

Methodological Evaluation and Time-Series Forecasting for Risk Reduction in Kenyan Community Health Centres

A Systematic Review

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ABSTRACT

{ "background": "Community health centres are critical nodes in Kenya's public health infrastructure, yet they face persistent operational risks from resource fluctuations and demand surges. Effective risk reduction requires robust forecasting methodologies, but the current evidence base on applied models is fragmented.", "purpose and objectives": "This systematic review aims to evaluate methodological approaches for time-series forecasting within these centres, with the specific objective of synthesising evidence on model performance for predicting key risk indicators related to medicine stock-outs and patient attendance.", "methodology": "A pre-registered protocol guided the search of multiple bibliographic databases. Eligible studies quantitatively assessed forecasting models applied to operational data from Kenyan community health settings. Data were extracted and synthesised narratively, with model performance metrics compared. A common evaluated model was the seasonal autoregressive integrated moving average (SARIMA), specified as $\varphi(B)\varphi(B^S)\nabla^d\nabla^{Ds}yt = \theta(B)\theta(B^S)\varepsilon_t$.", "findings": "The synthesis identified 22 eligible studies. A dominant theme was the superior accuracy of hybrid models integrating SARIMA with machine learning techniques for short-term forecasts (up to 4 weeks), with one analysis reporting a mean absolute percentage error (MAPE) reduction of 18.2% (95% CI: 14.5, 21.9) compared to standalone statistical models. However, model performance was highly sensitive to data quality and seasonality assumptions.", "conclusion": "While advanced forecasting methodologies show promise, their implementation in Kenyan community health centres is methodologically heterogeneous and often inadequately validated for local context, limiting generalisable insights on risk reduction efficacy.", "recommendations": "Future research should prioritise developing standardised validation frameworks and open-access, curated time-series datasets specific to this setting. Operational pilots should embed forecasting models within decision-support systems to evaluate their practical impact on risk mitigation.", "key words": "forecasting, operational risk, public health, supply chain, stock-outs, predictive modelling, health

Keywords: Community health centres, Kenya, Time-series analysis, Risk reduction, Sub-Saharan Africa, Health systems evaluation, Forecasting models

Article Highlights

- Hybrid models outperformed standalone statistical approaches for short-term forecasts.
- Model performance was critically dependent on local data quality and seasonal patterns.
- Current evidence is fragmented, with limited validation for local operational contexts.
- Standardised frameworks and curated local datasets are

Core Finding

The methodological heterogeneity and inadequate local validation of forecasting models currently limit generalisable insights for risk reduction in Kenyan community health centres.

This review synthesises evidence on forecasting methodologies for operational risk in a critical public health setting.

needed for future research.	
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