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A Methodological Protocol for Evaluating District Hospital System Resilience in Ethiopia

A Time-Series Forecasting Model for Risk Reduction (2000–2026)

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ABSTRACT

{ "background": "District hospitals in Ethiopia face persistent systemic shocks from climate, conflict, and disease, yet a robust, quantitative methodology for forecasting their operational resilience and evaluating risk reduction interventions is lacking. Existing assessments are often cross-sectional and descriptive, failing to model temporal dynamics and forecast future system states under stress.", "purpose and objectives": "This protocol details a methodological framework for evaluating the resilience of district hospital systems through a time-series forecasting model. The primary objective is to develop and validate a model that forecasts key service capacity indicators, enabling the simulation of intervention impacts on risk reduction over a multi-year period.", "methodology": "We will employ a longitudinal, quantitative design using retrospective administrative data. The core analytical model is a seasonal autoregressive integrated moving average (SARIMA) model, specified as $\varphi(B)\varphi(B^s)nabla^dnablas^D\ yt\ =\theta(B)\theta(B^s)epsilont$, where yt represents a hospital output metric. Model parameters will be estimated via maximum likelihood, with forecast uncertainty quantified using 95% prediction intervals. The model will be used to simulate

counterfactual scenarios for specific resilience-building interventions.", "findings": "As a research protocol, this paper does not present empirical results. However, the proposed methodology is designed to generate forecasts of hospital service outputs (e.g., monthly outpatient attendance). A key anticipated output is the simulated impact of a specific intervention, such as estimating the proportion of service degradation mitigated by a backup power supply during forecasted drought periods.", "conclusion": "This protocol establishes a novel, evidence-based methodological approach for proactively assessing and strengthening health system resilience. The forecasting framework moves beyond descriptive analysis to provide a tool for pre-emptive policy planning and resource allocation.", "recommendations": "We recommend the adoption of this time-series forecasting approach by health planners and researchers for routine resilience monitoring. Future work should integrate this model with early warning systems to enable dynamic, data-driven responses to emerging threats.", "key words":

Keywords: *Health systems research, Sub-Saharan Africa, Time-series analysis, Risk reduction, District hospitals, Operational resilience, Forecasting model*

Article Highlights

- Details a methodological framework for evaluating district hospital resilience via time-series forecasting.
- Employs a SARIMA model to forecast key service capacity indicators and simulate intervention impacts.
- Designed to generate forecasts of hospital outputs and simulate mitigation of service degradation.
- Aims to provide an evidence-based tool for proactive assessment and strengthening of health systems.

Core Analytical Model

Seasonal ARIMA (SARIMA) specified as $\varphi(B)\Phi(B^s)\nabla^d\nabla_s^D y_t = \theta(B)\Theta(B^s)\varepsilon_t$, where y_t represents a hospital output metric. Parameters estimated via maximum likelihood.

This paper presents a research protocol; empirical results are anticipated from future application.