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Prioritizing post-COVID-19 health research in sub-Saharan Africa: A modified Delphi study for future pandemic

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Abstract

Background: The COVID-19 pandemic exposed weaknesses in healthcare systems and disparities in healthcare access across sub-Saharan Africa (SSA). The insights of frontline healthcare professionals (HCPs), and healthcare researchers involved with the response to COVID in SSA are crucial to ensuring that health systems are optimally prepared for the next pandemic threat. Nonetheless, there is limited consensus as to what are the clinical and public health research priorities necessary to ensure that SSA is optimally prepared and responsive to future pandemics. The aim of this Delphi consensus process was to collate the insights of leading HCPs engaged in research and clinical practice across SSA and prioritize a set of post-COVID-19

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Declaration of competing interest

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Supplementary materials

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pandemic research priorities and determine the investment agenda necessary to address those priorities

Methods: A modified Delphi process was designed to prioritize a shared agenda. A group of researchers from the African Forum for Research and Education in Health (AFREhealth) were asked to first list potential research topics. Then, members of the broader AFREhealth community were invited to rate the importance of each topic on a 4-point Likert scale, through two rounds of consensus-seeking. Consensus for inclusion was predefined as ≥70 % of respondents' rating.

Results: Health professionals, academics, and scientists representing a variety of professions from twenty SSA countries responded to the survey rounds, delivered electronically. An initial subset of researchers suggested 11 initial topics; subsequently, 53 respondents completed round one, and 64 completed round two of the modified Delphi. A final list of 20 topics that met predetermined consensus was grouped into four technical domains: [1] Health workforce and health professions education research; [2] Epidemiology and surveillance; [3] Clinical and health systems research; and [4] and other cross-cutting topics. Across these four domains, the highest-ranking priorities included [1] leveraging digital tools to enhance the health workforce, [2] strengthening genomic surveillance, [3] assessing health system resiliency, and [4] conducting ethical research.

Conclusions: Post-pandemic research priorities for pandemic preparedness and response included strategies to determine to leverage digital tools to enhance workforce training and impact, leveraging genomic surveillance capacity to close epidemiologic gaps, and developing strategies to enhance health system resiliency. The priorities outlined in this analysis underscore the need for capacity-building and context-specific research in sub-Saharan Africa to ensure an effective and equitable response to future pandemics.

Keywords

Delphi methodology; Pandemic preparedness; Sub-Saharan Africa healthcare; Post-COVID-19 challenges; Health professions training; Research institutions in Africa; Future pandemic response strategies; Healthcare policy development

Introduction

The COVID-19 pandemic disrupted many aspects of life in Africa, including health and social welfare [1]. Moreover, the pandemic highlighted weaknesses in healthcare systems and exposed disparities in access to healthcare services [2,3]. Failure to ensure equitable distribution of vaccines has exposed longstanding obstacles to care across the continent [4]. The scarcity of healthcare professionals (HCPs) [5] and lack of access to high-quality molecular diagnostics [6] were also identified as major barriers to care during the COVID-19 pandemic. These challenges provided unprecedented opportunities for innovation in program design, delivery, and evaluation. Moreover, across Africa there were numerous positive outcomes, including increased investment in healthcare systems and research in service delivery, and health workforce training [7].

Moving forward, it is crucial to identify health research priorities to ensure that sub-Saharan Africa (SSA) is better prepared and able to respond effectively to future pandemic threats.

While many peer-reviewed publications were generated during the COVID-19 pandemic, highlighting clinical and public health responses to the pandemic, [8,9] most of these articles were descriptive [2]. Nonetheless, several recent publications have cited the need to establish a coordinated research agenda that ensures future pandemic response and preparedness initiatives are effective and equitable [2,10–12]. Defining post-pandemic public health priorities is a critical element of Africa CDC's strategic plan [13] and WHO's ongoing efforts to strengthen health systems in service of improving pandemic preparedness [14]. Furthermore, ensuring that Africa is optimally prepared and responsive to future pandemic threats clearly aligns with the Africa Union's 2063 aspiration for ensuring high-quality healthcare for all Africans [15].

