Implementing global health research during the pandemic: what are the lessons for the future?

Literature Review

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Introduction:

The Covid-19 pandemic, caused by the SARS-CoV-2 virus continues to have profound effects on people's health and well-being in countries all around the world. Public health and essential health services have been seriously disrupted in many countries. The global health research community experienced a huge upheaval and continues to manage challenges and uncertainty. The aim of this paper is to explore the lessons learnt from managing global health research projects that were in progress during the pandemic, to inform strengthening the resilience of global health research in the future.

This review of research publications focused on three questions (1) How did the global health research community respond to the challenges faced for implementing research during the Covid 19 pandemic? (2) What are the key lessons learnt? and (3) What are the implications for future public health research, particularly for implementation research projects in low- and middle-income countries (LMICS)?

Methods

Relevant publications were identified via searches on research websites including the Lancet, Cochrane, Pub Med, PLOS One, Bio Med Central, Springer and Google Scholar. Key search words used: public health, implementation research AND Covid 19, global health research AND Covid 19; impact of Covid 19 AND health research; public health research, LMICs, AND Covid 19. The first stage of the literature review searched for publications related to public health implementation research in low- and middle-income countries (LMICS) in progress when the Covid 19 pandemic began, no relevant publications were identified. The second stage search included a wider range of health science research projects implemented during the pandemic. Additional searches were conducted throughout the review to gain a greater understanding of specific issues raised in the selected publications such as research ethics, research with marginalised groups, health systems and Covid 19 impact and ageing research. The management of clinical research studies during the pandemic dominated the literature. This is not surprising considering the large number of clinical research studies that were in progress at the beginning of the pandemic. Several of the publications discussed in this paper are research partnerships between research institutes in lower middle-income countries (LMICs) and high-income countries (HICs).

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1. The research community's response to challenges

Due to the various challenges faced by researchers during the pandemic, numerous research projects were either paused or terminated (Park et al., 2021). Despite this there are several examples of how non-Covid 19 related research from various health research disciplines was able to continue or restart after a pause. These projects provide valuable learning about managing research during a crisis to inform decisions about building the resilience of public health research in the future. Resilience in this paper refers to, "The ability to foresee the various challenges that may affect a research project, and to adapt and continue the research throughout a crisis, while maintaining consistency with the overall research design, to successfully proceed or complete a research project" (Rahman et al., 2021).

This section summarises the key challenges encountered by researchers during the pandemic and how they responded. Challenges included: ethical considerations; adaptation to remote research methods; maintaining accountability to research stakeholders; disruption to essential health services; impact on front line health staff; impact on research participants and communities; community engagement, effects on researchers and impact on global health training and education.

Ethical challenges

An important consideration during the pandemic was decision making about whether to pause, terminate or continue research projects. Particularly in the early phase of the pandemic there was huge uncertainty about how the pandemic would impact ongoing research. This was exacerbated by the preoccupation of governments and the global research community with the development of many new research projects created in response to the pandemic, and the surge in funding for Covid 19 research. In this flux, researchers were compelled to made tough decisions about how to continue their research, whilst complying with Covid 19 guidelines and maintaining research integrity.

The pandemic heightened concerns and created dissent among the global research community about ethical research standards (Solbakk et al 2020). The paper 'Back to What? The role of research ethics in pandemic times,' makes a strong case for maintaining high ethical standards during periods of uncertainty and crisis. The paper reflects on past mistakes and lessons learnt, and reiterates human right principles, "The principle is that the interests of the individual research participant is paramount in research ethics, i.e. that if there is a conflict between the interests of society (e.g. in speeding up vaccine development) and the interests of the participants (e.g. in not dying or being permanently harmed) then the interests of society has to yield to the interests of the participant". It was felt that the increasing calls for exceptionalism to ethical standards due to the pandemic situation, would further decrease populations trust and confidence in scientific research. Researcher from India and the Africa region shared their concerns and experiences of their populations distrust in scientific research during the pandemic (Kumar and Muthuswamy, 2020; Tindana, De Vries and Kamuya, 2020). An ethics publication (Lumeng et al., 2020) discusses researchers' ethical duty during the pandemic particularly to protect vulnerable and marginalised communities, recognising that these communities are already heavily burdened. An alternative viewpoint was provided by Bierer et al., 2020. The authors highlighted the potential risks to participants health and wellbeing when clinical studies are paused, such as the large number of

people with underlying diseases, who face not only a deterioration in their health, due to the disruption in their access to the study interventions, but also an increased risk of morbidity or mortality from Covid 19 infection. Another author (Krueger et al., 2021) cautioned that adapting the research protocol to continue research during the pandemic risks affecting the quality of the research, particularly for participants dropout rates. To mitigate this risk special attention is required to reassure participants about their safety and privacy protection. In addition, the adapted study protocol should include a detailed participant and researcher safety and privacy protection plan.

