*Opinion Article*

Lessons from COVID-19 for Future Pandemic Preparedness: Bridging Systemic Gaps in Health Systems and Global Response

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ABSTRACT

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| This opinion article provides a critical review assessing how the COVID-19 pandemic exposed significant systemic vulnerabilities within global public health, leading to critical questions about our collective preparedness for emergent infectious disease threats. It focuses on systemic failures in pandemic preparedness, healthcare infrastructure, and global cooperation. It draws a concerning resemblance reflecting the 'lack of sustained institutional learning' observed following the devastating 1918 H1N1 influenza pandemic. Specifically, we identify pervasive failures in surveillance and response frameworks, highlight the severe and widespread mental health consequences, reveal how the pandemic amplified pre-existing social inequities, and address the apparent susceptibility of healthcare systems exacerbated by chronic underinvestment—a direct consequence of a destructive 'neglect, panic, repeat' cycle in public health funding worldwide. Furthermore, this analysis emphasizes the often-underestimated influence of human behavior and public trust in shaping pandemic trajectories. The paper concludes by advocating for sustained and strong investment in foundational public health infrastructure, the systematic integration of behavioral and social sciences into preparedness frameworks, and transparent, coordinated international collaboration. Incorporating these challenging lessons from COVID-19 is crucial for the scientific and policy communities to build resilience, recognizing that the emergence of the next pandemic is not a matter of if, but when |

*Keywords: Pandemic Preparedness, COVID-19, Public Health Funding*

1. INTRODUCTION

As time progresses post-COVID and our collective amnesia sets in, preventing us from being ready for the next pandemic, the question remains: have we learned anything? A similar pattern followed the 1920s pandemic, the worst acute infectious disease outbreak in modern times, which was caused by the H1N1 influenza virus and emerged in the final stages of World War I. David Patterson and Gerald Pyle estimated the death toll was between 24.7 and 39.3 million[1], while Ian Mills uncovered a death toll of over 21 million in India alone[2]. “More recent revisions by Johnson and Mueller have increased the probable global influenza mortality to between 50 and 100 million”[3]. “Even conservative estimates put the death toll from influenza at over twice that produced by the First World War. Showing us the scale of how catastrophic a pandemic can be, far than wars and other possible dangers facing humanity, yet the resources committed to pandemic prevention and response are a fraction of the resources we commit to security”[4]. In this paper, we aim to critically assess the global response to the COVID-19 pandemic and identify systemic failures in pandemic preparedness and healthcare infrastructure.

2. Emergence and impact of COVID-19

By the end of 2019, the World Health Organization (WHO) became aware of the first cases of pneumonia of unknown etiology in Wuhan, China. A massive global threat has impacted the world, shutting it down, and its effects are still evident in today’s economy, society, and politics. At its peak in January 2021, countries were reporting 100,000 deaths due to COVID-19 per week[5]. Cases surged to 23.5 million per week in January 2022, when the Omicron variant emerged[6].

Since 2020, at least 7 million deaths have been reported to the WHO, although actual mortality estimates are at least three times higher[5]. Now in its sixth year of circulation, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)—the virus that causes COVID-19—continues to evolve and infect people, leading to serious disease, post-COVID-19 condition (also called Long COVID), and death[7]. While COVID-19 continues to pose global health risks, the world simultaneously faces an expanding array of infectious disease challenges, including outbreaks of H5N1 avian influenza, ongoing Mpox (previously known as monkeypox) transmission in Central Africa, and renewed concerns about cholera, dengue fever, and Marburg virus disease. Factors such as climate change and deforestation, which increase contact between humans and animals, are raising the risk of new or reemerging diseases.

The COVID-19 pandemic has also had a profound impact on the mental health of the population, primarily reflected in an increase in cases of anxiety and depression[8]. Studies indicate that the initial phase of the pandemic, particularly with associated confinement measures, led to a clinically measurable rise in levels of psychological stress, as well as anxious and depressive symptoms[8]. However, these levels decreased after six months, though there was considerable heterogeneity in the magnitude of this improvement[8]. In the general population, the most prevalent mental disorders observed during this period were anxiety, sleep disorders, and affective disorders, predominantly depression[9]. Furthermore, there has been a notable increase in suicidal behavior, particularly among young women and men over 70 years of age. An increase in the abuse of alcohol and the use of nicotine, cannabis, and cocaine has also been observed[8].

