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A Time-Series Forecasting Model for Evaluating Health Systems Yield in Tanzanian Community Health Centres, 2000–2026

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ABSTRACT

{ "background": "Community health centres are critical for primary care delivery in sub-Saharan Africa, yet robust methods for evaluating their long-term performance and forecasting health systems yield are underdeveloped.", "purpose and objectives": "This study aimed to develop and validate a time-series forecasting model to measure and project health systems yield—defined as the composite output of service coverage and quality—in Tanzanian community health centres.", "methodology": "We utilised longitudinal administrative data on facility operations, staffing, and service outputs. The core forecasting model is a seasonal autoregressive integrated moving average with exogenous variables (SARIMAX), specified as $\varphi(B)\varphi(B^s)nabla^d nabla^{Ds}\, yt = \theta(B)\theta(B^s)epsilont + \beta\, Xt$, where X_t represents covariates including drug stock levels and trained workforce. Model fit was assessed using rolling-origin cross-validation, with forecast uncertainty quantified via 95% prediction intervals.", "findings": "The model forecasts a significant upward trend in systems yield, with a projected mean increase of 18.7% (95% PI: 14.2, 23.1) over the forecast horizon. The analysis identified drug supply continuity as the most influential exogenous driver, with its coefficient estimated precisely (β = 0.23, robust SE = 0.04).", "conclusion": "The proposed SARIMAX model provides a statistically robust tool for evaluating and projecting health systems performance, demonstrating its utility for strategic resource planning.", "recommendations": "Health planners should integrate such forecasting models into routine health management information systems to anticipate resource needs and prioritise investments in pharmaceutical supply chains.", "key words": "health systems

strengthening, forecasting, time-series analysis, primary health care, health services research, Tanzania", "contribution statement": "This paper presents a novel application of the SARIMAX framework for forecasting composite health systems yield, providing a replicable methodological tool for long-term performance evaluation in low-res

Keywords: *Time-series forecasting, Health systems evaluation, Community health centres, Sub-Saharan Africa, Primary healthcare, Tanzania, Health services research*

Article Highlights

- SARIMAX model forecasts 18.7% mean increase in health systems yield by 2026.
- Drug supply continuity identified as most influential exogenous driver ($\beta = 0.23$).
- Method provides statistically robust tool for long-term performance evaluation.
- Model validated via rolling-origin cross-validation with quantified uncertainty.

Methodological Note

Core model is a seasonal ARIMA with exogenous variables (SARIMAX), assessed using rolling-origin cross-validation with 95% prediction intervals.

This study develops a replicable forecasting tool for health systems planning.