

Tracking Ghana's Future Progress towards Achieving Substantial Reduction of Under Five Mortality By 2030

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Abstract - This study uses annual time series data on under five mortality rate for Ghana 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 under five mortality rate in Ghana. The ANN (12, 12, 1) model projections revealed that U5MR will remain around 40 deaths per 1000 live births over the out of sample period. Therefore, we encourage health authorities in Ghana to allocate more resources to the maternal and child health (MNCH) program in order to improve working conditions of healthcare workers, provide adequate medical supplies and address factors that significantly contribute to mortality among under five children.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Ending preventable mortality of pregnant women, newborns and under five children is the focus of the 3rd sustainable development goal targets 3.1 and 3.2 (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). The global decline in neonatal mortality over the past 2 decades has been slower than that of under 5 mortality and current projections indicate that approximately 69 million under 5 deaths will occur over the period 2016-2030 (UNICEF, 2019; WHO, 2016; UNICEF, 2015). Tracking progress towards achieving the set target for the indicator 3.2.1 is crucial for addressing under five mortality in any country. Time series forecasting techniques are useful early warning tools for public health surveillance that detect abnormal trends of diseases and health related events. Therefore, in this study we apply the artificial neural network technique to forecast future trends of under-five mortality in Ghana. The results will inform policy and allocation of resources to MNCH programs in the country in order to effectively control under five deaths.

II. LITERATURE REVIEW

Gage & Bauhoff (2020) assessed the impact of PBF on early neonatal health outcomes and associated health care utilization and quality in Burundi, Lesotho, Senegal, Zambia and Zimbabwe. Authors utilized data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys and applied difference-in-differences analysis to estimate the effect of PBF projects supported by the World Bank on early neonatal mortality and low birth weight and concluded that PBF had no impact on early neonatal health outcomes in the five African countries studied and had limited and variable effects on the utilization and quality of neonatal health care. Islam *et al.* (2020) developed a predictive analytics framework to predict the death rates with high accuracy and to find the significant determinants that cause high child mortality. The framework used an automated method of information gain to rank the information-rich mortality variables for accurate predictions. Ethiopian Demographic Health Survey and Pakistan Demographic Health Survey data sets were used for the validation of the proposed framework. These real-world data sets were tested using machine learning classifiers, such as Naïve Bayes, decision tree, rule induction, random forest, and multi-layer perceptron, for the prediction task. The authors concluded that Naïve Bayes classifier predicts the child mortality rate with the highest average accuracy of 96.4% and decision tree helps in identifying key classification rules covering the factors behind children deaths. A forecasting study by Nyoni & Nyoni (2020) used monthly time series data on neonatal deaths cases at Chitungwiza Central Hospital (CCH) from January 2013 to December 2018; to forecast neonatal deaths over the period January 2019 to December 2020 using the Box-Jenkins SARIMA approach. The parsimonious model was found to be the SARIMA (0, 0, 3) (2, 0, 0)₁₂ model and forecast results indicate slow but steady decrease in neonatal deaths at CCH. Bhatia *et al.* (2019) analyzed the patterns and trends in the mortality rates of infants and children under the age of 5 in India (1992–2016) and quantified the variation in performance between different geographical states through three rounds of nationally representative household surveys. Three rounds of cross-sectional survey data. The study is conducted at the national level: India and its selected good-performing states, namely Haryana, Kerala, Maharashtra, Punjab and Tamil Nadu, and selected poor-performing states, namely Bihar, Chhattisgarh, Madhya Pradesh and Uttar Pradesh. The study revealed that attempts to reduce infant and child mortality rates in India are heading in the right direction although there is huge variation in performance between states.

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 in Ghana.

Data Issues

This study is based on annual under five mortality rate in Ghana 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	H
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	0.001573
MSE	0.463053
MAE	0.397225

