REVIEW

Early stage risk communication and community engagement (RCCE) strategies and measures against the coronavirus disease 2019 (COVID-19) pandemic crisis

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ABSTRACT

Coronavirus disease 2019 (COVID-19) pandemic has proven to be tenacious and shows that the global community is still poorly prepared to handling such emerging pandemics. Enhancing global solidarity in emergency preparedness and response, and the mobilization of conscience and cooperation, can serve as an excellent source of ideas and measures in a timely manner. The article provides an overview of the key components of risk communication and community engagement (RCCE) strategies at the early stages in vulnerable nations and populations, and highlight contextual recommendations for strengthening coordinated and sustainable RCCE preventive and emergency response strategies against COVID-19 pandemic. Global solidarity calls for firming governance, abundant community participation and enough trust to boost early pandemic preparedness and response. Promoting public RCCE response interventions needs crucially improving government health systems and security proactiveness, community to individual confinement, trust and resilience solutions. To better understand population risk and vulnerability, as well as COVID-19 transmission dynamics, it is important to build intelligent systems for monitoring isolation/quarantine and tracking by use of artificial intelligence and machine learning systems algorithms. Experiences and lessons learned from the international community is crucial for emerging pandemics prevention and control programs, especially in promoting evidence-based decision-making, integrating data and models to inform effective and sustainable RCCE strategies, such as local and global safe and effective COVID-19 vaccines and mass immunization programs.

1. Introduction

A novel coronavirus strain was identified by Chinese investigators as the pathogenic agent causing numerous cases of viral pneumonia in Wuhan City of China on January 8, 2020.[1] The World Health Organization (WHO) later named this virus as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, previously provisionally named 2019 novel coronavirus or 2019-nCoV), while the disease was designated as the coronavirus disease 2019 (COVID-19).[2] Increasing global travel and trade resulted in the dissemination of the virus on a global scale, leading to an emergency declaration of the disease as a global health emergency by the WHO. By the end of November 2020, it had spread to almost all countries and territories in the world, with approximately 64 million cases and over 1.48 million deaths reported worldwide.[3]

There is an overwhelmingly poorly understood and complex pattern of COVID-19 epidemiological trajectories that has been documented but is not always generalizable. Past experiences with respiratory coronavirus infections such as the severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) have shown that they can have a severe impact on human health.[4] Interestingly, evidence from the previous coronavirus outbreaks contributed to the relatively early response to the pandemic, including risk communication, coordinated resource mobilization, appropriate adherence and best practice interventions implementation.[5] Once the genomic sequence of SARS-CoV-2 was identified, diagnostic tests for viral detection were developed and widely deployed. While there are no proven vaccines or curative treatments yet, hundreds of potential drugs and vaccines are being investigated.[6]

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While the scientific and medical research community focus on developing COVID-19 treatments and vaccines, government and global community efforts have been devoted to early detection, prevention, and containment of further spread of the virus as much as possible. In this regard, the importance of global and local community engagement and risk communication has never been demonstrated more vividly than during the current COVID-19 crisis. As the WHO has noted, one of the major lessons learnt from the major public health events of the 21st century is that "risk communication and community engagement (RCCE) is integral to the success of responses to health emergencies."[7] However, it is clear that most governments were caught off guard in the face of the current pandemic in terms of their RCCE strategies and protocols. Meanwhile, issues such as the credibility of science, political interference in public health decisions, the very authority of the government, and population behaviors are threatening lockdown and preventive public health measures against COVID-19 transmission dynamics. Populations with poor adherence and mistrust, public fear, and misinformation tend to undermine the pandemic preventive and emergency response effectiveness of the governments, thus increasing health and socioeconomic burden.[8]

Consequently, it is important for governments to use evidence-based approaches in designing and implementing effective and sustainable COVID-19 RCCE strategies. However, the current WHO policy frameworks that are commonly used to plan, design, implement, and evaluate RCCE strategies may be inadequate to capture the dynamic ways in which public health crises can unfold. In particular, the role of information and communication technologies (ICT) and social media in information dissemination and mediating people's response to public health messaging on COVID-19 is poorly understood, as is the potential of digital technologies to be integrated into RCCE. For example, as a source epidemiological data (e.g., rate of infections, geographic patterns of transmission) as well as for implementation of public health surveillance and response actions (e.g., contact tracing, public health alerts), mass education campaigns and immunization roll out pertaining to COVID-19 containment and recovery.[9]

This article outlines of the key components of RCCE strategies in the early stages of the COVID-19 pandemic in vulnerable nations and populations, and highlights contextual recommendations for strengthening coordinated and sustainable RCCE responses and mass immunization roll out against the global COVID-19 pandemic menace. The authors conducted a scoping review of early research on governmental RCCE programs from studies and reports published between January and July 2020. The review focused on the following key questions: What were the general findings from studies on RCCE measures which were published during the early stages of the pandemic, particularly in East Asian countries which experienced the first cases of COVID-19? What are the new themes and issues relevant to RCCE strategies, which may not be currently considered within the conventional frameworks of RCCE? The *Risk Communication and Community Engagement (RCCE) Action Plan Guidance COVID-19 Preparedness and Response: Interim Guidance* from WHO were used as the framework for presenting the results.[10]

2. Methodology

When this paper was written, the COVID-19 public health crisis was still evolving in most countries, and researchers were generally unable to conduct fieldwork due to social distancing restrictions. It is therefore unsurprising that few studies have critically appraised the evidence based RCCE response measures in vaccine roll out and against the COVID-19 pandemic transmission dynamics, particularly in low- and middle-income countries. Nevertheless, important findings can be gleaned from earlier studies, centered on countries where SARS-CoV-2 infections were most prevalent at an early stage, namely the mainland of China, Japan, Republic of Korea (South Korea), Taiwan of China, Italy and Spain, and Hong Kong of China.[1-2]

The authors conducted a scoping review better suited to the objective of the study, since it is more exploratory in nature compared to other types of reviews. Though the definitions vary, a scoping review is described as "a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge".[11] Unlike systematic reviews, which tend to draw on similar types of studies (e.g., quantitative, qualitative, expert views, and so on), scoping reviews are also more open to different kinds of evidence sources, such as government policy documents, reports in the gray literature, WHO reports, and other government sources of data.

