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A Bayesian Hierarchical Model for Evaluating Public Health Surveillance System Adoption in Rwanda

An Intervention Study, 2000–2026

Jean de Dieu Uwimana[1], **Jean Paul Mugabo**[2]
Marie Aimee Mukantwari[1,3]

[1] *Department of Public Health, University of Rwanda*
[2] *Rwanda Environment Management Authority (REMA)*
[3] *Department of Pediatrics, African Leadership University (ALU), Kigali*

Correspondence: juwimana@aol.com

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Author notes

Jean de Dieu Uwimana is affiliated with Department of Public Health, University of Rwanda and focuses on Medicine research in Africa.

Jean Paul Mugabo is affiliated with Rwanda Environment Management Authority (REMA) and focuses on Medicine research in Africa.

Marie Aimee Mukantwari is affiliated with Department of Public Health, University of Rwanda and focuses on Medicine research in Africa.

ABSTRACT

Background: The adoption of public health surveillance systems in low-resource settings is critical for food security and disease control, yet robust methodological frameworks for evaluating their uptake are lacking. Existing approaches often fail to account for hierarchical data structures and uncertainty inherent in longitudinal implementation studies.

Purpose and objectives: This study aimed to develop and apply a novel Bayesian hierarchical model to evaluate the adoption rates of a nationwide electronic integrated disease surveillance and response system. The primary objective was to quantify temporal and spatial heterogeneity in adoption across administrative districts.

Keywords: *Bayesian hierarchical modelling, public health surveillance, intervention study, sub-Saharan Africa, methodological evaluation, adoption rates*

Article Highlights

- Develops a novel Bayesian hierarchical model for evaluating surveillance system adoption.
- Quantifies temporal and spatial heterogeneity in adoption rates across districts.
- Posterior probability >0.99 indicates the intervention had a positive effect.
- Reveals some regions lagging by an estimated 15-20

Core Model Specification

$\text{logit}(p_{ijt}) = \alpha + \beta X_{ijt} + u_i + v_{jt}$, where p_{ijt} is the adoption probability for facility i in district j at time t.

Presents a probabilistic framework for evaluating public health surveillance adoption in Rwanda.

percentage points.	