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A Bayesian Hierarchical Model for Assessing the Reliability of Public Health Surveillance Systems in Uganda, 2000–2026

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ABSTRACT

Background: Public health surveillance systems are critical for disease control, yet their reliability in low-resource settings is often uncertain. Existing evaluation frameworks lack robust quantitative methods to integrate heterogeneous data sources and account for spatial and temporal dependencies in system performance.

Purpose and objectives: This study aimed to develop and apply a novel Bayesian hierarchical model to quantitatively assess the reliability of national public health surveillance, defined as the probability of correctly detecting and reporting a notifiable disease event.

Keywords: *Bayesian hierarchical modelling, public health surveillance, health information systems, sub-Saharan Africa, reliability assessment, Uganda, disease control*

Article Highlights

- Develops a novel Bayesian latent variable model to quantify surveillance reliability.
- Reveals median national reliability of 0.72 with significant spatial heterogeneity.
- Identifies health facility density as a key determinant of system performance.
- Provides a data-driven tool for targeting surveillance strengthening efforts.

Core Reliability Metric

The model estimates reliability ρ_{it} via $\text{logit}(\rho_{it}) = \alpha + \beta X_{it} + u_i + \gamma_t$, incorporating covariates, spatial random effects, and temporal trends.

This study presents a novel quantitative framework for assessing public health surveillance systems.