



(RESEARCH ARTICLE)



Level of global preparedness to pandemics and responsiveness of health systems to pandemics: Lessons learned from Covid-19 and Monkeypox Outbreak

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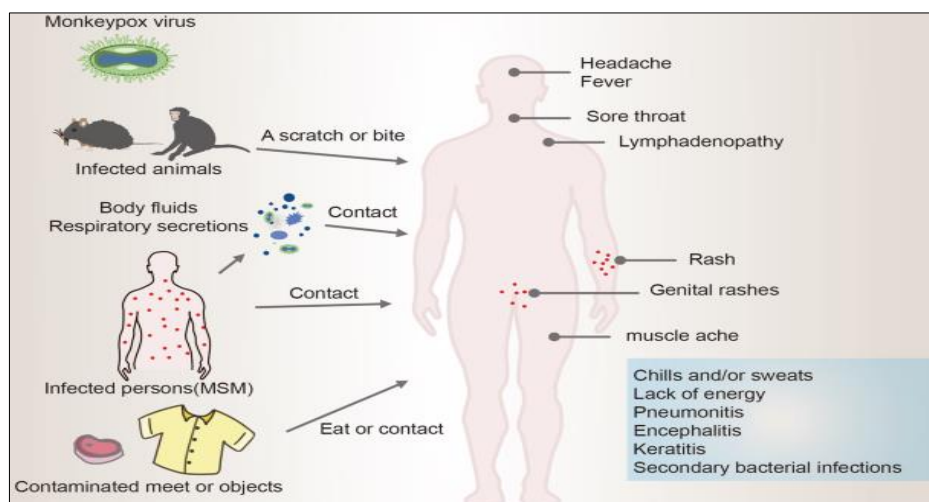
Abstract

The monkeypox disease has been declared a global health emergency in the recent past by WHO since cases have been observed to be increasing in many countries where it is not common. Thus, epidemics and pandemics such as the novel coronavirus disease 2019 (COVID-19) have had adverse effects on populations, and healthcare systems, especially in Low and Middle-Income Countries (LMICs) because of borrowing or inadequate resources when compared to high-income countries. The Ebola and Covid-19 for instance have also revealed the existing deficiencies and vulnerabilities in the global structure of the pandemics' prevention and control all in one. New epidemics are constantly emerging such as the current monkeypox outbreak that is ravaging the global population; hence it has dawned on the world that there is need for combined efforts at a global level and probably investing more in the health systems to be able to prevent and deal with other similar epidemics. Further, there is required more equal distribution of the resources and health intervention in all countries to build strong containment responses. Based on prior episodic outbreaks, there is the need for immediate coordinated response to the ongoing monkeypox outbreak. The purpose of this research article is to review and discuss the main underlying autopsies from past outbreaks, including Ebola and Covid-19 with emphasis on readiness, answering to the outbreak, coordination measures, health system robustness, risk communication and the international community. It also evaluates the readiness globally and by country to the present monkeypox outbreak based on other recent large viral epidemics. It also prevents social stigmatization, which is the negation of outbreaks, and rightful inequities that may arise from the same. As such, and with health system reforms launched now, countries can prepare themselves against present and future known and unknown urgencies and leave no one behind. As such the general research question of this study is to obtain strategies for enhancing pandemic preparedness taken from successes and failure noticed earlier and the focus placed on LMIC capacity strengthening.

Keywords: Monkeypox; COVID-19; Pandemic preparedness; Global health security; Health systems resilience; Infectious diseases; Surveillance; One Health; Zoonotic diseases; Stigmatization

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Graphical Abstract



1. Introduction

Infectious disease outbreaks have increasingly impacted global health in recent decades. Starting with the deadly 2014–2016 Ebola virus disease (EVD) epidemic in West Africa to the ongoing unprecedented COVID-19 pandemic, it has become apparent that current preparedness and response mechanisms require strengthening (Abubakar et al., 2022). Despite gains from past challenges, the World Health Organization’s (WHO, n.d) recent declaration of monkeypox virus disease as a Public Health Emergency of International Concern underscores prevailing gaps in global health security efforts (WHO, 2022a). This article aims to examine key lessons obtained from previous epidemics on health systems resilience, risk communication, coordination and resource equity which can help optimize current and future pandemic preparedness.

The 2014–2016 West Africa EVD outbreak exposed weaknesses in global outbreak response coordination and country-level healthcare infrastructure (Borges do Nascimento et al., 2022). Nearly three decades of civil conflict in the region had undermined basic public health capabilities and trust in governance hampering containment for almost a year with over 28,000 cases and 11,000 lives lost (BBC News, 2021). Similarly, the COVID-19 pandemic caught most nations off guard with its rapid global spread, overwhelming even well-resourced health systems and straining social and economic sectors (Centers for Disease Control and Prevention, 2022a). By June 2022, the virus had infected over 500 million leading to over 6 million deaths worldwide with low-income regions hardest hit due to pre-existing vulnerabilities (Ritchie et al., 2022). Both crises fueled social unrest through discrimination, misinformation and economic hardships threatening global solidarity needed for successful containment (Mukherjee, 2020).

The ongoing 2022 monkeypox outbreak underscores that greater coordination and equitable access to strategic international public health interventions is still inadequate. While the epidemiology of this strain spreading unusually amongst networks of men who have sex with men (MSM) in non-endemic nations warrants understanding heterosexual transmission remains theoretically plausible as seen during past African outbreaks indicating future shift potential (Centers for Disease Control and Prevention, 2022b; The Conversation, 2022; World Health Organization, 2022c). Meanwhile, independent of transmission routes stigma, misconceptions and inequitable access continue marginalizing at-risk communities hindering outbreak control (Kozlov, 2022; United Nations, 2022). Promisingly, certain countries with strong primary healthcare systems like Singapore demonstrated relatively effective early containment with robust surveillance, community engagement and political willpower applied judiciously without unnecessary rights infringements (Makerere University News, 2022).