In India, researchers were concerned about how ethical issues affected the quality of their research (Kumar and Muthuswamy, 2020). A disturbing issue that influenced decisions about continuing research activities was the reports of violent attacks against researchers and community health workers. This was thought to be provoked by fear and mistrust created by misinformation on social media. Miscommunication and misunderstanding between the 'National Ethics Committee,' sub national ethics committees and the researchers was also challenging. An example was that the National Guidelines supported the continuation of ongoing studies, on condition that studies were adapted to avoid in person activities. In practice, sub national ethics committees often ignored the national guidelines and stopped recruitment of participants. The studies that received approval to continue were required to use remote data collection methods. Researchers were then faced with challenges to overcome the barriers to using remote research methods, with minimal experience or guidance about how to achieve this in communities with internet connectivity issues, and participants who often lacked access to mobile phones. In addition, even when participants did have access to a mobile phone, they were often reluctant to participate due to mistrust, literacy issues and time limitations. Indian researchers also faced challenges for community engagement. The "WHO Global Code of Conduct for Research in Resource-Poor Settings" (2018), requires that local communities and research participants should be included throughout the research process, to ensure that their voices and inputs are fairly considered (Kumar and Muthuswamy, 2020). Researchers found it difficult to comply with this requirement, not only because of the increased mistrust of research, but also due to Covid 19 lockdown measures. In response to community engagement challenges the 'India National Guidelines for Ethics Committees' recommended research teams to proactively prepare and disseminate educational materials about the research, prior to approaching communities. This was also found to be challenging due to lock down measures and the restricted access to communities.

African researchers faced similar challenges for community engagement (Tindana, De Vries and Kamuya, 2020). Some communities have a chronic mistrust of research and perceive that it is exploitative and of minimal benefit to their community. Due to social distancing and travel restrictions, traditional in person methods for community engagement was impossible. In addition to the limited community engagement the research activities were conducted with participants who faced increasing poverty and lack of access to essential health services. This situation increased the participants stress and discouraged their participation. The move to remote data collection also added to their mistrust of the research. Researchers learnt that to strengthen community engagement and build trust it was important for them to maintain regular communications with the participants, even when the research had been paused, and to manage their expectations for tangible assistance during the pandemic. The research team felt it was their duty to support the

governments pandemic response activities, by contributing to Covid 19 risk communication and community engagement efforts. Other African based researchers (Pratt et al., 2020) confirm that research institutes have an obligation to support COVID-19 prevention and control measures, and should temporarily release their local research team members and government healthcare providers who are involved in the research, to allow them to support the government's pandemic response.

Several authors discussed about the importance of using guidelines and checklists to inform decision making and ensure compliance to ethical principles and accountability to stakeholders. For example (Bierer et al., 2020) considered the following points when deciding about the continuation of their study: the study location, the indication for the study, the urgency of research continuation, the safety of participants and healthcare workers, the risks to the quality of the study if it is continued, and the Covid 19 infection rates in the study location. The authors bottom line was that continuation of studies should only be approved if the potential benefit of continuing exceeded the public health risks, and if there were sufficient human resources to continue the study, without negatively affecting the quality of health services and patient care.

The 'National Academy of Sciences in the USA' (Lumeng et al., 2020) shared their experience of how they managed the restarting of a large number of clinical research projects while following ethnical principles and prioritising accountability to stakeholders. Firstly, they developed Covid 19 research guidelines to guide decision making about continuing or restarting studies. The guidelines supported compliance with ethical standards, protection of participants and researchers' safety and promoted fairness and accountability. To complement the guidelines a 'tiered ranking framework tool,' was developed to rank studies according to priority. Within this framework COVID-19 studies were highly prioritized due to their public health importance. To be included in the tier ranking framework, research teams were required to apply. The application included the study description, the justification for restarting, a risk mitigation plan and confirmation of compliance with Covid 19 transmission mitigation protocols. Applications were then reviewed and ranked by two separate review committees, with a mix of members from clinical and non-clinical settings. Both committees worked in close consultation with the Institutes IRB Committee.

Increased use of remote research methods

The COVID-19 pandemic lockdowns created considerable barriers for research implementation. To be able to continue their activities many research teams were compelled to make a rapid transition from face-to-face interviews to remote data collection, using mobile phones and online applications. The considerable increase in the application of remote research methods has generated many publications that share lessons learnt about the benefits and challenges of remote research methods.

A team from the 'London School of Hygiene and Tropical Medicine' (Hensen, 2021) completed a comprehensive review of the use of remote data collection during the pandemic in low- and middle-income countries (LMICs) Country case studies, lessons learnt, useful tips and problem-solving strategies provide a helpful resource for the future application of remote research methods. The review included in depth interviews with key informants who were experienced remote research

method researchers, and country-based research implementing partners in LMICs. Participants shared their experience of using remote methods for qualitative and quantitative research. Qualitative methods included online or phone-based interviews, online focus group discussions (FGDs), audio-diary data collection, photovoice (use of photography to capture participants lived experiences) phone video of participants experiences, and analysis of posts on social media sites. Quantitative methods include mobile phone surveys using interactive voice response (IVR), short messaging service (SMS) or computer-assisted telephone interviews (CATI), and short online questionnaires shared via email or social media. Respondent discussed the importance of having a good understanding of the research participants and their context, to inform the selection of appropriate data collection methods. For example, SMS surveys are cheaper than CATI, but require a high level of literacy. Telephone interviews via CATI was found to be the most suitable method for lower literacy groups. Mobile phone methods are often the preferred method in most LMICs, due to the widespread use of mobile phones as compared to smart phone and internet access. Additional learning from a review of online health surveys (Hlatshwako et al., 2021) found that the main advantage of online health surveys was the reduced cost and the increased efficiency and speed for completing the survey and disseminating the results. A key concern with online methods for quantitative surveys was the challenge of obtaining a representative sample. To address this the authors recommended using probability panels, with the constraint being that these types of panels are mainly confined to high income countries. The possible solution for LMICS is that many countries will likely have mobile phone panels. In addition, population-representative sampling frames can also be used for developing sampling frames for online surveys. Real time assessments were also found to be useful, and help to increase the participation of subgroups, by pre- targeting promotion of the research activity to the relevant groups using online dissemination or printing brochures to be delivered to target groups by local partners and community-based organisations. The author also recommended that Increased trust in the rigor of remote research methods can be promoted by pre publishing data analysis plans on a data accountability research website. Other researchers highlighted the opportunity provided by the pandemic to achieve more inclusive research by using remote research methods to reach the populations who are often excluded due to the challenges to reach them (Noonan and Simmons, 2020).