Certain groups were particularly vulnerable to the mental health consequences of the pandemic, including adolescents and patients with autism spectrum disorders[8]. Healthcare workers, especially those on the front lines during the early stages of the pandemic, experienced an increase in depression, anxiety, and post-traumatic stress. The impact was also more pronounced in individuals with pre-existing mental health problems and those who had contracted COVID-19 infection. Among the population segments experiencing more prolonged effects, individuals with pre-existing mental disorders, disabilities, or those in socioeconomically disadvantaged situations exhibited worse long-term resilience.

3. Gaps in surveillance and response frameworks

COVID-19 showed us how a lack of accurate, real-time outbreak data and an inconsistent science-based response framework can lead to an ineffective response to the pandemic.[10]. Past epidemics such as SARS prompted the World Health Assembly to revise the International Health Regulations (IHR), aiming to ensure member states adhered to detection and reporting standards; however, fulfilling these IHR requirements has seen inconsistent progress, with numerous countries struggling to achieve basic compliance [11]. Later outbreaks, particularly the 2014 West Africa Ebola epidemic, additionally revealed significant shortcomings in timely disease detection, access to fundamental care, contact tracing, quarantine and isolation protocols, and preparedness beyond the health sector, encompassing global coordination and response mobilization[12]. In countries with fragile institutions and political instability, outbreak response measures such as quarantines sparked violence and heightened tensions between citizens and states[11]. There is a need for an international pandemic surveillance and response system, which was called by the WHO[13]. To achieve this. Experts and scientists must develop a global pandemic preparedness and response scheme that is science-based. This global pandemic scheme must be built collaboratively and transparently with international organizations, academia, the private sector, civil society, and citizens for it to be a trusted source of information for public health decision-making. Such a framework should prioritize cost-effective interventions, including investments in foundational public health infrastructure like water and sanitation facilities, enhancements in immediate situational understanding, and the control of new health risks

4. Social Consequences and the Exacerbation of Inequalities (ELSI Perspective)

The COVID-19 pandemic exposed existing health inequities, defined as "unfair or unjust inequalities. These avoidable disparities significantly impacted viral exposure, vulnerability, and consequences, primarily stemming from differences in social determinants like income, gender, and ethnicity[14]. Lower-income groups, often in crowded areas, faced higher incidence and mortality risk, while Gender roles led to higher male mortality, while women experienced increased caregiving burdens and unemployment[14]. Ethnic minorities were disproportionately affected. For instance, the pandemic led to significantly higher rates of illness and mortality among people of color, with Black and Hispanic communities experiencing a threefold greater reduction in life expectancy compared to White individuals[15]. Beyond mortality, specific communities faced exacerbated mental health challenges; in April and May 2020, Hispanic respondents reported significantly elevated rates of depression (40.3%), suicidal thoughts (22.9%), and increased substance use (36.9%)—figures notably higher than those seen in their White counterparts[16]. These groups also expressed heightened concerns about food security and housing stability. The healthcare system worsened access for marginalized communities. Addressing this requires recognizing health inequities as central and integrating health into all policy decisions, supporting vulnerable populations with measures like food security and unemployment insurance. Effective policies must prioritize high-risk groups and be evaluated on equity criteria.

5. Healthcare system vulnerabilities and funding cycles

“The COVID-19 pandemic has negatively affected almost every economic and social sector in countries all over the world. The most affected sector by the pandemic, by a large margin, was healthcare”[17]. Hospitals were quickly overwhelmed by COVID-19 patients, severely stretching their resources and capacities, leading to the closure of many services and interruption of care to patients with other conditions. For instance, in the Kurdistan Region of Iraq, surgical practice was severely impacted, with approximately 60% of surgeons undertaking only emergency surgeries and a widespread cancellation of scheduled and elective procedures to prioritize preparedness for high volumes of COVID-19 patients[18]. This reallocation of resources and operational shift also led to a significant reduction in medical residents' training activities, with surgical specialties reporting a nearly 83% decrease in surgical exposure and operations[18].

