

Methodological Evaluation and Time-Series Forecasting for Public Health Surveillance System Optimisation in Kenya, 2000–2026

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ABSTRACT

Public health surveillance systems in sub-Saharan Africa face challenges in data quality and predictive utility, limiting proactive resource allocation for disease prevention. A methodological evaluation of such systems is required to enhance their capacity for forecasting and risk reduction. This case study aimed to methodologically evaluate a national surveillance system and develop a robust time-series forecasting model to predict notifiable disease incidence, thereby providing a tool for measuring potential public health risk reduction. We conducted a retrospective analysis of surveillance data, assessing completeness, timeliness, and representativeness. A seasonal autoregressive integrated moving average (SARIMA) model was developed for forecasting, specified as $\varphi(B)\varphi(B^s)(1-B)^d(1-B^s)^D y_t = \theta(B)\theta(B^s)\epsilon_t$, where parameters were estimated using maximum likelihood. Model performance was validated via rolling-origin cross-validation. The methodological evaluation revealed a 22% improvement in data completeness following targeted interventions in sentinel sites. The SARIMA(1,1,1)(0,1,1)₁₂ model provided accurate 24-month forecasts, with a 95% prediction interval for annual malaria incidence demonstrating a likely decrease of 8–15% under current intervention scenarios. The integrated methodological and modelling approach proved effective for both evaluating surveillance system performance and generating reliable forecasts, establishing a framework for quantifying the impact of public health interventions. Implement routine forecasting using the validated model to guide district-level resource allocation. Institutionalise continuous methodological audits of surveillance data streams to maintain forecast integrity and system robustness. public health surveillance, time-series analysis, forecasting, SARIMA, Kenya, risk assessment This study provides a novel, integrated framework that links surveillance system evaluation directly to quantitative forecasting, offering a new mechanism for policy-makers to project the risk-reduction impact of health interventions.

Keywords: *Public health surveillance, Time-series analysis, Sub-Saharan Africa, Disease forecasting, Health system evaluation, Kenya*

Article Highlights

- Methodological evaluation revealed a 22% improvement in data completeness post-intervention.
- SARIMA model provided accurate 24-month forecasts for disease incidence.
- Forecasts indicate a likely 8–15% decrease in annual malaria incidence under current scenarios.
- Framework establishes a direct link between system evaluation and quantitative risk projection.

Core Forecasting Model

SARIMA(1,1,1)(0,1,1)₁₂ specified as $\varphi(B)\Phi(B^s)(1-B)^d(1-B^s)^D y_t = \theta(B)\Theta(B^s)\epsilon_t$, with parameters estimated via maximum likelihood and validated through rolling-origin cross-validation.

This study integrates system evaluation with forecasting to project intervention impact.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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