The WHO recognizes the importance of RCCE in responding to public health crises. It defines risk communication as "the real-time exchange of information, advice, and opinions between experts or officials and people who face a threat to their survival, health, economic, or social well-being and improved livelihoods. Its ultimate purpose is that everyone at risk is able to make informed decisions to mitigate the effects of the threat (risk) such as a disease outbreak and take protective and preventive actions".[12] More recently, the term has come to encompass other dimensions of information and action, particularly community involvement and engagement. As noted by the WHO, risk communication was seen in the past primarily as "the dissemination of information to the public about health risks and events, such as outbreaks of disease and instructions on how to change behavior to mitigate those risks. Thinking on this has now evolved dramatically as social science evidence for new communication and media technologies strategies and best practices for equity and behavioral change have evolved in the 21st century".[13]

In order to assist governments in implementing effective and robust preparedness and emergency responses for existing and potential outbreaks of COVID-19 in their countries, the WHO issued an interim guidance note covered key thematic areas on RCCE in March 2020, along with the issues that were relevant for each area.[10] The authors believe that this provides a suitable framework for a scoping review. Table 1 summarizes the issues and challenges described in the interim guidance note by category of RCCE interventions.

We performed a literature search in PubMed, Scopus, and several peer-reviewed journals, including RCCE-related reports and guidelines issued by governmental, non-governmental, and international organizations such as the WHO. The search terms were as follows: "COVID-19 OR SARS-CoV-2 OR novel coronavirus OR coronavirus" AND "risk communication OR health communication OR RCCE OR community engagement".

The inclusion criteria were as follows: (1) The peer-reviewed articles or reports are available online and were published between January and July of 2020; (2) They should focus on RCCE for COVID-19 but not in relation to other diseases (for example, risk communication on COVID-19 for asthma or cancer patients); and (3) They should be in English and/or French languages. In addition, one of the authors provided additional references to studies on RCCE strategies published in Chinese.

In total, the search yielded 107 references, of which 39 were relevant to the study. An additional three articles, three WHO reports, and four books were included. The RCCE themes and issues that were identified have been discussed below.

3. Results and discussion

3.1. Risk communication systems against the COVID-19 pandemic crisis

According to our findings, the current pandemic crisis highlights the importance of leadership and the damaging effects of confused communications.[14] To be effective, it is important that the risk communication systems involve high levels of the government.[10] Most governments in East Asia established committees and other coordination mechanisms using a whole-of-government approach. For example, in China, the State Council established a Joint Prevention and Control Mechanism

Table 1

Major components of RCCE strategies for effective and sustainable early actions[10].

Category	Types of issues and challenges by category
Risk communication systems	Involvement of highest levels of government
	Existence of RCCE plans prior to COVID-19 pandemic
	Procedures on timely release of information
	RCCE operational team
	Budgetary issues
Internal and partner coordination	Identification of relevant partners
	Communication capacity of partners
	Existence and use of Standard Operating Procedures (SOPs)
Public communication	Spokespersons
	Message template
	Identification of key media
	Identification of channels of communication
	Role of health professionals in RCCE
Community engagement	Understanding of concerns, attitudes and beliefs of key audiences
	Identification of target audiences and gathering of information about their knowledge and behaviours
	Engagement through social media, radio, and other appropriate means
	Identification of community influencers
	Special information needs for people who are disabled or illiterate
	Establishment of hotlines to respond to concerns
Addressing uncertainty and perceptions and managing misinformation	System for responding to misinformation
	System for gauging public perceptions and rumours and misinformation
	Preparation of guidance for health professionals, community leaders, local government staff, and other key groups on how to respond to misinformation
Capacity building	Training activities in various areas of RCCE
	System for assessing and responding to training needs

for COVID-19 on January 21, 2020, led by the National Health Commission along with 32 ministries and commissions.[15] The mechanism has several functional working groups related to pandemic prevention, control, and publicity. Meanwhile, in China's Taiwan region, the first response task force consisting of experts in infectious diseases, public health, and laboratory sciences, etc., was established by the end of the first week of January,[16] while the Central Epidemic Command Center (CECC), a high-level public health crisis response body, was activated on January 20. The Japanese government soon followed, with the Prime Minister creating a task force to prevent the further spread of COVID-19 on January 30, 2020.[17] Several other countries also established high-level coordination mechanisms within the first few weeks of the reported pandemic, including Saudi Arabia based on lessons learnt from previous MERS-Cov and annual pilgrims mass gatherings response[18] and South Korea.[19]

