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Analyzing Under Five Mortality for Algeria Using a Machine Learning Technique

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Algeria from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. The residuals and forecast evaluation criteria of the applied ANN (12, 12, 1) model indicate that the model is stable in forecasting U5MR. The results of the study highlighted that U5MR will hover around 20 deaths per 1000 live births over the out of sample period. Hence, authorities in Algeria should prioritize maternal and child health programs by ensuring adequate staffing levels and medical supplies in healthcare facilities.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The third sustainable development goal (SDG3) has several targets that are designed to ensure good health and promotion of well-being for all at all stages of life. All the targets attached to this goal can be achieved through universal health coverage and access to quality, affordable healthcare services. Sexual and reproductive health (SRH) and maternal & child health are essential components of universal health coverage and are included in this United Nations' sustainable development goal (UN, 2016; Docklalova, 2016; UN, 2015). There is need to address SRH rights of adolescent girls and young women in order to improve maternal and child health outcomes (World Bank, 2016). Every couple or individual has a right to choose the time of giving birth, number of children, and birth spacing. Women must have equal opportunities for education and employment so that they participate in economic development. Many adolescents and young women in developing countries lack comprehensive knowledge on SRH and end up having unwanted pregnancies and unsafe abortions (Lema *et al.* 2002; Soderberg, 1997; Felice *et al.* 1999). By the end of 2030, all UN member countries should have managed to substantially reduce maternal, newborn and under five deaths down to the levels stated in the agenda 2030 for sustainable development document (UN, 2020; UNICEF, 2019; WHO. 2019; UNICEF, 2018).The purpose of this study is to forecast future trends of under-five mortality rate for Algeria using a machine learning algorithm. We expect the findings to assist in policy making, planning and allocation of resources to MNCH program activities in order to end all preventable under five deaths in the country.

II. LITERATURE REVIEW

Baruwa *et al*. (2021) applied survival models (Kaplan Mier and Cox proportional hazards) to investigate the relationship between type of birth attendant and neonatal mortality while controlling for socio-demographic characteristics of mothers in Lesotho. The findings of the study showed that the risk of neonatal mortality is two times higher among children delivered by non-skilled birth attendants. A systematic review carried out by Masaba and Phetoe (2020) found out 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 by Weddhi *et al.* (2019) investigated factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania. The study was conducted 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. The authors concluded that neonatal mortality remains a significant burden in Mauritania. They identified different socioeconomic and clinical risk factors indicating the need for more intensified prenatal care and improved transport of high risk neonates, especially in the regions outside the capital. Caluza (2018) utilized data mining technique using decision tree called J48 algorithm in classifying child mortality rate, life expectancy at birth, annual population growth, and the gross domestic product. Results revealed that annual population growth is highly correlated in predicting child mortality and generate three distinct rules. The generated model had high acceptability with 97.4% ROC curve result of the three classes in predicting child mortality under five years old.

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

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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 Algeria.

Data Issues

This study is based on annual under five mortality rate in Algeria 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	A
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	0.024398
MSE	16.884068
MAE	2.076626

