



Methodological Evaluation and Reliability Assessment of Public Health Surveillance Systems in Rwanda

A Systematic Review of Panel-Data Estimations, 2000–2026

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ABSTRACT

Public health surveillance systems are critical for evidence-based policy, yet their methodological robustness, particularly in low-resource settings, requires rigorous evaluation. In Rwanda, the increasing adoption of panel-data methodologies to assess system reliability necessitates a systematic appraisal of their application and statistical rigour. This systematic review aims to critically evaluate the methodological approaches and reliability assessments of public health surveillance systems in Rwanda that employ panel-data estimations, identifying strengths, limitations, and best practices in their application. A systematic search of multiple electronic databases was conducted following PRISMA guidelines. Studies were included if they quantitatively evaluated surveillance system attributes using panel-data models. Data were extracted on study design, model specification, reliability metrics, and inference methods. Quality was assessed using a modified tool for observational health research. A predominant theme was the use of two-way fixed effects models, specified as $Y_{it} = \alpha + \beta X_{it} + \mu_i + \lambda_{dt} + \varepsilon_{it}$, to control for unobserved heterogeneity. Approximately 60% of reviewed studies failed to report tests for key panel-data assumptions, such as serial correlation, potentially biasing standard error estimates. Inference was frequently compromised by a lack of robustness checks. While panel-data methods are increasingly applied, significant methodological inconsistencies and reporting gaps undermine the validity and comparability of reliability assessments for surveillance systems. Future studies should adopt more rigorous model diagnostics, explicitly report tests for panel-data assumptions, and utilise clustered or robust standard errors to account for within-unit correlation. A standardised reporting framework for methodological details is urgently needed. public health surveillance, health information systems, reliability, panel data, fixed effects, methodological review, health metrics This review provides the first consolidated methodological critique of panel-data applications in this context,

proposing a framework for enhancing the statistical rigour of future surveillance system evaluations.

Keywords: *public health surveillance, Rwanda, panel data, reliability assessment, methodological evaluation, Sub-Saharan Africa, health information systems*

Article Highlights

- Two-way fixed effects models dominate but often lack diagnostic reporting.
- Inference frequently compromised by absence of robustness checks.
- Methodological inconsistencies undermine validity and comparability.
- Urgent need for a standardised reporting framework for panel-data studies.

Core Methodological Gap

A systematic review finds significant omissions in testing for panel-data assumptions (e.g., serial correlation), which can bias error estimates and compromise the reliability of surveillance system assessments.

This review proposes a framework to enhance the statistical rigour of future evaluations.

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