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Tracking Future Trends of Under Five Mortality Rate in Syria Using a Machine Learning Technique

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Syria 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. ANN model projections suggest that annual U5MR will initially increase from around 26.6 deaths per 1000 live births in 2021 to 34 deaths per 1000 live births in 2025 and then decrease to 22 deaths per 1000 live births in 2030.Therefore, we encourage the Syrian government to address all the major factors that affect the quality of maternal and child healthcare program in the country.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Ending preventable maternal, neonatal and under five deaths remains a priority for both developing and developed countries (UN, 2016;UN, 2015). The 2030 Agenda for sustainable development outlined specific targets to ensure significant reduction of neonatal and under five mortality rate to at least 12 per 1000 live births and 25 deaths per 1000 live births respectively in every country by 2030 (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). Remarkable progress has been witnessed in the reduction of under-five mortality, however high rates of neonatal mortality are being reported in Sub-Saharan Africa and Southern Asia (OCHA, 2018; Lawn *et al*. 2016). The global neonatal mortality rate (NMR) has been declining at a slower rate than that of under 5 mortality (World Bank, 2020). The aim of this paper is to predict under five mortality rate for Syria using a machine learning technique. The research findings are expected to inform maternal and child health (MNCH) policies and allocation of resources to effectively control deaths among under children.

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.Masaba & Phetoe (2020) 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 study conducted in Zimbabwe by Nyoni & Nyoni (2020) analyzed monthly time series data on neonatal death cases at Chitungwiza Central Hospital (CCH) from January 2013 to December 2018 using Box-Jenkins SARIMA models and found out that there will be a slow but steady decrease in neonatal deaths at CCH over the out-of-sample period.A study conducted by Brault *et al*. (2018) examined factors contributing to the reductions in under-five mortality in Postwar Liberia by conducting a case study mixed methods approach drawing on data from quantitative indicators, national documents and qualitative interviews were used to describe factors that enabled Liberia to rebuild their maternal, neonatal and child health (MNCH) programmes and reduce under-five mortality following the country's civil war. The findings revealed that three main factors contributed to the reduction in under-five mortality: national prioritization of MNCH after the civil war; implementation of integrated packages of services that expanded access to key interventions and promoted inter-sectoral collaborations; and use of outreach campaigns, community health workers and trained traditional midwives to expand access to care and improve referrals. Dejong *et al*. (2017)utilized Countdown to 2015 (Millennium Development Goals) health indicators to provide an up-to-date review and analysis of the best available data on Syrian refugees in Jordan, Lebanon and Turkey and internally displaced within Syria and explored data challenges in this conflict setting. The study obtained data from electronic databases and relevant stakeholders. The results indicated that in Syria, the infant mortality rate and under-five mortality rate increased, and coverage of antenatal care (one visit with a skilled attendant), skilled birth attendance and vaccination (except for DTP3 vaccine) declined. The number of Syrian refugee women attending more than four antenatal care visits was low in Lebanon and in non-camp settings in Jordan.

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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 Syria.

Data Issues

This study is based on annual under five mortality rate in Syria 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	Y
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	0.038310
MSE	10.250249
MAE	2.255443