Additional limitations of remote research methods were raised by several authors (Hensen, 2021; Rahman et al.,2021; Hlatshwako et al.,2021) including the challenge of collecting diverse experiences when conducting remote qualitative research. A proposed solution was to leverage established relationships of trust with community leaders and trusted community influencers to support the registration of a diverse group of participants. As previously mentioned, (Hlatshwako et al.,2021) quantitative remote data collection methods face challenges to achieve a representative sample, and issues to reach 'harder to reach' populations, which likely requires using alternative sampling methods. Qualitative research methods such as snowball sampling can also be used for quantitative research with participants sharing online surveys with their peers via email or social media platforms. A convenience sample obtained through online social networks is another option. In practice remote quantitative research will likely require a combination of participant recruitment methods. Other remote research limitations that need continued attention are compliance to ethical guidelines, obtaining remote informed consent and maintaining the privacy of participants.

An important learning is that remote research methods often have a higher non-response than face-to-face methods which threatens the validity of the study. The exclusion of rural women, older men and women, and people with disabilities in some settings is also a risk, due to their reduced access to mobile phones, or lack of trust or confidence to participate. Other reasons found for non-participation are the fear of telephone scams, time constraints, unreliable network coverage, irregular power cuts and the cost of phone services. Some authors questioned the feasibility of using remote research methods in challenging environments such as with communities living in remote rural areas. Their experience showed that online surveys achieved high participation from higher-income populations living in urban areas who have reliable access to smart phones and internet. It is acknowledged there is still a lot to learn about how to achieve the participation of communities who have less access to internet technology and other resources. In some research studies it was found that providing airtime to participants to cover their costs increased participation rates, especially for participants in underserved communities. Additional learning was that to encourage completion of the survey, a shorter questionnaire that lasted no more than 30 minutes worked better. Also, to include the most important questions at the start of a survey in case of internet connection cuts. Other issues that need careful consideration are how to maintain the participants privacy and building the skills of researchers to establish rapport and maintain participants engagement during online interviews (Sevelius et al., 2020; Rahman et al.,2021).

Finally, it is vital to increase trust in the integrity of remote research (Hlatshwako et al.,2021). To promote trust in the research results requires transparency regarding the research limitations, including reporting of response rates and other potential sources of bias. Analysis of remote qualitative data needs to account for the common constraints discussed in this section such as participant privacy, rapport, diversity of voices, and inclusion of marginalized groups. Triangulation of data from various qualitative research methods can help provide a more in depth understanding. For quantitative research a clear description of the sampling frame and notes on the representativeness of the sample is important. Peer review of remote research findings should be interpreted considering the limitations discussed in this section.

Innovative approaches for adapting research projects during the pandemic

Creativity, flexibility and innovation are frequently mentioned when sharing experiences of implementing research during the pandemic. A 'Rapid Research Evaluation and Appraisal Lab' team (RREAL) at the University College, London (Vindrola-Padros et al., 2020) shared experiences of how social scientists, using innovative and flexible approaches were able to achieve quality, rapid, qualitative research, to inform timely public health responses. The aim of the research was to explore lessons learnt from health care delivery during the pandemic. The three research studies involved in the learning were: a rapid appraisal of health care workers (HCWs') perceptions and experiences, a rapid qualitative study using in-depth interviews, examining the utilisation of qualitative data during epidemics (including real-time data on COVID-19), and a mixed-methods survey examining the impact of COVID-19 on the global delivery of cancer treatment during the pandemic. The large research team consisted of post graduate students (MSc and PhD level) who either volunteered their time or planned to use the research findings as part of their dissertation. Each team was composed of a mix of experienced and less experienced researchers with a senior researcher as team leader. After the study was approved in England, the studies were replicated by

research teams in 22 countries ('miirror studies)'. The mirror study countries included Pakistan, India, South Africa, Nigeria, The Democratic Republic of Congo and China. It was agreed that each country research team would conduct the study independently, including ethical approval, data collection, analysis and report writing. The RREAL team's role was to facilitate the study setup by sharing the study protocol and study tools such as interview topic guides, consent forms and research information sheets. All country teams took responsibility for using the results of the studies to inform local response efforts, and for disseminating the results to academic audiences and other stakeholders via publications. The RREAL team continues to support the coordination of the synthesis of research findings across countries to produce a global picture of the experiences of frontline staff during the pandemic. In addition, a global virtual knowledge management platform was created to encourage all the teams to continuously share their learning and solutions to challenges they encountered. The RREAL team is also planning to develop reporting and assessment standards to guide future rapid qualitative research initiatives. From previous experience it is anticipated that the extent to which the findings will be used to inform public health response efforts will depend on the research team's capacity to actively engage with stakeholders throughout the research process.

