoption of DHIs | | |
| Reported strategies for improving implementation of DHIs | | |
| Other | | |

BMJ Open

# Exploring digital health interventions to support community health workers in low-and-middle-income countries during the Covid-19 pandemic: a scoping review protocol.

| | |
|---|---|
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| Keywords: | Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Public health < INFECTIOUS DISEASES, PUBLIC HEALTH |
| | |

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**Title of Scoping Review**

Exploring digital health interventions to support community health workers in low-and-middle-income countries during the COVID-19pandemic: a scoping review protocol.

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## Abstract

***Introduction:*** COVID-19has significantly affected community health workers' (CHWs) performance as they are expected to perform pandemic-related tasks along with routine essential healthcare services. A plausible way to optimize CHWs' functioning during this pandemic is to couple the efforts of CHWs with digital tools. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in low-middle-income countries (LMICs) amid the COVID-19pandemic. The paper describes a protocol for a scoping review of primary research studies that aim to map evidence on the use of unique digital health interventions to support CHWs during COVID-19in LMICs.

***Methods and Analysis:*** Our methodology has been adapted from scoping review guidelines provided by Arksey and O'Malley, Levac et al, and the Joanna Briggs Institute. Our search strategy has been developed for four main electronic databases: EMBASE, MEDLINE, Cochrane Central Register of Controlled Trials, and CINAHL. Google Scholar and reference tracking will be used for supplementary searches. Each article will be screened against eligibility criteria by 2 independent researchers at the title and abstract and full-text level. The review will include studies that targeted digital health interventions at CHWs' level to provide support in delivering COVID-19related healthcare and other essential healthcare services. A date limit of December 31, 2019 to the present date will be placed on the search and English language articles will be included.

***Ethics and Dissemination:*** The immense physical, psychological, and emotional burden on CHWs during the COVID-19pandemic has highlighted the urgent need to critically examine the use of digital health interventions to support CHWs. The results from our scoping review will provide valuable insight into the use of digital health interventions to optimize CHWs' functioning and will reveal current knowledge gaps in research. The results will be disseminated through journal publications and conference presentations.

**Strengths and limitations of this study**

- This will be the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic.
- This protocol outlines a rigorous design that includes an established research framework, a search strategy, and a selection process.
- The search strategy includes four different databases with peer-reviewed literature as well as supplementary search from Google Scholar and reference tracking.
- Our review will not include reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books, which will allow us to map original research on the use of digital health interventions to support CHWs in LMICs.

## Background

Community health workers (CHWs) play an integral role in improving health outcomes at the community level due to their proximity to households, communities, and the primary healthcare system (1, 2). However, several CHW programs have failed in the past because of unrealistic expectations, poor planning, and an underestimation of the effort and input required to make them work. With the advent of Covid-19, maintaining the credibility of the CHW concept is even more daunting as healthcare systems across low-middle-income countries (LMICs) are overwhelmed due to the COVID-19outbreak(3).

In the wake of Covid-19, the CHWs are playing a significant role in preventing the transmission of COVID-19(4), through promoting physical distancing and other precautionary measures like hand washing, wearing masks, contact tracing, recognizing early signs of Covid-19, referring individuals for testing, providing isolation and quarantine guidance, and COVID-19vaccination (4) (5). With the prevention, detection, and management of COVID-19cases, CHWs are also expected to deliver mental health services at the community level to address issues of stress, anxiety, anger, grief, and depression, which are rising because of the pandemic(6). Despite being a vital part of the COVID-19pandemic response, CHWs in LMICs are not well-supported and equipped with resources such as personal protective equipment to contain the spread of Covid-19. This has caused stress and anxiety among CHWs across LMICs. Some CHWs are apprehensive of becoming vectors of spreading COVID-19in communities while others are concerned about contracting COVID-19during household visits and transmitting it to their family members (7).

The pandemic has significantly affected the regular duties of CHWs which include the provision of antenatal and postnatal care, child immunization, and community case management of pneumonia, malaria, tuberculosis, and diarrhea. Assigning new COVID-19related tasks to CHWs, within the scope of existing roles, pose the question of whether these COVID-19related tasks will produce significant population health benefits and outweigh the risks posed to CHWs. Feroz et al. argue that public health departments, NGOs, and social enterprises operating CHW programs need to devise innovative solutions to strike the right balance, between COVID-19related tasks and other essential services (1) as it makes little sense to divert all CHWs for COVID-19response and vaccination at the expense of other essential services.

Prior to the pandemic, digital health technologies have been used by CHWs in LMICs to address a range of health issues related to maternal and child health, sexual and reproductive health, family planning, HIV/AIDS, general health, acute respiratory infections, infectious diseases and injury and trauma (8-10). There is an opportunity to couple the efforts of CHWs with digital tools to optimize CHWs' functioning during this pandemic. Evidence suggests that CHWs equipped with digital tools can serve as a valuable lifeline to support the public-health response to COVID-19 worldwide, including population surveillance, information sharing, case identification, contact tracing, decision support, training, and evaluation of interventions based on mobility data and communication with the public(11-19). In LMICs, CHWs reportedly used a range of digital health interventions during the pandemic for remote data collection and health assessments, health education through short message service (SMS) and voice message, behavior change through the use of digital megaphones, and digital contact tracing using mobile-based tracking systems (20). Numerous digital tools have been operationalized to optimize CHWs' functioning for COVID-19 related tasks and other essential health services including Living Goods' Smart Health app, DiMagi's CommCare, mHero, and Medic Mobile's Community Health Toolkit (21-23).

Bhaumik et al. conducted a rapid evidence synthesis on CHW's role in COVID-19 pandemic in response to a request from National Health Systems Resource Centre, a public agency in India (20). The review identified 36 articles, mainly from LMICs, which highlighted that CHW roles and tasks have been changed substantially during the pandemic and the most common additional activities were community awareness, engagement, and sensitization. CHW roles and tasks also changed considerably for countering stigma and contact tracing (20). However, the review did not mention the use of digital health interventions to support

CHWs' functioning during Covid-19. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in LMIC during the COVID-19pandemic. This gap highlights the need to explore unique digital health interventions to support CHWs in LMICs during pandemic response. This review aims to systematically explore the available literature on evidence-based digital health interventions presently being used to support CHWs' performance during Covid-19.

## Methods

A scoping review method was selected as a method to outline different types of evidence on the use of digital health interventions for supporting CHWs during the pandemic and to fill in the gaps for further research. Our scoping review will use "Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews " to guide the design and reporting of results (24). The review has been registered in the Open Science Framework - Center for Open Science on May 19, 2021 (Registration link: https://osf.io/eu5yb/). The review will be guided by the methodological framework by Levac et al. (25), Arksey et al (26), and the Joanna Briggs Institute Tricco et al. (27) to examine studies describing the use of digital health interventions to support CHWs in LMICs amid pandemic. Following five steps will be followed in this scoping review: (i) identifying the research question, (ii) identifying relevant studies, (iii) selection of eligible studies, (iv) charting the data, and (v) collating and summarizing the results. Since this review aims to explore the general scope of research conducted on the area of interest, quality appraisal of studies will not be conducted.

### *Step 1: Identifying the Research Question*

The main research question for this scoping review is:

What is known in the literature about the use of digital health interventions to support CHWs in LMICs during the COVID-19pandemic response?

The research sub-questions are as follows:

What types of digital health interventions have been used by CHWs at the community level for providing essential health services and COVID-19additional tasks?

What are the barriers and facilitators associated with the use of new digital health interventions for providing essential health services and COVID-19additional tasks?

How has the use of digital health interventions supported CHWs, in terms of reducing workload and improving their performance through training , in LMICs during the pandemic?

### *Step 2: Identifying Relevant Studies*

To identify relevant studies that would inform our research questions, we first operationalized the following 2 key concepts within our study: CHWs and digital health interventions. We then outlined the search strategy and decided on the types of studies that would be the most relevant to include in our scoping review.

