

Under Five Mortality Will Remain Under Control in the United States: Evidence From Artificial Neural Networks

¹Dr. Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This study uses annual time series data on under five mortality rate (U5MR) for the USA 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 ANN (12, 12, 1) model is stable in forecasting under five mortality rate. The ANN model projections suggested that U5MR will consistently remain below 10 deaths per 1000 live births throughout the out of sample period. Hence, health authorities in the USA should continue providing financial support to the maternal and child health program (MNCH) in order to keep under five mortality under control.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The major problems being faced by developing countries include poverty, hunger, economic meltdown, deteriorating health systems, and climate change with its associated challenges. The adoption of the sustainable development goals in 2015 came at the right time to address various issues which fall into three dimensions- social, economic and environmental (UN, 2016; UN, 2015). It was agreed that the implementation of SDGs should respect human rights and dignity. The SDG on health was crafted to attend to the numerous challenges that are faced globally such as maternal, neonatal and child mortality (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 18). In addition, the third SDG seeks to prevent deaths from epidemic diseases such as TB, HIV and malaria which contribute significantly to maternal and child mortality particularly in developing countries which consistently report worrying trends of maternal, neonatal and under five deaths (UNICEF, 2020; Huges *et al.* 2019; World Bank, 2019; GSS, 2019; WHO, 2016). The aim of this paper is to forecast future trends of under-five mortality rate for the USA using a machine learning technique. The results of this research are expected to inform maternal and child health (MNCH) policies and allocation of resources so as to keep mortality among under five children under control.

II. LITERATURE REVIEW

Harpur *et al.* (2021) investigated trends in infant mortality rates (IMR) and stillbirth rates by socio-economic position (SEP) in Scotland, between 2000 and 2018, inclusive. Data for live births, infant deaths, and stillbirths between 2000 and 2018 were obtained from National Records of Scotland. Annual IMR and stillbirth rates were calculated and visualized for all of Scotland and when stratified by SEP. Negative binomial regression models were used to estimate the association between SEP and infant mortality and stillbirth events, and to assess for break points in trends over time. The study revealed that IMR fell from 5.7 to 3.2 deaths per 1000 live births between 2000 and 2018, with no change in trend identified. Stillbirth rates were relatively static between 2000 and 2008 but experienced accelerated reduction from 2009 onwards. When stratified by SEP, inequalities in IMR and stillbirth rates persisted throughout the study and were greatest amongst the sub-group of post-neonates. Juarez *et al.* (2020) conducted a quality improvement study to increase the detection of neonatal complications by lay midwives in rural Guatemala, thereby increasing referrals to a higher level of care. A quality improvement team in Guatemala reviewed drivers of neonatal health services provided by lay midwives. Improvement interventions included training on neonatal warning signs, optimized mobile health technology to standardize assessments and financial incentives for providers. The primary quality outcome was the rate of neonatal referral to a higher level of care. It was found that structured improvement interventions, including mobile health decision support and financial incentives, significantly increased the detection of neonatal complications and referral of neonates to higher levels of care by lay midwives operating in rural home-based settings in Guatemala. Bandeira *et al.* (2016) described Portugal's achievements in the maternal and child health program. The study highlighted that the joint venture of pediatricians and obstetricians with adequate top-down government commissions for maternal and child health for the decision making by health administrators and a well-defined schedule of preventive and managerial measures in the community and in hospitals, registry of special diseases and training of medical personnel are the most likely explanations for this success. Chow *et al.* (2015) carried a selected review to examine the etiology of neonatal mortality rates in different countries by utilizing

electronic databases. The findings indicated that mortality rates in neonatal ICU units vary in different countries but are still high in both developing and developed countries.

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 the USA.

