



ADAPT – PROTECT – CONNECT

# THE CHANGING FACE OF PANDEMIC RISK

2024

The changing face of pandemic risk: 2024 GPMB pandemic risk report

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# Foreword

The 21st century has brought an undeniable surge in global health threats. Our reality is no longer one where pandemics are rare shock events but where they pose a constant, real danger. These threats present far-reaching and complex challenges, as highlighted by the recent spillover of H5N1 to humans and the unfolding mpox outbreak. These events are clear warnings: the world must act now to prevent future pandemics from catching us unprepared. Our responses must be informed by a deeper understanding of the social, economic, and environmental forces that drive pandemics, along with the patterns of disease spread.

This report from the GPMB is a call to action for global leaders, policy-makers, health professionals, and communities. It outlines the key drivers of pandemic risk and provides a roadmap for strengthening our defences. We live in an interconnected world where urbanization, increased mobility, changing land use, and deforestation have created fertile conditions for pandemics to emerge and spread rapidly. The shifting interface between humans, animals, and the environment, coupled with climate change, is amplifying these threats. Ignoring these realities is no longer an option.

We already have the tools to respond – advanced technologies, improved surveillance systems, and the potential for stronger global cooperation – but these tools will only be effective if we use them proactively. Trust is the linchpin. Without trust, our efforts will fail. Misinformation will spread, public health measures will be ignored, and collaboration will break down. Building trust means acting with transparency, sharing information openly, and ensuring equitable access to pandemic countermeasures. Trust must be prioritized as a cornerstone of pandemic preparedness.

Equity is also non-negotiable. The COVID-19 pandemic exposed glaring inequities in global health systems. Wealthy nations secured vaccines, treatments, and protective equipment, while many others were left behind. This cannot happen again. We must ensure that everyone, regardless of their location, social standing, or economic status, has access to life-saving interventions. Equity is not just a moral imperative; it is a practical necessity for global health security.

This report lays out a clear framework for action: adapt, protect, and connect. It is based on the GPMB's comprehensive assessment of the full range of pandemic drivers. We must adapt to the evolving nature of pandemic threats. The next pandemic will be different from the last, and our responses must be flexible and forward-looking. We cannot simply prepare for the last battle – we need to anticipate new and evolving risks.

We must also protect our health systems and communities by building resilience. Strengthened health infrastructures, more robust social safety nets, and aligned global and regional health systems are crucial defences against the inevitable risks of future pandemics.

Finally, we must connect the dots between health, the environment, and society. Cross-sector collaboration, especially at the intersection of human, animal, and environmental health, is critical. The next pandemic could well arise where these interactions are most intense. Coordinated action, holistic responses, and shared resources are the connections that will enable us to confront pandemic risks head-on.

We have the choice to build a safer, more resilient future. Let us not wait for the next pandemic to remind us of what is at stake.

The path forward is clear – the time to act is now.



**Ms Kolinda Grabar-Kitarović**  
GPMB Co-Chair  
and former President  
of Croatia



**Ms Joy Phumaphi**  
GPMB Co-Chair and  
former Minister of Health  
of Botswana

# Executive summary

## **The changing face of pandemics**

Global interconnectedness and mobility have driven the increase of pandemic risk in the 21st century. Outbreaks of avian influenza H5N1 in cattle and its spillover to humans, and a new strain of mpox in Central Africa are the most recent signals of concern. The high likelihood that they will spread further should be a wake-up call for the global community.

While global pandemic response capacity is better than ever, with improved surveillance coordination and national capacities, the world nevertheless remains acutely vulnerable. Without proactive measures that identify and rectify vulnerabilities, we run the risk that the next pandemic will again catch us unprepared.

In order to future-proof preparedness, the GPMB has undertaken a review of fundamental pandemic risk drivers to highlight the most effective and urgent pathways to making the world safer.

The emergence and spread of pathogens are not random events, but arise from ecosystem change. The rapid spread of diseases in highly mobile populations is exacerbated by urbanization and international trade. The increased volume and changed patterns of trade in animals and animal products contribute to the spread of animal pathogens. Digital connectivity has positively transformed disease surveillance and health emergency response, but comes with risks, including the spread of misinformation and disinformation. Artificial intelligence (AI) amplifies both the opportunities and the risks of the digital transformation. These risks to pandemic preparedness and response need to be managed by ensuring that enhanced and equitable digital technology access is accompanied by regulatory frameworks that align with ethical and public health principles, and promote cybersecurity.

## **Trust: an asset in pandemic response**

Trust and mistrust are at the centre of pandemic response but have not yet received the sustained policy and scientific attention they deserve. Lack of trust can drive both the emergence of novel viruses and the amplification of outbreaks, by undermining compliance with control measures and incentivising secrecy rather than transparency.

Trust between countries enables stronger international collaboration and cooperation at global and regional levels. Amendments to the International Health Regulations (IHR) (2005) adopted by World Health Organization (WHO) Member States in 2024 have helped to build trust, highlighting the global community's willingness to rise above competing interests for the sake of enhanced mutual health security.

### **The One Health approach to preventing pandemics**

Risks of disease outbreaks in animal populations and increased likelihood of spillover are driven by high animal density in industrial farming, changing environments in smaller-scale farming, and unregulated wildlife trade. Increased disease surveillance, effective regulatory regimes, and better protection and training of farmers are needed to mitigate these risks.

Climate change — along with land-use changes, deforestation and reforestation, loss of habitat and changes in water ecosystems — also impacts species distribution, migration patterns and the ecology of pathogens, disrupting current natural host-pathogen dynamics.

Places that have a dense human—animal—environment interface and are undergoing rapid change are ripe to become new hotspots of emergence of novel diseases with epidemic potential. Soon temperate countries may see outbreaks of diseases that are usually seen in tropical areas, such as epidemics transmitted by mosquitoes, including dengue or yellow fever.

### **Maximum security comes from maximum equity**

Equity is the cross-cutting factor that makes or breaks pandemic preparedness and response. Inequity creates the ideal conditions for new outbreaks and exposes all countries, regardless of their wealth, to devastating epidemics and long-term economic, social and political impacts.

Inequitable access to countermeasures scars global solidarity. The COVID-19 pandemic highlighted stark inequities in access to life-saving interventions, not only vaccines but also products such as rapid diagnostic tests, oxygen extractors, and personal protective equipment (PPE). The unfolding mpox public health emergency runs the risk of repeating all the mistakes of inequitable pandemic response.

Violent conflicts are exacerbating insecurity. Such conflicts are at their highest level since the Second World War, affecting about 2 billion people, with more than 117 million displaced from their homes in 2023.<sup>1,2</sup> Conflict situations delay the detection, response to and containment of infectious disease, as exemplified by the mpox outbreak in the Democratic Republic of Congo (DRC) or the polio cases in Gaza. The killing of health care providers during armed conflicts also undermines the most vital of capacities.

### **Pandemics and the fourth industrial revolution**

Biomedical innovations are crucial for faster and more effective epidemic and pandemic preparedness and response. Research into both pathogen-specific and pathogen-agnostic tools is essential to develop higher quality, more effective measures.

Effective response to health crises relies on a seamless end-to-end process. This includes research and development, testing, manufacturing, regulation, supply chains, and delivery. Addressing gaps at any point in this process is crucial now to avoid deepening inequities and increasing global vulnerability. Strengthening the global health architecture, including through an equity-promoting Pandemic Agreement, will help ensure that biomedical innovations are accessible and effective during crises, reducing vulnerabilities and enhancing resilience.

Effective governance in pandemic and epidemic preparedness and response requires transparency, inclusiveness, equity, flexibility and learning. Whole-of-society and whole-of-government approaches are key determinants of good responses.



## Retooling preparedness for new pandemic realities



### 1. ADAPT

The next pandemic will be different from the last, therefore responses must be adaptable to changing local, national and global contexts. There is a risk that focusing solely on lessons learned from the COVID-19 pandemic could result in preparing for the last battle rather than the next one.

Agile planning requires the capacity to sustain response efforts while addressing an evolving set of risk drivers and managing multiple crises.

**Every country requires a pandemic risk driver assessment, and each region should conduct a region-wide assessment. Preparedness plans at both national and regional levels should be adapted accordingly.**

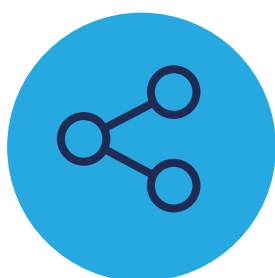


### 2. PROTECT

Many pandemic risks cannot be easily or rapidly mitigated. Countries therefore need increased protection.

Holistic systems approaches to protection are needed to boost resilient and capable health systems that articulate with social protection. They require support from the global and regional health and financing architecture, which needs to be aligned to increase capacity to prevent outbreaks and forestall amplification.

**Four critical protective shields need to be enhanced: health system resilience, international collaboration, social protection, and safeguards against accidental release of dangerous pathogens and other biotechnological risks.**



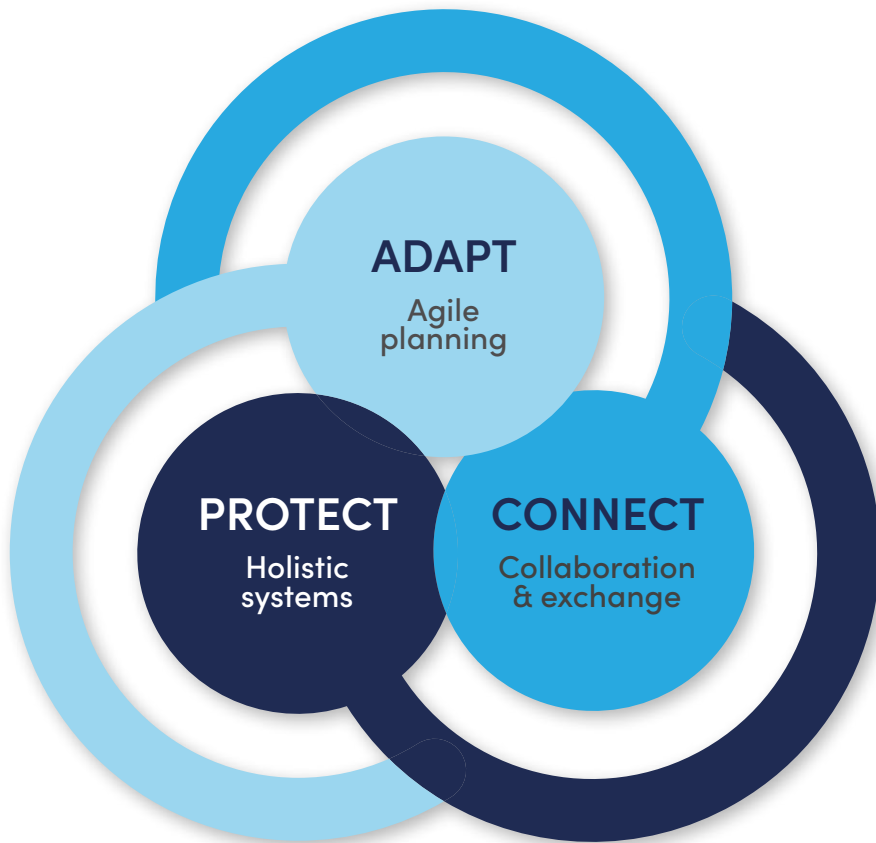
### 3. CONNECT

The risks attached to increasing planetary connectivity need to be mitigated by better supported intersectoral efforts. Stronger collaboration and exchange between the health and environmental sectors can orient investments towards win-win solutions for both sectors.

One Health approaches reduce the risk of emerging zoonotic diseases at the human–animal–environment interface. They are especially critical in emergence hotspots, where concerted efforts are needed to address underdevelopment, inequities, social protection, and the strengthening of primary health care. Better metrics are needed to define hotspots of emergence and to pinpoint the risks and solutions related to human–animal–environment dynamics.

Investing in whole-of-society approaches and more inclusive pandemic preparedness and response is crucial to addressing the complexity of pandemic risk drivers.

**Specific financing at scale for cross-sectoral collaboration, including the implementation of One Health approaches, is essential. It will accelerate solution-finding at the interface of the multiple sectors that are implicated in pandemic risk, and enable pandemics to be addressed in their full complexity.**



### **Conclusion**

The next pandemic will likely be different from the last, requiring adaptive, innovative and inclusive approaches to preparedness and response. The global community must invest in equity, trust building, and collaboration to ensure effective responses to future health crises. By addressing the complex interactions between humans, animals and the environment, the world can better prepare for and mitigate the impact of future pandemics.