Residual Analysis for the Applied Model

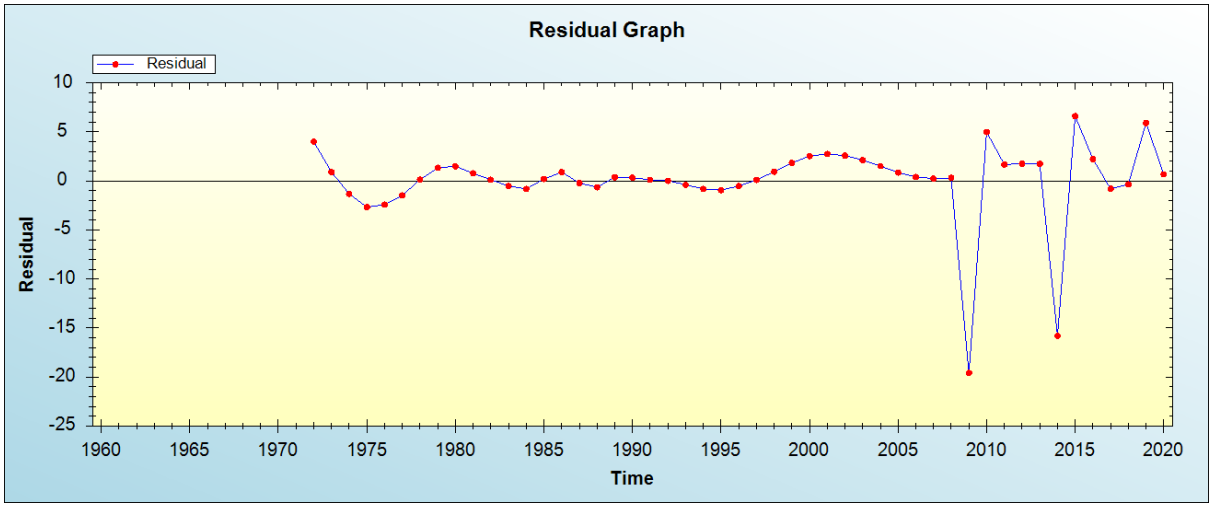

Figure 1: Residual analysis

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In-sample Forecast for A

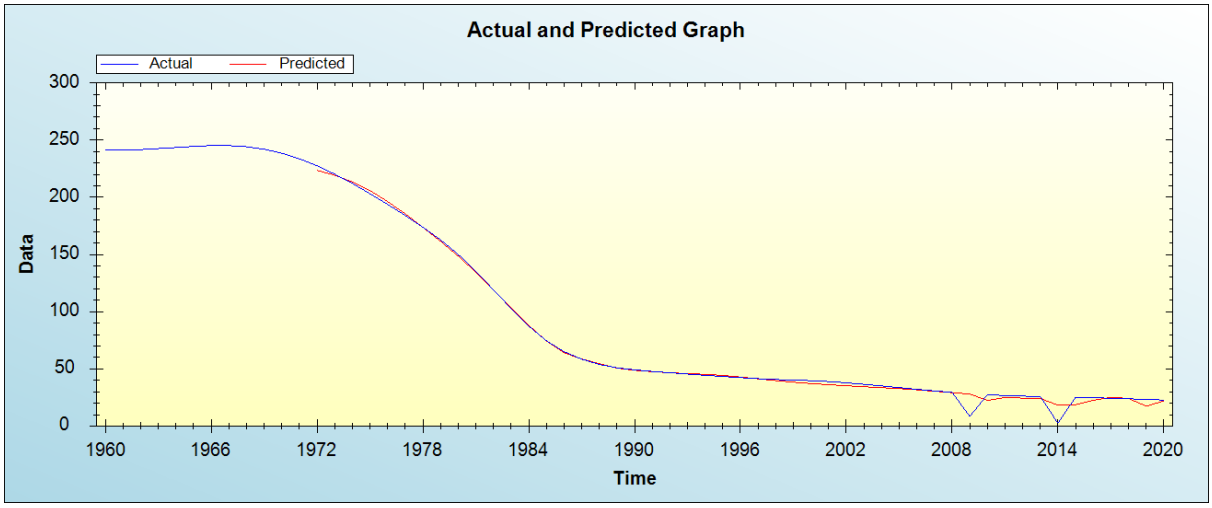

Figure 2: In-sample forecast for the A series

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

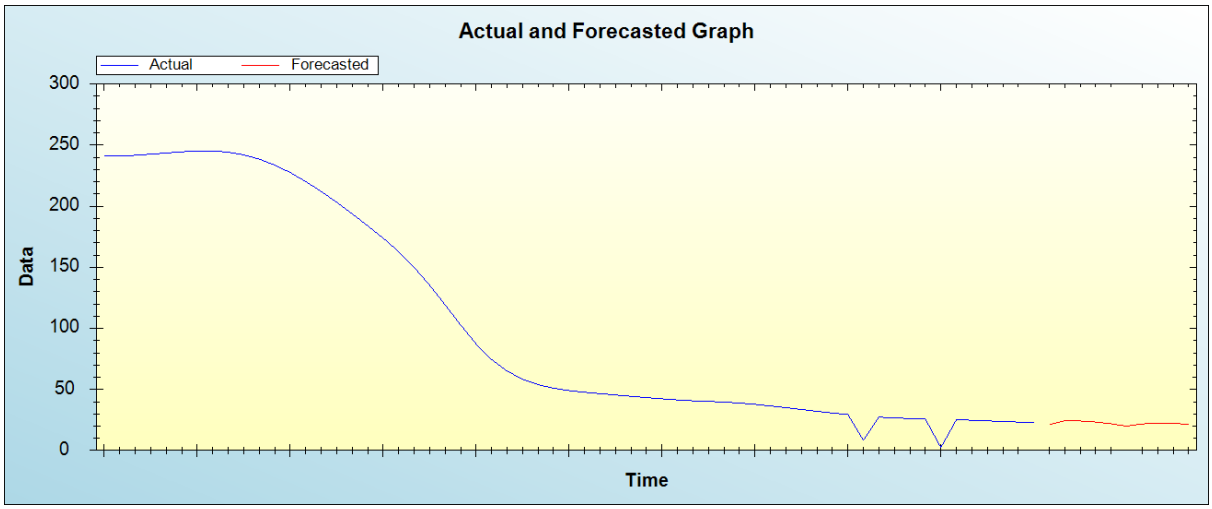

Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	21.1703
2022	24.3938
2023	24.2414
2024	23.3619
2025	21.8376
2026	19.9933
2027	21.8607
2028	22.2466
2029	22.2239
2030	21.5298

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

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V. POLICY IMPLICATION & CONCLUSION

By the end of 2030, all governments are expected to achieve all the targets mentioned in SDG3. Establishing sound monitoring and evaluation mechanisms will assist in tracking SDG progress including target 3.2 which aims at the substantial reduction of under-five mortality. The results of this study revealed that U5MR will hover around 20 deaths per 1000 live births over the out of sample period. Therefore, authorities in this country are encouraged to formulate appropriate strategies to keep under five mortality under control. These strategies include ensuring adequate medical staff and medical supplies.

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