A focused approach is imperative to design a research agenda that is streamlined and coherent and that represents the perspectives of HCPs, researchers and scientists engaged in clinical and public health in SSA; as such, the objective of this study was to identify a set of research priorities that were relevant, specific, and purposeful, reflecting the expertise and interests of all participating stakeholders, while also ensuring consistency with best practices for research priority setting [16,17]. Given the importance of context in improving health and implementation of pandemic response activities, local research can also identify potential challenges, set priorities, devise original solutions to locally relevant problems, and, as necessary, make the best use of scarce resources [2,18,19] Therefore, the post-pandemic research agenda for sub-Saharan Africa must define not only gaps in health system capacity but also opportunities for innovation and knowledge translation. Defining a local health systems research agenda can also help improve the resilience of health systems in advance and during future crises [20]. One assumption is that having a shared agenda among relevant research stakeholders can also contribute to the appropriate allocation of research resources. Therefore, through leveraging the input of regional experts and researchers from the African Forum for Research and Education in Health (AFREhealth), we sought to identify a set of research priorities to facilitate the implementation of regionally relevant initiatives and concomitantly guide resource allocation. AFREhealth is an interdisciplinary health professional group of researchers, educators, and service providers that seek to work with Ministries of Health, training institutions, and other stakeholders to improve healthcare quality in Africa through research, education, and capacity building [21].

Methods

We used the Delphi method (with modifications) to establish a set of post-pandemic research priorities to ensure that Africa's healthcare systems are optimally prepared and responsive to future pandemic threats. The Delphi method is a consensus-building approach that seeks expert opinion on a pre-determined topic in a structured and iterative manner [22,23]. It can be helpful in areas where evidence-based literature is limited, as it can unearth collective knowledge from those in the field. A series of rounds are used to clarify, refine, and ultimately achieve consensus on the area under discussion. A vital feature of the method is that participants provide input independently and anonymously during each round, resulting in a process that is not unduly influenced by any individual or subset of respondents. The Delphi method usually involves six steps: identifying a research question, conducting a literature search, developing a set of statements around the topic of choice, performing

anonymous iterative rounds, providing feedback to the respondents between rounds, and summarizing the findings [22–24]. We report our process accordingly.

Step 1 – Identifying the research domain/question.

Our process involved a round of item generation and two rounds of consensus-seeking carried out between March 2023 and May 2023, as outlined in Fig. 1. A group of researchers involved in the AFREhealth network led the process, refining the research question over several project meetings and discussions.

Step 2 – Literature search

To inform the development of the protocol for our study, we performed a rapid literature review, reviewing all the identified English-language published literature describing research priorities related to pandemic preparedness and response and constrained to Africa and countries therein. In addition, we reviewed gray literature and non-peer-reviewed publications from several African healthcare institutions relevant to determining research priorities for pandemic preparedness and response.

Step 3 – Topic generation

A group of 12 AFREhealth educators and investigators with academic interests in pandemic preparedness and response (including those involved in step one) were invited to participate in a two-day on-site workshop in May 2023 in Maputo, Mozambique. This group consisted of ten faculty from African universities with expertise in health professions education, infectious disease, obstetrics, and radiology; two participants were from the United States. Eight of the workshop participants were physicians, one was a nurse, and three had advanced degrees in public health and translational science. At this workshop, these stakeholders reviewed the literature identified in Step Two. They sought to ask, ‘What are the post-pandemic research topics that AFREhealth should prioritize in support of ensuring that Africa is optimally prepared and responsive to future pandemic threats?” A list of 18 research priorities across four broad technical domains was generated in an initial list. All 12 members of this core group were invited to rank this list of priorities; the ranked list was then synthesized by two researchers (MJAR and JC) to remove unnecessary duplication, resulting in a final list of 11 priority topics across four technical domains.