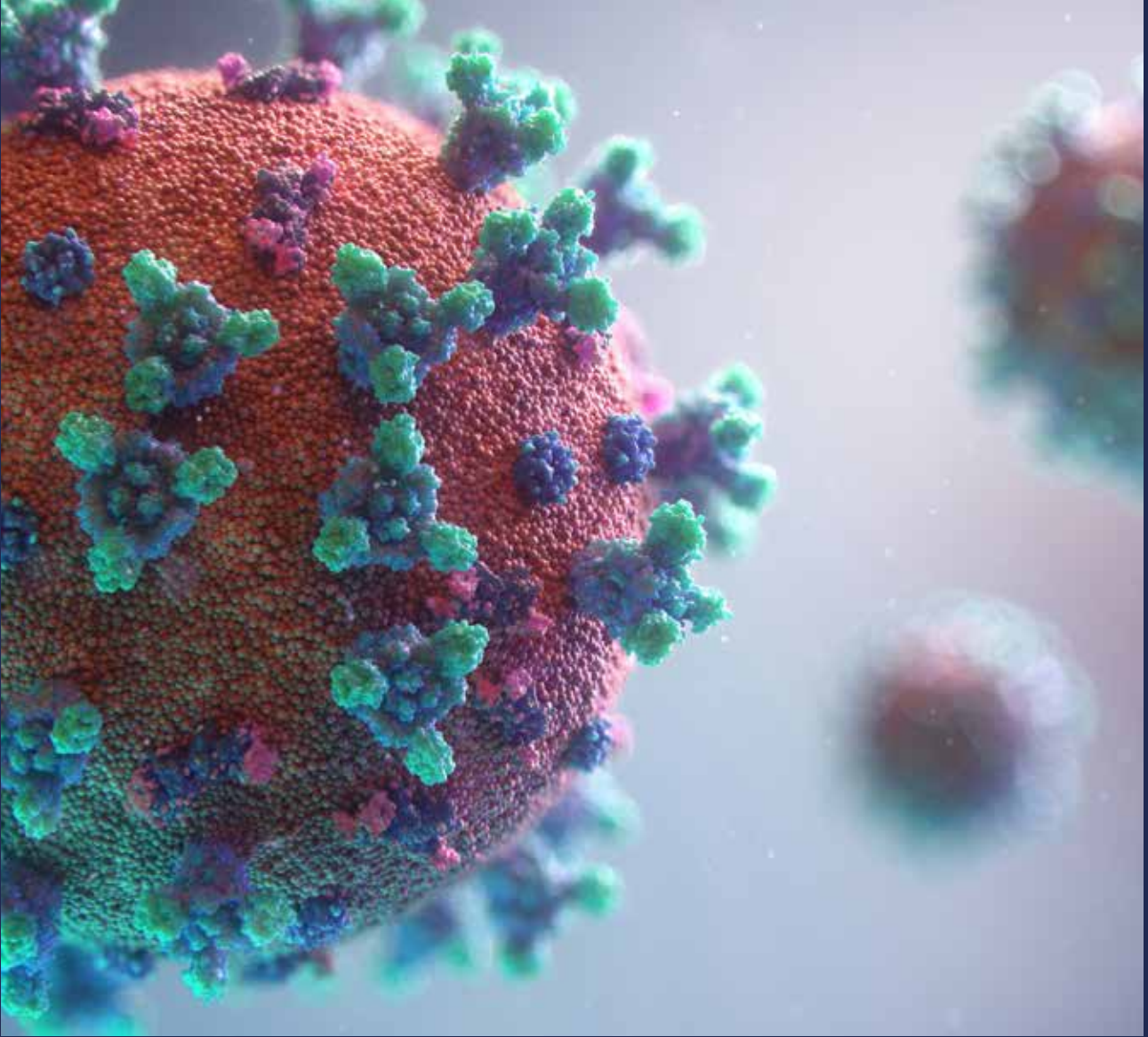


Photo credit: Unsplash

# Introduction

**The 21st century has seen escalating pandemic risk due to increasing human interconnectedness and mobility, which facilitate the rapid transmission and geographic spread of epidemic diseases.**

This is compounded by changing patterns of life and the ongoing encroachment of human activities into natural environments, which are altering the global risk landscape and making the emergence of new pathogens more likely.

In the 21st century, epidemics are therefore more likely to occur, spread more rapidly and have a higher impact on a globalized economy. The world needs to be prepared to face multiple concurrent epidemics, requiring national and international planning and preparedness for protracted epidemics, and sustained responses.

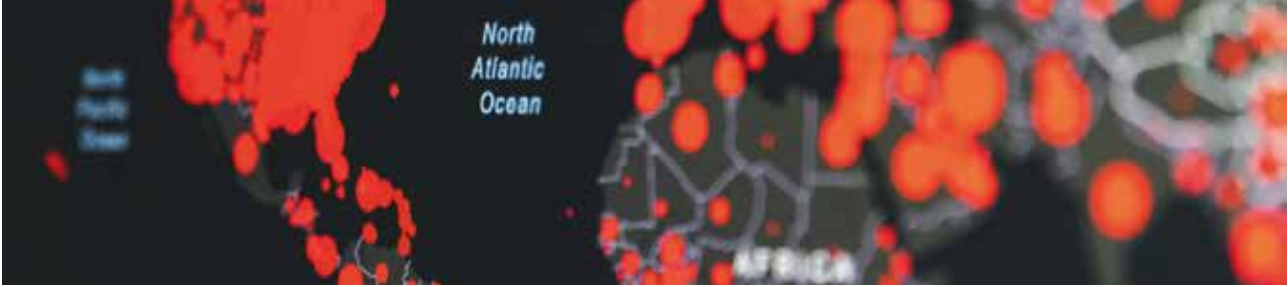


Photo credit: Martin Sanchez on Unsplash

“Pandemics are no longer confined to public health – they are shaped by every facet of our society, from the interface with the environment and climate change to digital infrastructure. To be truly prepared, we must acknowledge and address this interconnected complexity.”



Ms Kolinda Grabar-Kitarović,  
GPMB Co-Chair

The recent spread of avian influenza H5N1 in cattle and its spillover to humans, and the emergence of a new strain of mpox in East Africa with a high likelihood of global spread, are a pandemic wake-up call. These diseases need to prompt increased and more effective investment in preparedness and an acceleration in international collaboration to guard against and respond to new threats.

Humanity is better equipped than ever to contain outbreaks at source; it has better medical interventions that can reduce morbidity and mortality, and is better organized to respond through international frameworks such as the International Health Regulations. Despite these improvements, made in the wake of the COVID-19 pandemic, there is every likelihood that the next pandemic will again catch the world napping, without the readiness plans primed for implementation from day one.

When and where the next pandemic will emerge and how it will spread is uncertain, and its driving pathogen or other threat, is unknown. In the face of uncertain threats, prevention efforts need to be geared up to reduce the likelihood of a new pandemic. If a pandemic does emerge, responses must be crafted rapidly, scaled up and delivered where needs are greatest, and have the capacity to gather intelligence and reshape countermeasures in the face of incomplete and uncertain knowledge.

In the face of the inevitable ‘fog’ of the next emerging pandemic, the importance of preparedness cannot be overstated. It is the essential infrastructure to ensure that we can fully utilize our existing tools and strategies to mitigate pandemic impact and protect global health. The challenge therefore is to sustain preparedness efforts that focus not on fighting the last battle, but that instead anticipate what type of threat will come next, where vulnerabilities are deepest, and what strengths can be built up now.

Already this century a series of outbreaks has underscored the world’s vulnerability to epidemics and pandemics, including SARS, MERS, the 2009 influenza pandemic, Ebola in West Africa, yellow fever in Angola and the DRC, cholera, Zika, plague, COVID-19 and mpox, along with the continuing prevalence of HIV/AIDS. These outbreaks have demonstrated that the 1960s optimism that wealth and antibiotics would eradicate infectious disease in all but the poorest countries was sadly misguided. The singular achievement of smallpox eradication in 1978, and pathways to eradication of other diseases, are beacons of hope in reducing the global disease burden. But for all these triumphs, novel pathogens have continued to emerge, posing new and additional challenges to global health. No country, regardless of wealth or development, is immune to the impact of infectious diseases.

Epidemics and pandemics will continue to occur. In order to future-proof preparedness, the GPMB has undertaken a review of fundamental pandemic risk drivers to highlight the most effective and urgent pathways to making the world safer. They take account of lessons learned from COVID-19, and the changing global context shaped by the ongoing technological revolution and the overarching pressures of climate change.

The recommendations developed by the GPMB are intended to support a critical appraisal of preparedness in this new world. Vigilance and adaptability are the core skills that will enable the global community to manage the epidemics of the 21st century and the evolving and complex dynamics of risk.

# 1






## The pandemic risk landscape

**Pandemics are complex phenomena that require a holistic and systemic approach, extending beyond health sector analysis.**

Based on its Monitoring Framework, the GPMB has developed an analysis of 15 key drivers that are increasing global pandemic and epidemic risk levels, either by driving the emergence of pathogens or by amplifying outbreaks into epidemics and pandemics, or both. These drivers are processes or conditions that influence the level of risk by increasing levels of exposure and vulnerability, or reducing capacity.

**The 15 drivers are grouped into five categories:** social drivers, technological drivers, environmental drivers, economic drivers and political drivers (the STEEP approach). The technical report *Expanding pandemic risk assessment* accompanying this report presents the analysis of each of the STEEP drivers and further details on the methodology used.

**Figure 1.** 15 STEEP drivers of pandemic and epidemic risk and their mechanisms of action

		Exposure/vulnerability to pandemic (virus emergence and amplification)	Reducing capacity to respond
<b>SOCIAL</b> 	Social inequity	✓	✓
	Individualism		✓
	Global movement	✓	
<b>TECHNOLOGICAL</b> 	Digital connectivity		✓
	Misinformation		✓
	Biomedical innovation		✓
<b>ECONOMIC</b> 	Economic development	✓	✓
	Economic inequality	✓	✓
	Social programmes		✓
<b>ENVIRONMENTAL</b> 	Climate change	✓	
	Agricultural practices and farming	✓	
	Cities	✓	✓
<b>POLITICAL</b> 	Governance		✓
	Trust		✓
	Conflict and instability	✓	✓

Source: GPMB

Analysis of the outbreaks in the 21st century shows that the interaction of these drivers is complex, very context specific, and takes place over long periods of time. The action of these drivers, however, is often what makes the difference between a small zoonotic outbreak and a pandemic.

Drivers often amplify one another to create a unique situation of vulnerability, which may change rapidly depending on the nature of the pathogen; the inherent characteristics of a population; or global, regional or national developments, such as a sudden conflict or disaster, or changes in the political or economic environment.

**Box 1. Pandemic drivers that influenced the emergence and spread of influenza H5N1****DRIVERS****1997**

In 1997 the H5N1 influenza virus, which had only been previously found in birds, began to infect humans in Hong Kong, causing 18 cases and six deaths. These cases were linked with markets housing live chickens. Families in Hong Kong would shop regularly in these markets, which are located in the most densely populated areas of Hong Kong, facilitating wider spread and threatening a large-scale outbreak. The outbreak was contained when the authorities slaughtered all poultry in Hong Kong. Subsequently, Hong Kong implemented a new system to manage live poultry markets, including the prohibition of the sale of aquatic birds and weekly market closures for disinfection.<sup>3,4,5</sup>

**2003**

In 2003 the H5N1 virus re-emerged in China and across Asia, causing clusters of cases, including in domestic backyard poultry in rural environments. Domestic poultry is an important source of income and food in many rural communities. In Vietnam, close to 17% of the nation's stock were either culled to stop the spread of the virus or died from the disease.<sup>6</sup> This represented a major cost to vulnerable farmers, who bore the brunt of the economic toll of about 0.5% of Vietnam's GDP, or US\$250 million.<sup>7</sup> The outbreak put considerable pressure on the health care system in Vietnam as it struggled to test, treat and vaccinate patients.

**2007  
–2009**

In 2007-2009, cases were detected in Egypt in urban settings. Domestic birds raised by families on rooftops were being infected due to contact with migrating wild birds. These outbreaks caused close to 200 cases in humans.<sup>8</sup> The government implemented a campaign of culling but faced the challenge of identifying and managing this type of 'backyard farming'. Individuals often do not report infected birds for fear of losing an important source of income. Compensation schemes and poultry vaccination campaigns were instrumental in containing this outbreak.

**2009**

The emergence of an H1N1 influenza pandemic in humans in 2009 surprised many, since most of the focus had been on the H5N1 virus. However, due to preparedness efforts to prevent the spread of H5N1, many countries were better prepared to respond to H1N1. The H1N1 pandemic did however highlight inequities in access to vaccines and other medical countermeasures. H5N1 has continued to circulate and has been intensively studied. Gain-of-function studies conducted by researchers since 2012 to better understand the virus and improve public health interventions have raised concerns with many in the scientific community about biosecurity risks and the possibility of an accident that would lead to the virus being better adapted to humans.

**2022**

More recently, the H5N1 virus has been causing cases globally, reaching South America at the end of 2022, through the movement of animals in the air, on land and in the seas. The co-habitation of wild birds and sea lions has led to mutations in the virus that make it more fit to infect mammals, and therefore a greater threat to humans. The virus is now circulating widely in cattle in the United States and has already caused at least nine human cases. This has important implications for the food and dairy industry, which must now take urgent action to protect farm workers and mitigate the economic cost of the outbreaks. The response to H5N1 has been challenging due to the lack of federal testing requirements for cattle, and difficult coordination across US states and between the agriculture and health sectors. The legacy of mistrust left by the COVID-19 pandemic has also made farmers less willing to trust government authorities.

**2024**

So far, there has not been sustained human-to-human transmission of H5N1. This may be because the virus has yet to adapt sufficiently. However, it is also likely due to surveillance vigilance and swift action that has been taken to implement interventions. Between the emergence of H5N1 in 1997 and July 2024, there have been 912 human H5N1 cases reported in 24 countries, about half of which have been fatal.<sup>9</sup> Unless urgent action is taken to quell the current explosion of cases in cattle and poultry, this toll will accelerate.

**SOCIAL DRIVERS****TECHNOLOGICAL DRIVERS****ENVIRONMENTAL DRIVERS****POLITICAL DRIVERS**

## Box 2. Mpox case study: analysing pandemic drivers

### DRIVERS

Mpox is a zoonotic disease. The primary animal reservoir for mpox is believed to be certain species of rodents and small mammals. Although the exact reservoir is not definitively known, several animals have been identified as potential hosts. While mpox can affect monkeys and apes, they are not believed to be the primary reservoir, but rather incidental hosts – hence the former name ‘monkeypox’.

Most human outbreaks have historically been linked to contact with infected animals, particularly in rural parts of Central and West Africa, where close human–animal interaction is common. This highlights the environmental driver related to agricultural and farming practices.

### The first wave: clade II in non-endemic regions

The initial wave of mpox in 2022 predominantly affected non-endemic regions in Europe and the Americas, primarily involving clade II of the virus. This outbreak had distinct epidemiological characteristics.

The outbreak was largely driven by close physical contact, particularly during sexual activities. The primary affected group was men who have sex with men (MSM), with over 95% of cases in this population.<sup>10,11</sup> The majority of those affected were healthy adult males. The few fatal cases were observed in people with immunosuppression due to HIV infection (mortality was inferior to 0.1%).<sup>12</sup>

This wave spread rapidly through international travel and large social gatherings, such as festivals and parties, illustrating the social driver of global movement. This marked a shift in the disease’s epidemiology, from zoonotic transmission in rural African settings to human-to-human transmission in highly mobile, urban populations. This wave affected 116 countries in all regions of the world.

