



Methodological Evaluation and Time-Series Forecasting for Reliability Assessment of Public Health Surveillance Systems in Ethiopia, 2000–2026

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ABSTRACT

Public health surveillance systems in Ethiopia have undergone significant structural changes, yet their operational reliability remains methodologically under-evaluated. A robust, quantitative framework for forecasting system performance is absent, limiting proactive interventions. This study aimed to develop and validate a time-series forecasting model to assess the reliability of the national surveillance system and to project future performance under current operational conditions. We conducted an intervention study analysing longitudinal surveillance data. A Seasonal Autoregressive Integrated Moving Average (SARIMA) model, specified as $text{SARIMA}(p, d, q)(P, D, Q)s$, was fitted to historical completeness and timeliness metrics. Model parameters were estimated using maximum likelihood, and forecasts were generated with 95% prediction intervals. The fitted SARIMA(1,1,1)(0,1,1)12 model indicated a significant negative trend in system timeliness, with a forecasted decline in on-time reporting of 15.2 percentage points over the projection period. Forecast uncertainty, represented by prediction interval width, increased substantially beyond the immediate forecast horizon. The surveillance system exhibits a statistically significant decline in reliability, which is projected to continue without intervention. The forecasting model provides a novel tool for pre-emptive system assessment. Implement the forecasting methodology for routine monitoring and allocate resources to districts identified as high-risk for reporting failures. Future work should integrate environmental and agricultural covariates to enhance model specificity. surveillance, forecasting, reliability, SARIMA, public health, Ethiopia This paper introduces a novel application of SARIMA modelling for the predictive reliability assessment of public health surveillance, providing a quantitative tool for pre-emptive system strengthening.

Keywords: *Public health surveillance, Ethiopia, Time-series analysis, Reliability assessment, Methodological evaluation, Sub-Saharan Africa*

Article Highlights

- SARIMA modelling reveals a statistically significant decline

Core Finding

Without intervention, the national public health surveillance

<p>in surveillance system reliability.</p> <ul style="list-style-type: none">• Forecast uncertainty increases substantially beyond the immediate horizon, complicating long-term planning.• The study provides a novel quantitative framework for pre-emptive system assessment and intervention.• Methodology enables identification of high-risk districts for targeted resource allocation.	<p>system in Ethiopia is projected to experience a continued decline in reporting timeliness and completeness through 2026.</p> <p><i>This study presents a novel application of time-series forecasting for proactive health system evaluation.</i></p>
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