Step 4 – Conducting two iterative anonymous rounds

The list of 11 research priorities generated during Step Three was then distributed as an electronic survey (designed in Qualtrics) for prioritization to a broad network of researchers and healthcare stakeholders associated with AFREhealth. This step represents a modification of the Delphi process as we invited participation from a more comprehensive network of relevant experts than were engaged in step three. The AFREhealth network includes researchers and educators in various health professions and service providers from across SSA Africa [21,25]. The survey was disseminated in English, French, and Portuguese concurrently to optimize engagement from as many respondents as possible. The email was sent in June 2023; two email reminders were sent. Basic demographic information was requested from respondents, including age, sex, professional cadre, and years of professional

and research experience, to ascertain each respondent's expertise relevant to the survey. Responses were anonymous and treated confidentially. In this first survey, all respondents were asked to rate how important each priority was using a four-point Likert scale that ranged from 'very important," "important," "somewhat important," and "not important." Respondents could also choose to place no vote if they felt they did not have enough knowledge on a topic to make an informed decision about its importance.

Consensus criteria that only topics rated as "important" by at least > 70 % of respondents could be included were set a priori. In addition, an open-ended question prompted the submission of additional research questions or agenda items in this round. The research team reviewed and consolidated new topics into existing domains and added them to the list of priorities.

A second survey was sent to the same email listserv in July 2023; two email reminders were sent. This survey included 11 topics that met consensus criteria in the first round (Supplemental Table 1), and nine additional suggested topics, generating 20 topics. Respondents were again invited to rate each research priority on the same 4-point Likert scale (used in the first survey) in terms of importance. In addition, all participants were invited to separately rank each priority relative to the other topics in the exact technical domains on an ordinal scale. After both rounds of survey, sufficient consensus was reached on fewer topics for the process to be terminated [23].

The protocol for this project was reviewed and approved by the Institutional Review Board (IRB) at the University of California, San Francisco's in San Francisco, California. Consent was required at the time of completion of both rounds of the survey, as approved by the IRB (protocol #: 19–28,447).

Step 5 – Provide feedback to respondents.

The results of the first round of the survey were communicated to respondents in the email request to participate in the second round. In addition, the additional items generated in round one were included in the second survey, as outlined above.

Step 6 -summarizing the findings.

The research team reviewed the results of the two survey rounds, including the ranking of priorities within technical domains in the second round. Likert scores were transformed into an ordinal scale with "very important" equal to 1, "important" equivalent to 2, "somewhat important" equal to 3, and "not important" equal to 4. Descriptive statistics were subsequently used to evaluate scores between research priorities; student *t*-test and Chi-Square statistics were used to compare Likert scores between respondents in rounds one and two and stratified by gender, cadre, age categories, and research experience. In addition, a sensitivity analysis was performed to determine if ranking preferences aligned with Likert score results. Table 1 reports the quality of the Delphi studies' criteria as Humphrey-Murto et al. proposed, with three additional criteria from Diamond et al. as applied to our research [22,24].

Results

Informed by an extensive review of existing peer-reviewed literature, the core group of 12 researchers generated 11 key research priorities across four technical domains to inform strategies to ensure SSA's response to future pandemic threats is optimized (Supplemental Table 1). Fifty-three respondents from 17 SSA countries (Ghana, Kenya, Lesotho, South Africa, Mali, Nigeria, Democratic Republic of Congo [DRC], Cote D'Ivoire, Uganda, Malawi, Central African Republic [CAR], Botswana, Mozambique, Ethiopia, Zimbabwe, Liberia, Madagascar) evaluated this list of priorities in the first survey (Table 2). Subsequently, 64 individuals from across 20 SSA countries (Benin, Botswana, CAR, Cote D'Ivoire, DRC, Eswatini, Egypt, Ghana, Kenya, Lesotho, Mozambique, Malawi, Mali, Nigeria, South Africa, Sierra Leone, Tanzania, Uganda, Zimbabwe, and Zambia) evaluated the revised list of topics in the secondsurvey. Of the 64 respondents who completed the second survey, 50 % also completed the first survey. On both rounds of the study, all respondents completed surveys in their entirety.

