



## Randomised Field Trial of a Diagnostic Framework for Primary Healthcare System Reliability in South Africa

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### ABSTRACT

Primary healthcare system reliability is a critical determinant of health outcomes, yet robust, field-applicable diagnostic tools for its measurement are lacking in many resource-constrained settings. This study aimed to evaluate a novel diagnostic framework for assessing the operational reliability of community health centres via a randomised field trial. We conducted a cluster-randomised field trial across 40 community health centres. Centres were randomised to implement either the new diagnostic framework (intervention) or a standard checklist (control). The primary outcome was a composite reliability score. Data were analysed using a linear mixed-effects model:  $Y_{ij} = \beta_0 + \beta_1 T_{ij} + u_j + \varepsilon_{ij}$ , where  $u_j$  is the random intercept for centre  $j$ , with robust standard errors. Centres using the diagnostic framework showed a statistically significant improvement in mean reliability scores (adjusted mean difference: 12.4 points, 95% CI: 8.1 to 16.7,  $p < 0.001$ ). The framework was particularly effective in identifying medication stock-out vulnerabilities, with a 22% reduction in unreported stock-outs compared to control centres. The diagnostic framework is a feasible and effective tool for systematically identifying and quantifying reliability failures in primary healthcare delivery systems. The framework should be integrated into routine supervisory visits and health system strengthening initiatives to enable proactive reliability management. health systems research,

primary healthcare, reliability, diagnostic tool, randomised trial, South Africa This paper provides a novel, validated methodological tool for the empirical assessment of health system reliability, demonstrating its efficacy through a rigorous field experiment.

**Keywords:** *Primary healthcare, Randomised controlled trial, Health systems research, Sub-Saharan Africa, Diagnostic framework, Health centre reliability, Implementation science*

**Article Highlights**

- Cluster-randomised trial shows 12.4-point improvement in mean reliability scores with the new diagnostic framework.
- Framework proved particularly effective in surfacing medication stock-out vulnerabilities.
- Study provides a validated, field-applicable tool for proactive health system management.
- Findings support integration into routine supervisory visits in resource-constrained settings.

**Methodological Note**

A cluster-randomised field trial across 40 community health centres compared the novel diagnostic framework against a standard checklist, with primary outcomes analysed via linear mixed-effects modelling.

*This study offers an empirical tool for strengthening primary healthcare system reliability.*

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