Together, the experiences from these outbreaks highlight social, technical and systemic frailties exacerbating the negative impacts. Especially concerning is the disproportionate brunt borne by economically disadvantaged regions and vulnerable groups therein due to diminished access to healthcare, income security and participation in decision making (Banerjee et al., 2021). Addressing cross-cutting determinants of health requiring multi-sectoral collaboration therefore remains integral to building resilient pandemic preparedness nationally and globally (Haines et al., 2007). The current monkeypox scenario provides an opportunity to reflect on lessons from prior crises and strengthen health systems, risk communication strategies and cooperation platforms towards limiting future spillover events and facilitating equitable recovery for all.

1.1. Study Background

1.1.1. Global Context of Emerging Infectious Diseases

As the world entered the twenty-first century, the threat of infectious disease remained very much alive, and in some respects became even more formidable. The WHO (2022a) further notes that the occurrences of new pathogens, and that of re-emerging ones over the past years have been felt most recently and most notably with the declaration of monkeypox as a Public Health Emergency of International Concern in 2022 (WHO, 2022c). This declaration sets the tone of permanently revealed deficiencies for global health security irrespective to the lessons learned in previous outbreaks. Based on the study of Abubakar et al., 2022, these emerging infectious diseases have not only affected people's health but have also burdened the global health systems especially in LMICs that are constrained with inadequate health facilities and amenities.

The world has experienced a few massive disease outbreaks in the past few decades that have to some extent defined the world of infectious diseases. The west African 2014-2016 Ebola virus disease (EVD) epidemic was a wake-up call for the world creaking over emerging pathogens of such calibre. Papers by Borges do Nascimento et al. (2022) reveal that this outbreak revealed gaps in outbreak coordinated response at the global and national levels and health systems. The epidemic which has affected over 28 000 people and claimed over 11 000 lives was worsened by civil conflicts that had thrashed basic public health cadres and people's confidence in the government (BBC News, 2021).

In the modern era, COVID-19 took a tremendous toll on most nations, which almost none of them was ready for such a global outbreak. Ritchie et al. (2022) posited that by June 2022, the virus affected over 500 million people resulting in well over 6 million fatalities. According to the Centers for Disease Control and Prevention (n. d.), the pandemic impacted the health system, as well as social and economic systems despite, and indeed because of, the relative resources of the countries involved. Mukherjee in his study finds that discrimination, misinformation, and economic crisis after the Ebola and COVID-19 crises led to social disorder which erodes the collective effort needed during the outbreak.

1.1.2. Monkeypox Outbreak: A New Challenge

The most recent outbreak of monkeypox in the year 2022 has also helped in underlining the significance of "One Health approach" and equity in interventions in the global health system. As cited by the agency of the United States, the kind of monkeypox has been transmissible unusually across the networks of men having sex with male partners in countries not having such transmission history. Nevertheless, The Conversation (2022) points out that the chance of transmission between heterosexuals is theoretically possible and was noticeable during prior African outbreaks and can possibly change in the future. According to the World Health Organization (2022c), such epidemiological features must be fully considered while developing containment measures.

Monkeypox has intensified previously unresolved problems of stigma, misconceptions, and health disparities, which impede identification, vaccination, and management of at-risk populations. Kozlov (2022) says that such social and systemic impediments are difficult to overcome in public health intervention. In the same year, the United Nations noted that preventing and controlling monkeypox, it is important to avoid language stigmatizing LGBTI people in calls for testing, contact tracing and vaccination.

Nevertheless, some of the countries have put in place rather efficient early containing measures. For example, in a recent article, Makerere University News (2022) analyses Singapore's handling of the outbreak as resulting from adequate surveillance, public involvement as well as political commitment. This example plays out the need for early detection of threat and robust primary level health care systems as well as increased forward thinking in dealing with new and re-emerging infectious diseases. The success stories being recorded give inspiration to other nations to pull up their bets to prepare for future catastrophes such as pancreatic pandemic, (Jeyaraman, 2022).

1.1.3. Transmission of Human Monkeypox Virus

Human monkeypox virus is known to spread through close contact with an infected person or animal. According to the CDC (2022a), monkeypox can spread through direct contact with infectious sores, scabs, or body fluids of an infected person. It may also be spread through respiratory secretions during prolonged face-to-face contact or during intimate physical contact such as kissing, cuddling or sex. Respiratory droplets from infected persons can also spread to others especially in indoor settings like households (Sky News, 2022). Percutaneous or transcutaneous introduction of the virus including through bites or scratches from infected animals may also result in transmission (WHO, 2022b).

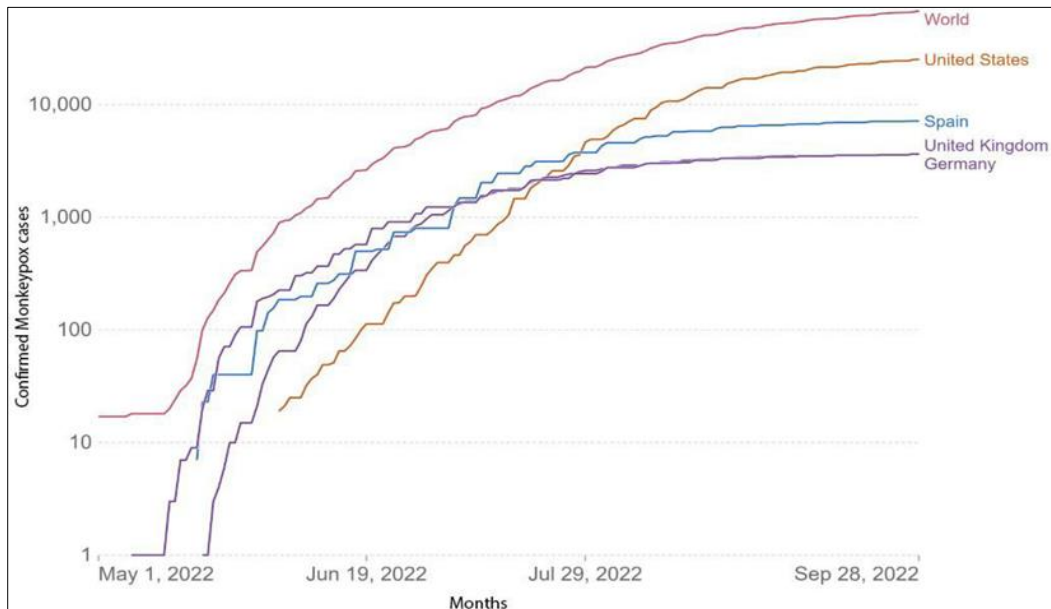


Figure 1 Top 4 countries with highest reported numbers of monkeypox infections as of 30th September 2022. <https://ourworldindata.org/monkeypox>