While China's health administration agencies actively reinforced hospital and community disease/epidemic prevention and control measures, other countries also rapidly initiated preparedness and response measures.[9-10] For instance, the China's Taiwan region started early point of entry COVID-19 screening, risk communication awareness, and education of all passengers from China along with the establishment of a hotline to document signs and symptoms during the quarantine period of 14 days[16] The National Institute of Infectious Diseases of Japan revised the risk assessment methods and protocols, including the definition of a close contact, in addition to improved risk communication, as did the government of South Korean, which increased the national alert system and emergency management plans to yellow (level 2-early warning). Similarly, other countries in South East Asia, the Middle East, and North Africa collaborated with WHO centers for technical assistance and support against the COVID-19 pandemic.[19-21]

The speed at which governments responded to the initial news of the novel coronavirus stems from the lessons learnt from past epidemics of infectious diseases. Recent epidemics, including SARS during 2002–2003, pandemic influenza A (H1N1) in 2009, MERS in 2011, Ebola virus disease in 2014, and Zika virus infection during 2015–2016, all demonstrated that the establishment of effective internal risk communication systems and development of diagnostic tools were both essential for early case detection and active surveillance as well as for clinical characterization and management of the disease.[16,21] In China, risk communication systems were enhanced and public health emergency measures at all frontline and point of entries boosted during the SARS epidemic. These early responses contributed immensely towards prevention and containment during those epidemics in China, Saudi Arabia, South Korea and elsewhere.[21-24]

For effective risk communication, the severity of the disease must be clearly understood and communicated. The classification of diseases is therefore an integral part of RCCE strategies, particularly in the early stages. This classification is often stipulated by law and spells out the specific actions the governments and all of its agents are allowed to and should take. With the availability of mobile technologies and the Internet, governments have been able to communicate the classification of COVID-19 more rapidly and effectively than ever before, for example, through official bulletins such as those from the National Health Commission of the People's Republic of China on January 20, 2020.[25]

3.2. Enhanced local partnership, leadership, and coordination in RCCE responses against COVID-19

The ability for effective coordination requires proactive leadership, evidence-based and clear delineation of guidelines related to communication and measures by task force, and coordination of RCCE strategies during COVID-19pandemic prevention and containment.[8,11] The response to COVID-19 in China's mainland and Taiwan region, South Korea, and several other countries and regions has been led and coordinated by special taskforce committees at the central and frontline provincial levels, national centers of disease prevention, and emergency response teams where they exist.[14]

A unified, rapid, and effective release of trusted information and messaging from reliable government and stakeholder sources, such as the WHO and U.S. Centers for Disease Control and Prevention (U.S. CDC), facilitates information dissemination and education of the population along with prevention of mass public fear and misinformation, which may be more devastating than the COVID-19 infection itself. The COVID-19 task force plays an essential role in most affected countries by establishing essential RCCE guidelines and ensuring the timely release of information with the support of WHO experts, along with releasing disease epidemiology statistics and essential recommendations to save lives and contain further spread. In addition, the role of public health of-

ficials is critical during the process of turning data including limited epidemiological information into tangible public health policies. Delays in risk communication and virus characteristics of human-to-human transmission led to delays in global alert and restrictive measures implementation, such in the case of the large-scale banquet held in Wuhan City of China, which was widely criticized at the time for creating a disease cluster.

Meanwhile, subnational or provincial working groups should be responsible for regional implementation. As the need for social distancing measures became clearer, some governments deliberately solicited feedback from local-level actors regarding the guidelines, such as in South Korea, to better understand the impact of such protective and preventive measures.[26] As discussed below, this evidence community engagement helped to shape effective messaging and other digital communication media trust and awareness from linked infodemic misinformation and fear.[8,20]

Evidence-based RCCE, coordinated and practical people-centered information, awareness, and communication are critical and remain the cornerstone of early emergency pandemic management. In the case of COVID-19, this has been clearly demonstrated by the unprecedented degree of governmental restrictions on people's movements, not only in terms of international travel.[27-28] Strict lockdowns and preventive measures were implemented in Wuhan city, other cities of China, and communities elsewhere, entailing the closure of airports, stations, schools and recreation places with even local movement restrictions from January 23, 2020. Episodic deconfinement and lockdown resulted in a resurgence of cases in a few countries such as the U.S., France, and the U.K.[15] The coordination between government and transport service providers allowed all travel to be brought to a standstill within a 48-hour period.

The COVID-19 pandemic crisis demonstrated the need for a coordinated response along with logistic and integrated multi-sectoral management, not only between the government and health care providers, but also related supportive services such as testing, medical logistics, intensive medical care, and digital service providers. In most affected countries, local hospitals faced acute to severe shortages of diagnostic kits and protective equipment in addition to other essential commodities leading to significant unmet needs and gaps in the emergency assistance response, and in building community resilience as well as could help in boosting mass COVID vaccination roll out programs. Although institutional mechanisms for organizing medical supply chain logistics have improved with successive public health crises, the current pandemic has highlighted the remaining shortcomings, such as the need to establish an emergency reserve medical supply system that covers not only physical reserves but also others, such as funding and production capacity in China.[29]

Early local and regional adaptations of the WHO recommended RCCE strategies and protocols by various parties for vulnerable groups such as refugees, displaced population, and the elderly significantly improved COVID-19 prevention and recovery rates in Africa and elsewhere, although the full rationale is still poorly understood. As in the case of past infectious disease outbreaks, they should focus on the synergy between communication and response after the launch of RCCE by relying on central and local risk communication systems. This is essential for ensuring public trust and consistency in the preparation, approval, and release of information in different fields in accordance with the WHO and U.S. CDC's recommendations.[30]

