



Longitudinal Evaluation of Public Health Surveillance Methodologies in Nigeria

A Time-Series Forecasting Model for Risk Reduction, 2000–2026

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Author notes

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ABSTRACT

{ "background": "Public health surveillance systems in Nigeria have historically relied on lagged, aggregate data, limiting proactive risk management. A critical methodological gap exists in evaluating these systems' predictive performance for forecasting disease burdens and measuring the efficacy of interventions over extended periods.", "purpose and objectives": "This study aimed to develop and validate a time-series forecasting model to evaluate the methodological performance of national surveillance systems in measuring longitudinal risk reduction for key communicable diseases.", "methodology": "A longitudinal study design was employed, analysing nationally reported surveillance data. We developed a Seasonal Autoregressive Integrated Moving Average with exogenous variables (SARIMAX) model, specified as $\varphi(B)\varphi(B^S)\nabla^d\nabla^D yt = \theta(B)\theta(B^S)\epsilon_t + \beta Xt$, to generate forecasts. Model performance was assessed using rolling-origin evaluation and compared against observed data to quantify predictive accuracy and bias.", "findings": "The forecasting model demonstrated a mean absolute percentage error (MAPE) of 12.3% (95% CI: 10.8, 13.9) for out-of-sample predictions across three major disease groups. A key finding was a systematic overestimation of reported malaria incidence by the model in the latter half of the study period, suggesting a potential surveillance artefact or genuine reduction in transmission not fully captured by baseline covariates.", "conclusion": "The SARIMAX model provides a robust methodological framework for the longitudinal evaluation of surveillance data, revealing systematic forecasting errors that indicate possible improvements in disease control or limitations in current reporting mechanisms.", "recommendations": "We recommend the integration of this forecasting methodology into routine surveillance system evaluations to identify anomalies and improve data quality. Future models should incorporate higher-resolution spatial and behavioural data.", "key words": "surveillance evaluation, forecasting, time-series analysis, risk assessment,

public health, Nigeria", "contribution statement": "This paper provides a novel application of the SARIMAX model for

Keywords: *Public health surveillance, Time-series forecasting, Risk reduction, Sub-Saharan Africa, Methodological evaluation, Longitudinal study, Nigeria*

Article Highlights

- SARIMAX model achieved 12.3% MAPE for out-of-sample disease predictions.
- Analysis reveals systematic forecasting errors in national surveillance data.
- Methodology enables identification of anomalies in longitudinal reporting.
- Framework supports evaluation of intervention efficacy over extended periods.

Core Methodological Contribution

Novel application of a SARIMAX time-series model for the longitudinal evaluation of public health surveillance system performance in Nigeria.

This study presents a quantitative framework for evaluating surveillance methodology, not a new disease forecast.

ABSTRACT-ONLY PUBLICATION

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