Operational Definitions

For this scoping review, we used widely accepted definition of CHWs which was proposed by the World Health Organization: 'Community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should

be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers' (28).

This review will focus on all kinds of digital health interventions that supported CHWs for providing essential health services and carrying out additional COVID-19tasks. In particular, the review will include original papers that focused on the use of digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions(29). For this review, the digital health interventions will include wearable devices, predictive models operationalized through clinical applications, health information technologies, health management systems, and other innovations related to mobile health, telehealth, and telemedicine that can guide diagnosis, monitoring, and treatment(30).

Search Strategy Development

We developed comprehensive search strategies with the assistance of an expert librarian specializing in health services research at Aga Khan University. The search strategies were developed for the following four main electronic databases: Excerpta Medica Database (EMBASE), Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane Central Register of Controlled Trials, and Cumulated Index to Nursing and Allied Health Literature (CINAHL). The databases were selected based on subject area coverage and functionality. Additionally, guidelines provided by Goosen et al (31) and Bramer et al (32) were applied to inform the database selection. A date limit of December 31, 2019, to the present date will be placed on the search given that the first case of Covid was reported from Wuhan, China, on 31 December 2019. The search strategy including four main concepts of interest: target population (CHWs), disease condition (Covid-19), intervention (digital health interventions), and settings (LMICs). The search strategies used a combination of text words, keywords, and subject headings such as MeSH, and Emtree for each concept (Supplementary file 1: Search strategy for all the databases). Before importing results into Covidence for screening, a systematic review software program that supports the screening and management of citations by multiple reviewers (33), all citations from the databases will be exported into EndNote X9 (Clarivate Analytics) for deduplication (32).

Type of Studies

Since we aim to summarize a comprehensive and diverse collection of literature on evidence-based digital health interventions presently being used to support CHWs during the pandemic, it will primarily include original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. All types of reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books will be excluded.

Supplementary Searching

To enhance our search, a supplementary search will be conducted using the first seven pages of Google Scholar to identify relevant peer-reviewed literature on the use of digital health interventions to support CHWs during the COVID-19pandemic. The supplementary search will help identify relevant studies that were not acknowledged during the database searches. The reference lists of relevant systematic reviews and final included articles will also be hand-searched to find pertinent studies. Potentially relevant articles will be selected and sent for abstract and full-text screening.

***Step 3: Selection of Eligible Studies***

The inclusion and exclusion criteria for study selection (Table 1: Eligibility Criteria) were developed iteratively by the research team based on the previously mentioned operational definitions and search strategy.

Table 1: Eligibility Criteria

| |
|---|
| **Inclusion criteria for study selection.**<br><br>**Types of participants**<br>• Primary research studies involving CHWs at which evidence-based digital health interventions were targeted for improving the functioning of CHWs during COVID-19pandemic.<br>**Concept**<br>• Primary research studies on the use of digital health interventions to support CHWs in LMICs during COVID-19pandemic.<br>• Original papers focused on digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions.<br>• Original papers focused on digital health interventions use for CHWs training to optimize workers functioning during the pandemic.<br>**Context**<br>• All health system settings in LMICs. LMICs were selected according to the World Bank's (WB) Country Classification lists for the current 2022 fiscal year(34). According to WB, LMICs are those with a Gross National Income (GNI) per capita between $1,046 and $4,095(34).<br>**Types of evidence**<br>• Original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. |
| **Exclusion criteria for study selection.**<br><br>**Types of participants**<br>• Original studies that describe the use of digital health interventions to support clinicians and other healthcare providers at the secondary and tertiary hospital levels instead of CHWs as described within our inclusion criteria.<br>**Concept**<br>• Original studies that do not explicitly focus on the use of digital health interventions to support CHWs during COVID-19pandemic.<br>**Context**<br>• Studies focused on high-income countries.<br>**Types of evidence**<br>• Literature reviews, including systematic reviews, meta-analyses, scoping reviews, realist reviews, and critical interpretive syntheses.<br>• Opinion papers, commentaries, editorial reviews, and letters to the editor, Conference abstracts/proceedings. |

A pre-defined screening guide has been developed by the primary author (ASF) with feedback from the research team, which will be used to determine if the eligibility criteria have been met. A total of four researchers (ASF, KV, SK, HK) will independently perform the pilot testing of the screening guide with a test sample of 100 abstracts to ensure the inter-rater reliability of screened articles. Based on the pilot test, results will be discussed, and modifications to the screening form will be made. The research team will also be provided with an example of an included and an excluded study.

A two-stage screening process will be implemented, once the screening guide is formulated a pilot-testing is completed. The first stage of study selection will require two reviewers (SK and HK) to independently

screen each article by title and abstract using Covidence Software. Reviewers will meet regularly to discuss any challenges related to study selection and refine the inclusion and exclusion criteria as needed. Any disagreement between the 2 reviewers will be resolved by a third reviewer (KV) in a consensus meeting or through a group discussion. The second stage of study selection will involve the screening of the full-text articles, shortlisted in the first stage of study selection, to determine their eligibility for inclusion. All the full-text articles will be reviewed independently by the two reviewers (SK, HK) to their eligibility for inclusion. In case of disagreement between two reviewers, a third reviewer (KV) will be involved to resolve conflict through discussion with the research team. At each stage of study selection, a strong justification for article exclusion will be provided by each reviewer. The study selection procedure will be recorded according to the "Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)" flow diagram (Figure 1: PRISMA Flow Diagram for Database Search of Studies).

***Step 4: Charting the Data***

A customized data extraction sheet has been developed by the primary author (ASF), which will be pilot-tested on 2 eligible studies by the four reviewers (ASF, KV, SK, HK) to evaluate the consistency and comprehensiveness of the data extraction form in capturing relevant data (Supplementary file 2: Data Extraction Form). Subsequently, modifications will be made to the form through team discussions after comparing pilot test results. Previously published articles on this research area have been reviewed to decide items of the data extraction form.

Identification of the fields for the extraction is grounded on the articles used for developing a search strategy. Extraction fields include (1) review identifiers ( article title, authors, date of publication, country of origin, type of study, study objectives); (2) Type of digital intervention used by the CHWs; (3) Study population and setting (the demographic characteristics of the study participants and the geographical setting where the intervention was implemented); (4) key study outcome (improvement in the CHW performance working in the LMIC); (5) barriers encountered during implementation and adoption of digital health interventions; and (6) the reported strategies for improving implementation of digital health interventions.

To ensure the inter-rater reliability of the identified key findings, a sample (20%) of the included studies will be reviewed and compared. Discrepancies will be discussed till consensus is attained or through the involvement of the third reviewer, if required.

***Step 5: Collating, Summarizing, and Reporting the Results***

Our review will synthesize the gathered data narratively using a qualitative descriptive approach. We will identify common features of the included studies to descriptively analyze study characteristics including, study type, objectives, study setting, participants, sampling technique, sample size, study methodology, data analysis technique, key study outcome. In keeping with established scoping review guidelines, our review will not conduct a quality appraisal of the included studies. Two of the team members will independently read each included article. An exploratory and inductive analysis approach will be considered as a critical process to thematically organize and summarize the results from the included articles to explore our research question. The extracted results from each article will be read several times to identify similarities, recurring patterns, differences, and group-related results. The focus of the emergent concepts will revolve around the use of digital health interventions to support CHWs in providing COVID-19related and routine health services in LMIC. Major themes and subthemes arising from the included studies will be summarized with a focus on the type of digital health intervention, the role of CHW in the study, improvement in CHWs performance, barriers encountered in implementation and adoption of digital health interventions at the level of CHWs amid COVID-19and associated strategies. All the reviewers will discuss the results and agree upon the final groupings of the results.

On the other hand, sub-group analysis will be carried out for the quantitative studies under the different categories of digital health interventions. Measures of associations for example relative risk, odds ratios, and prevalence ratios will be calculated for associations between digital interventions and CHWs Performance. This study will also state confounder or effect modifiers adjusted in quantitative studies to highlight the significance of independent digital intervention to improve the CHWs' performance during the pandemic.