In response, public health measures, such as targeted communication campaigns and testing facilities, were quickly deployed in Europe and the Americas, aided by strong technological drivers, such as digital connectivity and biomedical innovation. Even before vaccines became widely available, these efforts helped the MSM community to reduce transmission rates.

### The current outbreak: clade I in Africa

The ongoing outbreak, driven primarily by clade I of the virus, presents a different epidemiological picture and poses unique challenges in African countries, particularly in eastern DRC and Burundi.

Unlike the first wave, the current outbreak in Africa involves a broader range of transmission modes, including zoonotic transmission, close non-sexual contact, and even household transmission. Children, pregnant women, and individuals with compromised immune systems (such as those with HIV) are particularly vulnerable to severe outcomes. The mortality ranges from 0.6% to 1.8% and can rise to 10% in young age groups.<sup>13</sup> The limited access to tests is a challenge for precise epidemiological analysis. However, this represents a stark contrast to the predominantly adult male demographic of the first wave, underscoring the differing transmission dynamics in African settings.

2022

2024



SOCIAL DRIVERS



TECHNOLOGICAL DRIVERS



ENVIRONMENTAL DRIVERS



POLITICAL DRIVERS



**Box 2 continued.** Mpox case study: analysing pandemic drivers**DRIVERS****2024****Drivers of the current crisis**

The ongoing response to the clade I outbreak in Africa faces significant challenges:

**Limited access to medical countermeasures:** Vaccines, tests and treatments remain scarce across the continent. This led to the declaration of a Public Health Emergency of Continental Security (PHECS) by the Africa Centres for Disease Control (CDC) and of a Public Health Emergency of International Concern (PHEIC) by WHO to encourage global coordination, cooperation and solidarity.

**Challenges in identifying and vaccinating at-risk populations:** With intense human mobility in the region, and social stigma associated with sexual transmission, it is difficult to reach and vaccinate those at greatest risk.

**Economic and social challenges:** Many individuals in affected regions rely on daily wages from informal work and may not be able to afford to take time off for isolation. Additionally, limited social protection programmes and health care infrastructure make it difficult to protect vulnerable populations.

The epidemiological differences between the outbreaks in non-endemic regions and those in eastern Africa underscore that pandemic drivers are both complex and context-specific. 12 out of 15 key drivers (see the technical report *Expanding Pandemic Risk Assessment*) have influenced the dynamic of the two waves of mpox multi-country outbreaks since 2022. While both waves involve global mobility and technological advances, local political instability, social and economic inequality, and health care disparities significantly shape the course of the current outbreak in Africa and the risk of it becoming pandemic. Without a halt to transmission the virus may continue to spread, evolve and further expose vulnerable groups across many regions to severe disease and death.

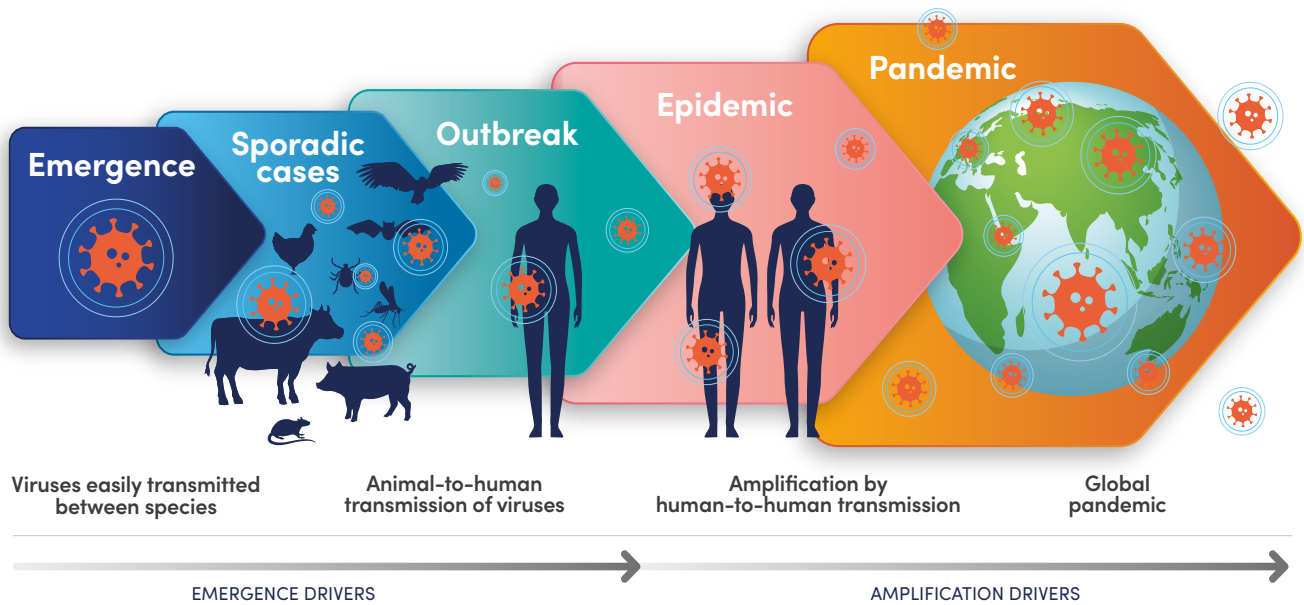
 SOCIAL DRIVERS

 TECHNOLOGICAL DRIVERS

 ECONOMIC DRIVERS

 POLITICAL DRIVERS

**Figure 2.** Steps from disease emergence to amplification



Source: GPMB

What this story tells us is that while complex, the emergence and spread of pathogens are not chance events: they are the result of a series of steps that create particular conditions. It is not inevitable that these conditions will lead to an epidemic or pandemic – if an emergence event is identified, monitored and acted upon either to prevent its initial occurrence or to mitigate its impact through the adoption of effective plans and measures, then an epidemic or pandemic can be averted. And ideally, it is best to act early, before a pathogen spreads rapidly among the population.

By analysing and monitoring the drivers of emergence and amplification, policy-makers at every level will better understand the conditions that exist in their countries and communities that put them at risk of epidemics and pandemics. Policy-makers will be able to devise agile pandemic prevention and preparedness plans and be more strategic in their measures to anticipate future threats.



Photo credit: Cerchi on iStock

# Viruses on the move

Human and animal  
mobility

Cities

# Human and animal mobility

**Human mobility, including travel, trade and migration, is an important factor driving the spread of pathogens.**

“We can’t stop human movement, but we can make it safer. This requires stronger international collaboration and frameworks.”

Ms Bente Angell-Hansen,  
GPMB Board Member



Due to population mobility, novel or re-emerging pathogens and some diseases that are endemic in certain settings can become epidemic in a newly infected population with no immunity against the disease.

Global mobility and interconnectedness have increased markedly over recent decades. They have created conditions for extremely rapid spread – for example, the Omicron variant of COVID-19 was initially detected by South African authorities in late November 2021 and by mid-December 2021 the variant was reported in over 70 countries, becoming the dominant strain in many.<sup>14</sup>

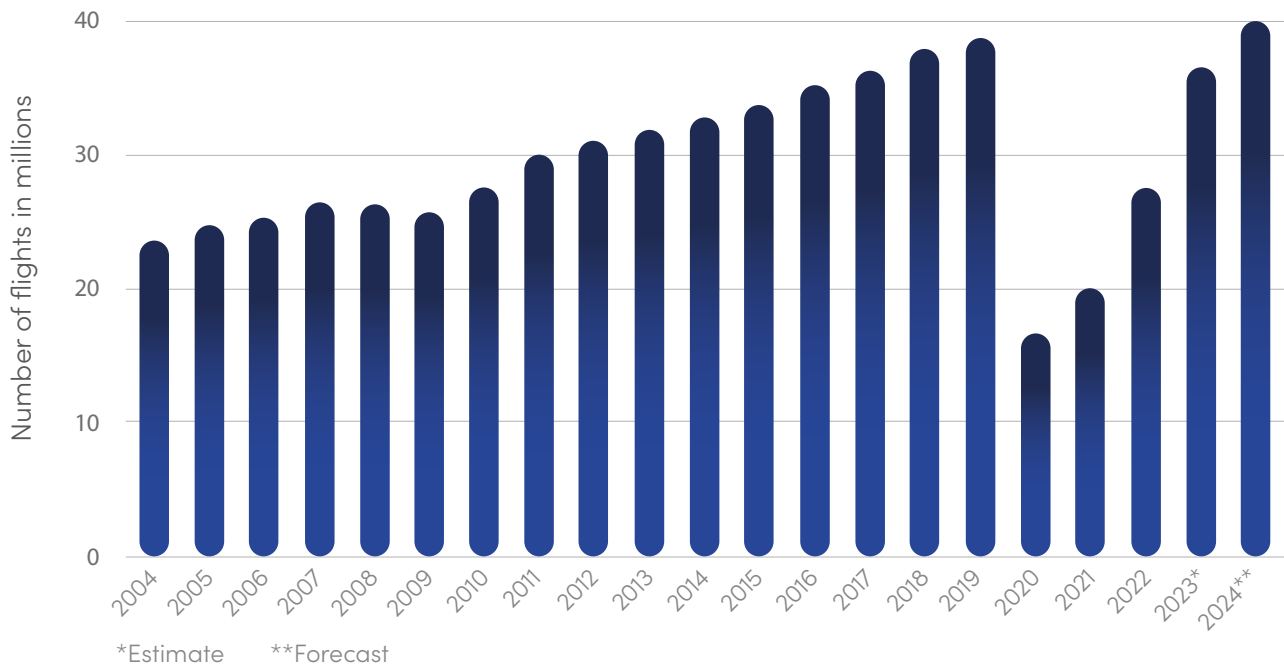
The movement of humans and animals facilitates the spread of viruses. In countries with high mobility – such as those with major international travel hubs, extensive livestock trade, or large numbers of displaced people and refugees – epidemic-prone diseases are more likely to spread rapidly and widely. In 2023, there were 36.8 million global flights, carrying over four billion passengers (see Figure 3).<sup>15</sup> It is not only the volume but also the pattern of human mobility that has been changing in conditions of globalization, and advances in aviation and tourism.

Similarly, trade in animals and animal products has significantly increased and changed shape, contributing to the spread of animal pathogens. Animals are transported long distances and across international borders in supply chains that connect production, primary processing and secondary processing in multiple countries. Livestock markets (buying and selling animals) and wet markets (where live animals are slaughtered and butchered for direct sale to customers) are an important feature of farming and food supply chains in many countries, and often operate with insufficient attention paid to biosecurity, food safety and traceability. There remains extensive and often unregulated trade in wildlife, and supply chains for wildlife, production animals and food often overlap and connect. Capacity to regulate these activities is limited in many countries.



Photo credit: WHO / Andrew Esiebo

**Figure 3.** Number of flights performed by the global airline industry 2004–2023, with forecast for 2024



Source: International Air Transport Association; International Civil Aviation Organization; Statista, 2024. <https://www.statista.com/statistics/564769/airline-industry-number-of-flights/>

The long history of quarantine has always sought to balance health risks with the desire to keep trade routes open. The core principle of the International Health Regulations (IHR) adopted in 1952 and revised in 2005 is that public health measures to control a disease be warranted and proportional to its risk, minimizing interference with trade and tourism. The implied promise of the IHR is that sticking to the rules will be in every country's best interests, and none will suffer avoidable damage. But a rule-based system will falter if countries do not trust one another, solidarity is lacking, and incentives are not aligned with compliance. For example, South Africa's rapid declaration of its detection of the Omicron variant in the COVID-19 pandemic was met with knee-jerk travel bans instead of a more measured and rational response. The most recent 2024 revisions of the IHR have therefore sought to create better incentives for solidarity.

"The interconnectedness of our world is a double-edged sword. It spreads diseases faster, but it also gives us the tools to respond swiftly if we invest in the right technologies."

Dr Palitha Abeykoon,  
GPMB Board Member



Photo credit: Patrick Schneider on Unsplash

# Cities

**Over the past century urbanization has surged, with the global population living in cities projected to rise from one-third in 1950 to 68% by 2050.<sup>16</sup>**

Large cities, as hubs for national and international transportation, can amplify localized outbreaks due to their high population density and intense internal movements.<sup>17</sup> Frequent commuting and population density in cities provide more opportunities for the rapid spread of epidemic-prone diseases. Cities are attractors for mass gatherings, such as cultural and religious events, further increasing dense mixing. Shrinking travel duration and intense exchange of goods mean that proximity is no longer purely about geographic distance: in terms of connectivity, London may be 'closer' to New York than to Edinburgh, and Lagos 'closer' to Hong Kong than Abuja.

The number of megacities (cities with over 10 million people) is increasing, and while they pose a higher risk for outbreaks, they also typically offer better access to health care, and have greater capacity to manage severe diseases when well prepared. The key challenge facing megacities is inequality – in income, housing, sanitation, transportation, overcrowding, and access to basic health care. Where these inequalities are pronounced, megacities are highly vulnerable to pandemics, even if world-leading health care is available to their wealthiest residents.<sup>18</sup> For example, during the COVID-19 pandemic in Mumbai, seroprevalence in informal settlements reached 55–61% within four months of the first confirmed case, compared to 12–19% in the rest of the city.<sup>19</sup>

The combined changes of modern transportation and urbanization are ideal for emerging pathogens from remote areas to quickly spread globally. West Africa's Ebola outbreak of 2014–2017 signalled the changing threat dynamics: all previous Ebola outbreaks were characteristically in remote rural settlements, but this time Ebola spread in peri-urban areas, and as a result the outbreak was 100 times larger than ever before.

"As cities grow larger, they become perfect sites for the amplification of pandemics. We must rethink how we design urban spaces to minimize this risk."

