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Tracking Kenya's Future Progress towards Substantial Reduction of under Five Mortality 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 Kenya from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied model is stable in forecasting U5MR. The ANN (12, 12, 1) model projections indicate that U5MR will remain around 42 deaths per 1000 live births throughout the out of sample period. Therefore, we implore the Kenyan government to allocate more resources to the maternal and child health (MNCH) program in order to address all the health challenges that contribute to high numbers of under five deaths especially in the rural areas.**

Keywords: ANN, Forecasting, U5MR

I. INTRODUCTION

Developing countries are lagging behind in terms of reaching the set sustainable development goal (SDG) targets, therefore authorities in these countries must find strategies that will effectively address the different challenges affecting their people (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). It is pleasing to report the tremendous progress that was achieved during the era of millennium development goals, however more needs to be done to ensure all outstanding challenges are solved by 2030 (UN, 2016; UN, 2015).Over the period 1990-2015, Kenya recorded a decline in under five and neonatal mortality rates, however neonatal deaths have declined at slower rate (World Bank, 2019). The majority of factors which cause neonatal mortality can be prevented by improving the quality of maternal health and childcare services. The purpose of this study is to forecast future trends of under-five mortality rate in Kenya using artificial neural networks and the findings will guide policy, planning and allocation of resources to child health programs with a goal of ending all preventable under five deaths.

II. LITERATURE REVIEW

A prospective, population-based observational study was conducted by Aziz *et al.* (2020) to compare pregnancy outcomes in Pakistan to other low-resource countries and explore factors that might help explain these differences. The research included all pregnant women and their pregnancy outcomes in defined geographic communities in six low-middle income countries (India, Pakistan, Democratic Republic of Congo, Guatemala, Kenya, and Zambia). Study staff enrolled women in early pregnancy and followed them up soon after delivery and at 42 days to ascertain delivery, neonatal, and maternal outcomes. The Pakistani pregnancy outcomes were found to be much worse than those in the other GN sites. Reasons for these poorer outcomes likely include that the Pakistani sites 'reproductive-aged women are largely poorly educated, under- nourished, anemic, and deliver a high percentage of preterm and low-birth weight babies in settings of often inadequate maternal and newborn care. Masaba & Phetoe described the trends of neonatal mortality within the two sub-Saharan countries. The study concluded that in 2018, the neonatal mortality rate for Kenya was 19.6 deaths per 1000 live births. The neonatal mortality rate had fallen gradually from 35.4 deaths per 1000 live births in 1975. On the other hand, South Africa had its neonatal mortality rate fall from 27.9 deaths per 1000 live births in 1975 to 10.7 deaths per 1000 live births in 2018.A cross-sectional study was conducted by Weddih *et al.* (2019) to examine factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania between January 2013 and December 2013 and included neonatal patients hospitalized at the National Referral Hospital (NRH). Data were collected by reviewing the medical charts and through questionnaires administered to the parents and logistic regression was used for analysis. The findings of this study revealed that low birth weight, hypothermia, and birth outside the NRH were independently associated with neonatal deaths. A matched case-control study using verbal social autopsy was conducted by Gupta *et al*. (2018) to investigate the causes and predictors of childhood mortality in Rwanda. Authors utilized conditional logistic regression to identify clinical, family, and household risk factors for death. It was found out that there was a large proportion of

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remaining deaths occur at home, with home deliveries still representing a significant risk factor for neonatal death. The major causes of death at a population level remain largely avoidable communicable diseases.

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 Kenya.

Data Issues

This study is based on annual under five mortality rate in Kenya for the period 1960 – 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

Table 1: ANN model summary

Variable	K
Observations	49 (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	0.001043
MSE	0.297636
MAE	0.375214