Residual Analysis for the Applied Model

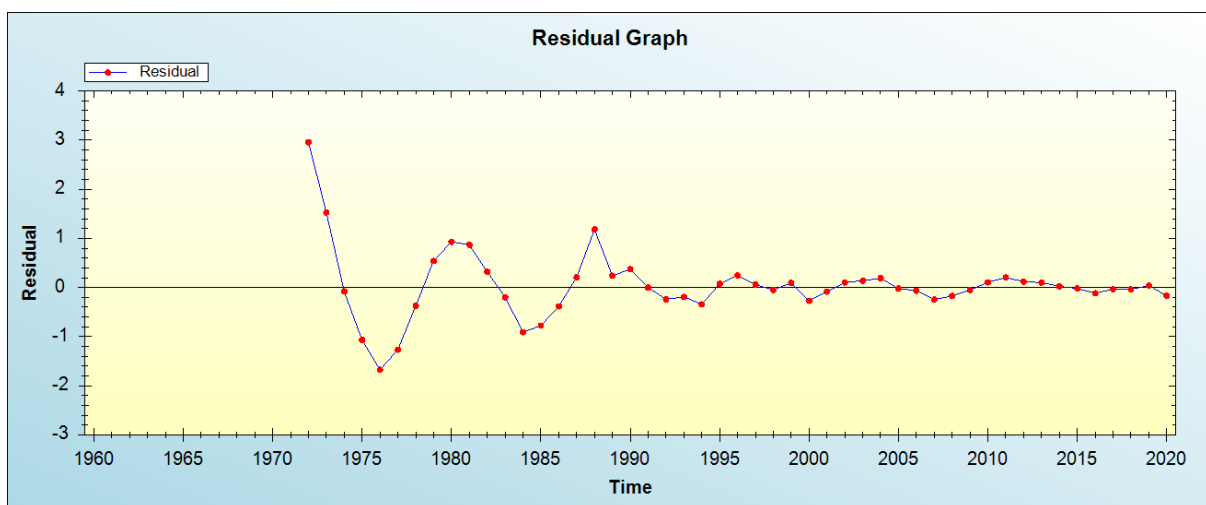


Figure 1: Residual analysis

In-sample Forecast for H

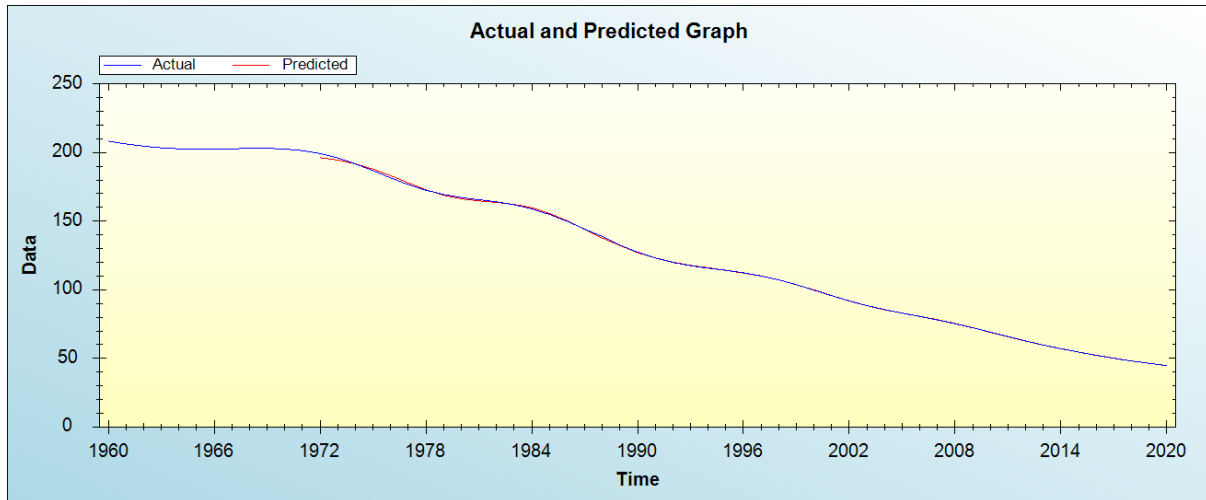


Figure 2: In-sample forecast for the H series

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

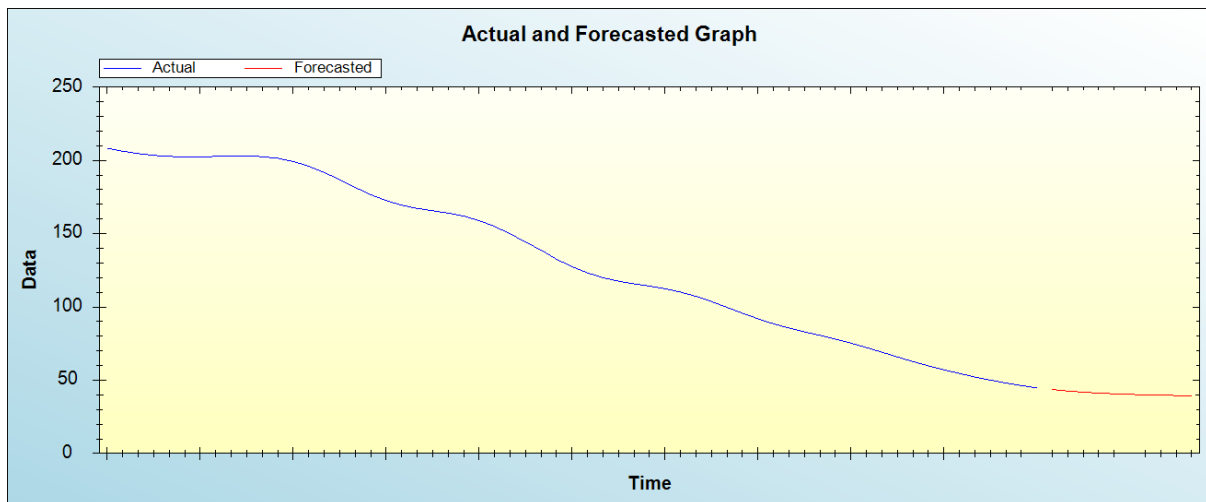


Figure 3: Out-of-sample forecast for H: actual and forecasted graph

Out-of-Sample Forecast for H: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	43.6419
2022	42.6357
2023	41.8474
2024	41.2316
2025	40.7428
2026	40.3387
2027	40.0343
2028	39.7946
2029	39.6087
2030	39.4583

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 40 deaths per 1000 live births over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Ghana has made significant progress in the reduction of under-five mortality as indicated by the reported downward trend of U5MR over the past decades. However, more needs to be done in order to substantially reduce high absolute numbers of under five deaths. In this study we applied the neural network model to project future trends of U5MR and the findings suggested that U5MR will remain around 40 deaths per 1000 live births over the out of sample period. Therefore, we encourage the government of Ghana to address of all the major drivers of under-five mortality and allocate more resources to the MNCH program so as to improve working conditions of healthcare workers and provide adequate medical supplies.

REFERENCES

- [1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
- [2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
- [3] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [4] UNICEF (2018). Every Child alive. New York: UNICEF
- [5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [6] World Health Organization (2016). Fact Sheet. 2016. <http://www.who.int/media/centre/factsheets/fs178/en/>.
- [7] UNICEF (2015). Levels & Trends in child mortality. UNICEF, WHO, World Bank Group, UN. https://www.unicef.org/media/files/IGME_Report_Final2.pdf.
- [8] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

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