Residual Analysis for the Applied Model

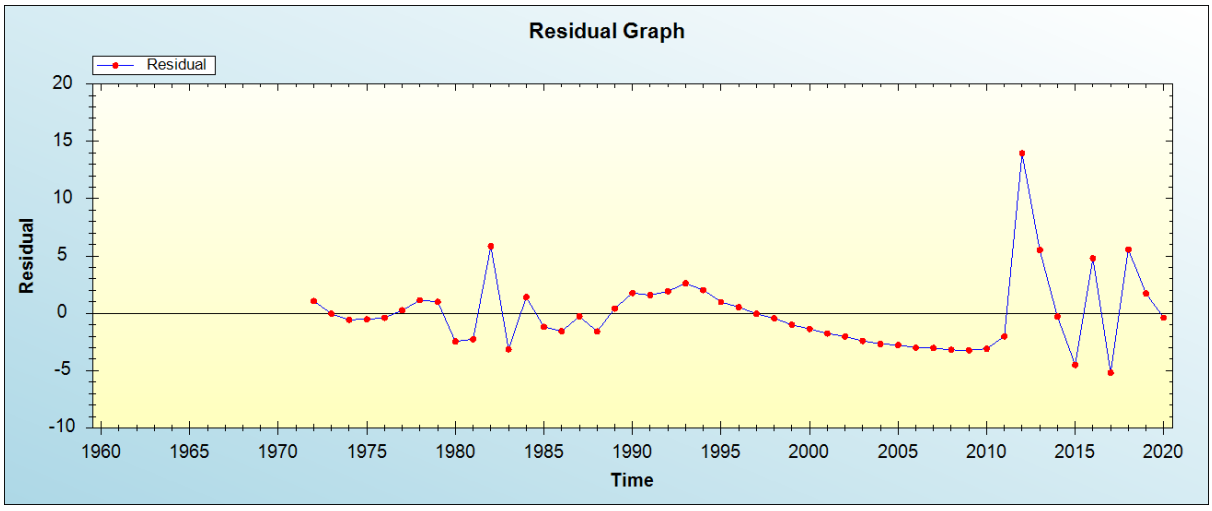

Figure 1: Residual analysis

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In-sample Forecast for Y

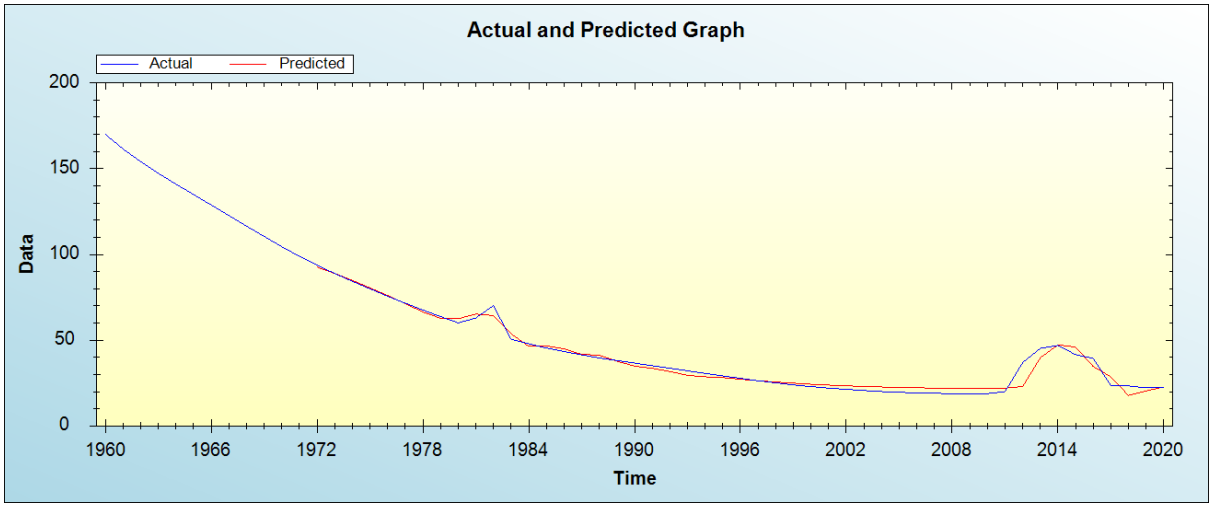

Figure 2: In-sample forecast for the C series

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

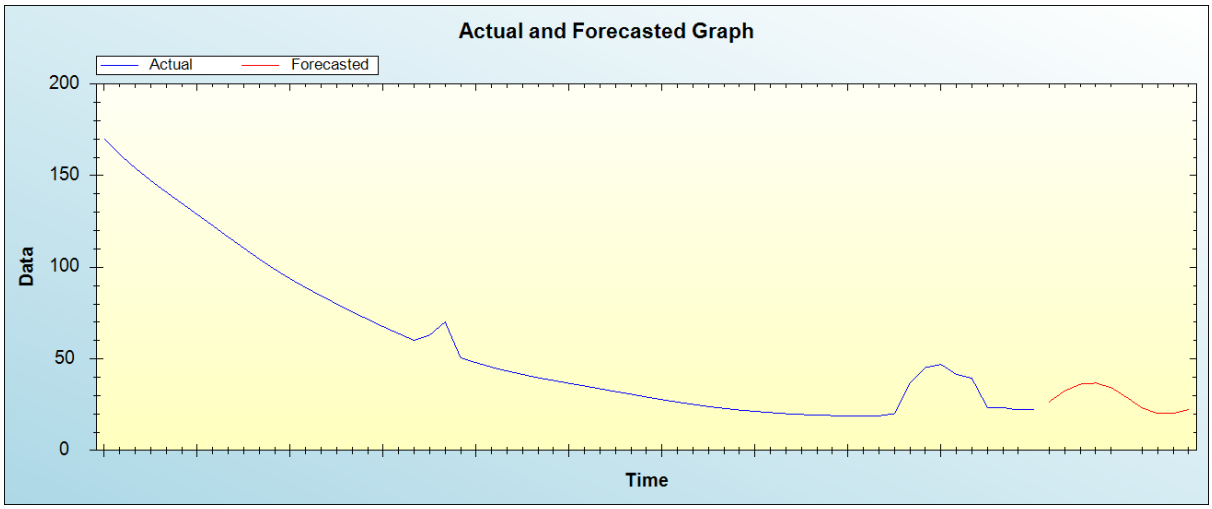

Figure 3: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	26.6099
2022	32.6427
2023	36.1793
2024	36.8002
2025	34.3662
2026	28.9850
2027	23.2270
2028	20.2467
2029	20.2090
2030	22.3705

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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 annualU5MR will initially increase from around 26.6 deaths per 1000 live births in 2021 to 34 deaths per 1000 live births in 2025 and then decrease to 22 deaths per 1000 live births in 2030.

V. POLICY IMPLICATION & CONCLUSION

The Syrian war has negatively impacted on the maternal and child health program due to the destruction of important infrastructure, mass exodus of healthcare workers and the prevailing humanitarian crisis with millions of people requiring food aid and adequate clean water for drinking. Under such circumstances under five mortality will remain a public health problem. In this study we applied the ANN model to forecast future trends of under-five mortality and forecast results indicate thatannual U5MR will initially increase from around 26.6 deaths per 1000 live births in 2021 to 34 deaths per 1000 live births in 2025 and then decrease to 22 deaths per 1000 live births in 2030.Therefore, the Syrian authorities must address all the major factors that contribute to under-five mortality so as to substantially reduce under five mortality to levels as low as 25 deaths per 1000 live births.

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