Why Africa Must Invest in Genomic Surveillance for Health Security

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Introduction

Genomic surveillance has emerged as a powerful tool in public health, revolutionizing how countries detect, monitor, and respond to health threats. The COVID-19 pandemic offered the most compelling example of how genomics and genomic surveillance can directly inform public health actions and deliver measurable impact[1]. During the pandemic, genomic surveillance played a pivotal role in generating valuable data on the novel coronavirus, SARS-CoV-2.[2] It enabled the rapid sequencing of the virus's genome, tracking of transmission patterns, and monitoring of genetic mutations that could affect virulence, transmissibility, treatment outcomes, and vaccine efficacy.[3] These insights allowed policymakers around the world to make timely, evidence-based decisions.[1] Moreover, the prompt sequencing and global sharing of the SARS-CoV-2 genome set the stage for the fastest vaccine development in human history. What began as a mysterious pneumonia in Wuhan, China, led to Pfizer producing a vaccine candidate in about 7 months, and within a year, vaccines were being rolled out for emergency use worldwide.[4]

Potential Use Cases for Genomic Surveillance Are Vast

The potential applications of genomics span nearly every aspect of public health, from outbreak detection to the control of endemic diseases.[5] While pandemic response has been a major focus of genomic surveillance, the use cases for genomic surveillance extend well beyond emergencies. It plays a critical role in addressing emerging and re-emerging public health challenges [6]. For instance, pathogen genomics is essential in monitoring antimicrobial resistance (AMR) by identifying resistant strains and informing treatment strategies.
It also aids in tracking the emergence and spread of drug-resistant malaria parasites and supports the development of more effective HIV treatments and vaccines.[7]

Another promising application lies in wastewater and environmental surveillance. Genomic sequencing can detect and monitor pathogens circulating silently within communities, serving as an early warning system for outbreaks. This method is not only non-invasive but also cost-effective, allowing for continuous monitoring of public health threats at the population level before they escalate.[6,8]

In the context of vaccine-preventable diseases (VPDs), genomics can significantly enhance traditional surveillance systems. It enables characterization of circulating strains, facilitates the monitoring of genetic mutations that may affect vaccine efficacy, and supports the design of next-generation vaccines tailored to specific regional variants.[7,9] For example, genomic data can guide the periodic updating of measles, rotavirus, and pneumococcal vaccines to ensure efficacy against locally dominant strains.[6,9]

Moreover, integrating genomics into the surveillance of endemic diseases such as malaria, tuberculosis, and HIV can transform disease control and elimination efforts. For malaria, genomic sequencing provides insights into parasite population structures and resistance patterns, allowing for more targeted interventions. In tuberculosis, genomics can pinpoint transmission hotspots and track multidrug-resistant strains with greater accuracy[10]. For HIV, sequencing helps identify resistance mutations, guides individualized treatment regimens, and informs vaccine development by mapping the diversity of viral strains across populations.[6]

These use cases demonstrate that genomic surveillance is not just a tool for outbreak response, as was evident during COVID-19, but a fundamental component for building more resilient, data-driven public health

systems.

Investing in Genomics and Genomic Surveillance is non-negotiable for Africa.

Africa bears the highest burden of infectious diseases globally and reports over 100 public health emergencies each year. [11] For instance, the continent accounts for 94% of the world's malaria cases and 95% of malaria-related deaths. Furthermore, Africa shoulders 40% of the global burden of Neglected Tropical Diseases, with every country on the continent facing at least one endemic NTD.[12] Endemic diseases such as HIV, tuberculosis, and malaria continue to cause substantial morbidity and mortality across the continent.[13] This complex and diverse pathogenic landscape demands robust surveillance systems capable of providing real-time insights into pathogen evolution and transmission dynamics. Yet, historically, disease surveillance in Africa has relied heavily on traditional microbiology and serology methods, which lack the precision, speed, and scalability required for timely public health decision-making.[7]