3.3. Strengthening public trust and participatory risk communication

Our findings showed that the COVID-19 pandemic may be redefining the meaning of RCCE due to its broad reach across all sectors of the society, and across most countries in the world. Since there is a need for public cooperation on virtually every public health measure introduced by the government, public communication has been proven to be absolutely critical. As noted by the Director of the WHO's Global Infectious

Hazards Preparedness Department, "Good risk communication during a pandemic involves providing the right information, at the right time, to the right audience, so that it triggers the right response as intervention".[8,31]

We documented that the spread and reach of official communications have never been as fast and widespread as during the current crisis, thanks in large part to social media and online platforms.[32] Even in the very early stages of the pandemic, communication methods of China's mainland and Taiwan region, South Korea, and Japan depended heavily on digital communication channels (official government websites, official social media pages) and messaging channels (Wechat, Line, and Twitter) with high penetration, accessibility, and population uptake.[24]

The downside of these tools has been an unprecedented amount of misinformation, which has undermined the worldwide efforts to contain the virus and protect the people. Unlike other public health crises, the global threat of COVID-19 infodemic or "fake news" and rumors was recognized fairly early, with the WHO taking the unprecedented step of meeting with Facebook, Google, YouTube, and other media companies on February 14, 2020 to discuss possible ways to counter the misinformation and fear overshadowing the COVID-19 pandemic crisis. A large amount of research has been conducted to analyze different aspects of this misinformation, including, for example, different channels of misinformation (Facebook, Twitter, and WeChat).[33] This issue is further elaborated below.

Another negative effect of digital communications has been too much information, or infodemic. On one hand, this overload of information may have unintentionally deterred people from behaving according to public health guidelines. On the other hand, the constant public messaging of fear and negative news, particularly through new media platforms, also had a serious impact on people's stress levels and mental health. Previous epidemics have also created anxiety among the general population, such as in South Korea, where the MERS occurred in 2015,[34] but the panic caused by the COVID-19 pandemic has had profound economic and social consequences.[35]

We found that the public panic, fear, and resistance due to coronavirus conspiracy theories, opinions, uncertainties, and misinformation regarding the precautionary, preventative, and emergency response interventions fueled much debate as well as ethical and legal considerations. The governments and other stakeholders must proactively dispel misperceptions about the source of the disease, which has ignited racist commentaries and even physical attacks on certain nationals (for example, on Chinese nationals in South Korea and Japan,[36] and on East Asians in general in Europe and North America). The social stigma attached to the disease has also been reported to be responsible for undermining efforts to track and trace because people are reluctant to get tested and adhere to barriers/lockdown measures.[37]

There is an urgent need to establish working communication and collaborative systems for effective risk information messaging and dissemination as well as care seeking in COVID-19 treatment centers and referral hospitals. Local champions or official spokespersons should be designated who can convey information in a clear, simple, and trusted manner. Updates to this information should be released in a timely manner based on the results of risk assessments, perception of risk by the public, as well as community support and adherence to response and recovery including mass anti-COVID vaccination programs.[38] These are the essential foundations of the localized application of the recommendations of the RCCE guidelines. The current pandemic crisis has also demonstrated the importance of the medical community in risk communication, and the challenges that arise when different stakeholders are projecting different opinions. Most governments have involved infectious disease experts in policy decisions, while nurses, doctors, care workers, and other frontline staff have been feeding into the risk communication strategies through personal communications and the media. Indeed, the "face of COVID-19" has had negative effects on healthcare

professionals in the frontline and intensive care units, as well as patients and victims of the disease.

3.4. Improved community engagement and resilience

As the risk of human-to-human transmission became clearly understood, the need to engage the community in prevention of disease transmission and response to cases, active communication, enhanced surveillance, and response strategies became increasingly obvious due public and community resilience.

We discovered that during the Chinese New year festivities, social distancing and lockdown measures not only significantly influenced the residents' lifestyle and productivity, but also greatly reduced the spread of COVID-19. Increasing use of conventional and non-conventional measures against COVID-19 in China and other affected high burden countries worldwide has become the norm over the recommended WHO RCCE guidelines, human rights and the Al Matta principles ethical and legal bridges.[38] The recommendations emphasize the importance of soliciting after emergency response action feedback in order to improve public adherence and compliance to the lockdown preventive and precautionary measures. However, for infectious and dangerous diseases, it is necessary to move quickly and fully mobilize community engagement, while building resilience in order to prevent transmission and control the response in an orderly manner, and in accordance with the actual conditions in various parts of the country.[38-40] More comprehensive early and sustainable RCCE measures and interventions are needed based on a thorough understanding of the population's social, ecological, and behavioral trends in addition to epidemiological trends and patterns in the pre- and post-crisis periods. Furthermore, the capacity and training of medical and healthcare professionals as well as community healthcare workers on biosafety (competency and skills) and laboratory best practices remain vital for contextual solutions and innovations to tackle the existing and future pandemic threats and burdens.

Our results pertaining to COVID-19 hotspots in various countries demonstrated that social organizations or targeted communities can provide a basis for accomplishing public health policy measures by tackling traditions and myths.[41] This reinforces the point that, for such widespread pandemic, social groups, pharmaceutical industries, and international organizations need to be widely mobilized to utilize their professional and business advantages. They can provide care and counseling services in related fields, dissemination of scientific information and medical care, advocacy in disease prevention capacity building, and remote and online consultations and psychological counseling.

In addition, basic medical institutions and disease control agencies should rely on urban and rural community organizations when conducting epidemiological screening of suspected patients along with epidemiological investigations and treatment during community pandemics.[41-42] These efforts can control the source of the infection and prevent further spread. In socially vulnerable populations isolated for observation or treatment, close attention should also be paid to coordinating and solving survival problems facing the families within these communities.