Dr Zijian Feng,  
GPMB Board Member



Photo credit: Andy Bridge on Unsplash



Photo credit: piranka on iStock

# Digital connectedness

Digital connectivity

Exposure to  
misinformation

# Digital connectivity

**The digital transformation is creating new dimensions of human connectivity and reshaping every aspect of social life. Pandemics are no exception.**

The conduct of scientific exchange today is hardly imaginable without digital connectivity, which enables real-time global sharing of rich and dense information, as well as connecting experts worldwide. During pandemics, this connectivity is crucial for disease surveillance, public communication, mental health support, remote health care, and international collaboration. Speed and reach are vital: during COVID-19, the sharing on digital platforms of the first sequencing of the new pathogen enabled diagnostic tests to be developed in multiple sites across the world within two weeks. Continuously updated repositories of the virus's genetic sequences allowed the evolution of SARS-CoV-2 to be monitored, vaccine compositions to be updated to match circulating variants, and improved population protection by tracking the genetic fingerprint. Pandemic intelligence is being transformed by data tools that not only capture tens of thousands of potential threat signals daily, but also separate the signals from the noise and transform them into policy-salient information. Interventions can be tailored, spread and impacts assessed in real time, and anticipatory measures put in place.

Countries with better digital connectivity and AI are better equipped to respond effectively to health emergencies, as these technological innovations impact all aspects of the response, as highlighted in the health emergency preparedness, prevention, response and resilience (HEPR) framework.

**Figure 4.** Health emergency preparedness, prevention, response and resilience (HEPR) framework



Source: World Health Organization; 2023. <https://www.who.int/publications/m/item/strengthening-the-global-architecture-for-health-emergency-prevention--preparedness--response-and-resilience>



Digital connectivity has broadened the notion of community, with the increasing role in social life of virtual communities that can evolve rapidly and have global reach. This dimension of the modern community should be considered for future pandemic preparedness and response.

While digital connectivity is crucial for modern epidemic management, it also introduces significant risks that need careful management. Cyber threats, such as ransomware attacks on hospitals, can disrupt services and delay critical treatments, endangering lives. Privacy concerns arise with digital contact tracing and surveillance, as these tools require the collection of personal data, which, if not protected, could lead to breaches of privacy and loss of public trust. Additionally, the digital divide can worsen health inequalities, excluding those with limited access to technology from essential information and services.

To address these risks, comprehensive strategies must enhance digital technology access while ensuring that cybersecurity and regulations align with ethical and public health principles for effective pandemic preparedness and response. The Global Digital Compact adopted at the Summit of the Future in September 2024 offers the promise of an inclusive global framework to overcome digital, data and innovation divides.<sup>20</sup>



Photo credit: onurdongel on iStock

The risks and opportunities attached to AI are the next frontier in the digital transformation, and global capacities to ensure that AI is a force for good are critical. The proposed United Nations-initiated Global Dialogue on AI Governance, which was one of the outcomes of the Summit, will be a key part of including all stakeholders in setting appropriate guardrails for safe, appropriate and transparent AI.<sup>21</sup> Pandemic preparedness will be reshaped by AI, therefore needs to be a key consideration as this dialogue proceeds.

“Artificial intelligence and digital tools will revolutionize pandemic preparedness, but we must protect these systems from misuse and ensure equitable access.”

Dr Ibrahim Abubakar,  
GPMB Board Member



# Exposure to misinformation

**A significant risk associated with the expansion of digital connectivity and AI tools is the spread of misinformation.**

Effective communication is vital during epidemics to inform the public, dispel falsehoods, and guide behaviour to mitigate disease spread. But while digital platforms such as X (formerly Twitter), Facebook, WeChat and Instagram have revolutionized public health communication, they also enable the rapid spread of misinformation and disinformation, cyberbullying, and online impersonation. Furthermore, the sheer volume of information which is now produced and shared is in itself a challenge, leading to an ‘infodemic’, where an overwhelming amount of both accurate and inaccurate information spreads quickly, especially on social media, causing confusion about which source to trust.

During the COVID-19 pandemic, misinformation spread globally, hindering the adoption of protective behaviours, and undermining compliance with public health measures. It fuelled panic, mental distress, and social polarization, exacerbated by social media algorithms that amplified echo chambers and stigmatization. Strategies to mitigate the damage caused by the infodemic are still in their infancy but will certainly require long-term efforts to build and maintain trust in health authorities and science, as well as clear regulatory frameworks that give priority to public health and the preservation of social cohesion.<sup>22</sup> These measures are needed well in advance of future crises.

Photo credit: @upgrateur\_life on Unsplash

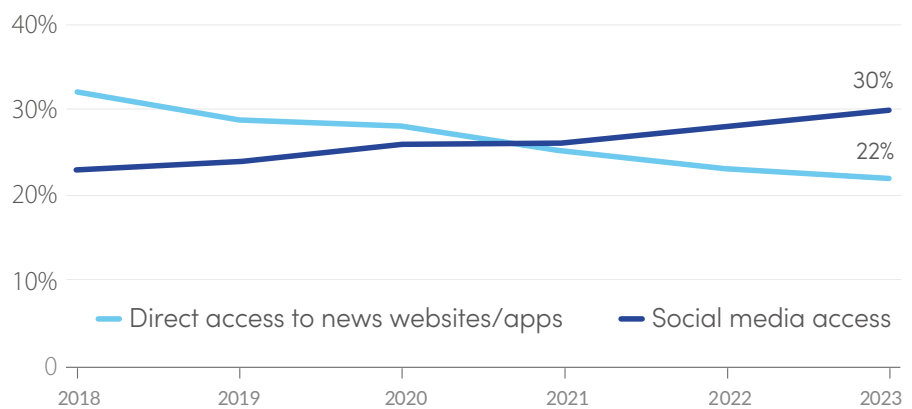


“Building trust is as important as developing vaccines. Misinformation will undermine every public health measure if we don’t address it head-on.”

Dr Chris Elias,  
GPMB Board Member



**Figure 5.** Proportion of individuals who access news through news websites/apps versus social media 2018–2023



Source: Digital News Report 2023. Reuters Institute for the Study of Journalism; 2023. doi:10.60625/risj-p6es-hb13



Photo credit: WHO / Fanjan Combrink

# Building trust

Trust

# Trust

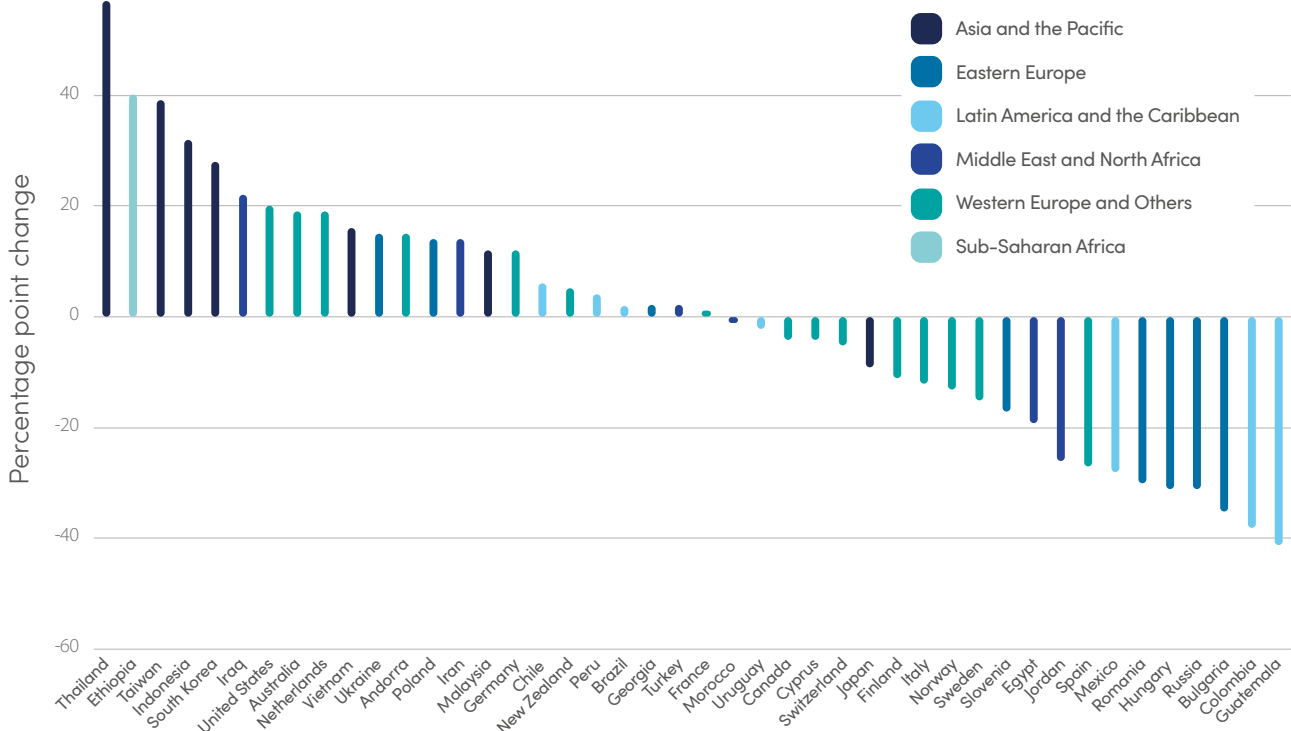
**Trust and mistrust are at the centre of pandemic response but have not yet received the sustained policy and scientific attention they deserve.**

There are as yet no comprehensive agreed metrics to measure trust, and the evidence base on interventions that can build trust is still emerging. This is despite the repeated experience across many pandemics that trust is as vital an asset as countermeasures such as vaccines. The key lesson has been that epidemic response is always better if the reservoirs of trust have been built and invested in during ‘peacetime’, because once an epidemic starts, it may be too late.

Higher levels of trust between people and various actors — such as governments, community members, health professionals, and scientists — have been linked to better health outcomes during emergencies. Trust in government influences the confidence people have in the legitimacy of public health institutions and their interventions, and trust in other community members supports responses based on mutual assistance. Conversely, lack of trust can drive both the emergence of novel viruses and the amplification of outbreaks, with individuals less willing to report zoonotic events if they fear repercussions, and reduced compliance with public health measures such as quarantine, or vaccination and treatments.

The countries that were most successful in curbing COVID-19 infections were not those with the highest health spending or best health research, but rather those with high levels of national and community trust.<sup>23</sup> Better functioning health systems and trusted health experts are themselves important ingredients in building increased trust across governments and communities.

**Figure 6.** Change in net confidence in the UN (2005–2009 to 2017–2022)



Source: European Values Study and World Values Survey. Joint EVS/WVS 2017–2022 Dataset, 2022. World Values Survey: Wave 5 (2005–2009), Inglehard et al. (eds). 2018. <https://ourworldindata.org/grapher/confidence-in-un-wvs>

Policy-makers must prioritize building trust during ‘peacetime’. During crises, they need to have a good understanding of trust levels at the outset of any epidemic or emergency event, so that they can adapt interventions to the context. In low-trust environments, response measures such as vaccination and contact tracing may need to leverage economic incentives, and in those settings it is critical to invest in community ambassadors and local leaders. In many contexts, community health workers are among the most valuable ‘trust assets’, as they know and are known by the communities in which they work. Bringing in outside experts during a crisis is fraught with danger: the Ebola outbreaks in West Africa demonstrated that using responders who were not part of the affected community led to mistrust, resistance, and sometimes violent rejection of outsiders.<sup>24</sup>

Trust between countries is an important asset to strengthen international collaboration at global and regional levels. Trust between countries has been decreasing in the recent past, undermining multilateralism. However, health stands out as an issue that can buck this trend. Strengthening global frameworks for cooperation around pandemic prevention, preparedness and response can advance trust globally. The package of amendments to the International Health Regulations (2005) adopted by WHO Member States in 2024 and the continuation of the Intergovernmental Negotiating Body (INB) process to draft and negotiate an international instrument to strengthen pandemic prevention, preparedness, and response could be seen as important markers of the global community’s willingness to set aside divisions for the sake of enhanced mutual health security.

“Trust not only fosters a unified response but also helps mitigate fear and misinformation, which can be as dangerous as the virus itself. Trust is the essential glue for communities to work together, making it one of the most critical components for an effective response to any public health crisis.”

Professor Ilona Kickbusch, GPMB Board Member



Photo credit: WHO/Christina Banluta

“As we’ve seen throughout various pandemics, trust is the foundation of a cohesive society. When people trust public health authorities, governments, and one another, they’re more likely to follow guidelines, share vital information, and support collective action.”

