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# Analysis of Under Five Mortality for Antigua and Barbuda Using Artificial Neural Networks

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Antigua and Barbuda from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Forecast evaluation criteria of the applied model indicate that the model is stable in forecasting U5MR for Antigua and Barbuda. The ANN (12, 12, 1) model projections suggest that U5MR will hover around 7.0 deaths per 1000 live births over the out of sample period. Therefore, the government should draft child health policies that will keep under five mortality under control.**

***Keywords:*** ANN, Forecasting, U5MR.

## I. INTRODUCTION

The 3rd sustainable development goal (SDG3) addresses all major health problems such as maternal and child health, sexual and reproductive health, adolescent health, communicable and non-communicable diseases, prevention and treatment of substance abuse, and prevention of deaths from road traffic accidents and harmful chemicals (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). The 1994 international conference on Population and development was an important event especially for adolescent girls and women (UN, 1995). From that time SRH and rights became a global health priority (WHO, 1998). WHO drafted guidelines to reduce adverse reproductive health outcomes and these included legal reform, strategies to reduce child marriages, increased contraceptive use, reduce coerced sex, unsafe abortions and increase in the use of maternity services (WHO, 2011). Family planning is regarded as an essential intervention for reducing maternal and infant mortality there by stimulating economic development through increased participation of women in labor force and equitable use of resources (Gribbi *et al.* 2012; Canning & Schultz, 2012). The objective of this paper is to forecast future trends of under-five mortality rate for Antigua and Barbuda using the artificial neural network technique. We expect the study findings to assist in child health policy making, planning and allocation of resources to MNCH programs in order to end all preventable under five deaths by 2030.

## 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. Iriondo *et al.* (2020) developed and validated different mortality predictive models, using Spanish data, to be applicable to centers with similar morbidity and mortality. Infants born alive, admitted in NICU, and registered in the SEN1500 database, were included. Multivariable regression models were used for the different time periods. The study concluded that using dynamic models to predict individual mortality can improve outcome estimations. Development of models in the prenatal period, first 24 hours, and during hospital admission, cover key stages of mortality prediction in preterm infants. Nath *et al.* (2020) examined the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. Authors used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistic. Infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life. An Indian forecasting study by Mishra et al. (2019) gave a detailed presentation of how they used the ARIMA model to forecast infant mortality rates (2017 – 2025). The forecast of the sample period (1971 – 2016) showed accuracy by the selected ARIMA (2, 1, 1) model. The post-sample forecast with ARIMA (2, 1, 1) model showed a decreasing trend of infant mortality (2017 – 2025). The forecast infant mortality rate for 2025 in India is 15/1000 live births.

 

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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 Antigua and Barbuda.

### Data Issues

This study is based on annual under five mortality rate in Antigua and Barbuda 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 | W |
| 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 | 0.001721 |
| MSE | 0.165448 |
| MAE | 0.348784 |

Residual Analysis for the Applied Model

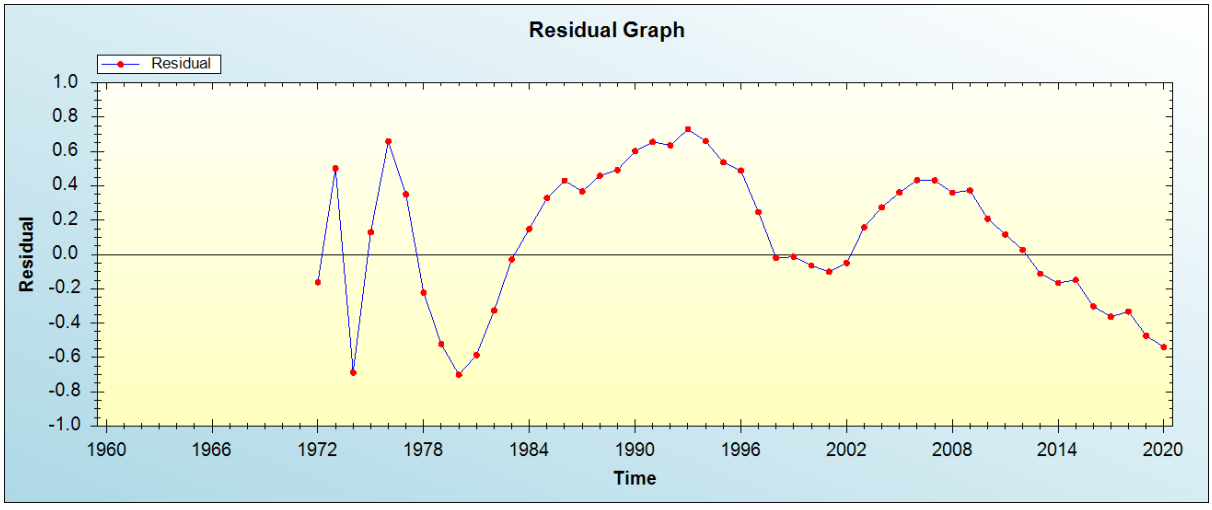


Figure 1: Residual analysis

 

