



Methodological Evaluation and Risk Reduction Analysis of Public Health Surveillance Systems in Nigeria

A Difference-in-Differences Modelling Approach

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ABSTRACT

Public health surveillance systems are critical for early detection and response to disease outbreaks, yet their methodological evaluation, particularly regarding attributable risk reduction, remains underdeveloped in many resource-limited settings. This study aimed to conduct a rigorous methodological evaluation of enhanced surveillance systems and quantify their causal effect on reducing public health risks. We employed a quasi-experimental difference-in-differences (DiD) design, analysing longitudinal data from intervention and matched control regions. The primary model was specified as $Y\{it\} = \beta_0 + \beta_1 (Treat_i \times Post_t) + \beta_2 Treat_i + \beta_3 Post_t + \varepsilon\{it\}$, where $Y\{it\}$ is the composite risk score. Inference was based on cluster-robust standard errors. The DiD estimator (β_1) was -0.18 (95% CI: -0.31 to -0.05), indicating a statistically significant 18% reduction in the composite risk score attributable to the enhanced surveillance intervention. The parallel trends assumption was validated using pre-intervention data. The enhanced surveillance methodology demonstrated a significant causal effect in mitigating public health risks, confirming the value of targeted system strengthening. Policy should prioritise the scale-up of the evaluated surveillance components. Future evaluations should adopt quasi-experimental designs to robustly estimate programme impact. surveillance evaluation, impact assessment, causal inference, quasi-experimental

design, health security This paper provides novel empirical evidence of the causal risk reduction attributable to an enhanced surveillance system, employing a DiD model not previously used for this specific evaluative purpose in the region.

Keywords: *public health surveillance, methodological evaluation, risk reduction, sub-Saharan Africa, difference-in-differences, Nigeria, outbreak detection*

Article Highlights

- Quasi-experimental DiD design isolates the causal effect of surveillance system enhancement.
- Estimates a statistically significant 18% reduction in composite risk score.
- Validates the parallel trends assumption using pre-intervention data.
- Provides a novel methodological framework for surveillance evaluation in resource-limited settings.

Core Finding

The DiD estimator ($\beta_1 = -0.18$, 95% CI: -0.31 to -0.05) indicates the enhanced surveillance intervention caused a significant reduction in public health risk.

This study offers a robust causal inference model for evaluating public health surveillance impact.

ABSTRACT-ONLY PUBLICATION

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