As observed in Figure 1 above, the monkeypox outbreak has rapidly spread to many non-endemic countries predominantly through human-to-human transmission. As of 30th September 2022, Spain has reported the highest number of cases with 7,188 infections followed by Germany with 3,625 cases, the UK with 3,635 cases and the USA with 5,434 confirmed cases (Mathieu et al., 2022). This unusual spread in international communities suggests sustained person-to-person transmission which can happen through respiratory droplets during prolonged encounters, direct contact with contaminated surfaces or materials like bedding/clothing of patients and intimate physical contact among sexual partners (WHO, n.d.). Preliminary studies indicate that viral load may be high enough in oral mucosal and rectal swabs of symptomatic patients to transmit the infection (The Conversation, 2022).

1.1.4. Clinical Features of Human Monkeypox Virus Infection



Figure 2 Photographic illustration of the progression of monkeypox rash lesions through distinct stages of macule, papule, vesicle and pustule. Source: <https://www.cdc.gov/poxvirus/monkeypox/transmission.html>

The clinical features of monkeypox virus infection typically begin with initial generalized symptoms of fever, headache, muscle aches, backache and malaise. As shown in Figure 2, within a few days of onset of fever, lymphadenopathy occurs as swollen lymph nodes appear prominently in the neck area. A distinctive rash subsequently emerges, usually starting from the face and rapidly spreading to other parts of the body (CDC, 2022d). The rash progresses through different stages as visible in the series of photographs depicting the evolution of lesions over time. Initially, macular lesions arise which are flat and discolored areas on the skin. These advance to papular lesions that become palpable and elevated (Centers for Disease Control and Prevention, 2022d).

As the lesions continue developing, they become vesicular wherein a fluid-filled blister form. Finally, the lesions progress to pustular stage where they are inflamed and contain pus (Centers for Disease Control and Prevention, 2022a). The photographs clearly showcase these sequential changes in the rash, starting from a relatively flat macule and culminating as an inflamed pustule. Concurrently, patients may experience additional symptoms of fever, malaise and lymphadenopathy. The rash usually affects the face and extremities first but eventually involves multiple parts of the body (WHO, 2022b). Lesions concentrate prominently on the palms and soles but may involve oral and genital mucosa as well.

Consequently, the clinical course of monkeypox extends from onset of preliminary symptoms to development of rash and lasts 2-4 weeks according to WHO (2022b). As lesions crust over in the later stages, they begin drying up and detaching from the skin. However, there is a risk of bacterial superinfection of pockmarks left behind as reported by Yinka-Ogunleye et al. (2019). Rare complications can include encephalitis, blindness or infection of other organs in severe cases (Shafaati & Zandi, 2022). While most patients experience mild to moderate illness, young children, pregnant women or immunocompromised individuals are particularly vulnerable to experiencing more grave manifestations.

1.1.5. Global Distribution of Monkey Pox Infections

In May 2022, cases of monkeypox virus infection were reported in multiple non-endemic countries simultaneously for the first time (Riopelle et al., 2023). By September 1st, 2022, over 52,000 confirmed cases had been documented across 100 countries according to WHO data presented in Figure 1A. Riopelle et al. (2023) highlights that this outbreak differed significantly from prior events in West and Central Africa in terms of the unprecedented scale of geographic spread involving nations where monkeypox had never circulated before. Sustained human-to-human transmission emerged as a concerning feature enabling the virus to breach national borders efficiently. As of early September 2022, all impacted regions lay outside the historical zones of endemicity for monkeypox delineated in Figure 1B.