***Patient and public involvement***

As digital health interventions are essential to improve CHWs' functioning during the COVID-19pandemic, CHWs and the primary healthcare system will eventually benefit from the body of knowledge this review contributes to. However, specific interests of CHWs have not been examined. CHWs have not been involved in the design nor the conduct of the study. As this concerns a review, this study has no participants.

**Results**

Our scoping review is currently in the protocol development phase. The study selection phase will begin on June 01, 2021. The electronic database searches will be completed on June 30, 2021. All database searches will undergo title and abstract screening to identify relevant studies meeting the eligibility criteria. The final included studies will undergo a full-text review which will be followed by data synthesis. The authors anticipate that the results of this study will be submitted for publication in December 2021.

**Discussion**

*Protocol Overview*

The immense physical, psychological, and emotional burden on CHWs during the COVID-19pandemic has highlighted the urgent need to critically examine the use of digital health interventions to support CHWs in delivering their assigned tasks. Although technology-driven innovations in health care generally aim to improve access, quality, and health outcomes, it is also possible for these interventions to benefit CHWs via remote data collection and health assessments, contact tracing, and health education using short message service, voice message, digital megaphones, and digital tracking systems. To the best of our knowledge, this is the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic.

*Limitations*

A potential limitation of this study is the lack of quality assessment for included studies. Although a quality appraisal of included studies is not required in scoping reviews (26, 27, 35), we hope to improve the quality and rigor of our approach by limiting our search to original and primary research studies with well-established methodologies (randomized controlled trials, quasi-experimental studies, cohort, case-control, cross-sectional, qualitative studies, and study protocols). We recognize that our focus on primary research studies may exclude relevant review-level evidence. However, since the review-level evidence on the use of digital health interventions to support CHWs during the pandemic is limited, our focus on primary studies will allow us to capture the range of digital health interventions and their associated barriers for adoption and use among CHWs in LMICs. In addition, operationalizing the term "CHWs" in our search was challenging since CHWs are known by many different names in different countries. Bhattacharyya et al. and Gilroy & Winch list altogether 36 different terms by which CHWs are known in different countries, which is not exhaustive (36, 37).

Several in-depth discussions and a careful review of the literature were performed to inform our operational definition of "CHWs". We hope that our choice of search terms is purposefully broad enough to identify

relevant digital health interventions being used to support CHWs in different LMICs during the pandemic. Future research should be considered to assess the effectiveness of these digital health interventions being implemented to support CHWs in carrying out assigned tasks in LMICs during the COVID-19and beyond the pandemic period.

**Ethics and Dissemination**

Formal ethical approval is not required, as primary data will not be collected in this study.

COVID-19By identifying the unique digital health interventions and their associated barriers and facilitators for use and adoption among CHWs, our findings will offer providers, CHWs, health system leaders, and policymakers' evidence-informed recommendations on the use of digital health interventions to optimize CHWs' functioning for the delivery of COVID-19 related tasks and other essential healthcare services at the community level and reveal current knowledge gaps in research. The findings will eventually increase the use of digital health interventions among CHWs and strengthen the public health response to COVID-19. The findings of this scoping review will be published in a peer-reviewed journal and circulated through relevant mailing lists and social media platforms. The findings will also be disseminated through conference presentations, seminars, and policy briefs for key stakeholders and partners.

Figure 1: PRISMA Flow Diagram for Database Search of Studies

Contributors Design of protocol: ASF. Draft of the manuscript: ASF, KV, HK, SK. Final approval of manuscript: ASF, KV, HK, SK.

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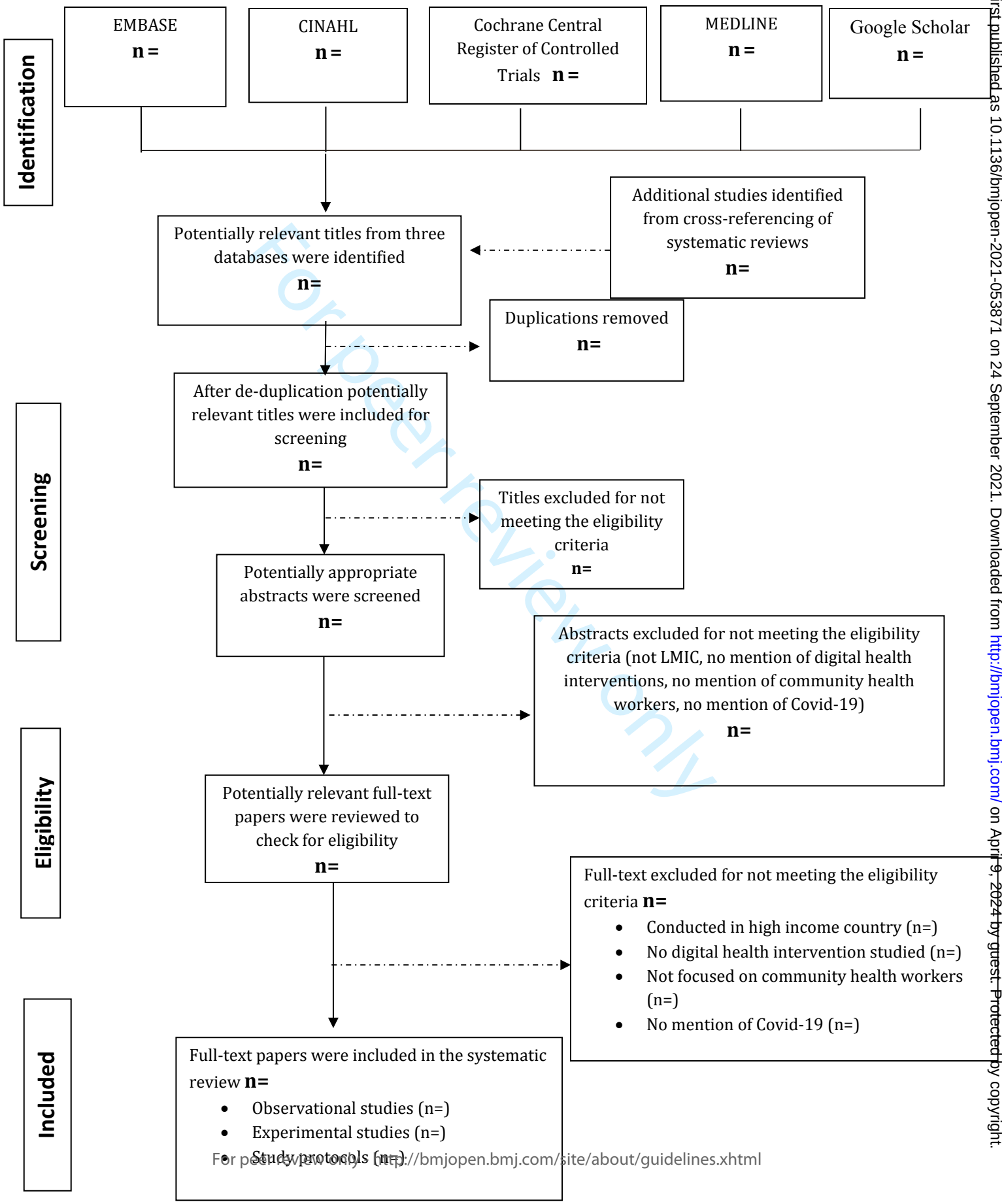
Figure 1: PRISMA flow diagram for database search of studies