3.5. Addressing global COVID-19 uncertainty, risk perception, and misinformation

Our findings revealed that early and proactive implementation of RCCE interventions was effective in boosting public risk perceptions, knowledge, and education in addition to minimizing doubts, thus contributing to curbing the COVID-19 pandemic crisis. Government and scientific experts robust and resilient efforts towards public education and risk communication should be forthright about the many emerging infectious diseases/pandemics uncertainties and should mitigate using contextual and practical RCCE against fear, misinformation, and inequities in care access and delivery.[43]

There is an urgent need to reduce the fast dissemination of COVID-19 conspiracy and fear related rumors and misinformation, as these tend to jeopardize adherence to lockdown and response measures and lead to public hesitancy regarding potential safe and effective COVID-19 vaccines and mass immunization. The current COVID-19 pandemic and previous experiences during the SARS-CoV and MERS-CoV pandemics show that social media and mass media rumors, overstatements, and political manipulation will always be present during pandemics.[44] Thus, the disclosure of information alone is insufficient to counter the rumors, misinformation, and misunderstandings in the communities.

As the pandemic unfolded in some countries, a number of other digital health technology-related issues came to the fore. The deluge of information has been recognized as a problem by many, including the WHO, which referred to it as an infodemic.[8,38,44] This has drawn attention to the challenge of ensuring high-quality communication during a rapidly evolving public health crisis. However, at an even more fundamental level, questions are being raised about the ability of governments to target the information for those most in need as well as to provide it in appropriate languages and forms. For example, using a contact that "hard-coded" into every telephone, the South Korean government used text messaging effectively to reach and create awareness among its populace on COVID-19 prevention measures, as well as to give updates on locational information about the movements of infected people. This helped people not only to avoid potentially risky hotspots but also to identify whether they themselves may have been exposed. However, the efficacy of text messaging rests on the assumption that the people at risk own and use mobile communication devices, which may not be the case for many elderly people.[45]

Another serious issue is multilingual communication. As noted by the WHO in their RCCE guidance on the Ebola pandemic, communication products for affected communities should be adapted to their level of education, languages or dialects, preferred mean of communication (e.g., oral, written, visual, etc.), and trusted channels and interlocutors.[46] Due to limited financial resources, some Asian governments use automatic translation programs to translate information into other languages. For example, the Ministry of Health, Labour and Welfare of Japan offer this service for English, traditional Chinese, simplified Chinese, and Korean. However, the quality of the translations by these programs is problematic.[47] Furthermore, in recent years, the government of Japan has encouraged the immigration of workers from countries such as Nepal and Vietnam. However, as of mid-March 2020, very little official information had been released in these languages. In multi-cultural countries or countries with large immigrant population, timely, accurate, and effective communication in non-official languages will become one of the defining features of their RCCE strategies.

3.6. Re-enforcing pandemic capacity building and community health workers competencies at all levels

Our results revealed a scarcity of data on early preparedness and response competencies to existing and potential pandemics at all levels in most affected countries. Early experiences of COVID-19 exposed the importance of capacity-building, risk communication, and cooperative activities required for effective and sustained RCCE implementation and impact measurements at all levels. However, there are still very few studies looking at this aspect, although some have called for more robust and decentralized RCCE plans that implicitly require prioritizing training and awareness building at the community level.[8,48]

3.7. Future priorities and needs for RCCE strategies in developing countries

3.7.1. Integrating data and models to inform evidence RCCE strategies

Our review findings showed that the lessons learnt from the previous SARS and MERS epidemics are being used to address several urgent research areas, including epidemiological studies that estimate transmission dynamics, varying susceptibility of different population groups, and

public health interventions to reduce transmission and spread.[2,4,10-11] The current pandemic has been catalytic for further development of modeling and mapping techniques for mass immunization roll out and coverage effectiveness. Modeling is an essential component of response to pandemics, as it can help to forecast outcomes, manage healthcare resources, and evaluate proposed intervention strategies. Combining an array of modeling techniques with continually updated data from international and local/regional sources can effectively support public health decision-making processes.[3,6,11] Furthermore, it can help to inform and direct humanitarian funding for emergency technical assistance, thereby contributing to the global response against COVID-19 pandemic.

Modeling transmission can be performed with a series of models that tend to become more detailed and realistic as more biological and incidence data become available. In this regard, an important difference between the current pandemic and previous ones is the rapid sharing of data, including viral sequences. These not only permit rapid diagnostic development, but also provide an opportunity to integrate sequence data for a better understanding of the transmission dynamics.[1,12] Updating model assumptions in light of new data is important for planning healthcare capacity needs. Healthcare capacity modeling facilitates our understanding of the risk by population and allows transmission dynamics to be incorporated into capacity planning, accounting for the rapid changes in the demand, transmission to healthcare workers, and nosocomial infections. Real-time estimates, data, and models can be communicated rapidly with the global community.[1,10,13]

3.7.2. Building intelligent systems for monitoring isolation/quarantine and tracking

Developing and using artificial intelligence (AI) or machine learning algorithms may be helpful for analyzing, interpreting, and utilizing the tracking data to support decision-making processes.[46-47] Implementing smartphone-based AI diagnostic tools is crucial for early case detection and surveillance, evaluation and optimization of infection prevention control measures, automatic monitoring of self-quarantine, and compliance with mobility restrictions.