Thirty-eight percent of respondents ($n = 20$) in round one and 48 % ($n = 31$) in round two were women. The largest fraction of respondents was between 50 and 59 years old for both rounds. Moreover, 55 % ($n = 29$) and 11 % ($n = 6$) of respondents in round one were doctors and nurses; in round two, these cadres comprised 46 % ($n = 29$) and 24 % ($n = 15$) of all respondents, respectively. Across both survey rounds, the proportion of respondents who had published more than 10 first-authored peer-reviewed publications exceeded 30 %. There were no significant differences among survey respondents in terms of gender ($p = 0.266$), age ($p = 0.935$), cadre ($p = 0.3$), or research expertise ($p = 0.836$).

In the first round of the survey, all original 11 topics generated were ranked as 'important' or 'very important.' Accordingly, all these topics achieved the a priori definition of > 70 % consensus with the initial list. An additional eight issues were added to this original list. There were no statistical differences in mean Likert scores when scores from round two were compared with those of round one (Supplemental Table 1). However, when respondents were asked to rank priorities across each of the four technical domains, key priorities were favored as the most important. The highest-ranking priorities are discussed below.

Research priorities

The final ranked research priorities across four technical domains are presented in Fig. 2a–d. Among the proposed priorities related to health workforce and health professions education research, respondents identified the most important areas of research on digital tools to train, prepare, and respond to future pandemic threats. Research leveraging genomics surveillance data was highlighted as the key priority in the epidemiology and surveillance category. Of the health system and clinical research priorities, assessing post-pandemic resiliency was identified as the leading research priority. In contrast, among other cross-cutting topics, a focus on health ethics research was the top research concern. Illustrative research questions generated by the authors of this paper but related to these top-ranking priorities are presented in Table 3.

Sensitivity analysis

Although the priorities outlined above were the four topics ranked first in each of the four technical domains, an additional sensitivity analysis, in which where all of the research priorities were ordered based on Likert scores rather than domain-specific rankings, the following were identified as the most critical research priorities: (1) strategies to enhance interprofessional education and collaboration, (2) research related to the impact of pandemics on non-communicable diseases (NCDs), and (3) the importance of health equity and addressing social determinants of health.

Discussion

With engagement and input from a diverse group more than 60 experts and stakeholders from across 20 African countries, this study yielded a set of research priorities that an overwhelming majority of the group agreed was important to ensure that SSA is optimally prepared and responsive to future pandemic threats. To our knowledge, this was the first time a modified Delphi has been used to determine the post-pandemic research priorities for SSA. It was also unprecedented in its focus on African HCPs and researchers, and the breadth of participation. Nonetheless, the priorities highlighted by this process are broadly aligned with those identified by other stakeholders, including the Africa CDC [18] and the Africa Academy of Sciences [11], as well as the recent Lancet Commission on the global COVID-19 response [26]. Moreover, as part of a broader investment in health, that includes prioritizing health security and pandemic preparedness, these research priorities are concordant with the health priorities outlined in the Sustainable Development Goals agenda [27].

Two of the top-ranking research priorities in each domain (assessing health system resilience and strengthening genomic surveillance systems) focused on generating critical evidence to inform policies, planning, and implementation strategies to strengthen health systems and surveillance systems necessary to respond to future pandemic threats. One priority (leveraging digital tools to enhance the workforce) highlighted the importance of leveraging digital innovations to advance pre-service education in-service training and optimize the function and performance of the health workforce. The top-ranking cross-cutting research priority (health ethics research in SSA) highlighted the shared consensus that more research is needed to ensure that future pandemic resource interventions are equitable and that strategies to use scarce resources are informed by rigorous ethical consideration. All the highest-ranking research priorities reflect the need to more fully characterize the barriers to scaling effective pandemic responses and mitigating the potential adverse sequelae of emerging public health threats in SSA. As illustrated in Table 3, a wide range of scholarship, leveraging diverse expertise, is necessary to address these priorities. Finally, the research priorities identified underscore the need for enhanced metrics and data related to pandemic responses and outcomes for other diseases, such as NCDs and mental health in the region. Outlined below are each of the highest-ranking priorities, as well as research strategies that could be employed to close knowledge gaps in each of these domains:

Health workforce research priorities, Digital tools to enhance the health workforce in Sub-Saharan Africa:

Context: While many countries were slow to equip frontline public health and clinical staff to respond to the evolving challenges posed by the COVID-19 pandemic [28], there were numerous examples where the adoption of digital innovation enabled the health workforce to respond expeditiously, including use of online platforms for just-in-time training [7,29,30], and virtual reality tools to enhance procedural competencies [31]. Many health professions training institutions across SSA had to pivot to digital education [7, 32]. Moreover, leveraging online training modalities enabled ministries of health and their partners to scale access to training and support that would have been impossible with traditional training modalities [7,32,33]. With this sudden shift, research evaluating the utility of digital tools for workforce development has become even more critical [34,35].

Research approaches: Although there is consensus that technology in health professions education may enable more accessible, standardized, relevant, timely, and affordable medical education and training [35,36], there is a lack of equipoise to adopt innovations, especially given limited internet accessibility and digital literacy in places likely to benefit the most. As such, there is a critical need for more research to determine the barriers and enablers of the uptake of digital tools in health professions training and education. Given the lack of data evaluating strategies for the capacity-building of healthcare professionals in resource-care settings [37,38], research evaluating how digital platforms can be scaled to enhance clinical outcomes is also essential.

Epidemiology and Surveillance research priorities; Genomic Surveillance Systems and Bioinformatics research:

Context: Africa has invested in preparedness and response efforts toward various outbreaks on the continent (e.g. Ebola virus disease, Lassa fever, polio, measles, tuberculosis, and HIV) [1]. This technical know-how was swiftly adapted to COVID-19 [39]. However, there remains a critical need to expand regional and national level laboratories that can perform genomic sequencing to monitor new outbreaks [2]. The identification of the omicron variant of SARS-CoV-2 by researchers in Botswana and South Africa in November 2021, and the subsequent rapid dissemination of data serve as examples of the benefits of existing genomics research capacity [19,31,40]. Nonetheless, there is a critical need to strengthen public health genomics and surveillance capacity in SSA to monitor for antimicrobial resistance, determine vaccine-preventable burden, assess the impact of immunization programs, as well as detect and control healthcare- and community-associated outbreaks, and study transmission dynamics.

Research approaches: Despite respondents agreeing on the need to scale capacity bioinformatics and public health genomic capacity across SSA, the technical expertise and the laboratory infrastructure to use these platforms are currently concentrated in three countries (South Africa, Kenya, and Nigeria) [41]. Unfortunately, most of the capacity is outside national public health institutes. As such, there is a critical need to build the capacity of national public health institutes and create functional networks between academic partners and countries [2]. Establishing a community of experts in pathogen genomics,

including genomics specialists, ethicists, biostatisticians, infectious disease physicians, and epidemiologists must be an early priority. Research to understand the barriers and enablers of successful scale-up using bioinformatics in clinical and public health should also be an early priority.

Health systems and clinical research priorities; Assessing Health System Resiliency:

Context: Across SSA, the impact of COVID-19 on routine health services has been striking [3]. For example, the pandemic had marked deleterious effects on immunization programs, maternal mortality, malaria control efforts, and prevention and treatment programs for TB and HIV [26]. Estimates suggest that there were 600,000 malaria deaths in Africa in 2020 [42]. Approximately two-thirds of the additional deaths compared to the year prior were linked to disruptions in the provision of malaria prevention, diagnosis, and treatment, such as insecticide-treated nets and diagnostics [42]. As such, the disruptive impact of COVID-19 on the African health systems highlighted the critical importance of strengthening health systems across Africa to ensure that they are resilient in the face of public health shocks, including future pandemics. Along with increased investments in health systems across Africa, there is a need to increase support for research and development to evaluate the critical determinants of health system resilience.