Dr Maha El Rabbat, GPMB Board Member





Photo credit: Johnny Coerend on Unsplash

# Pandemic prevention and planetary health

Agricultural practices and farming

Climate change

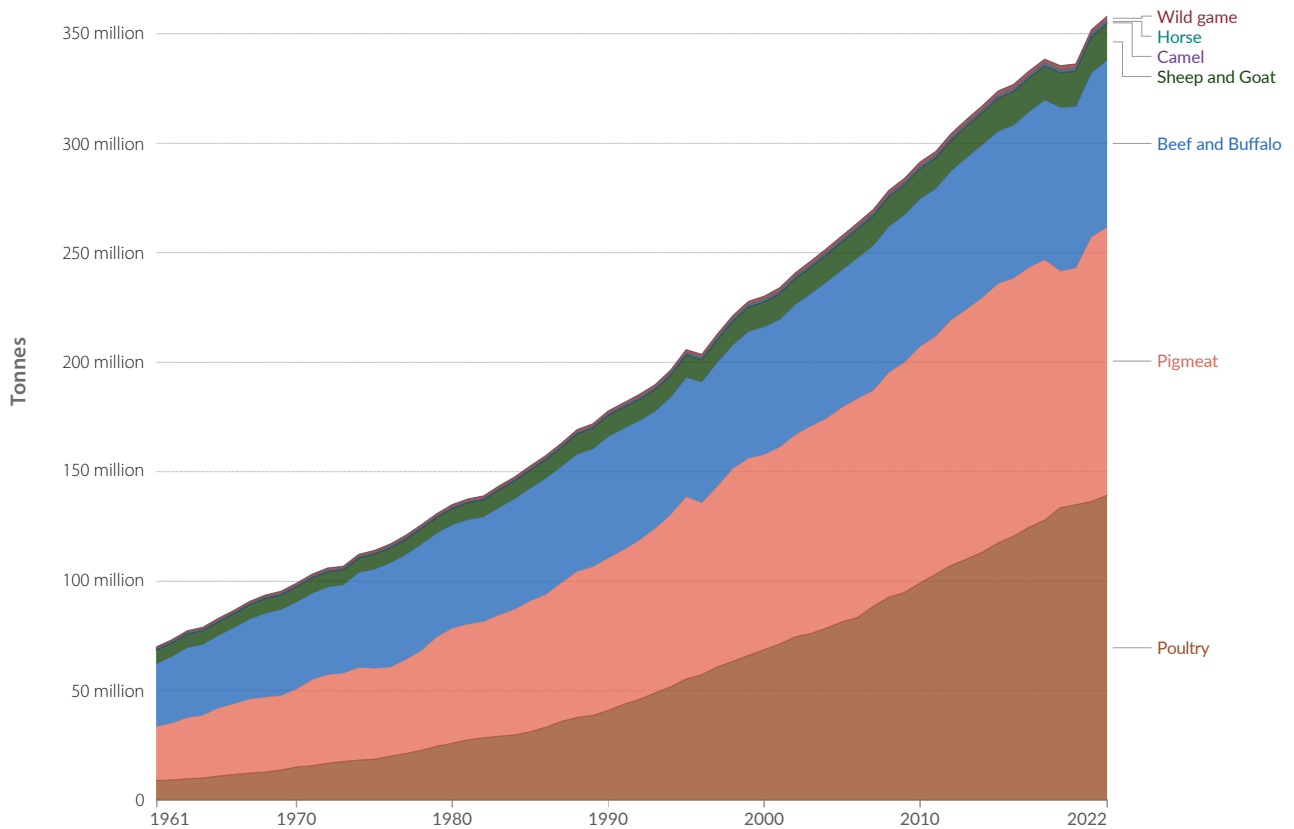
# Agricultural practices and farming

**Farming practices are rapidly evolving with the needs of populations, technological developments and increasing global demand.**

While both small-scale/backyard and intensive industrial-scale farming increase the risk of pathogen emergence at the human–animal interface, they do so in very different ways, requiring distinct mitigation efforts.

Intensive agriculture and farming, paired with globalization and trade in animal products, is increasing. Animal products account for two-thirds of total global protein production, and livestock enterprises are the world’s largest land user, either directly through grazing or indirectly through the production of fodder and grains.<sup>25</sup> Growing global demand for livestock, eggs and meat is increasing the pressure on agricultural farming. The high density of animals in intensive farming practices amplifies outbreaks in animal populations, creating selective pressures that facilitate the evolution of emerging pathogens and increase the likelihood of spillover to farm workers and the introduction of new pathogens in human populations.<sup>26,27</sup> These pressures are exacerbated by breeding programmes that are overly focused on enhancing traits related to production to the detriment of other traits such as robustness and disease resistance, and as a result animals can become more vulnerable to infections in general.<sup>28</sup>

**Figure 7.** Global meat production by livestock type, 1961–2022



Source: United Nations Food and Agriculture Organization (FAO); Our World in Data, 2023 <https://ourworldindata.org/meat-production>

“A One Health approach is critical. We must understand how human, animal and environmental health are connected if we want to prevent the next pandemic at its source.”

Dr Matthew Stone,  
GPMB Board Member



The increased pandemic risk attached to large-scale farming practices calls for increased disease surveillance, effective regulatory regimes that have the power to mandate safe practices for animals and humans, and, in the case of specific risks, timely interventions such as vaccination, movement control, culling in infected places and enhanced surveillance.<sup>29,30</sup>

For smaller-scale agricultural and farming practices, such as livestock husbandry and backyard farming, the risk of spillover can be reduced by increasing the protection and training of farmers and facilitating access to medical countermeasures, which are especially critical in containing the initial human chain of transmission. Economic compensation of small farmers is also essential to enable compliance with control measures and reduce social and economic inequity resulting from interventions to reduce epidemics in animals.



Photo credit: Annie Spratt on Unsplash



Photo credit: Thomas Quinn on Unsplash

Growth pressures on livestock production suggest that coming decades will see increasing interactions between wildlife and livestock<sup>31</sup>, amplifying interactions and opportunities for pathogen transmission.<sup>32</sup>

Produce markets where there is interaction of humans (both retailers and customers), live animals for sale, food products (including ready-to-eat food), as well as wild and peri-domestic animals, pose important risk factors for emerging infectious disease. However, they are also crucial for food supply in many countries. In general, the point of slaughter carries high spillover risk, therefore focused attention on these sites is of prime importance. Relevant authorities need to have the capacity to constantly adapt regulations as risks evolve, and to take quick and decisive action if needed, as in the example of Hong Kong's response to the H5N1 poultry outbreak in 1997.<sup>33,34,35</sup>



# Climate change

**Climate change shifts the geographic patterns of disease and affects the extent and timing of outbreaks.**



Photo credit: WHO / Halldorsson

Terrestrial and marine environments are affected, with an impact on all the animals and plants that live within them.

Land-use changes, deforestation and reforestation, loss of habitat and changes in water ecosystems also impact species distribution, migration patterns and the ecology of pathogens, disrupting current natural host–pathogen dynamics.<sup>36,37,38</sup> Anthropogenic environmental changes have been at the root of many epidemic events, including those arising both from the emergence of novel pathogens and from the re-emergence of ancient epidemic-prone diseases. For example, yellow fever outbreaks in Angola have been linked to the extractive industry and the fragmentation of landscapes due to deforestation.<sup>39,40,41</sup>

The human–animal–environment interface is in constant flux. The places where this interface is particularly dense, intricate and changing rapidly are ripe to become new hotspots of emergence of novel diseases with epidemic potential. The more viruses transmit between species or between humans, the more they evolve, providing increased opportunities for a zoonotic (or animal) virus to become fit for human-to-human transmission and lead to extensive disease spread within human populations (see Figure 2 above).

Climate change is altering the patterns of disease seasonality. Countries in all regions need to be prepared to face the new epidemic risks these changes bring. The spread of arboviral diseases such as dengue or Zika spread by *Aedes aegypti* mosquitoes is a direct consequence of the expanding habitat of these vectors under warmer latitudes. The autochthonous transmission of dengue in the south of France and the 2017 Chikungunya outbreak in Rome<sup>42</sup> illustrate the new risks faced by non-tropical countries where vectors have now settled and in some places are becoming resistant to insecticides. Epidemics of yellow fever, which were widespread in the south of Europe until the middle of the 19th century, could well re-emerge in the region due to climate change.<sup>43</sup>

The warming of the oceans is another climate-driven determinant of the frequency and intensity of outbreaks, given the reservoir of pathogens living in marine environments. Increases in cholera outbreaks in endemic areas have been linked to changes in aquatic ecosystems due to warming, with countries needing to increase surveillance and the intensity of early public health response to mitigate these intensifying risks.<sup>44,45,46,47</sup>

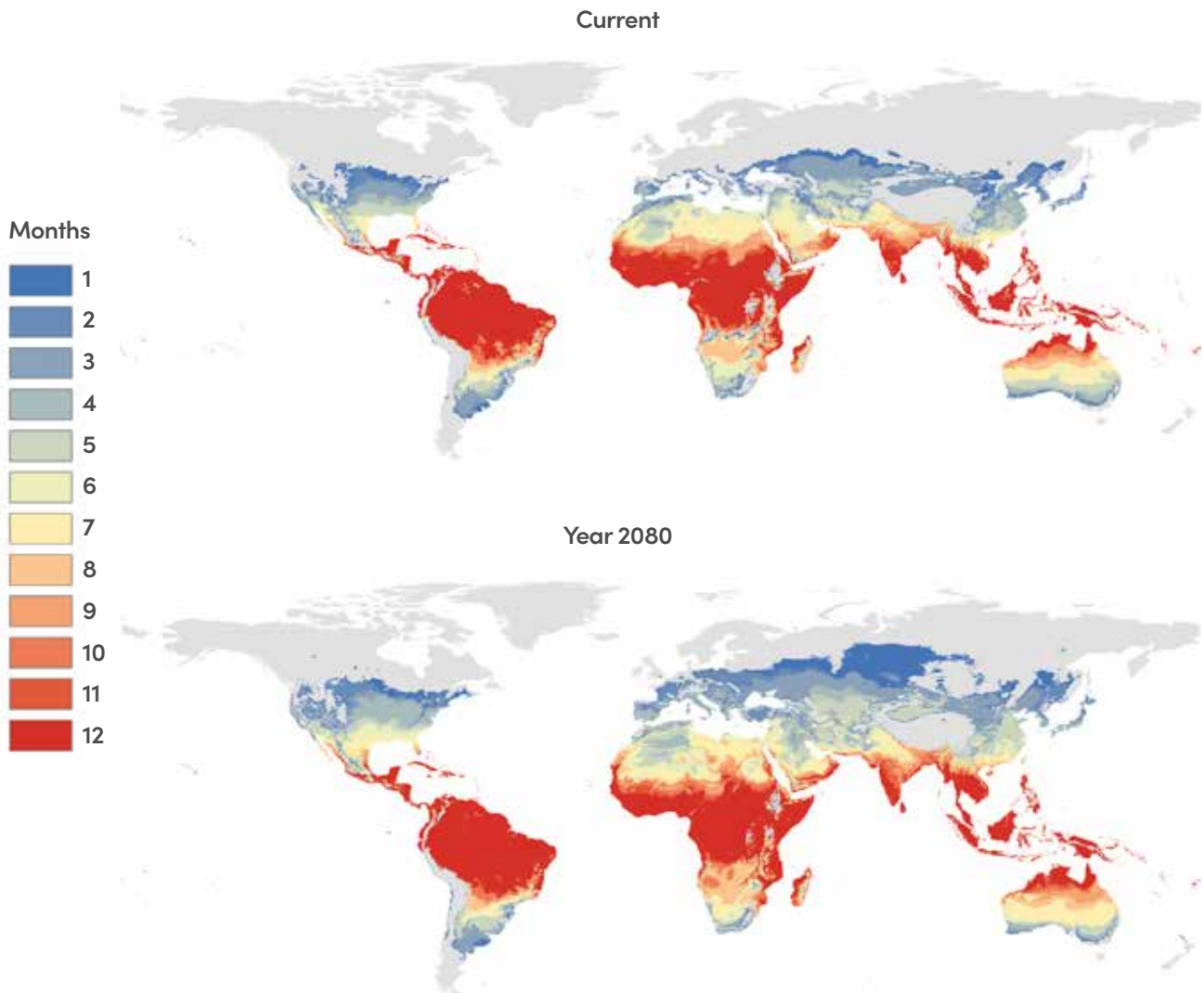
“Climate change is shifting disease patterns globally. If we ignore the environmental drivers of pandemics, we’re setting ourselves up for failure.”

Professor Naoko Ishii,  
GPMB Board Member



Photo credit: Michael Held on Unsplash

**Figure 8.** Current worldwide distribution of the mosquito *Aedes aegypti* by duration of time in each region and predicted range of the mosquito *Aedes aegypti* in 2080 if there is no change to global greenhouse gas emissions



Source: Stanford University, 2019 <https://sustainability.stanford.edu/news/how-does-climate-change-affect-disease>



Photo credit: Alfarnas Solkar on Unsplash

# Maximum equity equals maximum security

Social and economic equity

Equity in access to technological innovation

## Social and economic equity

**Rich countries should not believe that their wealth alone protects them from pandemics. Within-country inequality fuels vulnerability.**

The global economic loss due to the COVID-19 pandemic has been immense. The International Monetary Fund (IMF) estimated that the contraction of the global economy would result in a loss of output of US\$22 trillion over 2020 to 2025, relative to pre-pandemic levels.<sup>48</sup>

These impacts have not been distributed equally: COVID-19 caused close to 100 million more people to fall into extreme poverty and one in three International Development Association (IDA) countries have become poorer than before the pandemic.<sup>49</sup> The long-term costs of the pandemic are manifested in increased public debt, the impact of reduced investment in education and health care as fiscal space has been constrained, and ongoing disruptions to global supply chains. In many countries, investments in strengthening resilience and social protection made during the COVID-19 pandemic are being rolled back, increasing the vulnerability to future shocks. Only 39% of the working-age population would be covered by a social health protection scheme if the next pandemic hit us tomorrow.<sup>50</sup>

Constrained resources leave poorer countries more vulnerable to pandemics simply because they have less to invest in health systems and pandemic prevention and preparedness.<sup>51</sup> This cycle of vulnerability is compounded when these countries are further financially squeezed in the aftermath of a pandemic.

But rich countries should not believe that their wealth alone protects them from pandemics. Within-country inequality fuels vulnerability. Most countries have

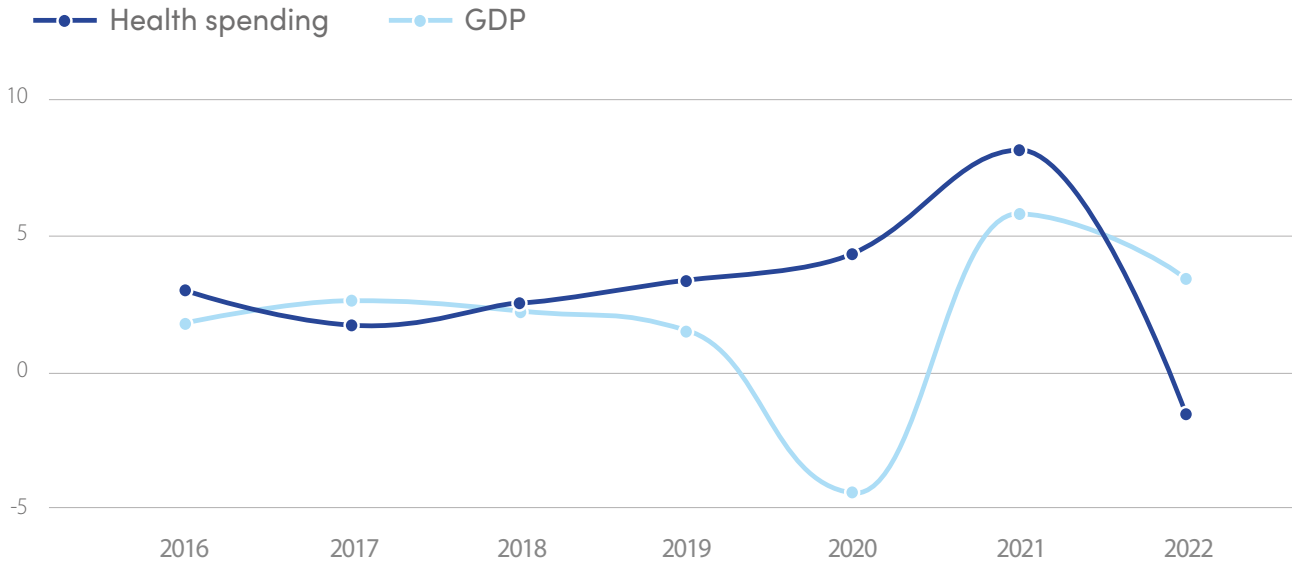
“Pandemics don’t just affect health; they destabilize societies. Strengthening social protection is vital for protecting the most vulnerable.”