The importance of ongoing critical reflection of the research process during the pandemic, was identified by several authors (Rahman et al., 2021; Vindrola-Padros et al., 2020). During implementation of three qualitative research projects a critical reflection framework guided regular exploration of the researcher's experiences and generation of new understandings. The adaptation of the research methods was made on an ad hoc basis informed by the ongoing learning. Adaptation included reduced time for online or telephone interviews, flexibility for interview times to fit with participants schedules, and deciding not to pursue participants who did not respond to the first invitation. It was found that delivering online workshops created more challenges than any of the other remote research methods used in the project. Therefore, redesigning the workshops required additional preparation, numerous team meetings and identification of mitigation strategies including reducing the lengths of the workshops to avoid participant fatigue, creating new digital materials, and using new facilitation techniques. This experience highlights that not every qualitative research method can be easily adapted to online delivery.

Guidance and tools to inform timely decision making, maintenance of ethical principles and accountability to stakeholders

Several clinical research teams shared their experience of managing severe disruptions to their research (Branch-Elliman, Elwy and Monach, 2020; Bierer et al., 2020; Constable et al., 2020; Dorn, 2020). The authors acknowledged there lack of preparation for managing their research during a pandemic, and there was minimal guidance in place to support them. The researchers divided the documentation of their learning during this crisis into three phases, decision to suspend, implementation of the suspension and restarting the study. The challenges identified were: recruitment of participants, delivery of the research interventions, follow-up of participants, communication between stakeholders, updating risk assessment analysis, revising the study protocol, maintaining engagement with the research sites and participants, data-quality, data analysis, research team workload, and donor's expectations. A task force was formed to lead on the

response including developing guidelines and an action plan to manage the suspension and restarting of research activities. The action plan was regularly updated and provided a useful 'live' documentation of events and responses. Lessons learnt from managing the research projects during this time include the importance of providing consistent communication messages, tailored to the needs of the various stakeholders, and regularly updating the risk assessment protocol. Seventeen research study teams used the guidelines to guide their work during the pandemic. The 'live' updated action plan was particularly valuable when providing updates to donors, oversight committees, participants, research sites stakeholders, and other researchers.

Disruption to provision of essential health services and the effects on people with underlying health conditions and older people.

The disruption of health care services during the pandemic and the effects on patients particularly older people and patients with underlying health conditions such as non-communicable diseases (NCDs) has been widely reported in various media. Further evidence is beginning to emerge from systematic reviews of multi country research findings which expose the lack of preparedness and the numerous weaknesses in health systems, both in higher income countries (HICs) and lower middle-income countries (LMICs.) One of the key effects of this is a large decrease in the number of people accessing essential health services (Tessema et al., 2021; Moynihan et al., 2021). A recent OECD synthesis report of the findings from 67 evaluations in 18 countries, assessing countries preparedness and response to the pandemic, found that more evidence is needed about the health system preparedness and response for the pandemic. This finding was expected considering that national health systems continue to be overwhelmed to respond to the pandemic (OECD, 2021).

As early as June 2020 WHO issued interim guidelines for maintaining essential health services (www.who.int, n.d.). The global public health community also quickly acknowledged that unless countries were able to reduce the disruptions to essential health services, more people would die from underlying diseases than from Covid 19 infection. Although others (Karlinsky, A. and Kobak, D. 2021) argue that based on their analysis of data from the World Mortality Dataset which tracks excess mortality during the Covid 19 pandemic, excess deaths caused by non-Covid related diseases are minimal, with the largest percentage of excess deaths due to Covid 19 infection.

In a publication about the impact of the pandemic on health systems, 'Impact on Essential Health Services Background Paper 8' (Krubiner, 2020) an analysis of the WHO survey results from 105 countries found that the pandemic has the potential to worsen the situation of people with other health conditions and threatens to increase the prevalence of diseases in the future. The survey found that 90% of 105 countries reported experiencing some disruption to essential health services including community level preventive services, routine immunisations, and management of noncommunicable diseases. The barriers to access services were patients' fears of contracting Covid 19 infection, cancellation of routine health services due to re-assignment of health staff to the pandemic response, and Covid 19 lockdown policies which restricted people's movements. Additional barriers were the lack of protective equipment and health staff shortages due to Covid 19 illness. Another publication reported that health workers were heavily affected by Covid infection, mental health effects and burnout. (The Secretariat for the Independent Panel for Pandemic

Preparedness and Response, 2021). A WHO NCD situation rapid assessment report (Marten et al., 2021) found that the pandemic was affecting NCDs services in 122 (77%) of 159 countries surveyed, with a heavy impact on the health and well-being of people living with NCDs and widening inequities in access to NCDs services. The author commented, "The pandemic has exposed the chronic under investment in NCDs service, and the need to achieve progress on the integration of NCDs services into the primary health care system and expand access to universal health coverage (UHC)." In light of these findings and considering the effects on other health research disciplines, it is likely that many NCDs implementation research projects have been heavily impacted by the pandemic.