Supplementary File 1: Search Strategy

1. Community Health Workers/
2. Community Health Worker.mp.
3. Health Worker, Community.tw.
4. Health Workers, Community.tw.
5. Worker, Community Health.tw.
6. Workers, Community Health.tw.
7. Community Health Aides.tw.
8. Aide, Community Health.tw.
9. Aides, Community Health.tw.
10. Community Health Aide.tw.
11. Health Aide, Community.tw.
12. Health Aides, Community.tw.
13. Family Planning Personnel.tw.
14. Personnel, Family Planning.tw.
15. Planning Personnel, Family.tw.
16. Village Health Workers.tw.
17. Health Worker, Village.tw.
18. Health Workers, Village.tw.
19. Worker, Village Health.tw.
20. Workers, Village Health.tw.
21. Village Health Worker.tw.
22. Barefoot Doctors.tw.
23. Barefoot Doctor.tw.
24. Doctor, Barefoot.tw.
25. Doctors, Barefoot.tw.
26. Case Work Aide.tw.
27. Community Care Coordinator.tw.
28. Community Health Advisor.tw.
29. Community Health Educator.tw.
30. Community Health Promoter.tw.
31. Community Health Representative.tw.
32. Community Outreach Worker.tw.
33. Family Service Worker.tw.
34. Lay Health Advisor.tw.
35. Neighborhood Health Advisor.tw.
36. Outreach Specialist.tw.
37. Patient Navigator.tw.
38. Peer Educator.tw.
39. Public Health Aide.tw.
40. or/1-38
41. Telemedicine/
42. Medical informatics/
43. Digital health.mp.
44. mHealth app.mp.
45. predictive model.mp.
46. informatics/
47. exp Telecommunications/
48. Monitoring, Ambulatory/
49. exp Telemetry/
50. Monitoring, Physiologic/
51. exp Computer Communication Networks/
52. Mobile Applications/
53. Smartphone/
54. Cell Phone/

55. (tele-monitor* or telemonitor* or telemed* or tele-med* or teleinterpret* or tele-interpret* or telecomm* or tele-comm* or telemetry).tw,kw.
56. (mhealth* or m-health* or ehealth* or e-health* or telehealth* or tele-health*).tw,kw.
57. (mobile adj3 (health* or technolog* or app* or solution* or phone* or communicat*)).tw,kw.
58. (remote* adj3 (transmi* or transfer* or tele* or monitor* or consult* or follow-up or program* or connect* or web-base* or "web base*" or term)).tw,kw.
59. (monitor* adj3 (home or remote or distan* or ambulatory or tele* or online or on-line or "on line" or phone or digital* or Skype or electronic* or implant* or wireless* or web-base* or "web base*")).tw,kw.
60. (interven* adj3 (remote* or distan* or tele* or online or on-line or "on line" or phone* or digital* or Skype or electronic* or wireless*)).tw,kw.
61. (smartphone* or "smart phone*" or bluetooth* or Internet* or phone* or text messag*).tw,kw.
62. ((app or apps or application*) adj3 (mobile or electronic or software)).tw,kw.
63. ((digital* or electronic* or online* or on-line* or "on line" or Internet) adj3 (health* or solution* or transmit* or transmiss* or transfer* or device* or connect*)).tw,kw.
64. (broadband adj3 (device* or capab*)).tw,kw.
65. (multi-media* or multimedia*).tw,kw.
66. (self monitor* or self-monitor*).tw,kw.
67. or/40-65
68. 40 and 67
69. developing countries/
70. low-and-middle-income countries.mp.
71. LMICs
72. Honduras/
73. Angola/
74. Papua New Guinea/
75. Algeria/
76. India/
77. Philippines/
78. Bangladesh/
79. Kenya/
80. Sao Tome and Principe.mp.
81. Benin/
82. Kiribati.mp.
83. Senegal/
84. Bhutan/
85. Kyrgyzstan/
86. Solomon Islands.mp.
87. Bolivia/
88. Laos/
89. Sri Lanka/
90. Cabo Verde/
91. Lesotho/
92. Tanzania/
93. Cambodia/
94. Mauritania/
95. Timor-Leste/
96. Cameroon/
97. Micronesia/
98. Tunisia/
99. Comoros/
100. Moldova/
101. Ukraine/
102. "Democratic Republic of the Congo"/
103. Mongolia/
104. Uzbekistan
105. Cote d'Ivoire/

106. Morocco/
107. Vanuatu/
108. Djibouti/
109. Myanmar/
110. Vietnam/
111. Egypt/
112. Nepal/
113. West Bank and Gaza.mp.
114. El Salvador/
115. Nicaragua/
116. Zambia/
117. Eswatini/
118. Nigeria/
119. Zimbabwe/
120. Ghana/
121. Pakistan/
122. (Angola or Honduras or Papua New Guinea or Algeria or India or Philippines or Bangladesh or Kenya or Sao Tome and Principe or Benin or Kiribati or Senegal or Bhutan or Kyrgyz Republic or Solomon Islands or Bolivia or Lao PDR or Sri Lanka or Cabo Verde or Lesotho or Tanzania or Cambodia or Mauritania or Timor-Leste or Cameroon or Micronesia or Tunisia or Comoros or Moldova or Ukraine or Democratic Republic of the Congo or Mongolia or Uzbekistan or Cote d'Ivoire or Morocco or Vanuatu or Djibouti or Myanmar or Vietnam or Egypt or Nepal or West Bank and Gaza or El Salvador or Nicaragua or Zambia or Eswatini or Nigeria or Zimbabwe or Ghana or Pakistan).tw,kw.
123. or/68-121
124. 68 and 123
125. COVID-19/
126. Covid-19.mp.
127. Coronavirus/
128. CORONAVIRUS.mp.
129. Or/124-127
130. 124 and 129
131. exp animals/ not humans.sh.
132. 130 not 131
133. remove duplicates from 132

Supplementary File 2: Draft Data Extraction Form

General

| | |
|---|---|
| Extractor Name/ID | |
| Title of Article | |
| Author(s) | |
| Publication Year | |

Methods

| | Descriptions as stated in text |
|---|---|
| Study Type | ☐ Experimental studies (e.g., randomized controlled trials, quasi-experimental studies)<br>☐ Observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies)<br>☐ Study protocols |
| Study Objectives | |
| Study Setting | |
| Study Participants | |
| Sampling Technique and Sample number | |
| Data Collection Methods | |
| Data Analysis Technique | |
| Key outcomes | |

Digital Health Intervention

| | Descriptions as stated in text |
|---|---|
| Description of technology used | |
| Categorization of technology | ☐ Telephone communication<br>☐ Digital Megaphones<br>☐ Video communication<br>☐ Text messaging (asynchronous)<br>☐ Email messaging (asynchronous)<br>☐ Patient portals, app etc. for data collection<br>☐ Digital Contract Tracing<br>☐ Patient portals, app etc. for health education<br>☐ Patient portals, app etc. for remote monitoring<br>☐ Predictive models operationalized through clinical applications |
| Notes | |

Community Health Workers

| | Descriptions as stated in text |
|---|---|
| Describe characteristics of study population (i.e. what makes them community health worker in their setting) | |
| Duties of community health worker outlined in the paper | |
| Notes | |

Covid-19

| | |
|---|---|
| Is Covid-19 explicitly stated? (Y/N) | ☐ Yes ☐ No |

Findings:

| Improvement in Community Health Worker Performance | Notes | Description as stated in text |
|---|---|---|
| Barriers encountered during implementation and adoption of DHIs | | |
| Reported strategies for improving implementation of DHIs | | |
| Other | | |

BMJ Open

# Exploring digital health interventions to support community health workers in low-and-middle-income countries during the Covid-19 pandemic: a scoping review protocol.

| | |
|---|---|
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| Manuscript ID | bmjopen-2021-053871.R2 |
| Article Type: | Protocol |
| Date Submitted by the Author: | 01-Sep-2021 |
| Complete List of Authors: | Shahil Feroz, Anam; Aga Khan University, Community Health Sciences; University of Toronto Institute of Health Policy Management and Evaluation, Dalla Lana School of Public Health<br>Valliani, Komal; Aga Khan University, Aga Khan Development Network, Digital Health Resource Centre<br>Khwaja , Hajra; Aga Khan University, Community Health Sciences<br>Karim, Sehrish; Aga Khan University, Department of Paediatrics and Child health |
| Primary Subject Heading: | Public health |
| Secondary Subject Heading: | Public health |
| Keywords: | Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Public health < INFECTIOUS DISEASES, PUBLIC HEALTH |
| | |

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**Title of Scoping Review**

Exploring digital health interventions to support community health workers in low-and-middle-income countries during the COVID-19pandemic: a scoping review protocol.