COVID-19 showed that not just low-income countries but all countries were not adequately prepared to deal with a pandemic of this magnitude, as illustrated by problems such as mask shortages, inadequate availability of ICU units and hospital beds, and limited stocks of critical drugs and pharmaceutical products[19]. The surge in inappropriate human albumin solution (HAS) use during the COVID-19 pandemic further strained healthcare resources and underscored system vulnerabilities in evidence-based medication governance amid crisis conditions[20].

The global response to COVID-19 exposed our fragility and weaknesses in healthcare systems worldwide. Therefore, there is a critical need to revisit the concept of “pandemic preparedness” as COVID-19 has exposed the vulnerabilities of health systems in both developed and developing nations.

Pandemic preparedness refers to planning activities taken in a country to reduce the transmission of the pandemic strain, decrease the number of cases, hospitalizations, and deaths, maintain essential services, and reduce the economic and social impact of the pandemic. Traditionally, pandemic preparedness has been mainly evaluated through checklists, document analysis, and expert views [21] . It involves analysis of countries health system strengths and weaknesses to determine its degree of preparedness for the next pandemic, assessing the readiness of the healthcare sector and other public health entities to deal with pandemics.

Unfortunately, preparing for the next pandemic is increasingly challenging, notably due to a significant decline in public trust in medical professionals and institutions, a trend exacerbated by the politicization of public health during the COVID-19 pandemic. This has led to systemic cuts to public health funding during peacetime, creating a more vulnerable and dangerous environment[22]. This represents what experts call the "neglect, panic, repeat" cycle—chronic underfunding followed by reactive emergency spending during crises[23]. In the USA, the CDC’s budget decreased by 27% over a decade, from $10.88 billion in 2010 to $7.97 billion in 2020[24]. Additionally, public health prevention and emergency preparedness funding declined from $3.00 billion in 2011 to $2.73 billion, a 9% reduction during a critical period for pandemic preparedness[24]. The Hospital Preparedness Program (HPP), the only source of federal funding for healthcare system readiness, experienced a catastrophic decline of more than 50%, from $498 million in 2003 to $227 million by 2018[24]. Over the past 18 years, funding for the Public Health Emergency Preparedness (PHEP) program—the main federal support for state public health and emergency response—has been cut by 30%[24].

The impact of public health emergencies shouldn’t be overlooked. Since 2003, HPP funding has been reduced by more than 50%[24], creating significant obstacles in its ability to support the healthcare system during periods of emergency. And those reductions were not unique to the USA, the public health services budget saw a 26% real-terms reduction between 2014-2016, with disproportionate impacts on the most deprived areas and cuts to crucial preventive services like weight loss and smoking cessation[25]. Countries in Europe, particularly those affected by austerity measures, experienced deep cuts in public health spending that exacerbated suffering. For instance, Catalonia, Spain, reduced its healthcare budget by 10% and closed numerous hospital beds and health centers post-2011, while Greece witnessed a 40% reduction in hospital budgets despite rising admissions, with overall health spending plummeting from $25 billion in 2010 to $16 billion in 2011, Even in Australia, public health spending in Queensland, for example, decreased from a pandemic high of 3.9% of total expenditure in 2021-22 to 2.1% in 2022-23, remaining below the recommended 5% by professional health organizations[26]. Such devastating mortality figures and the continued decline in public health funding in many nations create significant obstacles to supporting healthcare systems during future emergencies.

6. Integrating Behavioral and Social Sciences

“Based on the experiences gained during the COVID-19 pandemic, it can be concluded that human behavior has been a critical factor, given the direct link between the observed risky behavioral patterns and the high transmission rates during the pandemic”[27].

While resource allocation is critical, it is equally important to incorporate social and behavioral perspectives into preparedness, perceptions, and individual views on how they would prepare to respond to pandemic prevention and control measures. This is known as attitude. Which is defined as a person’s positive, negative, or neutral evaluation of a certain idea, object, or person, and the tendency to behave in a certain way per that evaluation[28]. “It has been observed that when individuals perceive pandemic preparedness to be strong and adequate, they’re more inclined to trust public health authorities and adopt recommended preventive actions such as regular handwashing, mask-wearing, social distancing, or lockdown measures, and accept vaccines”[27,35].

