News and Perspectives

Building a Malaria Intelligence System for Real-Time Prediction and Data-Driven Intervention Planning

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Abstract

Sub-Saharan Africa continues to face the highest malaria burden worldwide, accounting for 95% of malaria cases and deaths according to the World Health Organization. In this *News and Perspectives* article, JMIR Correspondent Sharon Muzaki reports on a new artificial intelligence system in sub-Saharan Africa that could help improve public health responses to the disease.

Key Takeaways:

- AI-driven malaria intelligence systems could transform disease surveillance and intervention planning in high-burden settings by integrating epidemiological, climatic, and environmental data into predictive public health models.
- Their success in supporting long-term malaria control will depend on continuous monitoring frameworks, localized adaptation, and integration into existing health care systems.

Malaria remains one of the most persistent public health challenges in sub-Saharan Africa, particularly among children under 5 and pregnant women. Despite decades of interventions involving insecticide-treated nets, antimalarial drugs, indoor residual spraying, vaccination campaigns, and donor-funded awareness programs, transmission remains high in many endemic regions.

Nigeria bears the world's highest malaria burden, while the Democratic Republic of Congo (DRC) ranks among the highest-burden countries globally. Together, the two countries account for a substantial proportion of malaria cases and deaths worldwide. In many high-burden settings, however, malaria surveillance still relies heavily on routine reporting systems and periodic surveys, limiting the ability to detect changing transmission patterns and evaluate interventions in near real time.

At the Femi Samson Institute of AI & Biomedical Research (FSI-AIBR) in Lagos, Nigeria, Daniel Onimisi, MSc, the institute's founder and executive director, is developing an AI-driven malaria intelligence platform designed to shift malaria control from reactive intervention toward predictive and precision public health.

The platform combines epidemiological data, environmental monitoring, climate indicators, and machine learning models into a continuous intelligence framework aimed at improving outbreak prediction, intervention targeting, and resource allocation.

From Static Surveillance to Continuous Intelligence

Traditional malaria surveillance systems, which typically rely on health-facility reports and routine case data collected after infections have occurred, are largely designed to describe what has already happened. By contrast, the new tool integrates multiple datasets to identify risk patterns and provide early warning signals that can inform preventive action. While traditional surveillance systems remain useful for broad planning, they often struggle to anticipate changing transmission patterns or evaluate the long-term effects of interventions.

Onimisi believes this represents a major gap in current malaria programs. "What happens after the intervention ends? How do we measure whether the resources deployed actually changed malaria outcomes over time?" Onimisi asks.

He says many interventions focus heavily on distributing mosquito nets and medicines, as well as conducting awareness campaigns, but lack mechanisms for continuous assessment once funding cycles end.

The malaria intelligence platform was designed to address this challenge by functioning as a decision-support system capable of supporting prediction, preparedness, monitoring, and postintervention assessment.

To achieve this, the system integrates multiple datasets, including Demographic and Health Survey (DHS) data, Malaria Indicator Survey (MIS) datasets, rainfall information, satellite-derived vegetation monitoring, historical malaria incidence records, and geospatial analyses.

Using geospatial segmentation, the platform divides Nigeria into state boundaries, local government areas, and smaller clusters linked to environmental and epidemiological variables. Onimisi says the system currently analyses approximately 435,000 localized clusters across the country.

Integrating Climate and Environmental Drivers

Malaria transmission is closely linked to environmental and climatic conditions.

Rainfall accumulation, vegetation density, stagnant water, flooding patterns, and changing climate conditions all influence mosquito breeding and transmission dynamics. Urbanization, deforestation, and population movement further complicate these patterns. Climate variability may also alter malaria distribution across Africa in ways that conventional surveillance systems struggle to detect.

To capture these relationships, the platform combines satellite-derived vegetation indices with rainfall and climate datasets spanning more than three decades. This allows the system to identify ecological conditions that may favor malaria transmission before outbreaks become visible through routine health reporting.

Machine Learning and Predictive Modeling

Machine learning forms the analytical core of the platform.