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c. Keywords: Digital health interventions, Community health workers, Primary health care, Low-and-middle-income countries, COVID-19Pandemic

d. Word count – 3,544 (excluding title page, references, figures, and tables)

## Abstract

***Introduction:*** COVID-19has significantly affected community health workers (CHWs) performance as they are expected to perform pandemic-related tasks along with routine essential healthcare services. A plausible way to optimize CHWs' functioning during this pandemic is to couple the efforts of CHWs with digital tools. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in low-middle-income countries (LMICs) amid the COVID-19pandemic. The paper describes a protocol for a scoping review of primary research studies that aim to map evidence on the use of unique digital health interventions to support CHWs during COVID-19 in LMICs.

***Methods and Analysis:*** Our methodology has been adapted from scoping review guidelines provided by Arksey and O'Malley, Levac et al, and the Joanna Briggs Institute. Our search strategy has been developed for four main electronic databases: EMBASE, MEDLINE, Cochrane Central Register of Controlled Trials, and CINAHL. Google Scholar and reference tracking will be used for supplementary searches. Each article will be screened against eligibility criteria by 2 independent researchers at the title and abstract and full-text level. The review will include studies that targeted digital health interventions at CHWs' level to provide support in delivering COVID-19 related healthcare and other essential healthcare services. A date limit of December 31, 2019 to the present date will be placed on the search and English language articles will be included.

***Ethics and Dissemination:***Formal ethical approval is not required, as primary data will not be collected in this study. . The results from our scoping review will provide valuable insight into the use of digital health interventions to optimize CHWs' functioning and will reveal current knowledge gaps in research. The results will be disseminated through journal publications and conference presentations.

**Strengths and limitations of this study**

- This will be the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic.
- This protocol outlines a rigorous design that includes an established research framework, a search strategy, and a selection process.
- The search strategy includes four different databases with peer-reviewed literature as well as supplementary search from Google Scholar and reference tracking.
- Our review will not include reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books, which will allow us to map original research on the use of digital health interventions to support CHWs in LMICs.

## Background

Community health workers (CHWs) play an integral role in improving health outcomes at the community level due to their proximity to households, communities, and the primary healthcare system (1, 2). However, several CHW programs have failed in the past because of unrealistic expectations, poor planning, and an underestimation of the effort and input required to make them work. With the advent of Covid-19, maintaining the credibility of the CHW concept is even more daunting as healthcare systems across low-middle-income countries (LMICs) are overwhelmed due to the COVID-19outbreak(3).

In the wake of Covid-19, the CHWs are playing a significant role in preventing the transmission of COVID-19(4), through promoting physical distancing and other precautionary measures like hand washing, wearing masks, contact tracing, recognizing early signs of Covid-19, referring individuals for testing, providing isolation and quarantine guidance, and COVID-19vaccination (4) (5). With the prevention, detection, and management of COVID-19cases, CHWs are also expected to deliver mental health services at the community level to address issues of stress, anxiety, anger, grief, and depression, which are rising because of the pandemic(6). Despite being a vital part of the COVID-19pandemic response, CHWs in LMICs are not well-supported and equipped with resources such as personal protective equipment to contain the spread of Covid-19. This has caused stress and anxiety among CHWs across LMICs. Some CHWs are apprehensive of becoming vectors of spreading COVID-19in communities while others are concerned about contracting COVID-19during household visits and transmitting it to their family members (7).

The pandemic has significantly affected the regular duties of CHWs which include the provision of antenatal and postnatal care, child immunization, and community case management of pneumonia, malaria, tuberculosis, and diarrhea. Assigning new COVID-19related tasks to CHWs, within the scope of existing roles, pose the question of whether these COVID-19related tasks will produce significant population health benefits and outweigh the risks posed to CHWs. Feroz et al. argue that public health departments, NGOs, and social enterprises operating CHW programs need to devise innovative solutions to strike the right balance, between COVID-19related tasks and other essential services (1) as it makes little sense to divert all CHWs for COVID-19response and vaccination at the expense of other essential services.

Prior to the pandemic, digital health technologies have been used by CHWs in LMICs to address a range of health issues related to maternal and child health, sexual and reproductive health, family planning, HIV/AIDS, general health, acute respiratory infections, infectious diseases and injury and trauma (8-10). There is an opportunity to couple the efforts of CHWs with digital tools to optimize CHWs' functioning during this pandemic. Evidence suggests that CHWs equipped with digital tools can serve as a valuable lifeline to support the public-health response to COVID-19 worldwide, including population surveillance, information sharing, case identification, contact tracing, decision support, training, and evaluation of interventions based on mobility data and communication with the public(11-19). In LMICs, CHWs reportedly used a range of digital health interventions during the pandemic for remote data collection and health assessments, health education through short message service (SMS) and voice message, behavior change through the use of digital megaphones, and digital contact tracing using mobile-based tracking systems (20). Numerous digital tools have been operationalized to optimize CHWs' functioning for COVID-19 related tasks and other essential health services including Living Goods' Smart Health app, DiMagi's CommCare, mHero, and Medic Mobile's Community Health Toolkit (21-23).

Bhaumik et al. conducted a rapid evidence synthesis on CHW's role in the COVID-19 pandemic in response to a request from National Health Systems Resource Centre, a public agency in India (20). The review identified 36 articles, mainly from LMICs, which highlighted that CHW roles and tasks have been changed substantially during the pandemic and the most common additional activities were community awareness, engagement, and sensitization. CHW roles and tasks also changed considerably for countering stigma and contact tracing (20). However, the review did not mention the use of digital health interventions to support

CHWs' functioning during Covid-19. So far, no systematic evidence is available on the use of digital health interventions to support CHWs in LMIC during the COVID-19pandemic. This gap highlights the need to explore unique digital health interventions to support CHWs in LMICs during pandemic response. This review aims to systematically explore the available literature on evidence-based digital health interventions presently being used to support CHWs' performance during Covid-19.

## Methods

A scoping review method was selected as a method to outline different types of evidence on the use of digital health interventions for supporting CHWs during the pandemic and to fill in the gaps for further research. Our scoping review will use "Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews " to guide the design and reporting of results (24). The review has been registered in the Open Science Framework - Center for Open Science on May 19, 2021 (Registration link: https://osf.io/eu5yb/). The review will be guided by the methodological framework by Levac et al. (25), Arksey et al (26), and the Joanna Briggs Institute Tricco et al. (27) to examine studies describing the use of digital health interventions to support CHWs in LMICs amid pandemic. Following five steps will be followed in this scoping review: (i) identifying the research question, (ii) identifying relevant studies, (iii) selection of eligible studies, (iv) charting the data, and (v) collating and summarizing the results. Since this review aims to explore the general scope of research conducted on the area of interest, quality appraisal of studies will not be conducted.

### *Step 1: Identifying the Research Question*

The main research question for this scoping review is:

What is known in the literature about the use of digital health interventions to support CHWs in LMICs during the COVID-19pandemic response?

The research sub-questions are as follows:

What types of digital health interventions have been used by CHWs at the community level for providing essential health services and COVID-19additional tasks?

What are the barriers and facilitators associated with the use of new digital health interventions for providing essential health services and COVID-19additional tasks?

How has the use of digital health interventions supported CHWs, in terms of reducing workload and improving their performance through training, in LMICs during the pandemic?

### *Step 2: Identifying Relevant Studies*

To identify relevant studies that would inform our research questions, we first operationalized the following 2 key concepts within our study: CHWs and digital health interventions. We then outlined the search strategy and decided on the types of studies that would be the most relevant to include in our scoping review.