Before the COVID-19 pandemic, genomic sequencing capacity was either limited or non-existent in many African countries, leading to dependence on overseas laboratories. This reliance often resulted in significant delays in data generation, analysis, and response, undermining the ability to act swiftly during outbreaks.[14] Several structural and technological barriers continue to impede progress. Establishing and maintaining sequencing facilities requires significant financial investment, and the shortage of trained personnel to operate, analyze, and interpret genomic data remains a significant constraint.[1] The lack of bioinformatics expertise, essential for transforming raw sequencing data into actionable public health intelligence, is one of the most pressing bottlenecks. Genomics is as much a data science as it is a laboratory science. However, many countries across the continent face a scarcity of skilled bioinformaticians, limited access to high-performance computing infrastructure, and unreliable internet connectivity, which hampers cloud-based analysis.[7,15] Additionally, challenges related to data sharing, harmonized standards, and customs delays in procuring laboratory reagents further constrain the effective use of genomics in real-time public health decision-making.[15]

Addressing these challenges requires sustained and substantial investment. For Africa, investing in genomics and genomic surveillance is not optional; it is essential for building resilient health systems that can detect, respond to, and ultimately control both emerging and endemic public health threats. Moreover, substantial investment in genomics will help bridge the genomic divide, positioning Africa to contribute to global health security.

Leveraging partnerships and networks will be critical.

The COVID-19 pandemic not only revealed vulnerabilities in global health systems but also served as a powerful catalyst for scientific innovation and technology transfer. Since 2019, Africa has made notable progress in building genomic capacity, progress that was mostly accelerated by the urgency of the pandemic.1 Fast forward to 2025, infrastructure initially established for COVID-19 genomic surveillance has since been used to identify the Mpox Clade 1b variant, monitor cholera outbreaks across seven countries, and support responses to Marburg virus in Rwanda and Ebola in Uganda.[1]

However, fully unlocking the potential of genomic surveillance will require continued commitment, strategic investment, and, crucially, strengthened collaboration through regional and global partnerships will be essential.[1] Partnerships offer opportunities for technology transfer, skills development, and coordinated resource mobilisation, which are vital for low- and middle-income countries, particularly in Africa.

In the aftermath of COVID-19, a number of global and regional networks have emerged to support these efforts. The International Pathogen Surveillance Network (IPSN), established two years ago, now comprises nearly 350 partners across more than 105 countries, working collectively to expand equitable access to genomic tools and expertise.[1] On the African continent, the Africa Pathogen Genomics Initiative (Africa PGI), launched in 2020, has focused on five key areas: creating enabling mechanisms, democratizing access to sequencing, especially in high-burden countries, strengthening regional and global networks, promoting data sharing, and enhancing data utilization for public health action.[1,16,17]

At the national level, Zambia has taken significant steps to scale up genomic capacity by launching the Pathogen Genomic Surveillance Strategy for Zambia (2025-2029) and establishing the Zambia Genomic Sequencing Consortium in 2025. These efforts aim to strengthen end-to-end capabilities, from the identification of priority pathogens, expanding use cases to

sampling, laboratory processing, genome sequencing, data analysis, storage, and sharing. The strategy prioritizes the development of a national genomic surveillance network, workforce development and retention, a robust supply chain, laboratory quality management systems, and sustainable partnerships. It is aligned with global and regional frameworks, including the World Health Organization's Global Genomic Surveillance Strategy for Pathogens with Pandemic and Epidemic Potential (2022-2032) and the Africa CDC's Pathogen Genomics Surveillance Policy Framework. A core aspiration of Zambia's strategy is to achieve integration of pathogen genomics across the human-animal-environmental interface to enhance evidence-based public health decision making anchored in the One Health Approach.

Given Africa's disproportionately high burden of infectious diseases, investing in genomics is not just strategic, it is essential.[16] Strengthening genomic capacity will not only accelerate the generation of timely genomic data but also enable its translation into actionable public health strategies.[1] To achieve this, governments, regional institutions, and international partners must prioritize long-term investment in genomics infrastructure, workforce development, and interoperable data-sharing systems. Only through sustained collaboration and shared responsibility can Africa realise the full potential of the use of genomics to improve health outcomes and strengthen health security.

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