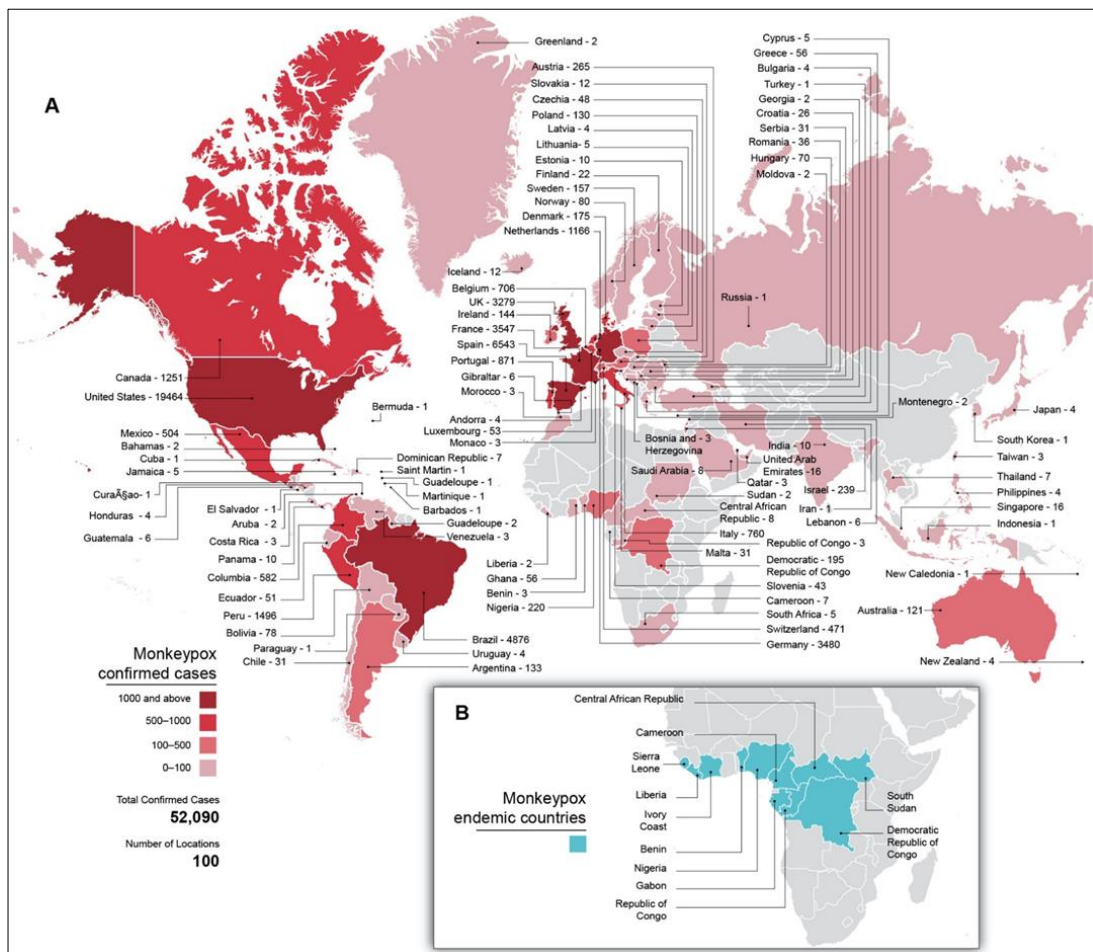


Figure 3 Relative case distribution of monkeypox infections by lineage and country

This figure shows the distribution of reported monkeypox cases by lineage and country, highlighting the predominance of Clade A infections in historically non-endemic regions during the 2022 outbreak, compared to past outbreaks dominated by Clade B lineages within endemic West and Central African nations.

Genetic studies elucidate three distinct clades of monkeypox virus (Riopelle et al., 2023). Formerly, two clades were recognized as the Central African (Clade 1) and West African (Clades 2A and 2B) lineages based on variations in transmissibility and disease severity. Clade 1 causes more severe morbidity, higher mortality, greater viral burdens and heightened transmissibility relative to Clade 2 strains as per prior investigations cited by Riopelle et al. (2023). Case fatality ratios from past outbreaks averaged 10.6% for Clade 1 versus 3.6% for Clade 2 monkeypox infections. Traditionally, human disease presents with a 2–4-day prodrome and characteristic rash emerging later.

However, the ongoing outbreak highlights several noteworthy deviations from the established understanding of monkeypox epidemiology. Many patients in 2022 lacked prodromal symptoms and presents with mild or asymptomatic illness, enabling covert transmission (Riopelle et al., 2023). Sustained person-to-person spread on a massive transnational scale differed from prior self-limiting events confined within endemic zones. While zoonotic spillover from animal reservoirs and subsequent human-to-human transmission drove previous outbreaks, the concerted global diffusion underscores knowledge gaps regarding transmission determinants that must be addressed to curtail further spread, (The Star et al., 2022).

1.2. Statement of the problem

Although past epidemics provided valuable lessons, ongoing challenges underscore the gaps that remain in optimizing global health security. According to Karbalaei and Keikha (2022), the overlapping outbreak of COVID-19 and monkeypox in 2022 serves as a warning for nations to urgently strengthen preventive and preparedness efforts. Despite advancements, the WHO (2022a) recent declaration of monkeypox as a Public Health Emergency of International Concern (PHEIC) highlights prevailing deficiencies in coordination, health system capacities especially in resource-constrained settings, and lack of equitable access to tools across populations still hamper effective containment.

Olumade et al. (2020) affirmed that infectious disease outbreak preparedness and response mechanisms in Nigeria have faced various historical and logistical limitations, curtailing prompt and coordinated action. Hemati et al. (2022) stressed that insights from COVID-19 must inform monkeypox prevention to avert pandemic escalation. However, risk communication remains challenging as Borges do Nascimento et al. (2022) cautioned about the proliferation of health misinformation complicating response. Additionally, social inequities and stigmatization tend to disproportionately impact vulnerable groups limiting coverage of interventions.

Other challenges include suboptimal global cooperation platforms, suboptimal community engagement strategies and inadequate consideration of cross-sectoral influences on health. While health systems strengthening in isolation offers some gains, Haines et al. (2007) emphasized the need for multi-sectoral collaboration to address broader determinants. With heterogeneous transmission dynamics observed from past African outbreaks (Yinka-Ogunleye et al., 2019), future shift potential remains theoretically possible warranting improvements across domains. If unchecked, prevailing weaknesses may undermine efforts to efficiently curb the current monkeypox spread and build resilience to re-emerging threats, Jeyaraman et al., (2022).

Aims and Objectives of this Study

The overarching aim of this study is to provide evidence-based recommendations for improving pandemic readiness based on successes and weaknesses observed from previous epidemics with a focus on optimizing LMIC capacity.

- To examine key lessons from the 2014-2022 Ebola outbreak and ongoing COVID-19 and monkeypox pandemic regarding health systems resilience, coordination efforts, risk communication strategies and resource equity.
- To assess global and country-level preparedness to the current monkeypox outbreak drawing from experiences with recent pandemics.
- To evaluate prevailing gaps, challenges and social determinants exacerbating outbreak impacts especially in resource-limited settings.
- To propose strategies to strengthen national and international cooperation, optimise health system capabilities, ensure equitable access and address stigmatization based on best practices observed.

- To provide a consolidated framework of reforms required across technical and systemic domains to build robust resilience against emerging infectious diseases of international concern.

By achieving these objectives, it is hoped that valuable insight will be offered to optimize pandemic readiness, control of ongoing outbreaks and global health security.

2. Methodology

This review employed a qualitative methodology relying on published peer-reviewed literature about previous epidemics, pandemic preparedness frameworks and lessons for optimising response.

The study systematically collected and synthesised learnings from extensive documentation of past outbreaks including the 2014-2022 West Africa Ebola and ongoing COVID-19 pandemic. Published reports, scientific briefs, commission articles and WHO situational reports served as primary sources of information. Relevant data was retrieved through manual searches of bibliographic databases like PubMed, Cochrane and Google scholar. The search incorporated, but was not limited to, the following terms - "Ebola lessons", "Covid-19 preparedness", "health systems resilience", "pandemic coordination", "risk communication", "resource equity", "social determinants of health", "global cooperation platforms" and "pandemic reform strategies".