Research approaches: Rigorous program monitoring and evaluation and other implementation science methods can generate evidence on the determinants of health system resiliency, including describing how and where COVID-19 had the most significant adverse impact on other disease programs. Moreover, implementation research on promoting the uptake of evidence-based interventions and policies into routine care and public health settings is needed to address persistent gaps between the promise of proven effective interventions and their successful implementation, especially in underserved and marginalized populations, both of which were severely impacted by COVID-19 [12,26].

Cross-cutting research priorities; Research on Health Ethics:

Context: Vaccine coverage for COVID-19 in SSA was abysmal, with less than 25 % of people in the region receiving the vaccine. Vaccine nationalism in many high-income countries led to calls for sharing intellectual property and the development of regional manufacturing capacity to address the term ‘vaccine apartheid’ [4,43,44]. This has led to a greater consensus on the need for context-specific bioethical research to define better how and where to prioritize scarce resources in SSA, which our analysis confirmed. Although a sufficient supply of COVID-19 vaccines is no longer a critical issue in SSA, the necessity of research to ensure that the response to future public health threats is informed by access, equity, and justice principles remains salient and was highlighted as a priority by participants in our study [31].

Research approaches: To avoid some of the pitfalls that led to inequitable distribution of diagnostics and COVID-19 medical countermeasures, a key bioethical research priority relates to how African health systems ensure equitable distribution of such resources in advance of future pandemic threats. Rigorous research characterizing regulatory systems for determining how and where to deploy novel treatments or experimental therapies in response

to new pandemic threats is also necessary. Scale-up of genomics capacity across SSA also poses essential ethical challenges. Increased use of genomic surveillance capability must lead to greater openness, sharing of resources, collaboration between scientists, and re-use of data samples for secondary research [45]. However, such efforts will also demand greater attention to the ethical principles and practices of health research. Ongoing evaluation of the governance of scientific resources, such as protocols for data sharing and informed consent, are necessary to promulgate ethical best practices [46].

In pursuing these research priorities, it is critical to utilize rigorous study designs (e.g., comparison groups whenever possible) and specify implementation approaches, intervention components, and program outcomes to support the replication and adoption of effective strategies. Ministries of health, academic institutions and centers of excellence, civil society, community partners, donors, and funders leverage programmatic implementation to support advancing the research agenda around these priorities. Through early and effective engagement of decision-makers in research, researchers and implementers can ensure that their findings are relevant and will be translated into policy, program, and healthcare services that ensure that the SSA is optimally prepared and responsive to future pandemic threats.

In addition, resources must be prioritized to build the capacity of health researchers and scientists in SSA to pursue the agenda outlined above. Other capacities include laboratory testing, data management, statistical analysis, clinical trial and community site development, ethical review boards, and regulatory systems [12]. The COVID-19 pandemic provided compelling evidence of how these capacities can be brought to bear to address new pandemic threats. A separate Delphi process is ongoing to determine these among AFREhealth's priorities. Additional research identifying metrics, data, and standards to inform research capacity investments is also urgently needed [47].

Strengths and limitations

The use of a Delphi approach to formulate and refine a list of research priorities to inform future pandemic preparedness and response in SSA leveraged the expertise of more than 60 researchers, educators, and other stakeholders from more than 20 countries, as well as multidisciplinary perspectives of an extended network of researchers, educators, clinicians, many with significant research expertise. The process also facilitated the participation of stakeholders from Lusophone, Francophone and Anglophone Africa. Despite the diverse backgrounds of participants, there was a high degree of consensus in ratings in the research priority groups. Moreover, key priorities were the same regardless of cadre or preferred language. The Delphi approach provided a means of engaging diverse participants in a research prioritization process. Nonetheless, sustaining participation across rounds is a known challenge [48]. In this initiative, only 50 % of those individuals that responded to the first round of the survey, completed the second round. However, in an additional sensitivity analysis, the ranking of the research priorities in round two was not different between those that participated in round one and those that only completed round two of the survey. The Delphi method also allows for independent and decentralized input from diverse participants [23]. However, the process outcomes are strongly shaped by those who are most engaged; as such, we acknowledge that critical knowledge gaps may be missing

from the approach, which reflect insufficient input from stakeholders from all disciplines and contexts. In this undertaking, the initial working group was predominantly composed of AFREhealth researchers with backgrounds in health professions education and clinical and implementation science rather than social science or public health. Although translational science and One Health research are recognized as vitally important, the background of participants in this process resulted in more emphasis on questions related to health workforce development and clinical care. Thus, there may be important research priorities for some settings that are not reflected here.

