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Bayesian Hierarchical Model for Risk Reduction in Public Health Surveillance Systems: An Assessment of South African Practices

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Abstract

Public health surveillance systems in South Africa aim to monitor infectious diseases such as Salmonella infections. These systems are crucial for early detection and control of outbreaks. A Bayesian hierarchical model was applied to assess the performance of South African surveillance data in measuring Salmonella infection risks. This model accounts for spatial and temporal variations within different regions and time periods. The analysis revealed that implementing a targeted intervention strategy reduced the incidence rate of Salmonella infections by approximately 20% across all monitored areas, with significant heterogeneity observed between regions. The Bayesian hierarchical model successfully quantified risk reduction effects in South African surveillance systems, highlighting the importance of localized interventions for effective control. Future public health initiatives should prioritise targeted interventions based on regional data to maximise impact and reduce infection rates further. 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 methods, Hierarchical modelling, Public health surveillance, Risk assessment, Statistical inference, Spatial epidemiology*