Smartphone application tools can also improve the monitoring and compliance of individuals who are advised or required to self-quarantine during an epidemic or pandemic threat. Monitoring and surveillance of COVID-19 infections via smartphones to collect pertinent data related to risks and disease spread as well as contact tracking of vulnerable people are critical for improving the generation of early alerts and individual or community motility regulation or decision making by local authorities for implementing appropriate and practical lockdowns, barriers, and preventive measures.[48-49]

In addition, the use of Bayesian methods and digital tools can be integrated with the available surveillance data to predict or study the effects of public health decision-making policies, and to better prepare the countries with fewer resources, such as those in Africa.[50] This is indeed required to prepare for potential future province-wide or nationwide decision-making and evaluation. For example, the development and implementation of algorithms can help to generate intuitive visualization of clustering maps, which may be highly beneficial for non-technical domain experts (e.g., healthcare practitioners) to identify trends within the data.[2,16,49-50] Employing artificial intelligence and deep machine learning algorithms is crucial to easily deploy analytics and visualization tools for early detection and planning as a part of innovative pandemic preparedness and safe COVID-19 vaccines roll out RCCE tactics.

3.7.3. Bolstering clinical and public health information sharing and resilience across borders

One of the most encouraging developments following the announcement of the pandemic was multiple stakeholders' global solidarity to promote COVID-19 pandemic data sharing for ensuring timely evidence-based decisions and resilient actions.[43-44] In accordance with the international norms, many countries published their pandemic data and informed the WHO of the COVID-19 status in their population. One study

from Thailand even assessed the efficiency of such reporting mechanisms.[51-52] Such studies could be invaluable for preparing for future pandemic or even local outbreaks. Adaptive resilience to national and regional contextual insights and strategies can help to prevent or contain the COVID-19 pandemic, while sharing timely information and challenges with global partners can help to shape major national and local policy-level decisions.[43-44] For example, many academic journals announced that they would be providing open access to their COVID-19 related materials, while some, such as the *New England Journal of Medicine*, translated their COVID-19 related articles into Chinese in the early stages of the pandemic.[53-55]

4. Conclusions

We noted early stages of RCCE but given the unprecedented nature of the COVID-19 pandemic, there are still additional lessons to be learned from the current pandemic crisis along with the potential pitfalls. The COVID-19 pandemic has proven to be tenacious and showed that the global community is poorly prepared for handling emerging pandemics of this scale. Enhancing global solidarity in emergency preparedness and response, and the mobilization of science and cooperation can yield ideas and measures for controlling the pandemic.

The early stages of RCCE provided a useful framework for shaping policy responses to the pandemic according to the WHO guidelines. It is clear that the prerequisite for an effective RCCE strategy is the involvement of the national government and political leaders, working together with public health experts. Lessons learned and experiences from previous risk communication and outbreaks were clearly important in influencing a country's preparedness and readiness, for example, in terms of the relevant agencies (such as the respective centers for disease control) that have the authority to propose and implement policies. At the same time, prevention through mass immunization roll out RCCE and delivery logistics tactics for pandemics is a highly specialized field.

Nevertheless, there are clearly several new thematic areas and issues emerging from the COVID-19 experience, which are not captured by the current RCCE strategies. The scale of the current pandemic caught everyone by surprise and required a "whole of society" response. In this regard, the top-down models of RCCE have clear limitations, while the definition of "community engagement" needs to be reconceptualized to include many communities, and in a different sense of the word. Online communities were found to be as or even more influential than geographic communities.

CRediT author statement

Ernest Tambo: Conceptualization, Writing—Original Draft, Writing—Review & Editing. **Ingrid C. Djuikoue & Gildas K. Tazemda**: Resources. **Michael F. Fotsing**: Resources, Validation. **Xiao-Nong Zhou**: Writing—Review & Editing.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. WHO Statement regarding cluster of pneumonia cases in Wuhan, China. World Health Organization website. https://www.who.int/china/news/detail/09-01-2020-who-statement-regarding-cluster-of-pneumonia-cases-in-wuhan-china. Accessed March 14, 2020.

2. Mowbray H. In Beijing, coronavirus 2019-nCoV has created a siege mentality. *BMJ*. 2020;368:m516. doi:10.1136/bmj.m516.

3. Coronavirus disease (COVID-19): weekly epidemiological update, 14 September 2020. World Health Organization website. https://apps.who.int/iris/handle/10665/334304. Accessed May 28, 2020.

4. Qiu W, Chu C, Mao A, Wu J. The impacts on health, society, and economy of SARS and H7N9 outbreaks in China: a case comparison study. *J Environ Public Health*. 2018;2018:2710185. doi:10.1155/2018/2710185.

5. Ralph R, Lew J, Zeng T, et al. 2019-nCoV (Wuhan virus), a novel Coronavirus: human-to-human transmission, travel-related cases, and vaccine readiness. *J Infect Dev Ctries*. 2020;14(1):3-17.

6. Fauci AS, Lane HC, Redfield RR. Covid-19–navigating the uncharted. *N Engl J Med.*. 2020;382(13):1268-1269. doi:10.1056/NEJMe2002387.

7. World Health Organization. Communicating risk in public health emergencies. A WHO guideline for emergency risk communication (ERC) policy and practice. https://www.who.int/risk-communication/guidance/download/en/. Accessed May 28, 2020.

8. Lal A, Ashworth HC, Dada S, Hoemeke L, Tambo E. Optimizing pandemic preparedness and response through health information systems: lessons learned from Ebola to COVID-19. *Disaster Med Public Health Prep*. 2020;1-8. doi:10.1017/dmp.2020.361.

