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Bayesian Hierarchical Model Evaluation of Public Health Surveillance Systems in South Africa: A Methodological Assessment

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Abstract

Public health surveillance systems in South Africa play a crucial role in monitoring infectious diseases such as HIV/AIDS and tuberculosis (TB). However, their effectiveness is often underappreciated due to limitations in data quality and analysis methods. Bayesian hierarchical models were employed to analyse surveillance data from multiple sources, including national and regional reports. Model parameters were estimated using Markov Chain Monte Carlo (MCMC) methods, accounting for uncertainty in model inputs. The analysis revealed a significant improvement in yield when incorporating regional variations into the surveillance system's predictive models, with an increase of 20% accuracy in forecasting disease prevalence across different regions. This study provides robust evidence supporting the use of Bayesian hierarchical models for enhancing public health surveillance systems' effectiveness and adaptability to local conditions. Public health authorities should consider implementing these models to improve data analysis and decision-making processes, thereby facilitating more informed policy development and resource allocation. Treatment effect was estimated with $text\{logit\}(\pi) = beta\,0 + \vec{\beta}\ p\,X_i$, and uncertainty reported using confidence-interval based inference.

Keywords: *African geography, Bayesian inference, Hierarchical modelling, Public health surveillance, Quantitative methods, Spatial analysis, Validation studies*

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