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Methodological Evaluation and Panel-Data Estimation for Clinical Outcome Measurement in South Africa's Public Health Surveillance Systems

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ABSTRACT

Public health surveillance systems in South Africa face methodological challenges in accurately measuring clinical outcomes, particularly in linking longitudinal patient data across disparate sources. Existing approaches often lack robust statistical frameworks for causal inference from observational surveillance data. This intervention study aimed to methodologically evaluate the country's surveillance infrastructure and develop a panel-data estimation model to improve the measurement of key clinical outcomes, specifically treatment adherence and morbidity rates. We implemented a quasi-experimental design across four provinces, integrating de-identified patient records from primary care facilities. The core analytical model was a two-way fixed effects panel regression: $Y\{it\} = alphai + lambdat + \beta\, X\{it\} + \varepsilon\{it\}$, where $Y\{it\}$ is the clinical outcome for patient i at time t. Inference was based on cluster-robust standard errors to account for heteroskedasticity and serial correlation. The methodological evaluation revealed significant inconsistencies in data capture, with an estimated 22% of records lacking necessary linkage identifiers. The panel model demonstrated a statistically significant positive association between integrated surveillance and reported treatment adherence ($p<0.01$, 95% CI: 0.07 to 0.15). The application of panel-data methods to surveillance data provides a more rigorous framework for measuring clinical outcomes, though underlying data quality constraints remain a substantial limitation. Surveillance systems should adopt persistent unique identifiers and implement the proposed panel estimation techniques routinely. Investment in data clerk training and validation protocols is critical. public health surveillance, panel data, fixed effects models, clinical outcomes, data linkage, health systems research This study provides a novel application of econometric panel-data techniques to public health surveillance data, demonstrating a method for deriving causal estimates of intervention effectiveness from routine administrative records.

Keywords: *Public health surveillance, South Africa, Panel data, Clinical outcomes, Methodological evaluation, Longitudinal data linkage*

Article Highlights

- Methodological evaluation revealed 22% of surveillance records lacked necessary linkage identifiers.
- Panel-data estimation provides a rigorous framework for causal inference from observational data.
- Study implemented a two-way fixed effects model across

Core Analytical Model

Two-way fixed effects panel regression: Y_it = α_i + λ_t + βX_it + ε_it, with inference based on cluster-robust standard errors.

This study applies econometric panel-data techniques to public

four South African provinces. • Findings advocate for persistent unique identifiers and routine panel estimation techniques.	*health surveillance data.*