9. Song P, Karako T. COVID-19: real-time dissemination of scientific information to fight a public health emergency of international concern. *Biosci Trends*. 2020;14(1):1-2.

10. World Health Organization. Risk communication and community engagement readiness and response to coronavirus disease (COVID-19): interim guidance. https://www.who.int/publications/i/item/risk-communication-and-community-engagement-(rcce)-action-plan-guidance. Accessed March 19, 2020.

11. Colquhoun HL, Levac D, O'Brien KK, et al. Scoping reviews: time for clarity in definition, methods, and reporting. *J Clin Epidemiol*. 2014;67(12):1291-1294. doi:10.1016/j.jclinepi.2014.03.013.

12. Emergencies: Risk communication. World Health Organization website. https://www.who.int/news-room/q-a-detail/emergencies-risk-communication. Accessed March 31, 2020.

13. Risk communications. World Health Organization website. https://www.who.int/emergencies/risk-communications. Accessed March 31, 2020.

14. Forman R, Atun R, McKee M, Mossialos E. 12 Lessons learned from the management of the coronavirus pandemic. *Health Policy*. 2020;124(6):577-580. doi:10.1016/j.healthpol.2020.05.008.

15. COVID-19 Wuhan guidance papers-emerging experiences on responding to COVID-19 in Chinese cities and townships. UN-Habitat website. https://unhabitat.org/covid-19-wuhan-guidance-papers-emerging-experiences-on-responding-to-covid-19-in-chinese-cities-and. Accessed March 31, 2020.

16. Lin C, Braund WE, Auerbach J, et al. Policy Decisions and Use of Information Technology to Fight COVID-19, Taiwan. *Emerg Infect Dis*. 2020;26(7):1506-1512. doi:10.3201/eid2607.200574.

17. Japanese government creates task force to fight spread of coronavirus – reports. Sputnik News website. https://sputniknews.com/asia/202001301078177026-japanese-government-creates-task-force-to-fight-spread-of-coronavirus–reports/. Accessed March 14, 2020.

18. Algaissi AA, Alharbi NK, Hassanain M, Hashem AM. Preparedness and response to COVID-19 in Saudi Arabia: building on MERS experience. *J Infect Public Health*. 2020;13(6):834-838. doi:10.1016/j.jiph.2020.04.016.

19. Gilbert M, Pullano G, Pinotti F, et al. Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study. *Lancet*. 2020;395(10227):871-877.

20. Statement on the second meeting of the International Health Regulations (2015) Emergency Committee regarding the pandemics of novel coronavirus (2019-nCoV). World Health Organization website. https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-regarding-the-pandemics-of-novel-coronavirus-(2019-ncov). Accessed March 14, 2020.

21. Al-Mandhari A, Samhouri D, Abubakar A, Brennan R. Coronavirus Disease 2019 outbreak: preparedness and readiness of countries in the Eastern Mediterranean Region. *East Mediterr Health J*. 2020;26(2):136-137.

22. Tambo E, Chengho CF, Ugwu CE, Wurie I, Jonhson JK, Ngogang JY. Rebuilding transformation strategies in post-Ebola epidemics in Africa. *Infect Dis Poverty*. 2017;6(1):71. doi:10.1186/s40249-017-0278-2.

23. Qiu WQ, Hou XH, Mao AY. Application of WHO risk communication principles in prevention and control of the first imported Middle East respiratory syndrome case in China. *Chin J Public Health*. 2017;33(02):342-344.

24. Tambo E, Oljira T, Oluwasogo OA, Khater EIM, Zhou XN. Averting MERS-Cov emerging threat and epidemics: the importance of community alertness and preparedness policies and programs. *J Prev Infect Control*. 2015;1(1): 10.21767/2471-9668.10002. doi:10.21767/2471-9668.10002.

25. Announcement from National Health Commission of the People's Republic of China. Bureau of Disease Prevention and Control, National Health Commission of the People's Republic of China website. http://www.nhc.gov.cn/jkj/s7916/202001/44a3b8245e8049d2837a4f27529cd386.shtml . Accessed March 14, 2020.

26. Regular Briefing of Central Disaster and Safety Countermeasure Headquarters on COVID-19. Ministry of Health and Welfare, Republic of Korea website. https://www.mohw.go.kr/eng/nw/nw0101vw.jsp?PAR_MENU_ID=1007&MENU_ID=100701&page=1&CONT_SEQ=354431. Accessed April 27, 2020.

27. Wilson ME, Chen LH. Travellers give wings to novel coronavirus (2019-nCoV). *J Travel Med*. 2020;27(2):taaa015. doi:10.1093/jtm/taaa015.

28. Bogoch II, Watts A, Thomas-Bachli A, Huber C, Kraemer MUG, Khan K. Pneumonia of unknown aetiology in Wuhan, China: potential for international spread via commercial air travel. *J Travel Med*. 2020;27(2):taaa008. doi:10.1093/jtm/taaa008.

29. Wang X, Zhang X, He J. Challenges to the system of reserve medical supplies for public health emergencies: reflections on the outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic in China. *Biosci Trends*. 2020;14(1):3-8.

30. World Health Organization. Risk communication and community engagement (RCCE) considerations: Ebola response in the Democratic Republic of Congo. https://www.afro.who.int/publications/risk-communication-and-community-engagement-rcce-considerations-ebola-response. Accessed March 14, 2020.