Selected articles then underwent an in-depth review of their abstracts and full texts by two independent reviewers to assess eligibility as per the objectives. Discrepancies were resolved through discussion with a third reviewer. Only English language papers published from 2014 onwards were considered for review to assure topicality.

Key findings around infodemics, disease dynamics, epidemiological understanding, medical counter-measures, health policies, disease surveillance systems, case management practices, infection control procedures, social and economic impacts as well as lessons learnt from previous epidemics were extracted, organised and analysed thematically. Gaps and challenges affecting outbreak response were also identified. Promising best practices and models that aided containment were additionally noted.

Furthermore, existing pandemic preparedness frameworks by esteemed agencies like the WHO and strategies employed for the current monkeypox outbreak were explored. Available country reports on Ebola, Covid-19 and monkeypox epidemiology, operations and lessons helped assess national capabilities from diverse perspectives.

Based on the review, conclusions were drawn pertaining to prevailing deficiencies compromising preparedness. Accordingly, a consolidated set of technically sound and feasible recommendations were proposed to strengthen health systems, optimise coordination mechanisms, effectively communicate risks, ensure social inclusion and build long term pandemic resilience globally with emphasis on resource-limited regions.

3. Results and Discussions

Level of Global Preparedness to Pandemics and Responsive of Health Systems

3.1. Gaps in Health System Infrastructure and Capacity

Despite advances in global health security, significant gaps remain in health system infrastructure and capacity, particularly in low- and middle-income countries (LMICs). The COVID-19 pandemic exposed weaknesses in even well-resourced health systems, overwhelming hospitals and straining medical supply chains worldwide (Centers for Disease Control and Prevention, 2022a). In LMICs, these challenges were exacerbated by limited healthcare infrastructure, shortages of trained personnel, and inadequate diagnostic and treatment capabilities (Banerjee et al., 2021). The West African Ebola outbreak of 2014-2016 similarly highlighted how decades of underinvestment in public health systems can hamper outbreak response (BBC News, 2021).

To fill these gaps, there is need to scale up investments in health sectors more specifically in the development of PPHC and disease early identification and reporting systems. These will entail ramping up available human resources in healthcare provision, increasing laboratory and diagnostic capabilities and strengthening healthcare facility's emergency preparedness. Moreover, efforts to make strategic stockpiles of critical healthcare instruments and medications to facilitate a country's ability to increase response capacities during exigent situations are also strategic (Alakija, 2023).

3.2. Coordination Mechanisms and Global Health Governance

There is need to have well-coordinated frameworks in preventing and managing the extent of pandemics at national, regional, and global levels. However, the experience of 2020 with COVID-19 showed that the existing frameworks of global health governance and international cooperation are far from perfect. Even in the early days of COVID-19, many governments applied a rather billiard strategy mix consisting of isolated virus containment measures and contradictory national and inter-governmental approaches to acquiring resources (Mukherjee, 2020). The ability and mandate of the World Health Organization (WHO) to direct the international intervention was also brought into the doubt.

Global health governance and co-ordination must be built up to increase effectiveness in combating the threats that are essential for future pandemics prevention. This encompasses defining the functions of such international organizations as WHO as well as defining relations between different organizations as regards sharing information and distributing resources during crises. Multi-country collaborations have been identified from the response of regional frameworks, for instance, Africa Centres for Disease Control and Prevention (Oluade et al., 2020). Thus, the establishment of similar regional structures and improvement of their effectiveness could help strengthen the corresponding results in other countries.

3.3. Surveillance and Early Warning Systems

The existence of hardy health surveillance and prompt warning mechanisms are instrumental in identifying new infectious diseases threats. Nevertheless, such countries fail to develop appropriate surveillance networks, much less at the community level. The slow cue detection of COVID-19 risk for cross-border transmission underlined the requirement for heightened and timely early-warning signs (Lee et al., 2020). Likewise, the first transmission of monkeypox beyond the countries where it is traditional to surface in 2022 also remained unnoticed for a while, which let the virus take root in several countries at once (WHO Europe, 2022).

There is need to improve the surveillance systems across the globe through investment in technology as well as personnel. This includes improving laboratory capabilities for pathogen identification and typing, increasing level of integrated disease surveillance and reporting, and improving knowledge and practice of disease identification and notification among health care providers. Furthermore, Haines et al., (2007) leads that the use of digital and big data could assist in predicting the roots of an emergence earlier. In particular, the surveillance system should be set with an egalitarian approach to include all the vulnerable people who are mostly affected during spread of diseases but are difficult to access, (The Star et al., 2022).

3.4. Medical Countermeasures and Equitable Access

The acquisition and distribution of the medical countermeasures, which include diagnostics, therapeutics and vaccines are other essential aspects of preparedness for pandemics. Thus, while COVID-19 vaccines were developed at an almost unprecedented rate from an initial declaration in mid-January 2020 to a series of Emergency Use Authorizations through October 2021 in the USA, the distribution of vaccines also laid bare the unequal world, (Eccleston-Turner & Upton, 2021). Most LMICs received many vaccines or other essential commodities and surpluses very slowly, which worsened the effects of the outbreak in various LMICs.

To address these pains, there is no one silver bullet for equity interventions. Eccleston-Turner & Upton, (2021) supports this point by explaining that the strategies include building and sustaining the R&D capacity in LMICs, enhancing technological procurement, and providing fair mechanisms of sharing IPRs during diseases outbreaks. ACT-Accelerator and COVAX Facility intended to facilitate equitable access to COVID-19 tools but have been implementational. To plan for something in the future the lessons to be learnt from these experiences should be utilized to developed better mechanisms to support health equity in provision of medical counter measure, (Rodriguez-Morales et al., 2022).