Operational Definitions

For this scoping review, we used widely accepted definition of CHWs which was proposed by the World Health Organization: 'Community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should

be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers' (28).

This review will focus on all kinds of digital health interventions that supported CHWs for providing essential health services and carrying out additional COVID-19tasks. In particular, the review will include original papers that focused on the use of digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions(29). For this review, the digital health interventions will include wearable devices, predictive models operationalized through clinical applications, health information technologies, health management systems, and other innovations related to mobile health, telehealth, and telemedicine that can guide diagnosis, monitoring, and treatment(30).

Search Strategy Development

We developed comprehensive search strategies with the assistance of an expert librarian specializing in health services research at Aga Khan University. The search strategies were developed for the following four main electronic databases: Excerpta Medica Database (EMBASE), Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane Central Register of Controlled Trials, and Cumulated Index to Nursing and Allied Health Literature (CINAHL). The databases were selected based on subject area coverage and functionality. Additionally, guidelines provided by Goosen et al (31) and Bramer et al (32) were applied to inform the database selection. A date limit of December 31, 2019, to the present date will be placed on the search given that the first case of Covid was reported from Wuhan, China, on 31 December 2019. The search strategy including four main concepts of interest: target population (CHWs), disease condition (Covid-19), intervention (digital health interventions), and settings (LMICs). The search strategies used a combination of text words, keywords, and subject headings such as MeSH, and Emtree for each concept (Supplementary file 1: Search strategy for all the databases). Before importing results into Covidence for screening, a systematic review software program that supports the screening and management of citations by multiple reviewers (33), all citations from the databases will be exported into EndNote X9 (Clarivate Analytics) for deduplication (32).

Type of Studies

Since we aim to summarize a comprehensive and diverse collection of literature on evidence-based digital health interventions presently being used to support CHWs during the pandemic, it will primarily include original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. All types of reviews, meta-analyses, letters to editors, commentaries, viewpoints, news articles, abstracts, and books will be excluded.

Supplementary Searching

To enhance our search, a supplementary search will be conducted using the first seven pages of Google Scholar to identify relevant peer-reviewed literature on the use of digital health interventions to support CHWs during the COVID-19pandemic. The supplementary search will help identify relevant studies that were not acknowledged during the database searches. The reference lists of relevant systematic reviews and final included articles will also be hand-searched to find pertinent studies. Potentially relevant articles will be selected and sent for abstract and full-text screening.

***Step 3: Selection of Eligible Studies***

The inclusion and exclusion criteria for study selection (Table 1: Eligibility Criteria) were developed iteratively by the research team based on the previously mentioned operational definitions and search strategy.

Table 1: Eligibility Criteria

| |
|---|
| **Inclusion criteria for study selection.**<br><br>**Types of participants**<br>• Primary research studies involving CHWs at which evidence-based digital health interventions were targeted for improving the functioning of CHWs during COVID-19pandemic.<br>**Concept**<br>• Primary research studies on the use of digital health interventions to support CHWs in LMICs during COVID-19pandemic.<br>• Original papers focused on digital health interventions to support CHWs in activities defined in Sections 2.1 – 2.7, client identification and registration, client health records healthcare provider decision support, telemedicine, healthcare provider communication, referral coordination, and health worker activity planning and scheduling, in the World Health Organization's Classification of Digital Health Interventions.<br>• Original papers focused on digital health interventions use for CHWs training to optimize workers functioning during the pandemic.<br>**Context**<br>• All health system settings in LMICs. LMICs were selected according to the World Bank's (WB) Country Classification lists for the current 2022 fiscal year(34). According to WB, LMICs are those with a Gross National Income (GNI) per capita between $1,046 and $4,095(34).<br>**Types of evidence**<br>• Original and primary research studies, including experimental studies (e.g., randomized controlled trials, quasi-experimental studies), observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies), and study protocols. |
| **Exclusion criteria for study selection.**<br><br>**Types of participants**<br>• Original studies that describe the use of digital health interventions to support clinicians and other healthcare providers at the secondary and tertiary hospital levels instead of CHWs as described within our inclusion criteria.<br>**Concept**<br>• Original studies that do not explicitly focus on the use of digital health interventions to support CHWs during COVID-19pandemic.<br>**Context**<br>• Studies focused on high-income countries.<br>**Types of evidence**<br>• Literature reviews, including systematic reviews, meta-analyses, scoping reviews, realist reviews, and critical interpretive syntheses.<br>• Opinion papers, commentaries, editorial reviews, and letters to the editor, Conference abstracts/proceedings. |

A pre-defined screening guide has been developed by the primary author (ASF) with feedback from the research team, which will be used to determine if the eligibility criteria have been met. A total of four researchers (ASF, KV, SK, HK) will independently perform the pilot testing of the screening guide with a test sample of 100 abstracts to ensure the inter-rater reliability of screened articles. Based on the pilot test, results will be discussed, and modifications to the screening form will be made. The research team will also be provided with an example of an included and an excluded study.

A two-stage screening process will be implemented, once the screening guide is formulated a pilot-testing is completed. The first stage of study selection will require two reviewers (SK and HK) to independently

screen each article by title and abstract using Covidence Software. Reviewers will meet regularly to discuss any challenges related to study selection and refine the inclusion and exclusion criteria as needed. Any disagreement between the 2 reviewers will be resolved by a third reviewer (KV) in a consensus meeting or through a group discussion. The second stage of study selection will involve the screening of the full-text articles, shortlisted in the first stage of study selection, to determine their eligibility for inclusion. All the full-text articles will be reviewed independently by the two reviewers (SK, HK) to their eligibility for inclusion. In case of disagreement between two reviewers, a third reviewer (KV) will be involved to resolve conflict through discussion with the research team. At each stage of study selection, a strong justification for article exclusion will be provided by each reviewer. The study selection procedure will be recorded according to the "Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)" flow diagram (Figure 1: PRISMA Flow Diagram for Database Search of Studies).

***Step 4: Charting the Data***

A customized data extraction sheet has been developed by the primary author (ASF), which will be pilot-tested on 2 eligible studies by the four reviewers (ASF, KV, SK, HK) to evaluate the consistency and comprehensiveness of the data extraction form in capturing relevant data (Supplementary file 2: Data Extraction Form). Subsequently, modifications will be made to the form through team discussions after comparing pilot test results. Previously published articles on this research area have been reviewed to decide items of the data extraction form.

Identification of the fields for the extraction is grounded on the articles used for developing a search strategy. Extraction fields include (1) review identifiers ( article title, authors, date of publication, country of origin, type of study, study objectives); (2) Type of digital intervention used by the CHWs; (3) Study population and setting (the demographic characteristics of the study participants and the geographical setting where the intervention was implemented); (4) key study outcome (improvement in the CHW performance working in the LMIC); (5) barriers encountered during implementation and adoption of digital health interventions; and (6) the reported strategies for improving implementation of digital health interventions.

To ensure the inter-rater reliability of the identified key findings, a sample (20%) of the included studies will be reviewed and compared. Discrepancies will be discussed till consensus is attained or through the involvement of the third reviewer, if required.

***Step 5: Collating, Summarizing, and Reporting the Results***

Our review will synthesize the gathered data narratively using a qualitative descriptive approach. We will identify common features of the included studies to descriptively analyze study characteristics including, study type, objectives, study setting, participants, sampling technique, sample size, study methodology, data analysis technique, key study outcome. In keeping with established scoping review guidelines, our review will not conduct a quality appraisal of the included studies. Two of the team members will independently read each included article. An exploratory and inductive analysis approach will be considered as a critical process to thematically organize and summarize the results from the included articles to explore our research question. The extracted results from each article will be read several times to identify similarities, recurring patterns, differences, and group-related results. The focus of the emergent concepts will revolve around the use of digital health interventions to support CHWs in providing COVID-19related and routine health services in LMIC. Major themes and subthemes arising from the included studies will be summarized with a focus on the type of digital health intervention, the role of CHW in the study, improvement in CHWs performance, barriers encountered in implementation and adoption of digital health interventions at the level of CHWs amid COVID-19and associated strategies. All the reviewers will discuss the results and agree upon the final groupings of the results.

