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Forecasting Under Five Mortality Rate for Egypt Using an Artificial Intelligence Technique

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***Abstract* - This study uses annual time series data on under five mortality rate for Egypt 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 U5MR. The ANN (12,12, 1) model projections indicated that annual U5MR will remain constant around 20 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Egyptian authorities to allocate more resources to the maternal and child health program and address health system challenges that contribute to mortality among under five children.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The sustainable development goals (SDGs) were launched in 2015 and SDG 3 targets 3.1 and 3.2 focus on maternal and child health (UN, 2016; UN, 2016).SDG 3.1 ensures the substantial reduction of global maternal mortality ratio to levels below 70 maternal deaths per 100 000 live births and target 3.2 aims to ensure substantial reduction in neonatal mortality rate to at least 12 deaths per 1000 live births and under five mortality to as low as 25 deaths per 1000 live births by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Global neonatal mortality rate (NMR) dropped from 37 per 1000 live births in 1990 to 19 per 1000 live births in 2016 (UNIGME report, 2017; UNIGME report, 2014). Neonatal mortality has been found to vary by region with Sub-Saharan Africa and Southern Asia reporting the highest NMR (Child mortality report, 2017). Egypt's maternal mortality ratio (MMR) dropped from 174 per 100 000 in 1992 to 37 in 2017 (WHO *et al*. 2019; Campbell *et al.* 2005). During the same period NMR dropped from 31 per 1000 live births to 12 per 1000 live births (UNICEF, 2019). In with the Agenda 2030 for sustainable development, this study applies the artificial neural network model to forecast future path of under-five mortality rate for Egypt. The findings of this study are expected to inform policy, decision making and resource mobilization for maternal and child health programs in the country so that effective MNCH policies are implemented timeously to prevent and control mortality among under five children.

II. LITERATURE REVIEW

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.Ouedraogo *et al.* (2020) conducted a retrospective, descriptive and analytical study to examine the risk factors for neonatal mortality in the Neonatology Department of Saint Camille Hospital of Ouagadougou (HOSCO - Hospital Saint Camille de Ouagadougou). The study included all newborns hospitalized in the neonatology department, at St Camille Hospital, in Burkina Faso from January 1 to December 31, 2017. Total of 710 records of hospitalized newborns in 2017 were analyzed and specifically focused on neonatal mortality. The study findings revealed that the leading cause of death was respiratory distress (89.8%). All the newborns had been hospitalized within 24 hours of life and the average time to death in the unit was 3 days and 54% of deaths occurred within 72 hours of hospitalization. A Sub-Saharan African study by Bitew *et al.* (2020) determined the incidence density rate and predictors of neonatal mortality by utilizing electronic databases. The study findings indicated that the incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors. A similar African study by Kayode *et al*. 2017 revealed that there is a wide variation in neonatal mortality in SSA. A substantial part of this variation can be explained by differences in the quality of healthcare governance, prevalence of HIV and socioeconomic deprivation.

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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 Egypt.

Data Issues

This study is based on annual under five mortality rate in Egypt 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	P
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	0.000424
MSE	0.454742
MAE	0.531284