3.5. Community Engagement and Risk Communication

Public engagement and communication about the risks are critical foundations in maintaining the social compliance such measures during an outbreak. Nevertheless, the COVID-19 epidemic and the monkeypox epidemic that began in 2022 can be characterized by misinformation and confusion in the population about threats and the correct precautions.

One of the main problems of recent years is the dissemination of the corresponding information through social networks and other platforms, which has become a great challenge for outbreak management (Borges do Nascimento et al., 2022).

Two of the most important measures for pandemic risk management would be to optimise the existing approaches to risk communication and to enhance the focus on community involvement. This encompasses such aspects as handling cultural sensitivity in the targeting and messaging, identifying key individuals and groups within the community who can be employed in the dissemination of the target health promotion message, and other aspects such as improving the health literacy of the public. Also, the fight against the spread of misleading information, and raising awareness concerning the role of media in the dissemination of health information is vital (Norman & Skinner, 2006). Incorporation of the communities in the formulation of response measures and planning can also assist instill trust besides ensuring that the responses made are culturally appropriate (Matta, 2020).

3.6. Lessons Learned from the Monkeypox and COVID-19 Outbreaks

3.6.1. Importance of Rapid Detection and Response

The SARS-CoV-2 virus outbreak and the monkeypox virus outbreak highlighted the value of early identification of novel infectious disease risks. In both instances, Knight et al., (2020) point out that failure to act meant that the pathogens were allowed the time they needed to spread to multiple countries before effective control measures could be taken. The first few weeks of transmissibility within the epicentre in Wuhan, China and subsequent exportation via international air travel demonstrated the way new pathogens may now spread across the world, (Ren, et al., 2022).

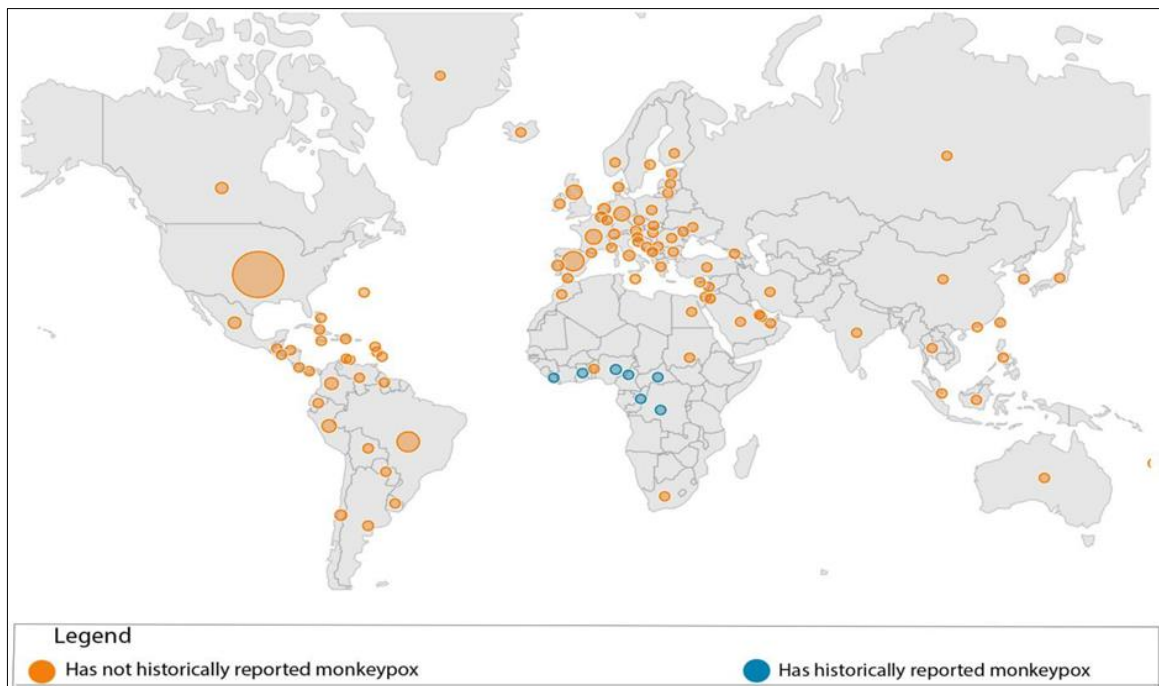


Figure 4 Global Distribution of Monkeypox Cases: Historical and Emerging Patterns (2022): Source: <https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>

This map illustrates the worldwide distribution of monkeypox infections, highlighting countries with and without historical reports of the disease as of 2022. Orange markers indicate nations that have not traditionally reported monkeypox but have detected cases since January 1, 2022. Blue markers represent countries with a history of monkeypox occurrence.

Notably, some locations without prior monkeypox history have reported isolated cases related to travel or animal imports before 2022. For instance, while Ghana lacks a history of indigenous monkeypox cases, it was identified as the origin of wild mammals linked to a 2012 outbreak in the United States. This visualization offers a snapshot of the evolving global monkeypox situation, emphasizing the disease's expansion beyond its traditional endemic regions in Africa. However, it's important to note that this information is subject to updates as the situation develops.

The monkeypox outbreak similarly demonstrated how an endemic disease can rapidly become a global concern when it spreads to non-endemic regions. As shown in Fig. 4 above, the 2022 outbreak saw a predominance of Clade A (formerly West African clade) infections in historically non-endemic regions, contrasting with past outbreaks dominated by Clade B lineages within endemic West and Central African nations. This shift in epidemiology emphasizes the need for flexible and responsive surveillance systems capable of detecting unusual disease patterns, even for seemingly familiar pathogens (Riopelle et al., 2023).

3.6.2. *Addressing Social Determinants and Health Inequities*

COVID-19 and monkeypox outbreaks revealed that social determinants of health as well as existing disparities played a huge role in the way diseases spread and the outcomes of the infected persons. Due to COVID-19, it impacted the racially and ethnically diverse, economically challenged, and less privileged population in terms of access to healthcare. These inequalities stemmed from live density stiff, workplace input, and limited health care and preventive measure access (Dionne & Turkmen, 2020).