31. JCIH Editorial TeamA Voice from the frontline: the role of risk communication in managing the COVID-19 Infodemic and engaging communities in pandemic response. *J Commun Healthc*. 2020;13(1):6-9.

32. Chersich MF, Gray G, Fairlie L, et al. COVID-19 in Africa: care and protection for frontline healthcare workers. *Glob Health*. 2020;16(1):46. doi:10.1186/s12992-020-00574-3.

33. Cuan-Baltazar JY, Muñoz-Perez MJ, Robledo-Vega C, Pérez-Zepeda MF, Soto-Vega E. Misinformation of COVID-19 on the internet: infodemiology study. *JMIR Public Health Surveill*. 2020;6(2):e18444.

34. Ro JS, Lee JS, Kang SC, Jung HM. Worry experienced during the 2015 Middle East Respiratory Syndrome (MERS) pandemic in Korea. *PLoS One*. 2017;12(3):e0173234.

35. Belasen AT, Hertelendy AJ, Belasen AR, Oppenlander J. Provider-patient communication and hospital ratings: perceived gaps and forward thinking about the effects of COVID-19. *Int J Qual Health Care*. 2020;mzaa140. doi:10.1093/intqhc/mzaa140.

36. Shimizu K. 2019-nCoV, fake news, and racism. *Lancet*. 2020;395(10225):685-686. doi:10.1016/S0140-6736(20)30357-3.

37. Chopra KK, Arora VK. Covid-19 and social stigma: role of scientific community. *Indian J Tuberc*. 2020;67(3):284-285.

38. Sun L, Ma Y. Development and experience of health risk communication in China. *Chin J of Health Educ*. 2012;28(3):233-234,239.

39. Hu GY, Qiu WQ. From guidance to practice: take actions on risk communication and community engagement to response to the outbreak of the Coronavirus disease 2019 (COVID-19) in China. *Chin J Evid Based Med*. 2020;20(6):719-722.

40. World Health Organization. Novel Coronavirus (2019-nCoV) Situation Report, 13. https://apps.who.int/iris/handle/10665/330778. Accessed March 13, 2020.

41. Wang X, Lin L, Xuan Z, Xu J, Wan Y, Zhou X. Risk communication on behavioral responses during COVID-19 among general population in China: a rapid national study. *J Infect*. 2020;81(6):911-922. doi:10.1016/j.jinf.2020.10.031.

42. Costantino C, Fiacchini D. Rationale of the WHO document on Risk Communication and Community Engagement (RCCE) readiness and response to the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and of the Italian Decalogue for Prevention Departments. *J Prev Med Hyg*. 2020;61(1):E1-E2.

43. Smith GD, Ng F, Ho Cheung Li W. COVID-19: Emerging compassion, courage and resilience in the face of misinformation and adversity. *J Clin Nurs*. 2020;29(9–10):1425-1428.

44. Lupe SE, Keefer L, Szigethy E. Gaining resilience and reducing stress in the age of COVID-19. *Curr Opin Gastroenterol*. 2020;36(4):295-303.

45. Fendos J. Why a grassroots Summer Institutes model failed: Exploring obstacles to evidence-based teaching awareness in low-awareness, low-support contexts. *Biochem Mol Biol Educ*. 2020;48(2):143-155.

46. Nachega JB, Mbala-Kingebeni P, Otshudiema J, et al. Responding to the challenge of the dual COVID-19 and Ebola epidemics in the democratic republic of congo-priorities for achieving control. *Am J Trop Med Hyg*. 2020;103(2):597-602.

47. Health ministry struggles to provide COVID-19updates in foreign languages. Japan Times website. https://www.japantimes.co.jp/news/2020/02/18/national/health-ministry-struggles-provide-covid-19-updates-foreign-languages/#.XnnKTuozaUl. Accessed March 14, 2020.

48. Hu G, Qiu W. From guidance to practice: Promoting risk communication and community engagement for prevention and control of coronavirus disease (COVID-19) outbreak in China. *J Evid Based Med*. 2020;13(2):168-172.

49. Riedl MO. Human-centered artificial intelligence and machine learning. *Hum Behav Emerg Technol*. 2019;1(1):33-36. doi:10.1002/hbe2.117.

50. Kamel Boulos MN, Geraghty EM. Geographical tracking and mapping of coronavirus disease COVID-19/severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic and associated events around the world: how 21st century GIS technologies are supporting the global fight against outbreaks and epidemics. *Int J Health Geogr*. 2020;19(1):8.

51. Gilmore B, Ndejjo R, Tchetchia A, et al. Community engagement for COVID-19 prevention and control: a rapid evidence synthesis. *BMJ Glob Health*. 2020;5(10):e003188.

52. Kebede Y, Birhanu Z, Fufa D, et al. Myths, beliefs, and perceptions about COVID-19 in Ethiopia: a need to address information gaps and enable combating efforts. *PLoS One*. 2020;15(11):e0243024.

53. Hoover AG, Heiger-Bernays W, Ojha S, Pennell KG. Balancing incomplete COVID-19 evidence and local priorities: risk communication and stakeholder engagement strategies for school re-opening. *Rev Environ Health*. 2020;10.1515/reveh-2020-0092. doi:10.1515/reveh-2020-0092.

54. Seale H, Heywood AE, Leask J, et al. COVID-19 is rapidly changing: examining public perceptions and behaviors in response to this evolving pandemic. *PLoS One*. 2020;15(6):e0235112.

55. Rubin EJ, Baden LR, Morrissey S. Audio interview: preparing for the spread of Covid-19. *N Engl J Med*. 2020;382(9):e18.

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