On the other hand, sub-group analysis will be carried out for the quantitative studies under the different categories of digital health interventions. Measures of associations for example relative risk, odds ratios, and prevalence ratios will be calculated for associations between digital interventions and CHWs Performance. This study will also state confounder or effect modifiers adjusted in quantitative studies to highlight the significance of independent digital intervention to improve the CHWs' performance during the pandemic.

***Patient and public involvement***

As digital health interventions are essential to improve CHWs' functioning during the COVID-19pandemic, CHWs and the primary healthcare system will eventually benefit from the body of knowledge this review contributes to. However, specific interests of CHWs have not been examined. CHWs have not been involved in the design nor the conduct of the study. As this concerns a review, this study has no participants.

**Results**

Our scoping review is currently in the protocol development phase. The study selection phase will begin on June 01, 2021. The electronic database searches will be completed on June 30, 2021. All database searches will undergo title and abstract screening to identify relevant studies meeting the eligibility criteria. The final included studies will undergo a full-text review which will be followed by data synthesis. The authors anticipate that the results of this study will be submitted for publication in December 2021.

**Discussion**

*Protocol Overview*

The immense physical, psychological, and emotional burden on CHWs during the COVID-19pandemic has highlighted the urgent need to critically examine the use of digital health interventions to support CHWs in delivering their assigned tasks. Although technology-driven innovations in health care generally aim to improve access, quality, and health outcomes, it is also possible for these interventions to benefit CHWs via remote data collection and health assessments, contact tracing, and health education using short message service, voice message, digital megaphones, and digital tracking systems. To the best of our knowledge, this is the first scoping review to explore the unique digital health interventions that have been used to support CHWs in LMICs during the pandemic.

*Limitations*

A potential limitation of this study is the lack of quality assessment for included studies. Although a quality appraisal of included studies is not required in scoping reviews (26, 27, 35), we hope to improve the quality and rigor of our approach by limiting our search to original and primary research studies with well-established methodologies (randomized controlled trials, quasi-experimental studies, cohort, case-control, cross-sectional, qualitative studies, and study protocols). We recognize that our focus on primary research studies may exclude relevant review-level evidence. However, since the review-level evidence on the use of digital health interventions to support CHWs during the pandemic is limited, our focus on primary studies will allow us to capture the range of digital health interventions and their associated barriers for adoption and use among CHWs in LMICs. In addition, operationalizing the term "CHWs" in our search was challenging since CHWs are known by many different names in different countries. Bhattacharyya et al. and Gilroy & Winch list altogether 36 different terms by which CHWs are known in different countries, which is not exhaustive (36, 37).

Several in-depth discussions and a careful review of the literature were performed to inform our operational definition of "CHWs". We hope that our choice of search terms is purposefully broad enough to identify

relevant digital health interventions being used to support CHWs in different LMICs during the pandemic. Future research should be considered to assess the effectiveness of these digital health interventions being implemented to support CHWs in carrying out assigned tasks in LMICs during the COVID-19and beyond the pandemic period.

**Ethics and Dissemination**

Formal ethical approval is not required, as primary data will not be collected in this studyBy identifying the unique digital health interventions and their associated barriers and facilitators for use and adoption among CHWs, our findings will offer providers, CHWs, health system leaders, and policymakers' evidence-informed recommendations on the use of digital health interventions to optimize CHWs' functioning for the delivery of COVID-19 related tasks and other essential healthcare services at the community level and reveal current knowledge gaps in research. The findings will eventually increase the use of digital health interventions among CHWs and strengthen the public health response to COVID-19. The findings of this scoping review will be published in a peer-reviewed journal and circulated through relevant mailing lists and social media platforms. The findings will also be disseminated through conference presentations, seminars, and policy briefs for key stakeholders and partners.

Figure 1: PRISMA Flow Diagram for Database Search of Studies

Contributors Design of protocol: ASF. Draft of the manuscript: ASF, KV, HK, SK. Final approval of manuscript: ASF, KV, HK, SK.

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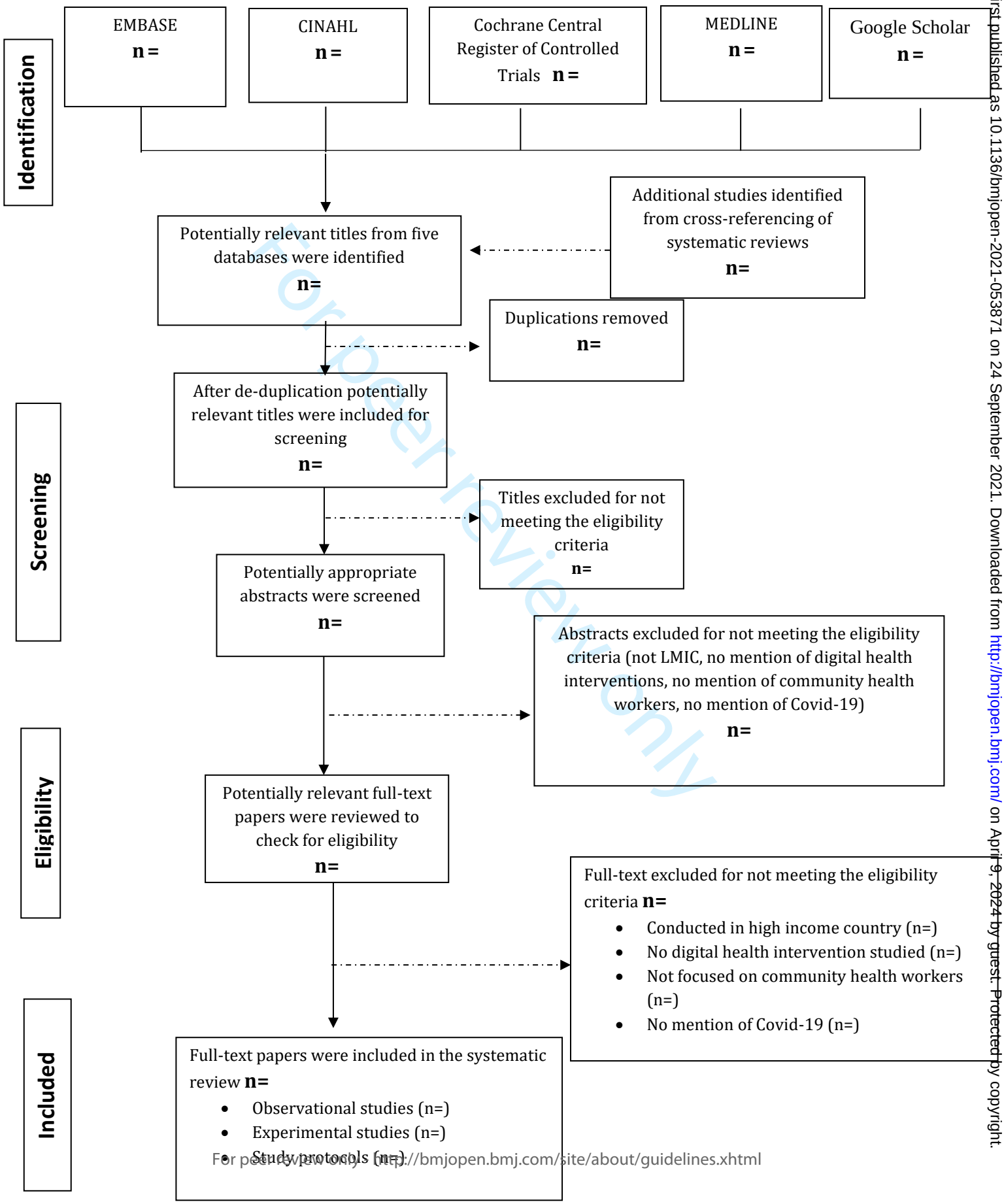
Figure 1: PRISMA flow diagram for database search of studies