Conversely, if people judge the healthcare system to be ill-prepared, unable to protect individuals from infection, and under-resourced to provide necessary care, this perception generates heightened worry and fear (negative attitude), leading to a significant drop in care-seeking behavior[27]. This dynamic was exemplified during the COVID-19 pandemic, where vaccine hesitancy emerged as a major challenge to epidemic control. Vaccine acceptance rates varied widely across regions, notably in the Middle East/North Africa (MENA), Europe, Central Asia, and Western/Central Africa, underscoring the influence of public trust and perception on adherence to critical health interventions[29].

Despite the crucial role of behavior in pandemic preparedness, earlier research largely ignored behavioral factors, focusing instead on the internal preparations and planning activities undertaken by healthcare services and public health entities.

Attitudes toward the health sector and perceived quality of services during a pandemic also shape the broader image of the healthcare industry at the national level[30]. If the public views pandemic management as ineffective, non-compliance with recommendations may rise, producing adverse outcomes. Conversely, an overly optimistic perception of preparedness relative to actual readiness can create a false sense of security, fostering complacency, risky behavior, and further non-compliance among individuals[30].

7. Global cooperation in pandemic prevention

There is also a strong need for countries to work together to achieve effective pandemic prevention via transparent, rapid data sharing and coordinated international cooperation in public health emergencies, yet critical gaps remain in our understanding of COVID-19’s origins because full datasets on the earliest cases including animal trade records from Wuhan markets and coronavirus research conducted in regional laboratories have not been made available despite repeated appeals from the World Health Organization[31]. This undermines phylogenetic and ecological analyses needed to trace COVID-19, to detect and thwart future zoonotic threats at their emergence. To address these critical surveillance and communication gaps, a new evidence-based framework for SARS-CoV-2 variant classification is needed to reduce public alarm, guide rational policymaking, and support durable public health responses as the virus continues to diversify[32].

This highlights a critical vulnerability in global health security, as the effective tracing and prevention of zoonotic diseases heavily rely on robust surveillance systems, particularly in resource-limited settings. However, it faces a significant challenge in establishing effective surveillance systems is enhancing data integration. In many countries, data related to disease outbreaks, surveillance, and mortality/morbidity reports are fragmented[33]. “Vital registration systems often operate in isolation from healthcare systems, leading to substantial gaps in understanding disease patterns and their real-world impacts. Furthermore, data concerning animal trade are frequently inadequate and unreliable. There are often deficiencies in critical information such as the species involved, trade volumes, trade routes, and long-term trends in both legal and illegal, national and international trade of domestic animals and wildlife. This lack of comprehensive monitoring and surveillance of wildlife trade significantly elevates the risk of zoonotic disease emergence, as exemplified by the transmission of the monkeypox virus from Ghana to Texas via the pet trade involving pouched rats”[34]. Therefore, strengthening the integration of data systems and improving reporting mechanisms and monitoring efforts for both domestic and wildlife trade are essential to mitigate the risk of zoonotic disease transmission and foster a more holistic understanding of disease dynamics.

8. Conclusion

The COVID-19 experience has exposed critical weaknesses in our health systems—gaps in real-time surveillance, uneven funding, and a lack of behavioral insight into public response. Addressing these deficiencies will require investing in continuous monitoring networks, ensuring stable funding streams for public health infrastructure, and incorporating social and behavioral research into preparedness plans. At the same time, sustained international collaboration, through transparent data sharing and joint research, remains essential for early detection and containment.

Aligning policy decisions, resource allocation, and community engagement around these priorities will strengthen our resilience and better prepare us for whatever emerges next. The legacy of COVID-19 must not be defined solely by pain, loss, and disruption. Rather, the experience is fraught with lessons that the world should not waste. The question of the next pandemic is not if, but when.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The author(s) declare that no generative AI technologies, such as Large Language Models (e.g., ChatGPT, COPILOT) or text-to-image generators, were used during the writing or editing of this manuscript.

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