

A Bayesian Hierarchical Model for Evaluating the Adoption of Community Health Centre Systems in Rwanda

A Methodological Assessment, 2000–2026

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ABSTRACT

Background: The evaluation of health system adoption in low-resource settings requires robust statistical methods to handle sparse, multi-level data and quantify uncertainty. Existing approaches often fail to adequately model the hierarchical structure of community-level interventions and their temporal evolution.

Purpose and objectives: This study presents a novel Bayesian hierarchical model to methodologically assess the adoption dynamics of community health centre systems. The objective is to provide a rigorous framework for estimating adoption rates and their predictors while fully characterising uncertainty.

Keywords: *Bayesian hierarchical modelling, health systems research, community health centres, sub-Saharan Africa, adoption evaluation, Rwanda*

Article Highlights

- A novel Bayesian hierarchical model for evaluating health system adoption in low-resource settings.
- Quantifies adoption trajectories and key drivers while fully characterising uncertainty.
- Posterior analysis shows significant spatial clustering in adoption rates across administrative units.
- Provides a statistically sound framework with probabilistic interpretations for policy planning.

Methodological Core

Bayesian hierarchical model specified as $y_{it} \sim \text{Binomial}(n_{it}, \theta_{it})$, with $\text{logit}(\theta_{it}) = \alpha + \beta X_{it} + u_i + v_t$, fitted using Hamiltonian Monte Carlo.

This study presents a methodological framework, not a policy outcome evaluation.

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