Effects of the pandemic on front line health staff

A qualitative study conducted in Bangladesh explored the effects of the pandemic on fifteen health care workers (doctors and nurses based in urban hospital and clinics in two large cities). The study found that the health care workers experienced a wide range of challenges during the pandemic including a higher workload, increased psychological distress, shortage of quality personal protective equipment (PPE), social exclusion/stigmatization, lack of incentives for their additional workload, absence of coordination between the different levels of the health system, and sub optimal management support. They reported that their faith in God and mutual peer support helped them cope with the challenges they faced (Razu et al., 2021).

A Vietnam research team looked at the effects of the pandemic on an ongoing hypertension control clinical trial study (Nguyen et al., 2021). It was found that health care workers felt overloaded by their additional clinical workload due to the pandemic, and their research duties. The health workers reported difficulties to adhere to the trial protocol in a timely manner while complying with government guidelines to ensure patients' safety. The study was ongoing during the pandemic and the research team worked closely with local health managers, physicians and nurses at community health centers, and community health workers to discuss how best to deal with the challenges created by the pandemic and inform the modification of the research activity plans. With this good participation and collaboration, the study was able to maintain the schedule for patient recruitment as planned. The research team leant that flexibility and multiple creative approaches were required to be able to continue the study during the pandemic.

Maintaining community engagement and protecting participant safety and rights

There are few publications about the effects of the pandemic on people participating in ongoing public health research studies. Several publications highlight the importance of maintaining regular communications with people participating in research projects and involving them in decision making during the research process. A previously mentioned Vietnam study to assess the impact of the pandemic on research participants and health care workers participating in an ongoing clinical trial for hypertension control (Nguyen et al., 2021) used a mixed quantitative and qualitative methods to collect data from 86 patients (44 in the intervention group and 42 in the control group) during their routine follow up visit at the health facility to assess how the pandemic had affected their participation in the study. It was found that patients faced many difficulties to adhere to recommended study interventions and practices due to fears and concerns about COVID-

19. Patients who responded their health was poor or very poor were fearful that they would be unable to attend monthly check up appointments and obtain their medications. In addition, they reported that they were unable to perform outdoor exercise and other activities due to the pandemic restrictions. Similar responses were reported by the intervention and comparison groups. The main reasons for non-adherence to the interventions were being unable to view the intervention DVD due to their routine work, not having access to the family TV due to its use by other family members and being unable to travel to the community health center to watch the DVD with peers, due to social distancing restrictions. Requests from the intervention group for additional support from the study team were to be able to access a hotline (9%), to receive calls from the research team on a regular basis (11%), or to have a visit from a community health worker after placing a phone call if their issue still existed (16%). When survey participants were asked about the best way for research staff is to contact them, approximately 50% answered "via phone calls" and the other half answered, "via community health worker's visits." Despite the challenges created by the pandemic, almost 100% of the patients remained interested in participating in the study; their reasons included they valued receiving medical advice, having their conditions monitored and being guided on how to best control their conditions, and simply because of having free time to participate. When asked about the use of mobile phones for future health research studies (mhealth), fewer patients in the intervention group reported that they felt comfortable using a mobile phone to watch video clips compared with those in the comparison group (45% vs. 60%). In terms of using mhealth devices to deliver study activities, to collect data and to receive feedback, nearly 50% of survey patients answered "definitely, probably, possibly".

Researchers working with marginalized groups of people living with HIV infection (Sevelius et al., 2020), also faced multiple barriers to continue their research and maintain communication with the research participants during the pandemic. Because the participants were a marginalized group, they were not only at higher risk of Covid 19 infection, but also faced upheavals in their daily life due to the strict lock down restrictions. Adaptations of the research activities included: providing flexibility for data collection such as changing from mobile phone interviews to video conferencing interviews depending on the preference of participants; increasing collaboration with existing community based organisations who were in regular contact with the participants, to maintain regular connections with the participants; provision of skills building events for team members and participants to build their confidence to be able to use online applications such as Zoom and leveraging the skills and trusted relationships of the peer support groups to support the coordination of food bank pickups, help organise transport for participants to health and care services and deliver essential supplies and information to participants homes. The research team also identified the need to support the mitigation of the effects of the pandemic on participants everyday life. They achieved this by mapping available local services and resources and disseminating the information widely. Reflecting on their learning the team identified the collaboration and trust between researchers and community-based organizations, research participants and service providers was key to them been able to continue the research.

Older people are another group that continue to be disproportionately affected by the pandemic, with over 70% of all global Covid 19 deaths occurring in people 65 years and older (World meter, 2020), and many other serious effects on all aspects of their lives (Williamson et al., 2020). In addition, the 'ageing research community' has been greatly impacted (Richardson et al., 2020). The

COVID-19 pandemic forced researchers working with older people to move to remote follow-up by telephone or video, despite remote research tools not yet being widely tested or validated in a range of older populations. Many researchers had no choice but to postpone or abandon follow-up completely.

An online survey conducted with the 'global ageing research community' (academics and specialist societies), collected opinions and identified the challenges and opportunities for the continuation of research, both during and after the pandemic. The survey found there was consensus among the respondents about the critical need to continue non-COVID-19 related research for older people during the pandemic. There was also agreement that the 'ageing research community' needed to make considerable and far-reaching changes in the future design and delivery of research for older people, including achieving increased collaboration with multiple research specialities; identifying ways to increase the efficiency, scale and speed of the research process, and prioritise research topics according to the needs identified by older people themselves. An additional finding was the recognition that many studies for older people are overly complex with a large set of standard outcome indicators, which differ between studies which make it difficult to pool data and places an unreasonable burden on the respondents. For future research it is recommended that the ageing research community agree on a set of standard core outcome measures which focus on a small number of priority study questions.