Historical malaria incidence data are combined with climatic and environmental variables to estimate malaria risk probabilities across geographic regions. This approach builds on earlier work by Onimisi and colleagues, currently available as a preprint, integrating DHS and MIS biomarkers with 34 years of CHIRPS-NDVI (Climate Hazards Center Infrared Precipitation with Stations - Normalized Difference Vegetation Index) climate data and machine learning techniques to predict malaria risk and generate spatial maps of transmission patterns. These predictions are then compared with reported malaria incidence to identify discrepancies between expected transmission patterns and observed disease burden.

Areas with high predicted risk but low reported incidence may indicate underreporting, limited health care access, disruptions to health services, self-medication, or other barriers preventing communities from seeking formal care.

Such mismatches may reveal potential blind spots in surveillance systems and health care delivery, prompting further investigation into the factors influencing malaria transmission and case reporting.

Onimisi recalls being surprised by some of the model's outputs. “When I first ran the model, there were areas where the outputs surprised me,” he says. “The risk patterns did not always match what we assumed from existing reporting systems.”

Beyond forecasting, the platform can also evaluate the impact of interventions such as mosquito net distribution, vaccination programs, health care worker training, and public awareness campaigns.

Supporting Smarter Intervention Decisions

The malaria intelligence system is designed to support governments, researchers, nongovernmental organizations, and public health agencies involved in malaria control.

Its outputs can guide allocation of mosquito nets and vaccines, identify high-risk communities, support deployment of surveillance teams, and improve targeting of awareness campaigns. Rather than relying solely on national-level prevalence estimates, the platform seeks to identify fine-scale transmission patterns at cluster and community levels, enabling more targeted interventions and more efficient use of limited resources.

It also promotes continuity between intervention cycles by creating an ongoing surveillance and response framework rather than treating malaria control as a series of isolated campaigns.

Scaling Beyond Nigeria

Although Nigeria serves as the initial implementation environment, the long-term vision extends beyond a single country. Onimisi is exploring expansion of the platform to the DRC, another high-burden setting characterized by environmental diversity, complex health systems, and ongoing humanitarian pressures.

Scaling the technology, however, involves more than technical replication. It requires adaptation to different health systems, infrastructures, and local realities.

In the longer term, similar predictive intelligence systems could potentially be adapted to diseases such as Ebola, Lassa fever, and future emerging infectious threats.

Challenges to Implementation

Despite its potential, scaling predictive malaria intelligence systems across Africa presents significant challenges.

Health, climate, and environmental datasets are often fragmented across institutions, limiting interoperability and integration. Computational requirements and funding constraints remain substantial, particularly when processing large geospatial and epidemiological datasets.

Infrastructure limitations, especially in rural areas, also affect data collection and system deployment. Limited internet connectivity, unreliable electricity, and weak digital health systems can constrain practical implementation.

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>
> Daniel Onimisi, MSc

For Onimisi, technological sophistication alone is insufficient.

“There is no value in building systems that communities and health workers cannot realistically use,” he says. Successful adoption, he argues, depends on ensuring that predictive technologies are aligned with the realities of frontline health systems and community needs.

Toward African-Led Disease Intelligence

The malaria intelligence platform highlights a broader transformation underway in global health.

Future surveillance systems are likely to become increasingly interdisciplinary, combining epidemiology, climate science, geospatial analytics, and AI into unified public health frameworks. Their effectiveness, however, will depend on sustained data infrastructure, usability, and integration into public health decision-making systems.

The project also reflects the growing role of African-led innovation in digital health. Rather than relying solely on externally designed surveillance systems, locally developed platforms such as SORMAS (Surveillance Outbreak Response Management and Analysis System), which is used for disease surveillance across several African countries, and Uganda’s mTrac health reporting system are increasingly shaping how health data are generated, interpreted, and translated into action.

With Nigeria serving as the primary testing ground and the DRC identified as the next phase of expansion, the project illustrates how African-led intelligence systems could help make malaria surveillance more predictive, adaptive, and responsive to changing patterns of transmission across malaria-endemic regions.

Updated July 02, 2026: An earlier version of this article contained a duplicate sentence that has since been deleted. The duplicate read “Such mismatches can reveal important blind spots in surveillance systems.”

Keywords: malaria; artificial intelligence; machine learning; public health; disease surveillance; Nigeria; Democratic Republic of the Congo; epidemiology

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