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A Difference-in-Differences Evaluation of System Reliability in South African Community Health Centres, 2000–2024

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ABSTRACT

Community health centres are critical nodes in public health systems, yet robust quantitative methods for evaluating their operational reliability over time are underdeveloped. This creates a significant evidence gap for health systems management and policy. This case study aimed to develop and apply a quasi-experimental difference-in-differences (DiD) model to assess the impact of a national infrastructure investment programme on the system reliability of a network of community health centres. We constructed a longitudinal panel dataset from administrative health records and facility surveys. System reliability was operationalised as a composite index of equipment functionality, drug availability, and staff absenteeism. The causal impact was estimated using a two-way fixed effects DiD model: $Y\{it\} = \alpha + \beta\,(Treati \times Postt) + gammai + deltat + \varepsilon\{it\}$, where robust standard errors were clustered at the facility level. The intervention was associated with a statistically significant 18.2 percentage point increase in the system reliability index (95% CI: 12.4 to 24.0) for treated centres relative to controls. The effect was driven predominantly by sustained improvements in drug availability chain logistics. The applied DiD framework provides a rigorous, replicable method for isolating the effect of health system interventions from secular trends. The results demonstrate that targeted infrastructure investment can substantially enhance the operational reliability of primary care facilities. Health policy evaluations should adopt quasi-experimental designs like DiD for causal attribution. Programme rollouts must be paired with strengthened supply chain management to realise and maintain gains in system reliability. health systems evaluation, difference-in-differences, primary healthcare, operational research, quasi-experimental design This study provides a novel methodological application of econometric causal inference to the longitudinal assessment of health centre operational performance, generating robust evidence for a specific national policy mechanism.

Keywords: *Difference-in-differences, Health systems evaluation, Community health centres, Sub-Saharan Africa, System reliability, Public health methodology, Operational research*

Article Highlights

- Infrastructure investment linked to 18.2 percentage point gain in system reliability.
- Effect driven predominantly by sustained improvements in drug supply chain logistics.
- Study develops a composite index to operationalize facility reliability.
- Demonstrates causal inference methods for health systems evaluation.

Core Methodology

Two-way fixed effects difference-in-differences model applied to a longitudinal panel dataset to estimate causal impact of a national investment programme.

Presents a novel application of econometric causal inference to health facility performance.