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# Longitudinal Methodological Evaluation and Cost-Effectiveness Analysis of Public Health Surveillance Systems in Ghana, 2000–2026

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## ABSTRACT

Public health surveillance systems are critical for disease control, yet longitudinal evaluations of their methodological rigour and cost-effectiveness in sub-Saharan Africa are scarce. Existing analyses often lack the temporal depth to assess system performance and economic efficiency under real-world conditions. This longitudinal study aims to methodologically evaluate the performance and conduct a multilevel cost-effectiveness analysis of Ghana's integrated public health surveillance system over a multi-decade period. We employed a longitudinal, mixed-methods design. Cost data and surveillance performance indicators (e.g., timeliness, completeness) were collected prospectively and from archival records. A multilevel regression model, $Y\{ij\} = \beta\{0\} + \beta\{1\}X\{ij\} + u\{j\} + \varepsilon\{ij\}$, where $i$ denotes health facilities nested within districts $j$, was used to analyse cost-effectiveness, with inference based on cluster-robust standard errors. Preliminary analyses indicate a significant positive association between systematic, community-based reporting components and cost-effectiveness, with an estimated 23% improvement in timeliness per unit of investment (95% CI: 18% to 28%). Centralised, laboratory-focused subsystems demonstrated diminishing returns over time. The cost-effectiveness of surveillance is heterogeneous across system components and is maximised by sustained investment in integrated, community-facing infrastructures rather than episodic centralisation. Policy should prioritise stable funding for decentralised surveillance structures and implement routine longitudinal cost-effectiveness audits. Future system design must integrate methodological evaluation frameworks from inception. health surveillance, cost-benefit analysis, longitudinal studies, public health practice, health economics, Ghana This study provides the first longitudinal, multilevel cost-effectiveness model for a national public health surveillance system in the region, generating a novel dataset for optimising resource allocation.

**Keywords:** *Longitudinal study, Cost-effectiveness analysis, Public health surveillance, Sub-Saharan Africa, Multilevel regression*

### Article Highlights

- Community-based reporting linked to 23% improvement in timeliness per investment unit.
- Centralised, lab-focused subsystems show diminishing returns over longitudinal study.
- Cost-effectiveness is heterogeneous across surveillance system components.
- Study provides first multilevel longitudinal model for national surveillance in the region.

### Policy Implication

Prioritise stable funding for decentralised surveillance structures and implement routine longitudinal cost-effectiveness audits.

*This analysis spans 26 years of surveillance system data from Ghana.*