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Methodological Evaluation and Time-Series Forecasting of Clinical Outcomes in Nigerian Rural Clinic Systems

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ABSTRACT

{ "background": "Rural clinic systems in Nigeria face significant challenges in resource allocation and outcome monitoring, often relying on reactive rather than predictive management. The absence of robust, scalable forecasting tools impedes proactive healthcare delivery and system strengthening in these low-resource settings.", "purpose and objectives": "This intervention study aimed to develop and methodologically evaluate a novel time-series forecasting model for key clinical outcomes, specifically designed for the operational constraints and data structures of rural primary care facilities.", "methodology": "We implemented a prospective, clinic-level intervention across 12 facilities. The core methodological intervention was the application of a Seasonal AutoRegressive Integrated Moving Average with eXogenous factors (SARIMAX) model, formalised as $\varphi(B)\varphi(B^s)nabla^d nablas^D\ yt\ = \theta(B)\theta(B^s)epsilont\ + \beta\ Xt$, to forecast weekly outpatient attendance and malaria case incidence. Model performance was rigorously assessed against historical baselines using rolling-origin validation and Diebold-Mariano tests.", "findings": "The SARIMAX model produced statistically significant forecasts, reducing the mean absolute percentage error for malaria case predictions by 32% compared to a naive seasonal benchmark (95% CI: 24% to 40%). Exogenous variables related to local agricultural cycles were particularly salient in explaining attendance variance.", "conclusion": "The study demonstrates that parsimonious time-series models, incorporating locally relevant exogenous data, can provide operationally useful forecasts for clinical outcomes in resource-constrained rural health systems.", "recommendations": "Health administrators should integrate simple forecasting models into routine health management information systems to guide staffing and supply chain decisions. Further research should focus on automating model inputs from existing data streams.", "key words": "health systems strengthening, predictive modelling, primary healthcare, resource-limited settings, health informatics", "contribution statement": "This paper provides the first validated application of a SARIMAX forecasting framework for clinical outcomes within the specific infrastructural and

Keywords: *Health systems research, Sub-Saharan Africa, Time-series analysis, Clinical outcomes, Rural health services, Predictive modelling, Nigeria*

Article Highlights

- Prospective intervention across 12 rural clinics testing a novel SARIMAX forecasting model.
- Model reduced mean absolute error for malaria case predictions by 32% versus seasonal benchmark.
- Local agricultural cycles proved salient exogenous variables for explaining attendance variance.
- Validates a scalable framework for integrating predictive analytics into routine health information systems.

Methodological Contribution

This study provides the first validated application of a SARIMAX forecasting framework, formally specified with exogenous factors, for clinical outcomes within Nigeria's rural primary care infrastructure.

This work demonstrates a practical pathway from data to proactive decision-making in low-resource health systems.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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