Dr Jayati Ghosh,  
GPMB Board Member



Photo credit: WHO

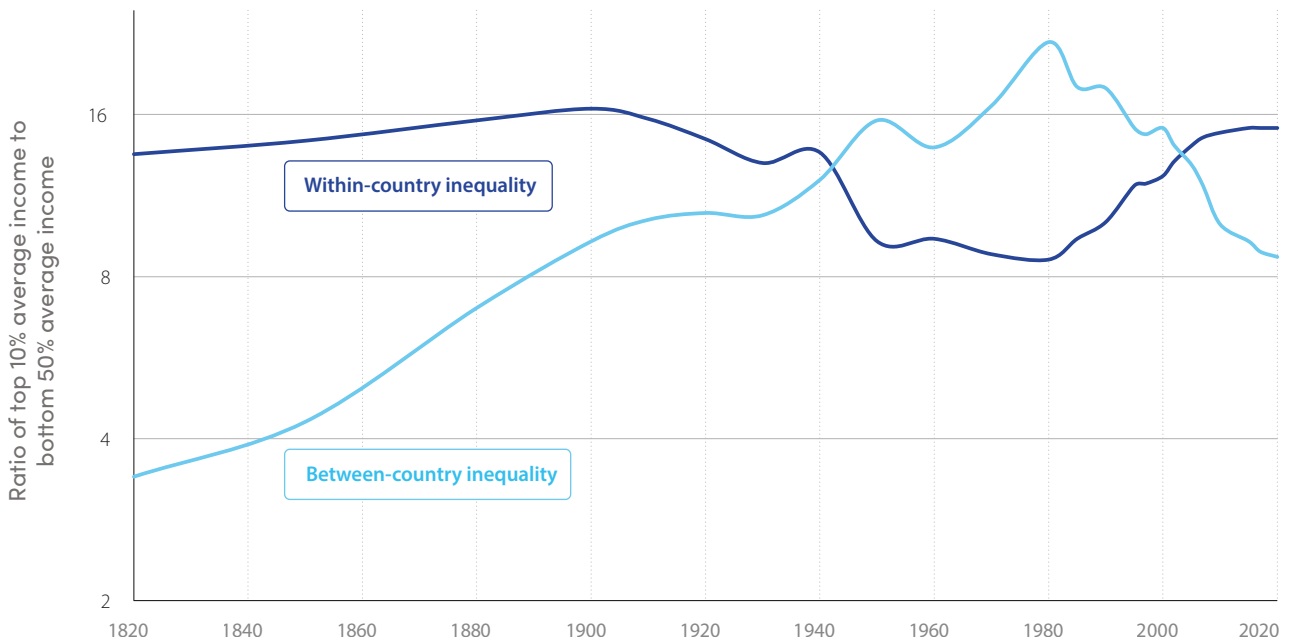
**Figure 9.** Annual real growth in health expenditure and GDP, % growth per capita, OECD average 2016–2022



Source: OECD Health Statistics, 2022. doi:10.1787/health-data-en

Note: Average of 38 OECD countries

**Figure 10.** Global income inequality: between-country vs within-country inequality



Source: World Inequality Lab; Chancel L and Piketty T, 2021. <https://wir2022.wid.world>

“The next pandemic won’t wait for us to perfect our systems. We need comprehensive, resilient, equitable universal primary health care, bolstered by robust surveillance, R&D, reliable financing and access to innovations, as well as manufacturing of medical countermeasures.”

Ms Joy Phumaphi,  
GPMB Co-Chair



Photo credit: WHO

seen rising income and wealth inequality since the 1980s and together with the economic development of many previously low-income countries, the result is that a greater proportion of global inequality is now within countries than between them.<sup>52</sup>

Major positive dividends have been realized where equity has been put at the heart of pandemic response. For example, while Kerala was the first Indian state to record a COVID-19 case, its exemplary response kept infection rates low, grounded in a strong public health system backed by community participation and strong efforts to protect the vulnerable.<sup>53,54</sup>

Eighteenth-century Scottish philosopher Thomas Reid observed that a chain is only as strong as its weakest link, which has proved the most true of truisms about pandemics. Social and economic inequity hampers the control of disease spread. Those left behind economically are less able to adopt public health and social measures to contain epidemics. Inequity leads to sustained pockets of uncontrolled transmission in vulnerable groups, allowing the virus to evolve and new variants to emerge, resulting in continuing waves of transmission across the entire population. Social inequity and marginalization intersect with each other and with economic inequalities, multiplying their effect and making individuals and communities even more vulnerable.

The pathways that lead from inequity to pandemic vulnerability are intertwined. Populations that are socially and economically excluded tend to be more exposed to infectious disease, have less capacity to cope with the disease, and are more likely to suffer from comorbidities and inadequately managed existing health conditions (for example, gaps in cancer, TB and HIV treatment access during COVID-19, and obesity-related comorbidity).<sup>55</sup> Preventive health care is hampered by discrimination and cost barriers to access; food insecurity escalates vulnerability; and inadequate living conditions such as overcrowded and shared housing or homelessness increase exposure. Inequity fuels the mistrust of public health authorities and health information. Evidence from many countries at all income levels consistently showed the disproportionate impact of COVID-19 across every dimension of disadvantage.<sup>56,57,58,59</sup>

Gender inequality must be carefully considered in pandemic preparedness planning, as women are often more vulnerable during health crises. Historically, women have taken on the larger share of primary caregiving, resulting in greater exposure to diseases which, combined with less access to health care, results in worse health outcomes. Health emergencies disrupt maternal and reproductive health services, as seen during the Ebola outbreak in West Africa.<sup>60</sup> Given that most health care workers are women, their deaths during crises further weaken health care systems. Women also face greater indirect impacts, such as increased gender-based violence and economic hardships during lockdowns, exacerbating existing economic inequalities, as evidenced by their global share of labour income being only 35% in 2022 (instead of 50%).<sup>61,62</sup>

# Equity in access to technological innovation

**The COVID-19 pandemic highlighted stark inequities in access to life-saving interventions, not only vaccines but also other products such as rapid diagnostic tests, oxygen extractors, and personal protective equipment.**

These disparities were not solely determined by economic status; while poorer nations faced significant challenges, even wealthy but small countries, such as island nations, struggled to secure medical supplies. This was often due to private providers prioritizing large contracts, or disrupted supply chains due to border control measures. In a pandemic, especially during the early stages when resources are scarce, it is crucial to prioritize the distribution of life-saving interventions based on public health impact and risk of amplification. By doing so, the global community can contain outbreaks more effectively, particularly when they originate in countries with limited access to countermeasures or in humanitarian settings.

Prioritizing equitable access based on need and impact is essential for a more effective global response to pandemics. It helps to prevent the spread of disease and to mitigate impact in all countries, and is essential to halting the progression from localized epidemics to pandemics. Growing inequity feeds a vicious cycle that increases pandemic vulnerability, fosters spread, widens the equity gap and undermines global health security. Needs-based equitable access is therefore a key goal that countries are striving towards in negotiating a new Pandemic Agreement, in the interests of better global health security to the benefit of all countries.

The unfolding mpox public health emergency runs the risk of repeating all the mistakes of inequitable pandemic response. Ensuring access to mpox vaccines where they are most needed, as well as diagnostics and other countermeasures, is an urgent test of global commitment to overcome some of the failures of the COVID-19 response. Reinforced regional responses, such as those the Africa Centres for Disease Control and Prevention (Africa CDC) is currently leading, backed by serious commitment to international solidarity, will be critical given the complex patterns of emergence of mpox (see Box 2, page 6).



Photo credit: WHO / Christopher Black



Photo credit: WHO / Stanley Makumba

# The face of the next pandemic

Leveraging the technological revolution

Effective governance during crisis

Conflicts and instability



# Leveraging the technological revolution

**The COVID-19 pandemic has been marked by an intense period of biotechnological innovation, beginning with the development and rapid deployment of a completely new type of vaccine, the mRNA vaccine.**

Significant advances were also made in surveillance (for example, wastewater monitoring, genomic sequencing, real-time modelling), care (for instance, new antivirals, monoclonal antibodies) and diagnostics (genomic surveillance, rapid diagnostic tests).

These biomedical innovations are crucial for faster and more effective epidemic and pandemic preparedness and response, and their momentum must be maintained if the next pandemic is to be tackled successfully. Research into both pathogen-specific and pathogen-agnostic tools is essential to develop higher quality, more effective measures (for example, better treatments to reduce mortality), accelerate interventions (such as rapid diagnostic tests, drone delivery, satellite surveillance), and increase access to and coverage of products and services (for instance, telemedicine).

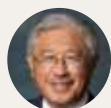
Innovation has been less pronounced in information management, approaches to trust-building, and in improving essential non-pathogen-specific items such as syringes, masks, immunomodulators and personal protective equipment. There are important needs for innovation in other sectors, such as online education systems, water supply, vector control, and animal vaccination. Research and development of these new tools should begin during the interpandemic period to ensure preparedness for future outbreaks.

Effective response to health crises relies on a seamless end-to-end process. This includes research and development, testing, manufacturing, regulation, supply chains, and delivery. Preparedness efforts must address each stage to ensure that products are available rapidly, equitably, and in sufficient quantities. Addressing gaps at any point in this process is crucial now to avoid deepening inequities and increasing global vulnerability. Strengthening the global health architecture will help ensure that biomedical innovations are accessible and effective during crises, reducing vulnerabilities and enhancing resilience.

Biomedical innovation will only be impactful if its social and governance context is addressed. The rise of anti-vaccine sentiments, particularly with the introduction of new vaccines such as mRNA vaccines, has fuelled conspiracy theories and undermined trust in established vaccines.<sup>63</sup> The privatization of public services, including health care, exposes countries to more vulnerabilities such as inequalities in access, less compliance with public health strategies during crises, and less coordination between different levels of the health system.

“It’s clear we need to adapt our preparedness strategies. COVID-19 was the past. The future brings different challenges and risks, and our response must evolve.”

Professor Victor Dzau,  
GPMB Board Member

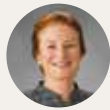


# Effective governance during crisis

**Effective governance is essential for ensuring that resources are well planned and utilized, public trust is built and maintained, and coordination across all levels of government is adequate.**

“Preparedness is not about perfection. It’s about adapting, learning, and improving after each crisis, so we are better equipped to handle the next one.”

Ms Henrietta Fore,  
GPMB Board Member



“Global health security is only as strong as the international collaboration behind it. We need better governance structures that are agile, inclusive and equitable.”

Professor Ilona Kickbusch,  
GPMB Board Member



Effective governance in pandemic and epidemic preparedness and response requires transparency, inclusiveness, equity, flexibility and learning. Whole-of-society and whole-of-government approaches are key determinants of good responses, and cross-sectoral and community engagement should be promoted before, during, and after crises.

Adapting response strategies to the cultural context is crucial for their success. For example, during the COVID-19 pandemic, several studies highlighted that a high level of individualism was associated with poorer outcomes,<sup>64</sup> suggesting that in these contexts more effective responses will need to identify pockets of collectivity such as religious groups, professional communities (for example, seafarers) or sports supporters as building blocks for support for public health measures. Additionally, tailoring risk communication strategies – such as focusing on messages about self-protection and health security – might be more effective in ‘individualist’ communities.

While pandemic preparedness primarily focuses on the natural emergence of new pathogens, the risk of deliberate or accidental events cannot be ignored. This risk has significantly increased with advances in technology, despite efforts to enhance biosafety and biosecurity measures in laboratories. The widespread availability of genetic sequence information and easier access to technologies for biosynthesizing dangerous pathogens make the accidental or deliberate release of deadly agents more likely. Complete sequences of all known historical pandemic viruses are already freely available on global databases, along with instructions on how to reproduce them from synthetic DNA.<sup>65,66</sup>



Photo credit: WHO / Christopher Black

# Conflicts and instability

**Globally, violent conflicts are at their highest since the Second World War, affecting about 2 billion people, with more than 117 million displaced from their homes.**<sup>67,68</sup>

“Health equity must be at the core of pandemic preparedness. We can’t afford to let the most vulnerable be the weakest link in our global defence.”

