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A Bayesian Hierarchical Model for the Methodological Evaluation and Efficiency Optimisation of Public Health Surveillance Systems in Ethiopia, 2000–2026

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ABSTRACT

Background: Public health surveillance systems are critical for disease control, yet their methodological evaluation, particularly regarding efficiency and predictive capacity, remains underdeveloped in many low-resource settings. Existing approaches often lack robust frameworks for quantifying uncertainty and integrating heterogeneous data streams.

Purpose and objectives: This study aimed to develop and apply a novel Bayesian hierarchical model to methodologically evaluate the efficiency of national public health surveillance and to identify key leverage points for its optimisation.

Keywords: *Bayesian hierarchical modelling, public health surveillance, efficiency optimisation, sub-Saharan Africa, methodological evaluation, predictive validity*

Article Highlights

- Bayesian hierarchical model quantifies surveillance efficiency and uncertainty.
- Identifies reporting timeliness as a critical leverage point for optimisation.
- Reveals substantial regional heterogeneity in system performance.
- Embeds stochastic frontier analysis within a probabilistic framework.

Core Methodological Contribution

A novel Bayesian hierarchical model integrating longitudinal performance data, resource metrics, and outcome indicators to evaluate and optimise public health surveillance systems.

Presents a robust quantitative framework for surveillance system evaluation in low-resource settings.