Data Issues

This study is based on annual under five mortality rate in the USA 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	
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	0.010893
MSE	0.077895
MAE	0.226947

Residual Analysis for the Applied Model

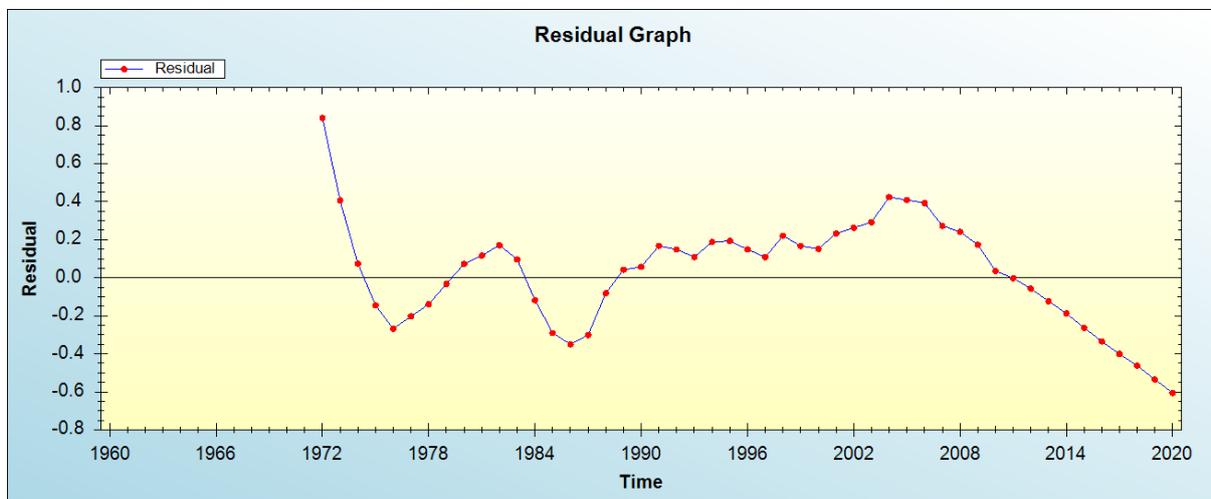


Figure 1: Residual analysis

In-sample Forecast for C

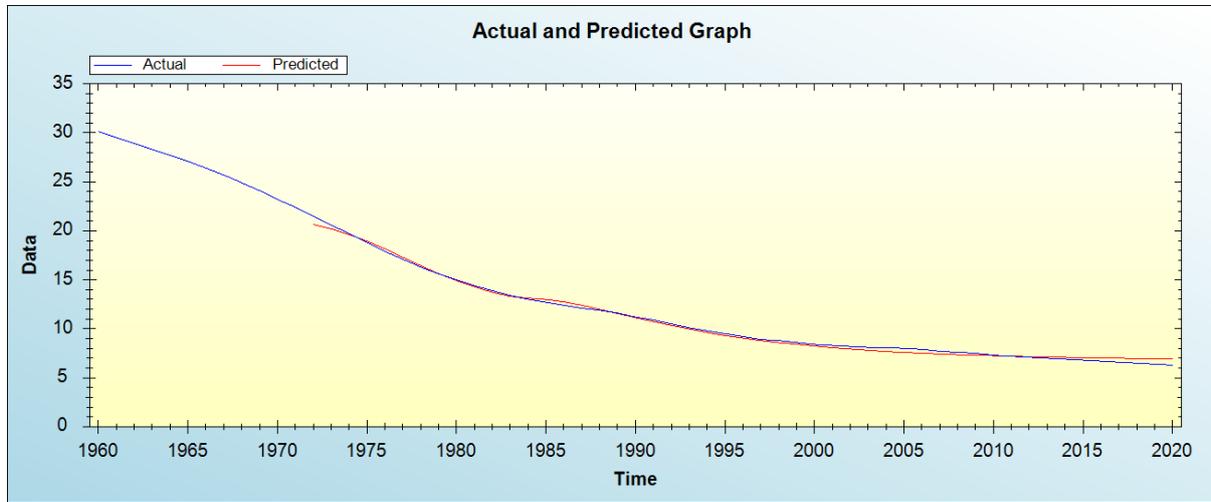


Figure 2: In-sample forecast for the C series

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

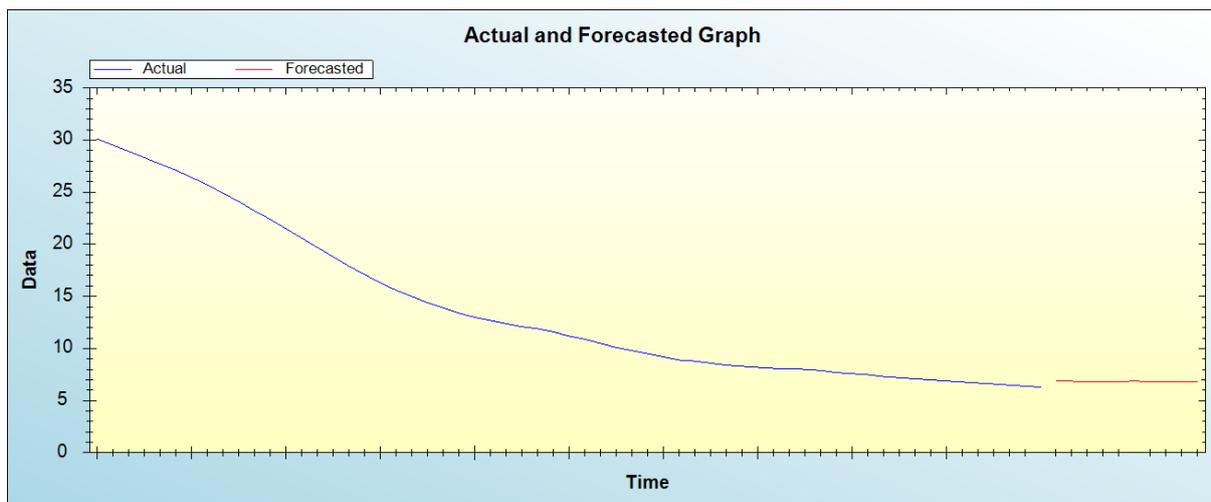


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	6.8691
2022	6.8728
2023	6.8525
2024	6.8392
2025	6.8499
2026	6.8770
2027	6.8560
2028	6.8460
2029	6.8253
2030	6.8108

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 consistently remain below 10 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

At the end of the SDG era most UN member countries are expected to have solved all the major challenges that cause human suffering and death across the globe. One of the aims under SDG3 is the substantial reduction of under-five mortality to levels as low as 25 deaths per 1000 live births by 2030. The US has made significant progress towards the achievement of this goal as indicated by the gradual decline of under-five mortality rate to levels below 10 deaths per 1000 live births. The ANN model was applied in this paper to project future trends of under-five mortality rate in the USA and forecast results revealed that U5MR will consistently remain below 10 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage health authorities in the USA to continue providing financial support to the maternal and child health program to keep under five mortality under control.

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] United Nations Children's Fund (UNICEF) (2020). UNICEF data: monitoring the situation of children and women.
- [7] World Health Organization (WHO) (2016). Global Health Observatory (GHO) country views. Haiti statistics summary (2002-present): WHO.
- [8] World Health Organization (2019). Newborns: reducing mortality. <https://www.who.int/news-room/fact-sheets/detail/newborns-reducing-mortality>. Accessed 20 Nov 2019
- [9] Ghana Statistical Service—GSS, Ghana Health Service—GHS, ICF International (2015). Ghana Demographic and Health Survey 2014. Rockville, Maryland, USA: GSS, GHS, and ICF International.
- [10] Hug L., Alexander M., You D., and Alkema L (2019). National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. *Lancet Glob Heal*, 7, 6, e710–20.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Under Five Mortality Will Remain Under Control in the United States: Evidence From Artificial Neural Networks" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 541-544, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607121>