Sir Mark Lowcock,  
GPMB Board Member

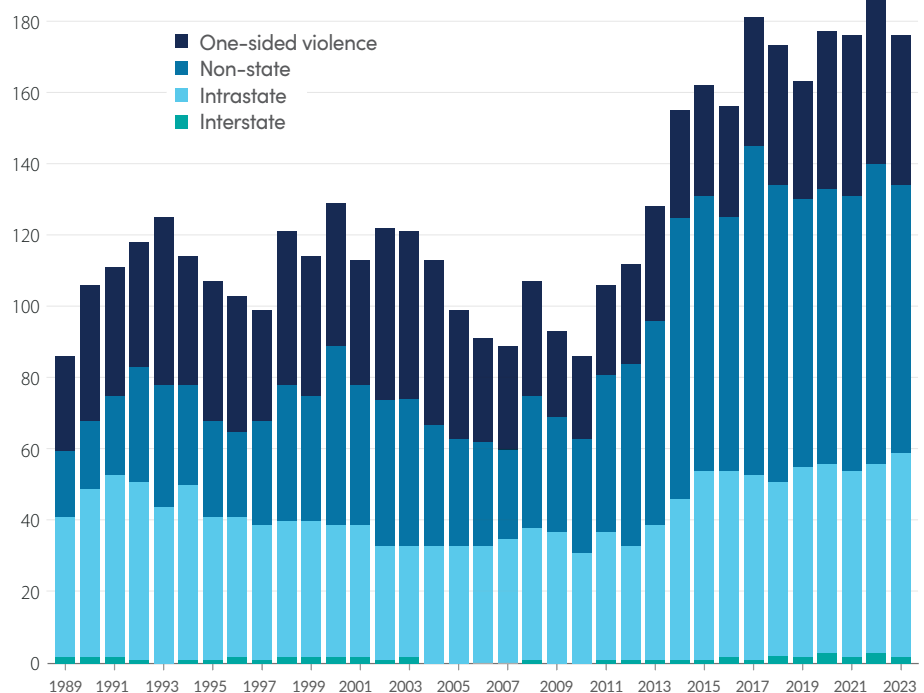


Increased population movement and density, including in refugee camps, increases risk of pandemics (for example, cholera and mpox), exacerbated by unsanitary living conditions and destruction of vital infrastructure (medical, sanitation, roads, and so on) that hamper access to basic health services and systems.<sup>69,70</sup>

Conflicts affect authorities’ ability to coordinate, share information or effectively cooperate with others during pandemics. Detection and control of many emerging infectious diseases in conflict situations require a functional health care system with a sufficient number of trained health care workers and adequate supplies of medications, vaccines and equipment.<sup>71</sup> Conflict situations delay the detection, response to and containment of infectious disease, as exemplified by the mpox outbreak in DRC or the polio cases in Gaza.<sup>72</sup> The killing of health care providers during armed conflicts undermines the most vital of capacities. Attacks on health care in situations of armed conflict have been reported at alarming levels over the past two decades. As well as their direct impact, these humanitarian outrages further reduce the capacity to contain epidemic outbreaks at source.

In the face of a conflict situation, access to countermeasures during a pandemic is also more challenging, yet essential in reducing the risk of outbreak emergence and amplification.<sup>73</sup> Better international mechanisms should be developed to ensure rapid and effective control of pandemic-prone disease in conflict areas.

**Figure 11.** Number of armed conflicts worldwide 1989–2023



Source: Uppsala Conflict Data Program, Our World in Data, 2024 <https://ourworldindata.org/grapher/number-of-armed-conflicts>



# 2024 GPMB assessment of pandemic risk

## Assessing the 15 pandemic risk drivers of the GPMB Monitoring Framework

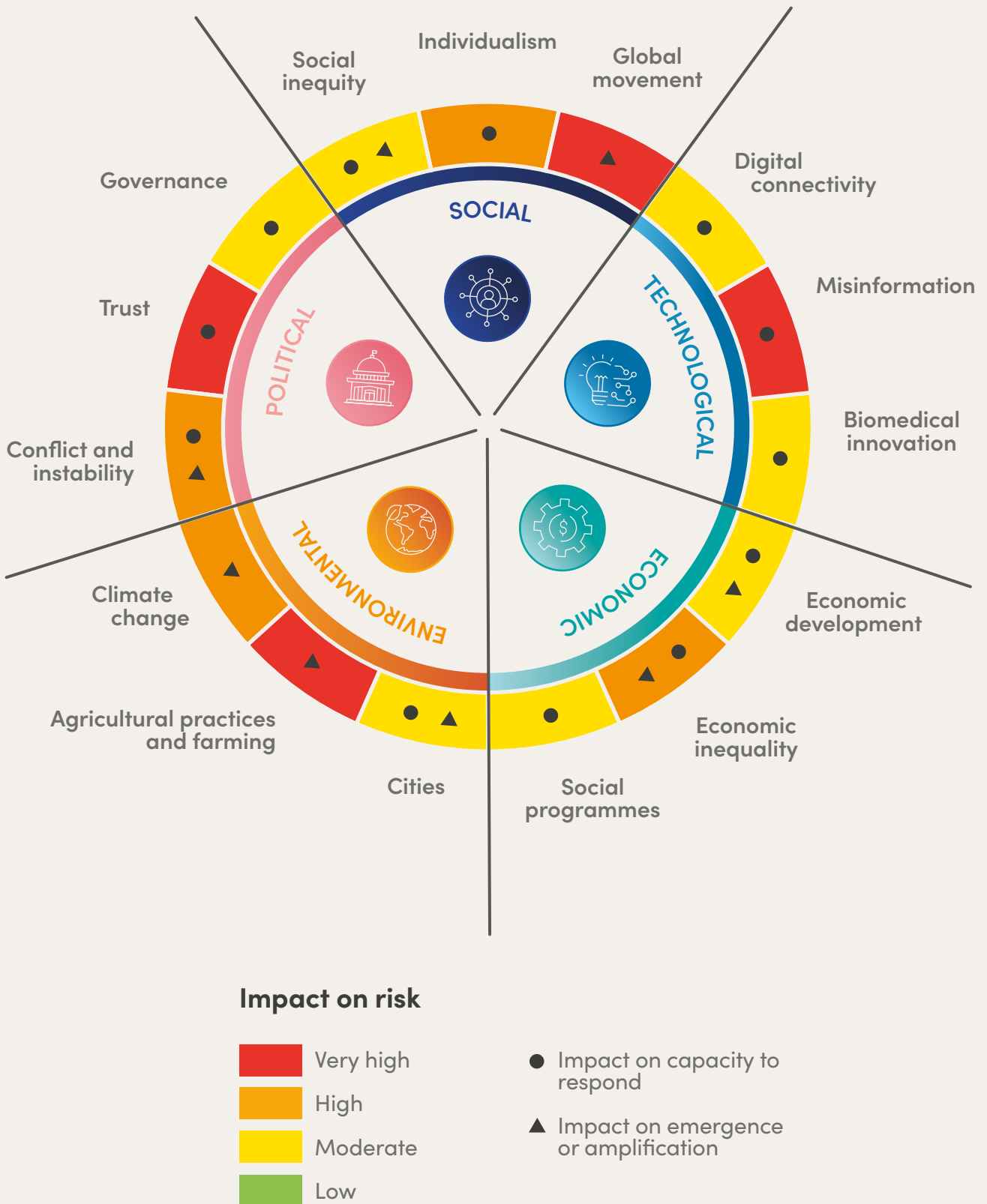
The heatmap opposite shows the GPMB's assessment of each STEEP driver's influence on pandemic risk, based on the quantitative indicators proposed in the GPMB Monitoring Framework. The assessments consider:

- **Trends for each driver** (for example, increasing, decreasing, or diverse trends in different contexts);
- **The driver's relative influence on pandemic risk**, ranging from low to very high, as compared to other drivers rather than on an absolute scale;
- **The need for and feasibility of urgent action** to mitigate these risks.

More information on the methodology informing the GPMB's assessment of pandemic risk can be found in the technical report *Expanding pandemic risk assessment* available on the GPMB website.

The box below provides a summary of this assessment, highlighting the most severe risk drivers for 2024.

**Figure 12.** Impact of drivers on global pandemic and epidemic risk in 2024, based on GPMB and expert analysis



### Box 3. State of global pandemic risk in 2024

Of the 15 pandemic risk drivers assessed by the GPMB in 2024, four impact the level of risk the most: global movement, agricultural practices and farming, misinformation, and trust. The GPMB has observed that these drivers are rapidly increasing and are the most likely to contribute to the emergence and amplification of new outbreaks and epidemics, and to impact our capacity to respond to current ones, if no action is taken soon to address them. This report provides recommended actions for policy-makers to strengthen prevention, preparedness and response in light of these emerging pandemic risk drivers.

- **Global movement** through travel, trade and migration is at a record high and is likely to continue to increase in the coming years. Global movement is becoming a major amplifying factor of epidemics and pandemics. Countries with high mobility (for example, those with international travel hubs, strong livestock trade or with a high number of internally displaced people and refugees) are likely to become more vulnerable.
- **Agricultural practices and farming:** The number of livestock overall has increased dramatically. We are already observing the impact of this driver on the rapid spread of H5N1 globally. As global demand continues to increase, and biosecurity and surveillance measures remain inconsistently applied, the overall risk of spillover and amplification caused by agricultural practices and farming is severe.
- **Misinformation:** Access to and use of social media is on the rise everywhere and individuals are increasingly exposed to false and misleading content. Public health organizations and governments are struggling to keep up with information needs, and to respond to misinformation in a timely manner and prevent mistrust.
- **Trust:** There has been a decline in trust in many countries, distrust in institutions is growing and trust in the multilateral system is at risk. This is impacting our collective capacity both to tackle health emergencies and to find multilateral solutions to protect the world. However, trust-building strategies can be developed to overcome the challenges of pandemic preparedness and response in low-trust environments.

Four other drivers have also been assessed as having a high impact on pandemic risk (**climate change, individualism, economic inequality, and conflict and instability**), and these should also be closely monitored in the future.

# 2

## Retooling preparedness for new pandemic realities

Based on the analysis of risk drivers and the evolving pandemic preparedness landscape, the GPMB proposes three guiding principles to expand the scope and effectiveness of pandemic preparedness:

- 1. Adapt** – the next pandemic will be different from the last. Responses must take into account changing local, national and global contexts, and preparedness approaches must be designed with a focus on adaptability;
- 2. Protect** – holistic systems approaches to protection are needed that boost resilient and capable health systems, articulate with social protection, and are supported by the global health and financing architecture;
- 3. Connect** – the risks attached to increasing planetary connectivity need to be mitigated by better supported intersectoral efforts, including comprehensive One Health approaches.

**Equity** is the cross-cutting factor that makes or breaks pandemic preparedness and response. Inequity creates the ideal conditions for new outbreaks to arise, amplifies spread, and concentrates impact on those least able to bear it. When countermeasures are not equally available to all on the basis of greatest need, global solidarity is undermined and the scars it leaves deepen mistrust between countries. Collective responses of mutual support are the bedrock of effective pandemic preparedness and response. They are the reserves of strength that need to be built up so that they can be ready when crises strike.

# Adapt

**The next pandemic will be different from the last one. The GPMB’s analysis of the drivers of pandemic emergence and amplification reveals a complex and evolving set of risks with considerable variation across countries and regions.**

Key drivers lie outside the traditional domains of health assessment and epidemiology and include social cohesion, trust and economic inequity.

Improved preparedness is cost effective, but plans developed before a crisis need to be applied with flexibility, otherwise they may miss their mark. There is a risk that focusing solely on lessons learned from the COVID-19 pandemic could result in preparing for the last battle rather than the next one. While learning from each crisis is essential, those lessons must be applied to future, unpredictable challenges and needs.

While the nature of the next pandemic is uncertain, analysing pandemic drivers at national and regional levels can highlight vulnerabilities that can be addressed and these mitigations then applied to a range of potential future risks.

Epidemic preparedness has often focused on containing outbreaks with efforts lasting only a few weeks, but policy-makers face the challenge of developing plans for prolonged and evolving crises that unfold in multiple waves of transmission. Agile planning must therefore sustain response efforts while managing multiple crises and an evolving set of risk drivers.

Risk communication strategies need to take account of the new information ecosystem in which we live, characterized by increasing speed and diversity. They need to be able to distinguish between misinformation (which is false) and disinformation (which is intentionally false) and tailor response strategies accordingly. Adaptability, fed by sound real-time intelligence from diverse sources and empathic listening to populations’ concerns, will be the hallmark of effective risk communication and infodemic management in the next pandemic.

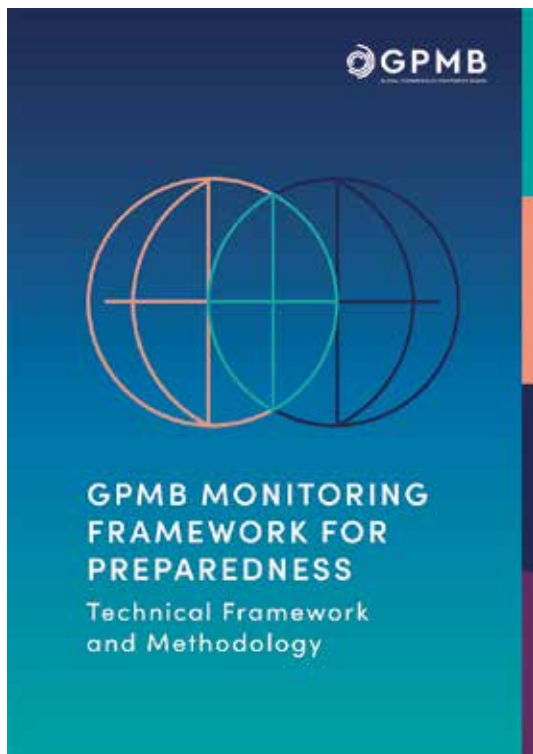
“Pandemic preparedness can’t be a top-down exercise. To truly protect society, we need plans that are inclusive, involving every sector—from local communities to national governments. A whole-of-society and whole-of-government approach is essential because no one is safe unless everyone is.”

Ms Bience Gawanas,  
GPMB Board Member



Photo credit: WHO / Nesma Khan





*GPMB Monitoring Framework for Preparedness*

## RECOMMENDED ACTIONS

Leaders and policy-makers must have to hand current and regularly updated risk profiles and risk assessments across the full range of pandemic risk drivers, as proposed in the GPMB Monitoring Framework for Preparedness.<sup>74</sup>

Countries should undertake regular risk driver assessments before, during and after an epidemic or pandemic and adapt prevention, preparedness and response plans accordingly.

Comprehensive risk assessments should be undertaken on a region-by-region basis to foster efficient international collaboration and increase the world's resilience. They should draw on the expertise of regional political, economic and health institutions, with the support of multilateral institutions, and include government, civil society, and faith and private sector stakeholders.

# Protect

**Protection against the next, unpredictable, pandemic is essential. Indeed, many pandemic risks cannot be easily or rapidly mitigated.**

“Primary health care and its workers are the backbone of global health.”