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In-sample Forecast for W

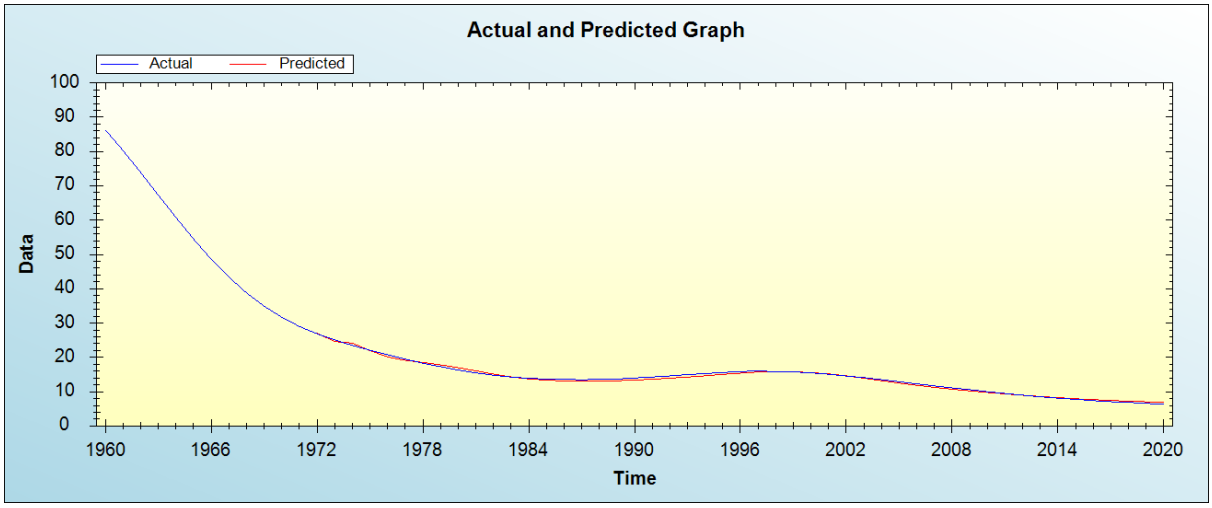


Figure 2: In-sample forecast for the Wseries

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

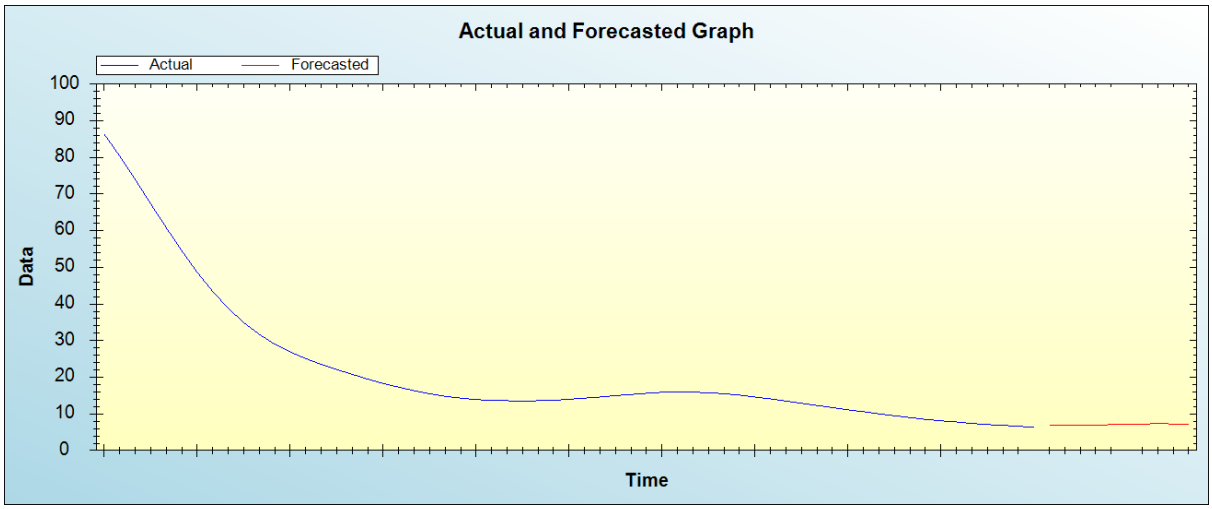


Figure 3: Out-of-sample forecast for W: actual and forecasted graph

Out-of-Sample Forecast for W: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 6.7903 |
| 2022 | 6.8177 |
| 2023 | 6.9484 |
| 2024 | 6.9919 |
| 2025 | 7.0577 |
| 2026 | 7.1668 |
| 2027 | 7.2752 |
| 2028 | 7.3285 |
| 2029 | 7.2848 |
| 2030 | 7.2049 |

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 7.0 deaths per 1000 live births throughout the out of sample period.

 

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## V. POLICY IMPLICATION & CONCLUSION

Sustainable development goals (SDGs) were designed to curb under five mortality in developing and developed countries of which the later have managed to keep mortality among under five children under control. The results of this paper showed that under five mortality rate is likely to hover around 7.0 deaths per 1000 live births over the out of sample period. The findings of this study confirm that there is significant progress made by first world countries. Therefore, health authorities should formulate local strategies that will keep under five mortality under control.

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