Conclusions

Although concerns for specific countries and contexts inevitably will differ, the priorities generated through this modified Delphi process reflect the consensus in a broad group of individuals actively responding to sub-Saharan Africa's emerging clinical and public health threats. To our knowledge, this study is the first of its kind to document consensus around post-pandemic research priorities. Given widespread agreement that Africa needs to invest health resources in anticipation of future pandemics, these research priorities highlight critical areas of inquiry with potential relevance for ministries of health, funders, donors, program strategies, and funding priorities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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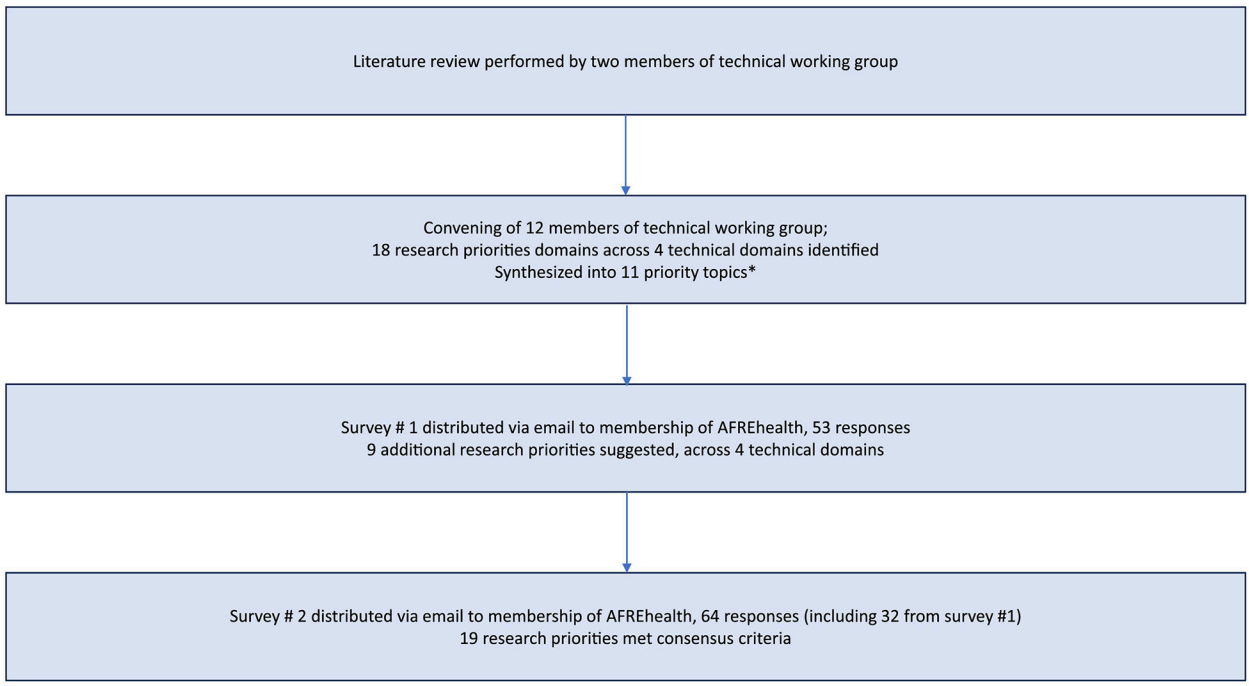

Fig. 1.
Flow diagram for documenting Delphi Process.

Fig. 2.

Ranking of research priorities across four technical domains (ranking from #1, most important, to least important).