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A Bayesian Hierarchical Model for Efficiency Gains in Tanzanian Community Health Centres

A Methodological Evaluation

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ABSTRACT

Background: Evaluating the efficiency of community health centres is critical for improving service delivery in resource-constrained settings. Existing methods often fail to account for unobserved heterogeneity and the hierarchical structure of health system data, leading to biased estimates of operational performance.

Purpose and objectives: This study presents and evaluates a novel Bayesian hierarchical model designed to measure efficiency gains within community-based healthcare systems. The objective is to provide a robust methodological framework that quantifies centre-level efficiency while formally incorporating uncertainty.

Keywords: *Bayesian hierarchical modelling, health systems research, Sub-Saharan Africa, community health centres, technical efficiency, resource-constrained settings, Tanzania*

Article Highlights

- Bayesian hierarchical model quantifies centre-level efficiency with formal uncertainty.
- Analysis of Tanzanian data shows significant variation in technical efficiency across centres.
- Hierarchical structure improved model fit substantially over non-hierarchical specification.
- Framework provides statistically rigorous tool for performance assessment in complex systems.

Methodological Innovation

A Bayesian stochastic frontier model with hierarchical random effects captures centre-level clustering and unobserved heterogeneity in health system data.

This study presents a novel statistical framework for evaluating health system efficiency in resource-constrained settings.