The Monkeypox outbreak also demonstrated how prejudice and prejudice can foster the management of several public wellbeing concerns. An early focus on MSM caused negative stereotyping of the LGBTQ+ populace in some places; there is potential that negative attitudes may reduce people from seeking the necessary testing and treatment (Kozlov, 2022). All these experiences underscore the missing dimension in pandemic preparedness— Social Determinants of Health – SDH and the necessity of integrating strategies and interventions that address health inequalities. These comprise appreciating, promoting, and protecting the rights, equality, and dignity of those affected by the diseases, promoting equal access to health care, fostering effective communication in the delivery of services to the communities of interest and the fight against discrimination and prejudice that accompany ailments considered as the renaissance of death (Abubakar et al., 2022).

3.6.3. *Strengthening One Health Approaches*

One cannot deny the fact that the COVID-19 and monkeypox both brought into the limelight the fact that the health of humans, animals and environment are interconnected and therefore One Health needs to be implemented in any epidemic or pandemic preparedness and response. The fact that COVID-19 is expected to have zoonotic origins and the contribution of wildlife trade to the emergence of the virus raised the concern about inadequate supervision of zoonotic diseases and human-animal interactions (World Health Organization, 2019). In the same way, monkeypox outbreak showed that a virus that was previously limited to rodents that live in defined regions of the globe became a planetary problem in a short period.

According to Fig. 4, the monkeypox outbreak in 2022 has also introduced changes in the dispersion of the viral lineages, and here Clade A emerged as the most common in former non-endemic areas. This is quite contrary to the expected results and underscores the importance of the human-animal interface surveillance programs. As the spillover events begin to unfold, there is need to enhance effective OS in the different sectors for public health, animal health and the environment where these spillovers occur, and to ensure that necessary strategies that address the new spillover events are instituted (Zumla et al., 2022).

3.6.4. *Enhancing Global Cooperation and Solidarity*

Both COVID-19 and monkeypox infected the world and both have proven that the world needs to unite and act as one in a fight against infectious diseases. But they also highlighted major obstacles in the integrated management of global actions, and the fair distribution of supplies. In the COVID-19 early years, inadequate supplies of medical equipment, travel bans imposed unilaterally, also did not contribute to global cooperation (Mukherjee, 2020). Reporting on the monkeypox outbreak revealed inequalities of vaccination and treatment on one hand between the high-income countries and on the other hand where the virus was endemics (Bhagavathula, & Khubchandani, 2022).

Said experiences pose the question of the urgency of the need to have enhanced structures of governance in global health, and enhanced systems of sharing and distribution of commodities in cases of emergencies in global health. This includes increasing the establishment of authority and ability of the international organisation such as WHO, Furthermore, the author points out that there is need to clearly define channels through which multinational response to a disaster can ensue and how effective system can be adopted and maintained for sharing of the data, resources and expertise among countries. Furthermore, practical solutions that extend far and wide designed to address long-standing irrationalities in nuts-and-bolts of health research and Development capability between the developed and the developing nations will remain incomplete until all parts of the globe can develop, and fund, and contribute to and benefit from medical countermeasures, (Tusabe et al., 2022).

3.6.5. *Importance of Flexible and Adaptable Response Strategies*

COVID-19 and the monkeypox outbreaks showed that it is essential to have response strategies applicable to changing epidemiology. The ability of the SARS-CoV-2 virus to mutate and evolve quickly and the subsequent release of new variants exhibiting higher transmissibility or the ability to avoid immunity given by the vaccines or previous infections required frequent modification of the measures implemented in controlling the spread of the virus and in the vaccination program implemented (Knight et al., 2020). Likewise, what had been observed with monkeypox virus in the 2022 outbreak represented patterns of transmission that have not been witnessed before and which forced the public health authorities to adjust to a known organism with a new behaviour as depicted in Fig. 3.

SARS and avian flu are good examples to illustrate that 'business continuity' needs to form part of any pandemic preparedness strategies – that is enhancing organisational agility to cope with shocks. This brings up next generation response plans that can quickly be adapted according to newer epidemiologic data, new flexible medical countermeasures production capabilities and trained public health workforces to deal with a variety of possibilities (Bunge et al., 2022). Furthermore, the buildup of the real-time data gathering and analysis capacities can contribute to the improvement of the response intervention preparedness and relevancy. However, response strategies must be developed in line with cultural features but at the same time, the actions should be coordinated at the national and global level (Chua et al., 2020).

Optimizing risk communication strategies

Clear risk communication is central to cultivation of public trust and as well altering people's behavior during previous disease outbreaks. Nonetheless, as per Borges do Nascimento et al. (2022), infodemics greatly hampered the response measures to the Ebola viral disease in 2014 and now continuously harming the COVID-19 response. According to the CDC (2022a) the spread of medical misinformation amplified on the internet accelerated far beyond efforts to debunk such information. This saw those vulnerable due to low health literacy being more misled translating to higher transmission risks. In monkeypox for instance, findings suggest that both facts and myths are trending in social media and the public hence reinforcing the need for effective risk communication to counter myths that may endanger the control of the outbreak as noted by Ennab et al., 2022.

According to Kozlov (2022) and the study conducted by Happi et al. (2022) there are underlying factors that encourage social discrimination against at risk population for monkeypox and this is also a threat for social cohesion and trust in authorities. To this end, there is need for transparent, empathic and contextualised communication to elicit buy-in and make communities adopt factual health information, as proposed by Matta (2020) and Norman and Skinner (2006). This process can be helped by CCAA at local levels as sources of culturally receptive risk communication content and anti-marginalizing attitudes. For instance, Makerere University News (2022) explain how end-user communication influenced the promotion of preventive measures in Uganda.

Furthermore, forming public-private-philanthropic partnerships with notorious technology and social media industries can enhance the spreading of normative narratives and fact-checking capacities to counter health misinformation as Dionne and Turkmen (2020) underlined. Regional health authorities must also harmonise risk communication plans across jurisdictions with a view of disseminating multilingually consistent health advisories. Given that expeditious information flows are pivotal to prevent the transmission of infectious diseases, enhancing different forms, and engaging citizens in the creation of the messages is an opportunity to build a stronger foundation which will allow reducing inequities in managing outbreaks, (Rodriguez-Morales et al., 2022).