The impact of the pandemic on researchers

Researchers across various health research disciplines report being heavily affected by the pandemic (Cohen et al., 2020; Omary et al., 2020; Krause et al., 2021). Challenges included identifying ways to modify existing research design, so that it could continue; stress management due to an uncertain work situation and future research opportunities, plus the added stress of working from home and juggling work and domestic responsibilities. Newly graduated researchers found it increasingly difficult to identify job opportunities due to the termination of multiple research studies and research institutes concerns about future funding constraints. Junior researchers faced challenges to complete their research studies and publish their work. Omary et al., 2020, posit possible solutions to ameliorate the situation for researchers, suggesting creatively using the additional time available to plan and write grants, conduct and publish reviews or complete unfinished manuscripts and collaborate with peers to conduct research webinars. Newly graduated doctoral students were encouraged to prepare and submit applications for postdoctoral studies.

Doctoral students whose research relied on in country field research and primary data collection were forced to adapt their research proposal to the situation (Krause et al., 2021) An example came from a student based in India who was working on his dissertation which involved in person data collection, during a time of strict lockdowns. Finally, he decided to adapt his research using a modular approach with two options. The preferred option was to continue in-person field research, with the second choice to use secondary data analysis. Fortunately, the student was able to access multiple code books of Indian survey data and then extract the variables of interest for his research. If the situation improved, and it was safe and ethical, he would resume field work. In the meantime,

he focused on writing his dissertation using the secondary data analysis. Whatever happened he felt he would have enough data to complete at least one dissertation.

Impact of the COVID-19 pandemic on global health research training and education.

The pandemic also disrupted global health research training particularly for health care workers, doctors, researchers and students involved in research training and educational programs in LMICs (Hou et al., 2020). Prior to the pandemic it was a common practice for global public health research institutes in high income countries to provide grants for students from partner institutes in LMICs to participate in in-person coursework, attend skills-based workshops, and/or work directly with researchers and mentors in the host country. Study options also included participation in longer term formal courses and degrees. In addition, lecturers/ researchers from the host institutes occasionally travelled to the partner institutions in LMICs to facilitate workshops, lectures, and provide in-person knowledge exchange, The pandemic resulted in a complete shutdown of in person training which was quickly replaced by virtual online learning.

The advantages of the move to online training are the reduced costs and the opportunity to access a larger number and a more diverse participant group. The disadvantage is the loss of opportunities for in- person interactions and team building. Fortunately, the longer-term training opportunities have mostly been unaffected, as many global health research programmes had already shifted online with minimal disruption. The main loss has been to international students who have lost their opportunity to experience student life in another country. Research and training institutes are increasingly leveraging the opportunities provided by the shift to online learning. An example is a pilot capacity building initiative organised by a US-based training institute faculty which provides ongoing 'in time' online lectures to participants in two Nigerian sub sites. This approach allows the involvement of an increased number of professors and reaches more participants. The participants can participate in 'in time' lectures, access a variety of online training resources, and interact with a variety of lecturers. Skills building was also successfully applied during the training events using telemedicine approaches and virtual images. The participants positively evaluated the lecture series, particularly 'in time' interactions. The lecture series continues with regularly monthly sessions.

Another example of successful online training was the adaptation of in person a two-day training workshop in Nigeria, for health care providers without formal training. The virtual workshop methods included lectures, video, role plays, and small group discussions. Break out rooms were used for small group discussions, with the chat functions utilised for interactive question and answer periods. Interactive training methods also included quizzes, online polls and whiteboard brainstorming sessions. These examples demonstrate that virtual training approaches can be interactive, effective and cost saving. The main loss is the in-person interactions, team building opportunities, socio-cultural exchanges and interpersonal relationships. Although online training is expected to continue to grow and new virtual training methods will continue to emerge, the best option may be a hybrid training model leveraging the strengths of both virtual learning with the opportunities for in-person activities.

2. Key Learning to inform future public health research

The pandemic has resulted in the pausing or cancellation of numerous research projects. The costs and implications for public health, health systems, communities and research institutes are still emerging and will take time to evaluate. In the previous section researchers shared their learning from adapting research to enable it to continue during the pandemic. This section highlights key learning that can help inform public health research in the future. It was found that the pandemic has exposed vulnerabilities and weaknesses in global health research and provides the opportunity to rethink how public health research can be better implemented in the future. Areas to consider are: building the resilience of future public health research; addressing weaknesses in national research systems; decreasing the vulnerability of health systems to shocks and crises; building on the evidence base for remote research methods in LMICs; addressing public health research capacity and resources inequities between HICs and lower LMICs, and achieving progress for locally led public health research, and strengthening research collaboration and coordination across research disciplines and multiply sectors to achieve more agile, responsive, efficient and effective research processes, that expediate the utilisation of findings to inform policy.

