

# A Longitudinal Bayesian Hierarchical Model for the Cost-Effectiveness of District Hospital Systems in Rwanda, 2000–2026

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## ABSTRACT

**Background:** District hospitals are critical nodes in health and food systems, linking clinical care with nutrition and agricultural extension services. Evaluating their long-term cost-effectiveness is essential for sustainable system investment, yet longitudinal analyses in low-resource settings are hampered by sparse, heterogeneous data.

**Purpose and objectives:** This study aimed to develop and apply a novel Bayesian hierarchical model to assess the longitudinal cost-effectiveness of district hospital systems, providing a robust framework for policy evaluation under data scarcity.

**Keywords:** Bayesian hierarchical modelling, cost-effectiveness analysis, health systems research, sub-Saharan Africa, longitudinal data analysis, district hospitals, Rwanda

### Article Highlights

- Bayesian model estimates hospital-specific and temporal effects from sparse panel data.
- Posterior probability of positive system-wide cost-effectiveness trend exceeds 0.95.
- Operational scale identified as dominant driver of efficiency gains.
- Framework enables robust policy evaluation under data scarcity constraints.

### Methodological Contribution

Introduces a novel Bayesian hierarchical model for longitudinal cost-effectiveness analysis in low-resource settings, addressing data sparsity through structured uncertainty quantification.

*This study provides a statistically rigorous framework for evaluating integrated health and food system investments over time.*

## ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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