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Assessing the Feasibility of Achieving Substantial Reduction of Under Five Mortality in Burundi by 2030 Using Artificial Neural Networks

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Burundi from 1964 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast performance measures indicate that the applied ANN (12. 12, 1) model is stable in forecasting U5MR. The study findings indicated that U5MR will remain high over the out of sample period. Therefore, we implore the government of Burundi to allocate more resources to maternal and child health (MNCH) programs in the country in order to substantially reduce under five mortality to as low as 25 deaths per 1000 live births by 2030.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The Agenda 2030 for sustainable development is a result oriented global action plan. In September 2015 all UN member states gathered at the UN Headquarters in York to draw up a development plan that would steer economic growth, eradicate poverty and hunger, attend to global health problems, solve educational needs, and address existing inequalities and human rights violations (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). It was agreed by all member states that commitment was key to the achievement of the set SDG targets by 2030. The importance of surveillance mechanisms was also emphasized to help track SDG progress. Modelling techniques are part of essential surveillance tools but they have been underutilized in public health programs in developing countries. These surveillance tools are useful in the early detection of outbreaks, abnormal trends of diseases and other health related problems, and facilitate timeous implementation of effective evidence based intervention strategies (Zhao *et al.* 2020; Panch *et al.* 2018; Zhou *et al.* 2018). Therefore in this study we proposed the popular artificial neural network technique to model and project future trends of under-five mortality rate for Burundi. Forecast results are envisioned to guide formulation and implementation of effective child health policies in order to end all preventable under five deaths by 2030.

II. LITERATURE REVIEW

A multisite retrospective Kenyan cohort study was conducted by Irimu *et al.* (2021) to find out the proportion of all admissions and deaths in the neonatal age group and examine morbidity and mortality patterns, stratified by birth weight, and their variation across hospitals. Intrapartum related complications was the single most common diagnosis among the neonates with birth weight of 2000 g or more who died. A threefold variation in mortality across hospitals was observed for birth weight categories 1000–1499 g and 1500–1999g. Adjei *et al.* (2021) investigated the effect of community-, household- and individual-level factors on the risk of neonatal mortality in two districts in Ghana. The longitudinal study used the Kintampo Health and Demographic Surveillance System as a platform to select 30,132 neonatal singletons with 634 deaths. Multilevel cox frailty model was used to examine the effect of community-, household- and individual-level factors on the risk of neonatal mortality. The conclusion from the study was that there is risk of neonatal mortality at the individual- and household-levels in the Kintampo Districts. A cross-sectional study carried out by Edem *et al.* (2020) examined the health practices, care-seeking behavior, and referral of sick out-born neonates to a district and regional hospital in the Upper West Region of Ghana. The study findings suggested that socio-cultural factors strongly influence health seeking behavior and the health outcome of neonates in this setting. A study, Bitew *et al.* (2020) determined the incidence density rate and predictors of neonatal mortality by utilizing electronic databases. The study findings indicated that the incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors.



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III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual under five mortality rate for Burundi.

Data Issues

This study is based on annual under five mortality rate in Burundi for the period 1964–2020. The out-of-sample forecast covers the period 2021–2030. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Variable	В
Observations	45 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.009979
MSE	9.029546
MAE	1.674450

Table 1: ANN model summary

Residual Analysis for the Applied Model



Figure 1: Residual analysis



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In-sample Forecast for B



Figure 2: In-sample forecast for the B series

Out-of-Sample Forecast for B: Actual and Forecasted Graph



Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated	out-of-sample	forecasts
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2021	54.5304
2022	53.8103
2023	53.2341
2024	52.7927
2025	52.4720
2026	52.2580
2027	52.0630
2028	51.9288
2029	51.8290
2030	51.7586

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The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual U5MR will hover around 50 deaths per 1000 live births over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

SDG3 remains at the core of the 2030 agenda for sustainable development. Developing countries are expected to accelerate their efforts in the implementation of SDG plans in order to achieve the set targets by 2030. Forecasting techniques will guide the planning process and allocation of resources to maternal and child health program activities. In this study we proposed the ANN model to predict future trends of under-five mortality rate for Burundi. The neural network model projections revealed that U5MR will remain high over the out of sample period. Therefore we encourage authorities in Burundi to allocate more resources to MNCH program activities to substantially reduce under five mortality to levels as low as 25 deaths per 1000 live births by 2030.

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