Residual Analysis for the Applied Model

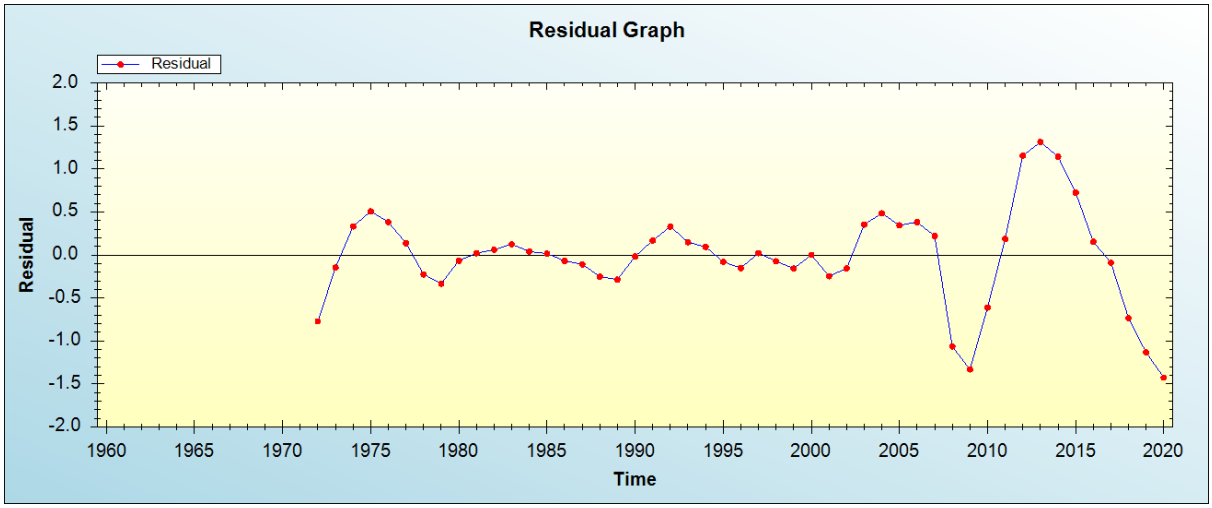

Figure 1: Residual analysis

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In-sample Forecast for K

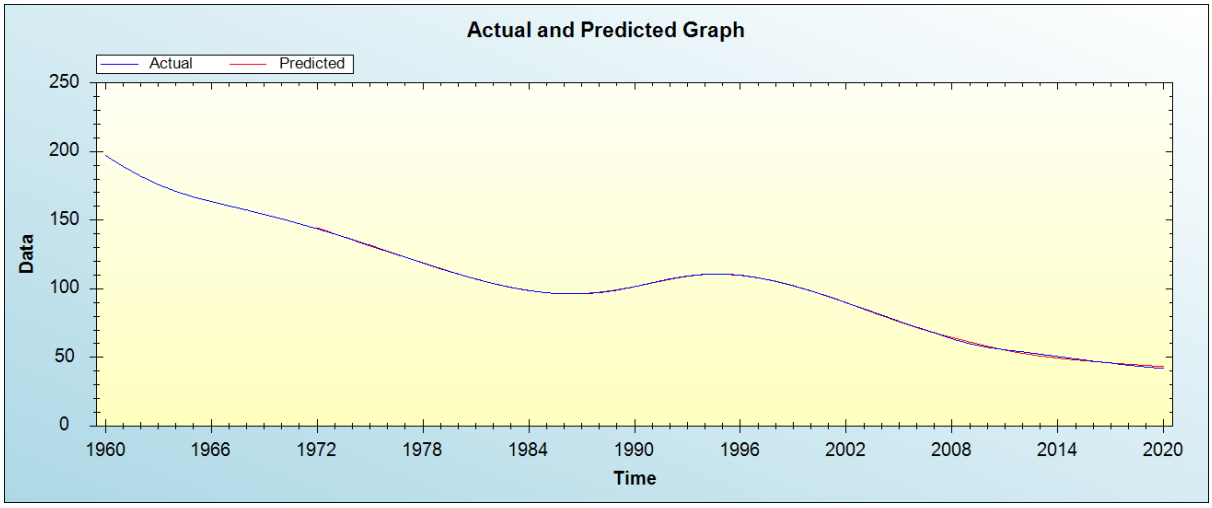

Figure 2: In-sample forecast for the K series

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

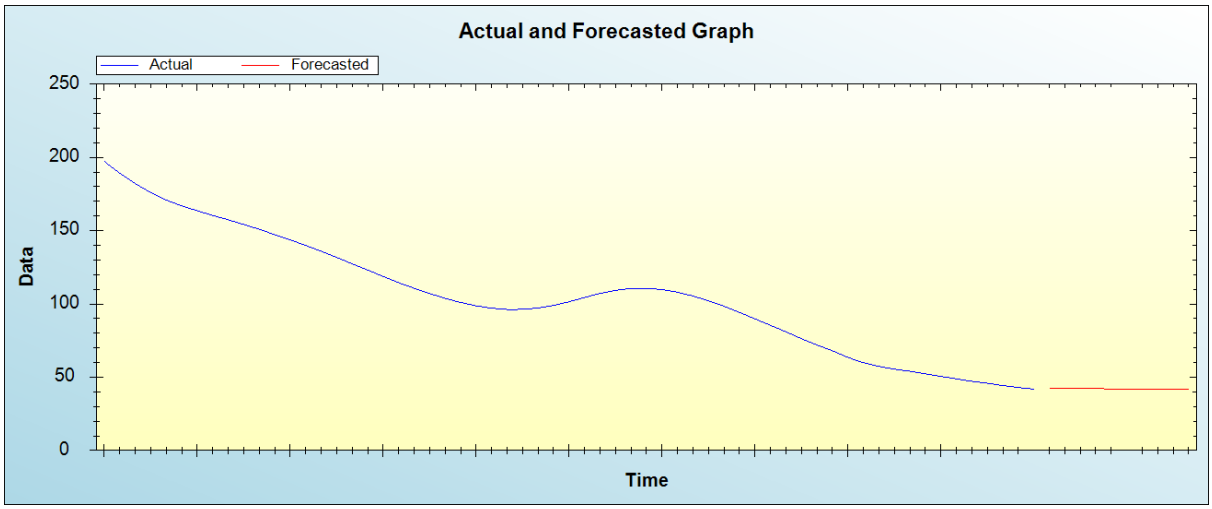

Figure 3: Out-of-sample forecast for K: actual and forecasted graph

Out-of-Sample Forecast for K: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	42.7590
2022	42.4431
2023	42.2950
2024	42.2012
2025	42.1348
2026	42.1048
2027	42.0208
2028	41.9467
2029	41.8300
2030	41.6930

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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 remain around 42 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Sub-Saharan African countries continue to face the problem of under-five mortality. However, they have managed to report tremendous progress towards the substantial reduction of under five deaths. Kenya reported a downward trend of under-five mortality rate over the past decades indicating the government's commitment in solving all major health challenges being faced by the Kenyan population. This study proposes the ANN model to project future trends of under-five mortality rate for Kenya and the forecast results indicate that U5MR will remain around 42 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Kenyan government to allocate more resources to the maternal and child health (MNCH) program in order to address all the factors that contribute to under five mortality particularly in the rural areas.

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