Supplementary File 1: Search Strategy

1. Community Health Workers/
2. Community Health Worker.mp.
3. Health Worker, Community.tw.
4. Health Workers, Community.tw.
5. Worker, Community Health.tw.
6. Workers, Community Health.tw.
7. Community Health Aides.tw.
8. Aide, Community Health.tw.
9. Aides, Community Health.tw.
10. Community Health Aide.tw.
11. Health Aide, Community.tw.
12. Health Aides, Community.tw.
13. Family Planning Personnel.tw.
14. Personnel, Family Planning.tw.
15. Planning Personnel, Family.tw.
16. Village Health Workers.tw.
17. Health Worker, Village.tw.
18. Health Workers, Village.tw.
19. Worker, Village Health.tw.
20. Workers, Village Health.tw.
21. Village Health Worker.tw.
22. Barefoot Doctors.tw.
23. Barefoot Doctor.tw.
24. Doctor, Barefoot.tw.
25. Doctors, Barefoot.tw.
26. Case Work Aide.tw.
27. Community Care Coordinator.tw.
28. Community Health Advisor.tw.
29. Community Health Educator.tw.
30. Community Health Promoter.tw.
31. Community Health Representative.tw.
32. Community Outreach Worker.tw.
33. Family Service Worker.tw.
34. Lay Health Advisor.tw.
35. Neighborhood Health Advisor.tw.
36. Outreach Specialist.tw.
37. Patient Navigator.tw.
38. Peer Educator.tw.
39. Public Health Aide.tw.
40. or/1-38
41. Telemedicine/
42. Medical informatics/
43. Digital health.mp.
44. mHealth app.mp.
45. predictive model.mp.
46. informatics/
47. exp Telecommunications/
48. Monitoring, Ambulatory/
49. exp Telemetry/
50. Monitoring, Physiologic/
51. exp Computer Communication Networks/
52. Mobile Applications/
53. Smartphone/
54. Cell Phone/

55. (tele-monitor* or telemonitor* or telemed* or tele-med* or teleinterpret* or tele-interpret* or telecomm* or tele-comm* or telemetry).tw,kw.
56. (mhealth* or m-health* or ehealth* or e-health* or telehealth* or tele-health*).tw,kw.
57. (mobile adj3 (health* or technolog* or app* or solution* or phone* or communicat*)).tw,kw.
58. (remote* adj3 (transmi* or transfer* or tele* or monitor* or consult* or follow-up or program* or connect* or web-base* or "web base*" or term)).tw,kw.
59. (monitor* adj3 (home or remote or distan* or ambulatory or tele* or online or on-line or "on line" or phone or digital* or Skype or electronic* or implant* or wireless* or web-base* or "web base*")).tw,kw.
60. (interven* adj3 (remote* or distan* or tele* or online or on-line or "on line" or phone* or digital* or Skype or electronic* or wireless*)).tw,kw.
61. (smartphone* or "smart phone*" or bluetooth* or Internet* or phone* or text messag*).tw,kw.
62. ((app or apps or application*) adj3 (mobile or electronic or software)).tw,kw.
63. ((digital* or electronic* or online* or on-line* or "on line" or Internet) adj3 (health* or solution* or transmit* or transmiss* or transfer* or device* or connect*)).tw,kw.
64. (broadband adj3 (device* or capab*)).tw,kw.
65. (multi-media* or multimedia*).tw,kw.
66. (self monitor* or self-monitor*).tw,kw.
67. or/40-65
68. 40 and 67
69. developing countries/
70. low-and-middle-income countries.mp.
71. LMICs
72. Honduras/
73. Angola/
74. Papua New Guinea/
75. Algeria/
76. India/
77. Philippines/
78. Bangladesh/
79. Kenya/
80. Sao Tome and Principe.mp.
81. Benin/
82. Kiribati.mp.
83. Senegal/
84. Bhutan/
85. Kyrgyzstan/
86. Solomon Islands.mp.
87. Bolivia/
88. Laos/
89. Sri Lanka/
90. Cabo Verde/
91. Lesotho/
92. Tanzania/
93. Cambodia/
94. Mauritania/
95. Timor-Leste/
96. Cameroon/
97. Micronesia/
98. Tunisia/
99. Comoros/
100. Moldova/
101. Ukraine/
102. "Democratic Republic of the Congo"/
103. Mongolia/
104. Uzbekistan
105. Cote d'Ivoire/

106. Morocco/
107. Vanuatu/
108. Djibouti/
109. Myanmar/
110. Vietnam/
111. Egypt/
112. Nepal/
113. West Bank and Gaza.mp.
114. El Salvador/
115. Nicaragua/
116. Zambia/
117. Eswatini/
118. Nigeria/
119. Zimbabwe/
120. Ghana/
121. Pakistan/
122. (Angola or Honduras or Papua New Guinea or Algeria or India or Philippines or Bangladesh or Kenya or Sao Tome and Principe or Benin or Kiribati or Senegal or Bhutan or Kyrgyz Republic or Solomon Islands or Bolivia or Lao PDR or Sri Lanka or Cabo Verde or Lesotho or Tanzania or Cambodia or Mauritania or Timor-Leste or Cameroon or Micronesia or Tunisia or Comoros or Moldova or Ukraine or Democratic Republic of the Congo or Mongolia or Uzbekistan or Cote d'Ivoire or Morocco or Vanuatu or Djibouti or Myanmar or Vietnam or Egypt or Nepal or West Bank and Gaza or El Salvador or Nicaragua or Zambia or Eswatini or Nigeria or Zimbabwe or Ghana or Pakistan).tw,kw.
123. or/68-121
124. 68 and 123
125. COVID-19/
126. Covid-19.mp.
127. Coronavirus/
128. CORONAVIRUS.mp.
129. Or/124-127
130. 124 and 129
131. exp animals/ not humans.sh.
132. 130 not 131
133. remove duplicates from 132

Supplementary File 2: Draft Data Extraction Form

General

| | |
|---|---|
| Extractor Name/ID | |
| Title of Article | |
| Author(s) | |
| Publication Year | |

Methods

| | Descriptions as stated in text |
|---|---|
| Study Type | ☐ Experimental studies (e.g., randomized controlled trials, quasi-experimental studies)<br>☐ Observational studies (e.g., cohort, case-control, cross-sectional, qualitative studies)<br>☐ Study protocols |
| Study Objectives | |
| Study Setting | |
| Study Participants | |
| Sampling Technique and Sample number | |
| Data Collection Methods | |
| Data Analysis Technique | |
| Key outcomes | |

Digital Health Intervention

| | Descriptions as stated in text |
|---|---|
| Description of technology used | |
| Categorization of technology | ☐ Telephone communication<br>☐ Digital Megaphones<br>☐ Video communication<br>☐ Text messaging (asynchronous)<br>☐ Email messaging (asynchronous)<br>☐ Patient portals, app etc. for data collection<br>☐ Digital Contract Tracing<br>☐ Patient portals, app etc. for health education<br>☐ Patient portals, app etc. for remote monitoring<br>☐ Predictive models operationalized through clinical applications |
| Notes | |

Community Health Workers

| | Descriptions as stated in text |
|---|---|
| Describe characteristics of study population (i.e. what makes them community health worker in their setting) | |
| Duties of community health worker outlined in the paper | |
| Notes | |

Covid-19

| | |
|---|---|
| Is Covid-19 explicitly stated? (Y/N) | ☐ Yes ☐ No |

Findings:

| Improvement in Community Health Worker Performance | Notes | Description as stated in text |
|---|---|---|
| Barriers encountered during implementation and adoption of DHIs | | |
| Reported strategies for improving implementation of DHIs | | |
| Other | | |