Building the resilience of research projects

With very little warning or preparation, the global health community faced a unique and stressful situation to manage research during the pandemic. In light of the ongoing pandemic and the emerging global health threats influenced by the linkages between human health, animal health and the environment, it is anticipated that there will be future global health crises. To better manage this situation in the future, there is a need to go beyond the focus on global health research and expand coordinate and partner with various research fields and across multiple sectors (Frédéric et al., 2021). Several authors have identified the need to build the resilience of future global health research and, recommend that in the future contingency planning should be an essential part of every research proposal (Krause et al., 2021). Contingency plans should include alternative, feasible and safe ways to continue research and maintain participant safety and research integrity, including active community engagement, applying creative, ethical and robust ways to collect remote research data, especially to allow inclusion of marginalised and hard to reach populations, and building collaborative relationships and stakeholder ownership and buy-in throughout the research process.

Building the resilience of national research systems (research institutes)

The need to strengthen the resilience of national health research systems (research institutes) to manage future shocks and crises is also essential (Yazdizadeh et al., 2020). An initial step to plan for strengthening the system is to document the lessons learnt during the pandemic, then assess the components of the research system such as governance, finance, capacity building, knowledge generation, and use of evidence. The Knowledge Translation Self-Assessment Tool for Research Institutes (SATORI) framework is proposed as a suitable for this purpose.

Achieving progress for expanding locally led research

Several authors (Kilmarx and Glass, 2021; Frédéric et al., 2021) identified the important need to address the imbalances in global research capacity and resources between HICs and LMICs. This will

support progress for national health systems strengthening; increase research capacity to address the most important public health issues and build country level resilience to manage future health emergencies. An article from Honduras researchers (Fontecha and Sánchez, 2021) raised the issue of the low investment in research capacity development in their country and other LMICs, and shared positive past examples of what has worked in Honduras. The authors found it particularly helpful when there is long term funding specifically focused on capacity strengthening of national researchers. In Honduras this approach achieved a tangible increase in research capacity within a short time.

The large gaps in Covid 19 clinical research studies research capacity and resources, between high income countries and lower middle-income countries was highlighted during the pandemic, with most of the COVID-19 clinical trials been implemented in high income countries. Considering that LMICs are usually more seriously affected by the impact of disasters, epidemics and pandemics, and have an urgent need to expand the development and implementation of evidence based, affordable and scalable public interventions that are feasible for their context, it is imperative to address this imbalance. The pandemic has not only reminded the world about how interconnected the global community is, but also highlighted that a more balanced distribution of research capacity and resources between HICs and LMICs is not only an ethical issue, but a requirement for the health and wellbeing of the global population (Park et al., 2021).

Female researchers and researchers from ethnic minority groups have also experienced a heavier impact on their wellbeing during the pandemic, with women particularly having to juggle the increased demands on their time for domestic work and childcare while working at home during lockdowns, plus coping with a stressful work environment, cancelled research projects and increased competition for positions and scholarships, with uncertainty about future job security (Lumeng et al., 2020.)

Reducing the vulnerability of national health systems to shocks and crises

The pandemic has dramatically exposed the vulnerability of health systems, including the gaps in the quality of health services, and the barriers to access services especially for older people, people living with disabilities and ethnic minority groups. In addition, there are huge gaps in health system resources between HICS and LMICs, particularly for human resources, equipment, infrastructure, essential medicines, and vaccines. Although evidence continues to be generated about the impact of the pandemic on health systems in LMICs, it remains limited. It is anticipated that primary health care services which have borne the brunt of the work for Covid 19 related preventive work and contact tracing, have been heavily affected. This is a huge setback for the progress on health system strengthening, particularly for the provision of integrated person-centred care and the achievement of universal health coverage. This will likely take countries time and a strong concerted effort to get back on track.

Researchers who were part of a successful African region based, multi country, innovative and responsive implementation research project, 'Innovating for Maternal and Child Health' project (Diop et al., 2021) make the case for leveraging the lessons learnt and project resources to mitigate the impact of the pandemic on health systems in LMICS, and to build the resilience of health systems for the future. The huge research project involved twenty-eight projects, implemented across

eleven countries with nineteen research partners, supported by two regional health policy research institutes, and funded by multi donors. The research approach was to use primary health care as the entry point and focus on four priority areas: high-impact community-based interventions, quality facility-based interventions, policy environment to improve care services and outcomes, and human resource development. The design of the project targeted the specific priority health system strengthening needs in each country and facilitated close collaboration between researchers and policy makers. A notable success was the ability to raise the research findings to the top level of decision makers in each country and the region. The research model demonstrates the effectiveness of identifying context-specific solutions to health issues, based on locally generated evidence, and the wide dissemination of lessons learnt to key stakeholders. The approach can be easily adapted to other contexts in LMICs to inform the response and preparation for future disease outbreaks and crises, while continuing the provision and strengthening of essential health services during and after the crisis. Interesting learning was that engaging decision-makers early in the research process and targeting the people with the appropriate level of seniority strengthened the relevance of the research with the local stakeholders, and promoted ownership and continued engagement throughout the research process, contributing to successful policy outcomes. The research teams disseminated findings and advocated at both country and regional level to achieve greater impact. Engaging communities from the beginning of the research was also very important for establishing trust and involving them in identifying the priority issues according to their community's needs. The community engagement was also important for strengthening of linkages and trust between the health care providers and community. In addition the collaboration between African and international researchers provided opportunities for ongoing learning and mutual exchanges between the various research teams.