Residual Analysis for the Applied Model

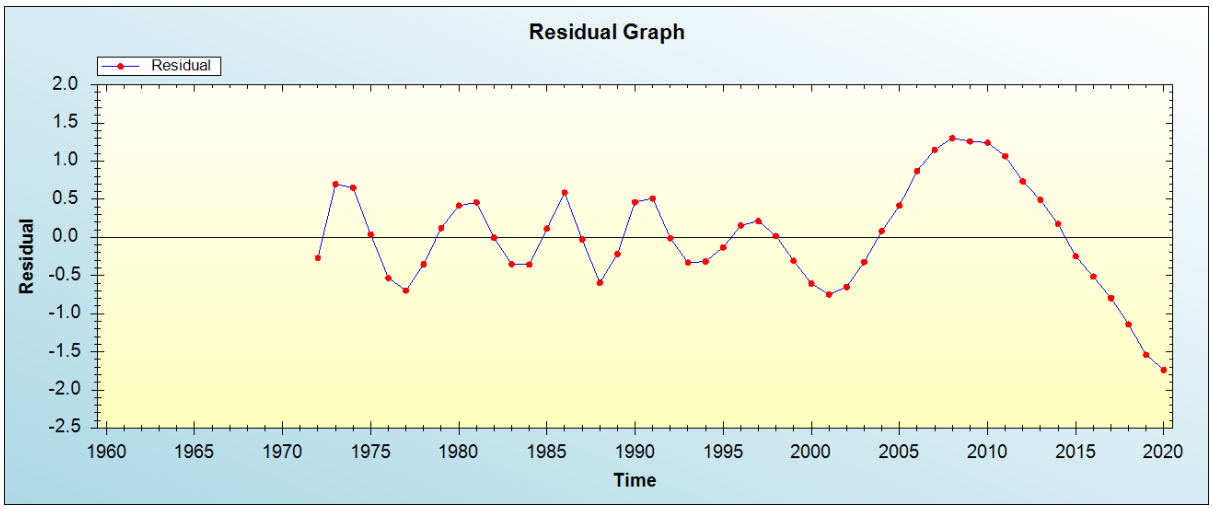

Figure 1: Residual analysis

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In-sample Forecast for P

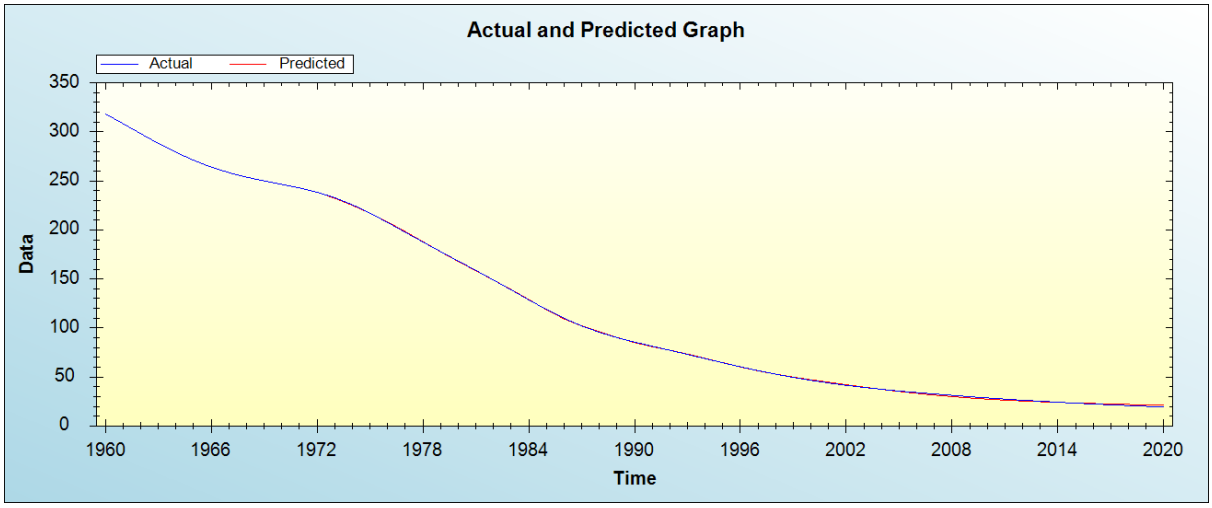

Figure 2: In-sample forecast for the P series

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

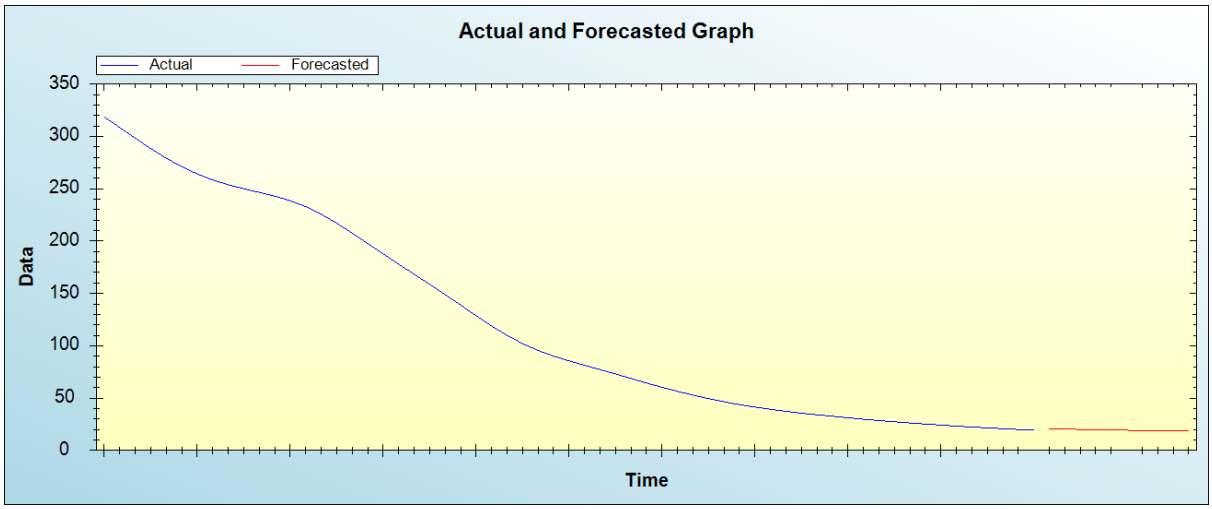

Figure 3: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	20.8560
2022	20.4317
2023	20.2404
2024	20.0077
2025	19.6491
2026	19.3892
2027	19.1279
2028	18.9313
2029	18.9672
2030	19.0908

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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 annual U5MR will remain constant around 20 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The era of sustainable development goals is expected to bring to an end all preventable under five deaths especially in Sub-Saharan Africa where socio-cultural, demographic and health system related factors are the major drivers of mortality among under five children. Tracking of SDG progress is important as a means of evaluating the impact of interventions. This study applies the ANN (12, 12, 1) to predict future trends of under-five mortality rate in Egypt and the findings showed thatannual U5MR will remain constant around 20 deaths per 1000 live births throughout the out of sample period. Therefore, the Egyptian authorities are encouraged to allocate more resources to the maternal and child health (MNCH) program and address health system challenges that contribute to under five mortality.

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