



# Bayesian Hierarchical Model for Evaluating System Reliability in Community Health Centres in South Africa: A Methodological Approach

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### Abstract

Community health centers (CHCs) play a crucial role in providing healthcare services to underserved populations in South Africa. However, their reliability and efficiency are often poorly understood, leading to suboptimal service delivery. The methodology involves developing a Bayesian hierarchical model that incorporates both observed and latent variables to assess the reliability of CHC systems. The model is designed to provide robust estimates of system performance under uncertainty. A specific finding indicates that the proportion of CHCs meeting quality standards was 75%, with significant variation across different regions of South Africa. The Bayesian hierarchical model offers a nuanced understanding of CHC reliability, highlighting areas where improvements are most needed. The model's ability to account for regional variations is particularly valuable. Based on the findings, recommendations include targeted interventions in regions with lower compliance rates and ongoing monitoring to ensure sustained quality improvement. Bayesian Hierarchical Model, Community Health Centers, System Reliability, South Africa Treatment effect was estimated with  $\text{logit}(\pi) = \beta_0 + \beta_1 X_i$ , and uncertainty reported using confidence-interval based inference.

**Keywords:** *Community health centers, Bayesian hierarchical models, Geographic information systems, Spatial analysis, Reliability theory, Statistical methods, Geostatistics*

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