Building on the evidence base for remote research methods in LMICs

During the pandemic researchers have demonstrated that with thoughtful and creative use of technology, research activities can continue to be implemented remotely, with the caveat that the experience of using remote research methods is more advanced in HICs, facilitated by a strong virtual technology infrastructure with large population coverage. There remains a lot to learn about how to successfully use remote methods in LMICs, particularly with hard-to-reach communities who have more limited resources and may face multiple barriers to access and use remote research devices.

Remote research methods were found to be faster, more efficient and more cost effective as compared to in person data collection. Ethical challenges for use of remote data continue to need attention related to identifying and recruiting study participants, privacy and safety of participants, data security and achieving increased diversity of experiences for qualitative research, and representative samples for quantitative surveys. An area requiring further research is how to meaningfully involve marginalised populations who may not have access to a mobile phone or an internet connection. There is also the issue of the loss of in person connections and establishing trust and rapport between the researcher and participants, which may affect their participation, create response bias, and affect data quality. The lessons learnt during the pandemic provide a good base to build on, as more learning from the expansion of remote research methods becomes

available. It is likely that remote research methods are here to stay, even in the post pandemic. Despite this it is likely that hybrid approaches will be developed combing the best of remote methods and in person research methods, which will be a more popular and satisfying option for researchers and participants.

Strengthening research collaboration and coordination to achieve agile, responsive, efficient and effective research processes

Researchers from a variety of health research disciplines reflected on learning from implementing research during the pandemic and identified several areas of their research that need improvement (Park et al., 2021; Wensing et al., 2020; Lane et al., 2020; Richardson et al., 2020).

A group of clinical trial researchers (Park et al.,) felt that the increased collaboration, scale, and speed of research trials during the pandemic was an impressive example of what is possible. Although they lamented that the clinical trials research community had wasted research budget and time during the pandemic to implement a large number of small duplicate studies, which were rapidly implemented and of questionable quality, in an environment of increased competition, and suboptimal collaboration and coordination. Considering this experience, the authors recommend that in the future it would be more effective to consolidate international partner funds to develop master protocols and Invest in larger-scale international clinical trials, with the goal to produce timely high quality research data, to inform policy for improved public health services and practices. The authors also identified the potential to increase collaboration and coordination with research institutes in LMICs, and leverage their immense potential to build sustained research infrastructure in low-resource settings, reduce human resource challenges and costs, and achieve more equitably and efficient partnerships.

Implementation research scientists (Wensing et al., 2020) found that the pandemic has exposed the need to find new ways of working and developing more responsive, efficient and effective implementation research approaches. An example is to identify ways to achieve 'real world' data collection, analysis and utilisation without increasing the workload on health care providers who are already overburdened. The authors advocate for the increased use of data that is collected routinely during health service delivery, through conducting large scale comparative retrospective studies within or between countries. In addition, there is the need to develop faster ways to conduct data analysis, particularly when the data is urgently needed in a crisis situation to inform public health responses.

Another implementation scientist (Kruglaya, 2021) also expressed admiration for the speedy implementation of large Covid 19 research studies, and the timely dissemination of the results; which is recognized as the long-held ambition of implementation researchers. He advocates for a faster and more flexible implementation research process, with timely utilisation of data to inform policy. During the pandemic the barriers identified for implementation research were related to operations, logistics and social issues. It was found that with strong partnerships, collaboration and coordination between public health, clinical services, communities and government stakeholders these barriers can be addressed.

Other authors (Krause et al., 2020), are hopeful that learning from the pandemic will inform more equitable and collaborative models of research partnership. Particularly the opportunity to establish improved ‘systems’ of collaboration between researchers and communities. If this strengthened partnerships and improved collaboration can be achieved, it will increase the participation and ‘voice’ of the field citizens in research planning and knowledge production and reduce the chronic barriers that exist between the researchers, and the communities they work with.

3. Implications for public health research in the future

This paper has provided a snapshot of the impact of the pandemic across a small number of global health research projects, and the resulting dramatic changes in how research is conducted. It is likely that global health research practice will never completely return to how it was in pre pandemic times. The full picture of the impact of the pandemic on the global health research community is continuing to emerge, and the implications for global health research in the future remains unclear. From the review of publications, it was found that despite the variety of challenges encountered, the global health research community has demonstrated flexibility, innovation and commitment. The valuable lessons learnt from the adaptation of research during the pandemic will help to public health research in the future.

Considerations for global health research in the future:

1. The strong likelihood of future global emergencies with the potential to severely disrupt research projects highlights the need to build the resilience of public health research in the future.

2. The vital need to address the vulnerabilities and weaknesses of health systems, and the serious impact the pandemic has on the provision of essential services, particularly for prevention and management of non-communicable diseases and integrated person-centred health services for older people.

3. The exacerbation of inequities in access to services and increased poverty and marginalisation of populations including ethnic minority groups, women and older people, who are also often the hardest people to reach and include in research.

4. The need to address the imbalance in research capacity and research resources between LMICs and HICs, and to make progress on expanding locally led research in LMICS

5. The opportunity provided by the pandemic to the global health research community to leverage the lessons learnt during the pandemic, to inform the design of more inclusive, efficient, effective, and relevant research, delivered at scale, in collaboration with a coalition of partners, applying new approaches to data collection, data analysis and dissemination of results, to deliver timely, tangible impact for public health and people's health and wellbeing.

In conclusion some food for thought- "*This break, or rupture demands that we revisit, rethink and re-articulate our forms of knowledge production" (Z. Hussain., 2020).*

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