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A Methodological Review and Bayesian Hierarchical Modelling of Maternal Care Facility Systems and Clinical Outcomes in Ghana, 2000–2026

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ABSTRACT

Background: Maternal healthcare facility systems in Ghana are complex, with heterogeneous performance and clinical outcomes. Existing methodological approaches for evaluating these systems often fail to adequately account for spatial dependencies, multi-level data structures, and uncertainty in key performance indicators.

Purpose and objectives: This review critically evaluates methodological approaches used to assess maternal care facility systems and proposes a novel Bayesian hierarchical modelling framework to analyse clinical outcomes. The objective is to synthesise methodological limitations and demonstrate a robust analytical alternative.

Keywords: *Maternal healthcare, Ghana, Sub-Saharan Africa, Bayesian hierarchical modelling, Health systems evaluation, Clinical outcomes, Facility-based care*

Article Highlights

- Identifies statistical inadequacies in current cross-sectional evaluation methods.
- Proposes a novel Bayesian model integrating spatial random effects and facility-level clustering.
- Exemplar analysis reveals significant spatial autocorrelation in postnatal care outcomes.
- Advocates for model outputs, like shrunken estimates, to guide equitable resource targeting.

Core Model Specification

A Bayesian hierarchical model with binomial likelihood and spatial conditional autoregressive term: $y_{ij} \sim \text{Binomial}(p_{ij}, n_{ij})$, $\text{logit}(p_{ij}) = \alpha + \beta X_{ij} + u_{j} + s_{j}$.

This review synthesises methodological limitations and demonstrates a robust analytical alternative for health systems research.