Ms Henrietta Fore,  
GPMB Board Member



Photo credit: Jan Kpriva on Unsplash

Effective protection relies on an alignment between innovation and equity. Integrated strategies are needed to ensure that these twin goals are paramount in pandemic preparedness and response.

Equity needs to be ‘baked in’ to preparedness from the outset in order to withstand the pressures of a pandemic crisis. Equity-enhancing protection comprises a set of interlocking and overlapping shields, which serve to mitigate risk when it arises and provide the safety nets that assist resilience and rapid recovery.

The GPMB has identified four critical shields that need to be enhanced: health system resilience, international collaboration, social protection and safeguards against accidents.

Even though epidemics and pandemics impact all sectors of society, the health sector remains at the centre of reducing their impact on health and mitigating effects on other sectors. Greater investment in the health system is necessary to ensure its resilience in times of crisis. Improving the preparedness of the health system to face the challenging early days of epidemics depends on ensuring equitable access to pathogen-agnostic interventions (for example, masks) and establishing a strong and equitable primary health care system to detect and address unusual situations locally. Additional training is required to equip health care workers, including the community health workforce, to better serve as credible and trusted ambassadors for medical countermeasures and overcome the challenges posed by low-trust environments. Their efforts should be linked to those of local leaders, respected elders and other community sources of confidence in the pandemic response.

Improved collaboration between countries acts as a shield against the amplification of outbreaks. The 2024 amendments to the IHR (2005) reflect a global commitment to developing a stronger health architecture to respond to pandemics. The ongoing discussions surrounding the Pandemic Agreement similarly aim to enhance political and operational collaboration in both preparedness and response efforts, grounding this collaboration in sustainable global mechanisms and increasing the predictability of future collective engagement. Inequity corrodes trust within countries and between countries, undermining faith in international collaboration. These corrosive effects need to be tackled.

The alignment between global preparedness and financial architectures is core to increased capacity to prevent outbreaks and forestall epidemic amplification. There are major efficiency and effectiveness dividends to be gained by countries from such alignment: enhanced empowerment to define their funding priorities, greater clarity of the financing landscape, increased domestic fiscal space and resource mobilization, and reduced transaction costs. The 21st replenishment cycle of the International Development Association (IDA)



currently underway presents a further opportunity for alignment of the global financial architecture, in particular with its emphasis on crisis preparedness.<sup>75</sup> There is room to further capitalize on synergies between the Pandemic Fund, health funds including the Global Fund to Fight AIDS, TB and Malaria, IDA windows, and IMF special drawing rights and related instruments.

Social programmes serve as a crucial safety net during health emergencies, ensuring that sick employees can stay home to recover, and that vulnerable individuals have the resources to limit their exposure. Evidence from the COVID-19 pandemic shows that public health and social measures were most effective in countries with strong social protection. The impact of pandemics is mitigated by strong social protection programmes, by preventing individuals from falling into poverty, and ensuring income protection. Global inequities in the level of social protection undermine pandemic preparedness, with vastly inadequate investment in social protection in most low-income countries, and situations of severe pandemic vulnerability for those in precarious or informal employment.

The increasing use of new technologies in health, and particularly in epidemics and pandemics, has created major new opportunities for more effective responses including, for example, the development of medical countermeasures. Where these are equitably accessible, they transform epidemic response. However, these technologies also carry the risk of deliberate malicious use, or accidental release of dangerous pathogens linked to those technologies. Similarly, health system vulnerability to ransomware or cyber attack has been repeatedly demonstrated. These risks require a comprehensive framework of regulations and controls to ensure safe and high-quality outcomes when new technologies and practices are implemented.

## RECOMMENDED ACTIONS

**Countries should adopt equity-focused and integrated approaches to pandemic preparedness and response, which include social protection and inclusion strategies, and proactive policies to address economic disadvantage.**

**Countries should take account of the risk of the emergence and amplification of epidemics in conflict situations and address the specific and basic needs of vulnerable populations in these contexts, and develop mechanisms to ensure access to medical countermeasures.**

**Current efforts to enhance international cooperation in pandemic preparedness and response, including implementation of the revised International Health Regulations and negotiation of a new Pandemic Agreement, should be supported. Trust-building measures need to be identified and pursued.**

# Connect

**Given the broad impact of epidemics and pandemics beyond the health sector, it is crucial to enhance communication, data sharing and analysis between sectors, and to develop solutions at the key point of interface between sectors.**

Stronger collaboration and exchange between health and environment sectors is needed to orient investments towards win-win solutions for both sectors. Unintended consequences need to be identified and mitigated, such as the risk that greening cities may improve air quality but inadvertently increase urban vector density, facilitating vector-borne epidemic diseases.<sup>76</sup> Urban pandemic planning is a key discipline to ensure adequate municipal infrastructure, including water and sewer systems, building codes to ensure adequate light, fresh air and bathrooms, and zoning to separate noxious industries from residential areas.<sup>77</sup>

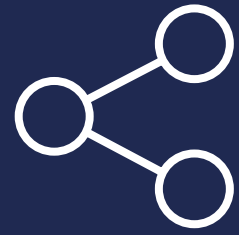
The One Health approach reduces the risk of emerging zoonotic diseases at the human–animal–environment interface.<sup>78</sup> It is more efficient when applied to contextual interventions to address the drivers of emergence in hotspots, including policies aiming at tackling underdevelopment, inequities, social protection and strengthening of primary health care. Better metrics are needed to define hotspots of emergence and to pinpoint the risks attached to human–animal–environment dynamics. The early detection of an epidemic in wild or domestic animals should trigger the strengthening of local responses, and a strengthened primary health care approach supports early detection and rapid access to health care and medical countermeasures, thus reducing the risk of amplification. In many countries this will require further capacity development of animal health and food safety services.

“During a pandemic, we are all in the same boat. The virus exploits any cracks in our defences, much like a Trojan horse – if we let it in it will seek out vulnerabilities in its quest to persist and spread. Our best weapon against it is unity—collaboration and cooperation act as a shield, protecting not just individuals but entire communities. By working together and reinforcing one another’s efforts, we can outmanoeuvre the virus.”

Ms Joy Phumaphi,  
GPMB Co-Chair



Photo credit: WHO



Innovative approaches are needed to maintain global mobility and interconnectedness while protecting health security. Harmonization of data collection would allow a better understanding of new patterns of mobility, measurement of intensity of travel, and modelling of future scenarios of disease spread. During a health emergency, any border control measures or travel restrictions should be carefully assessed to maximize public health impact and minimize negative impacts on countries and communities. Development and implementation of these measures will require strong collaboration and cooperation between countries and between sectors. Establishing this collaboration in advance of a health emergency will be essential.

Investing in a whole-of-society and more inclusive pandemic preparedness and response is crucial to addressing the complexity of pandemic risk drivers. This requires not only cross-sector collaboration, such as through One Health approaches, but also strong connections between multiple stakeholders at the interface of the public and private sectors, institutions, and civil society organizations.

## RECOMMENDED ACTIONS

Preparedness for health emergencies should be planned and financed intersectorally. Effective approaches to collaborative intersectoral efforts require dedicated funding streams, and designated and accountable coordination mechanisms.

Increasing disease outbreak risks at the human–animal–environment interface, including those driven by climate change, need to be better identified and understood, especially in hotspots that carry a higher likelihood of outbreak emergence.

Countries need to invest in risk mitigation in hotspots, by applying a One Health approach and intensifying the multinational and multilateral focus on collaborative preparedness.

The United Nations system, regional organizations and all elements of the global and regional multilateral governance system need to be better engaged in a coordinated and holistic approach to pandemic risk.

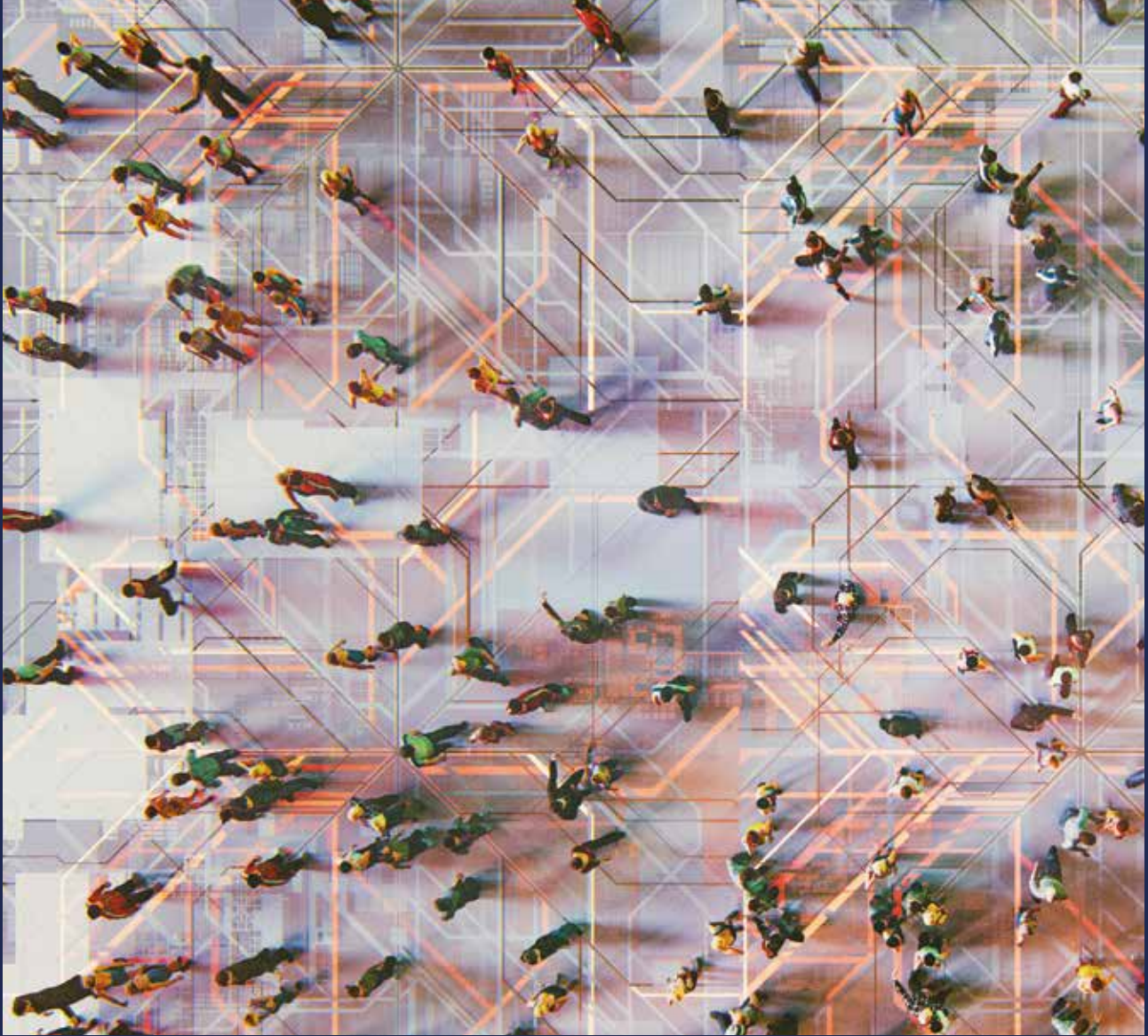


Photo credit: gremlin on iStock

# Conclusion

**Pandemic preparedness misses the big picture if it is solely focused on viruses and medical interventions.**

The recent experience of the COVID-19 pandemic compels us to rethink preparedness through the lens of the complex interactions between humans, the environment, animals, and new technologies. It requires new and enhanced tools that develop a more nuanced and contextualised understanding of human factors, along with a more profound practical understanding of the diverse sectoral disciplines that can be applied to preparedness. Embracing interdisciplinarity, intersectoral collaboration, and greater inclusiveness will allow us to harness the full potential of collective human intelligence to develop effective solutions for the pandemics of the 21st century.

The changing face of pandemic risk demands that we adapt our plans accordingly; that we protect the world's people with fit-for-purpose holistic systems, working and collaborating across sectors, stakeholder groups, countries and continents. The GPMB calls on all global leaders and stakeholders to respond urgently to this call.

# GPMB purpose and membership

The GPMB is an independent monitoring and accountability body to ensure preparedness for global health crises, co-convened by the World Health Organization and the World Bank Group. The Board provides an independent and comprehensive appraisal for leaders, key policy-makers and the world on system-wide progress towards increased preparedness and response capacity for disease outbreaks and other emergencies with health consequences. The Board monitors and reports on the state of global preparedness across all sectors and stakeholders, including the UN system, government, non-governmental organizations, and the private sector.

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# Abbreviations

<b>Africa CDC</b>	Africa Centres for Disease Control and Prevention
<b>AI</b>	Artificial intelligence
<b>COVID-19</b>	Coronavirus disease
<b>DNA</b>	Deoxyribonucleic acid
<b>DRC</b>	Democratic Republic of Congo
<b>HEPR</b>	Health emergency preparedness and response
<b>HIV/AIDS</b>	Human immunodeficiency virus/Acquired Immune Deficiency Syndrome
<b>IDA</b>	International Development Association
<b>IHR</b>	International Health Regulations
<b>IMF</b>	International Monetary Fund
<b>INB</b>	Intergovernmental Negotiating Body
<b>MERS</b>	Middle East respiratory syndrome coronavirus
<b>mpox</b>	formerly known as monkeypox
<b>mRNA</b>	Messenger ribonucleic acid
<b>MSM</b>	Men who have sex with men
<b>PHECS</b>	Public Health Emergency of Continental Security
<b>PHEIC</b>	Public Health Emergency of International Concern
<b>PPE</b>	Personal protective equipment
<b>R&amp;D</b>	Research and development
<b>SARS</b>	Severe acute respiratory syndrome
<b>SARS-CoV-2</b>	Severe acute respiratory syndrome coronavirus, second strain
<b>STEEP</b>	Social, technological, environmental, economic and political
<b>TB</b>	Tuberculosis
<b>UN</b>	United Nations
<b>WHO</b>	World Health Organization



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