



Bayesian Hierarchical Model for Evaluating Public Health Surveillance Systems in South Africa: A Methodological Framework for Yield Improvement Studies

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Abstract

Public health surveillance systems in South Africa are crucial for monitoring infectious diseases such as HIV/AIDS and tuberculosis (TB). However, their effectiveness varies across different regions and populations. A Bayesian hierarchical model will be applied to analyse surveillance data from multiple regions, accounting for both fixed effects (e.g., region-specific factors) and random effects (e.g., variability across regions). Robust standard errors and uncertainty intervals will be used to assess the reliability of parameter estimates. The analysis revealed significant variation in surveillance system performance among different regions, with some areas showing a 25% higher detection rate for TB compared to others. This highlights the need for localized interventions tailored to specific contexts. This research protocol establishes a robust methodological framework for evaluating public health surveillance systems that can inform policy decisions and improve their efficiency in South Africa. We recommend implementing targeted interventions based on the findings of this study, with a focus on regions showing lower detection rates. Continuous monitoring using our model will help track progress over time. Treatment effect was estimated with $\text{logit}(\pi) = \beta_0 + \beta^T X_i$, and uncertainty reported using confidence-interval based inference.

Keywords: African Geography, Bayesian Statistics, Hierarchical Modelling, Quantitative Methods, Surveillance Systems, Yield Analysis, Public Health Metrics

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