3.7. **Equitable access to interventions and care**

As noted by Banerjee et al. (2021) and Tusabe (2022), crucially, pointed out that earlier waves of infectious disease threatened marginalized communities to a greater extent for several reasons, including the ability to obtain means to enhance health outcomes. In relation to the COVID-19 vaccine, poor people in developing countries further underlined the global inequalities of the pandemic, Ritchie et al. (2022). Similarly, shortages of diagnostic and treatment substances in the underdeveloped regions may hinder social justice in monkeypox response as other researchers like Eccleston-Turner and Upton (2021) and Farahat et al. (2022) post.

Coordinated international and national SCM is hence crucial to guarantee all the population groups access to the required services as highlighted by Forbes Africa (2022). Initiatives like COVAX was devised to facilitate collaboration; further, according to Tamang and Dorji (2022) and Rodríguez-Morales et al. (2022) to enhance their functioning, they must be strengthened specifically to enhance the last-mile supply chain infrastructure that supports weak healthcare

infrastructure. For example, participating local physicians in diagnostic ability and contact tracing tools may help in case identification.

Moreover, community involvement 'last mile' prioritization decisions for endangered groups recognizing ethical issue fosters rights-based access as supported by Knight et al. (2020) as well as the UN (2022). It assists in meeting the reset of enduring marginalization barriers hindering the prevention of the outbreak if they are not met. Global cooperation and an alignment of the World Health Organization is needed for equitable vaccination, testing and a care irrespective of gender, place of residence or income status.

3.8. Addressing broader social determinants of health

Amidst these responses, it is usually highlighted that only the biomedical aspects of the outbreak are addressed; the total effects can hardly be resolved without taking socioeconomic factors into account, concerning which the general viewpoint is in unison with the statements of both the CDC (2022b) and Thornton, & Gandhi (2022). In previous pandemic social restrictions, and lockdowns many had their negative health impacts compounded by poor economic security deepening other risks. For instance, Banerjee et al. (2021) documented higher rates of mental health problems among the individuals who lost employment or income which affected the vulnerable groups that lack adequate social insurance. To prevent such disproportionate shares of secondary diseases among populations, one must use comprehensive, population-based, cross-disciplinary approaches that target social determinants.

Based on the WHO (2019) and Gostin (2022)'s recommendation, engaging the different stakeholders such as the health organizations/councils, non-governmental organizations, business entities, and city/shire administrators on measures and projects in communities could build the communities' especial resistance towards subsequent outbreaks. Generally, mechanisms that support enhancements in food security, availability of mental health support, temporary employment, and increase in the social welfare networks that factor local needs can supplement attenuation from outbreak impacts on health and development, (Ennab et al., 2022). Partnerships with long-term focuses with organizations creating custom long-term solutions to remove barriers that are magnified by issues like unemployment, substandard housing, or disrupted education become even more relevant.

Using additionally, participatory research or consultation with those populations affected by disproportional consequences enhances the development of theoretical and practical, culturally sensitive interventions and practical strategies. This, as illustrated by a cross-section of studies by Makerere University News 2022, involves working with the targeted groups in support of programming that promotes human rights and, more specifically, a human rights approach to the dignity of the affected people. It has been mentioned by Tusabe (2022) over and again that only through addressing societal determinants contributing to inequitable burdens can outbreak responses be optimized so that transmission could be halted without exacerbating widening health inequalities.

4. Conclusion

Thus, discussing the previous disease pandemics and the present monkeypox situation, the role of the health systems for the outcomes achieved and the social determinants shall be enforced. Biomedical solutions are still central to the conversation, but these are insufficient in the furtherance of improved containment since containment cannot occur in isolation from other considerations such as coordination, communication, accesses, and the general population vulnerability that worsens contagion risks. Previous practice also shows that if these inequalities are not addressed severe differentiated effects endangering vulnerable groups are the first to be affected. With these experiences in mind, it is possible to strengthen primary healthcare platforms, involve communities, improve Global cooperation mechanisms and remove barriers of access through open supply chains and close capacity shortfalls which threaten resilience. There is also a requirement for coordinated multi-sectoral action to reduce the negative social impacts through specific economic marginalization initiatives. Only an approach embracing social, cultural and economic determinants in addition to epidemiology can present and future outbreak responses put health and human rights for all at the center.

Recommendations

- Strengthen coordination platforms and response governance to facilitate real-time information exchange, streamline research priorities, optimize resource allocation, and ensure consistent guidelines implementation across regions. The WHO R&D blueprint and global monitoring framework requires reinforcing.

- Scale-up frontline health services in fragile contexts by training community health workers, equipping primary facilities for case detection and isolated management, and ensuring uninterrupted access to essential care. Preparedness spending needs increasing and cooperation streamlining supply chains.
- Develop multi-sectoral intervention packages addressing societal vulnerabilities with partners from public, private, nonprofit sectors. Target initiatives at improved food/income security, mental health, education continuity to bolster resilience against disruption risks.
- Foster cooperative research on optimizing context-specific risk communication and trust-building through community participation in message design, delivery and stigma mitigation strategies. Adapt best practices across heterogeneous settings.
- Elevate 'One Health' approach by strengthening human-animal-environmental disease surveillance integration and investigating interaction dynamics to curb future zoonotic threats at the source.
- Institutionalize inclusive participatory action frameworks for outbreak response to respect human rights and dignity. Prioritize equitable access and social participation in resource prioritization, policy-making and programme design.

In summary, lessons from past epidemics coupled with the ongoing challenges of the monkeypox outbreak highlight the pressing need to strengthen collaborative multilateral approaches and health system resilience. Promoting equitable access to resources, risk communication, and social protections aimed at reducing inequities is imperative. Ongoing preparation and evaluation through cooperative action across health and developmental sectors respecting human rights principles holds promise for building sustainable capacity against future inevitable outbreak threats. With adequate investment and commitment driving coordinated, community-engaged preparedness measures globally, the world can work to alleviate disproportionate impacts on vulnerable populations and curb health security risks for all.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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