International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 291-295, March-2021

https://doi.org/10.47001/IRJIET/2021.503049

Somalia Struggling To Control the TB Epidemic: Insight from Artificial Neural Networks

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

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Department of Economics, University of Zimbabwe, Harare, Zimbabwe

***Abstract* - Somalia is among the African countries which have been ravaged by political instability and poverty. The country recorded high TB incidence between 2000-2013. Modeling and forecasting of TB incidence is now critical in order to understand the future evolution of the TB epidemic and assess the impact of mitigatory and control measures in the fight against TB. In this research article, the ANN approach was applied to analyze TB incidence in Somalia. The employed annual data covers the period 2000-2018 and the out-of-sample period ranges over the period 2019-2023. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting TB incidence in Somalia. The results of the study indicate that TB incidence is likely to be high around 287 cases /100 000/year and TB program gains will be reversed over the period 2019-2023.Therefore the government of Somalia is encouraged to intensify TB surveillance and control programs and to channel more resources towards TB/HIV programs.**

Keywords: ANN, Forecasting, TB incidence.

I. INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by mycobacterium Tuberculosis and mainly affects the lungs (Esmaeilzadeh et al, 2019; Ali, 2016).The disease has caused suffering and deaths across the World especially in the developing countries mainly due to poverty and malnutrition aggravated by political instability in some of the African countries like Somalia (WHO, 2016; WHO, 2018; Wang et al, 2018; Goroh et al, 2020; Aryee et al, 2018). Somalia has one of the highest TB incidences in the World. In 2016, WHO reported an estimated TB incidence of 270/100 000 population with a prevalence rate of 481/100 000 population and an estimated mortality rate of 64/100 000 people (WHO, 2016). The National TB program is funded by the Global fund for AIDS, Malaria and TB (GFATM). The TB control service provision is implemented through key partners who consist of International and National Non-Governmental Organizations with WHO providing technical support in collaboration with Somalia government (World Vision, 2018).

The clinical symptoms of pulmonary TB are productive coughing for more than 2weeks, fever, night sweats and weight loss (WHO, 2013). The diagnosis of the disease requires history taking, clinical examination, Chest x-ray and microbiological testing of sputum samples (WHO, 2018). The gene X-pert/MTB/Rif machine is used to analyze sputum samples for the presence of mycobacterium TB. The machine is able to detect Rifampicin sensitive and resistant mycobacterium tuberculosis (MTB). The main goal of the National TB program in Somalia is to detect and treat all TB infected patients in order to reduce morbidity and mortality and to stop the spread of the disease in the community. Despite the availability of TB treatment drugs, TB remains a challenge in developing countries. The emergence of multidrug resistant TB (MDR-TB), TB/HIV co-infection and treatment non-adherence are the main problems encountered by many clinicians. In 2015 an estimated 480 000 new cases of MDR-TB and an additional 100 000 people with Rifampicin resistant TB were eligible for MDR-TB treatment (WHO, 2016). HIV is the single most important predictor of TB incidence across the African continent (Dalbo &Tamiso, 2016). The aim of this paper is to model and forecast the annual TB incidence in Somalia by applying the artificial neural network, ANN (9,12,1) model. The findings of this study will reveal the future TB incidence trends. This will assist in planning and policy formulation so as to reduce incident TB cases and curb the transmission of TB in the community. Furthermore, results will enable enough resource allocation to the TB/HIV treatment and care programme in Somalia.

II. LITERATURE REVIEW

Globally there are many empirical studies which did mathematical modeling of TB incidence. Mao et al (2018) forecasted the incidence of TB in China using the seasonal Autoregressive integrated Moving Average (SARIMA) model. Monthly TB

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 291-295, March-2021

https://doi.org/10.47001/IRJIET/2021.503049

incidence data for the period January 2004-December 2015 was used. SARIMA (1,0,0) $(0,1,1)_{12}$ was the best model. The model predicted that TB incidence from January to June 2016 as follows:6.6335; 4.7208; 5.8193;5.5474; 5.2202 and 4.9156 per 100 000 people. Wang et al (2018) modelled and forecasted the TB prevalence rates four World bank income groups. An artificial intelligence algorithm-cuckoo search was used to forecast the hierarchical TB prevalence from 2013-2016.The study concluded that the model was simple and satisfactory in approximating actual TB prevalence rate. In another similar study, Zheng et al (2015) modelled and forecasted morbidity of TB in Xinjiang, China. The study applied the SARIMA and SARIMA-ARCH models using data covering the period January 2004 to June 2014in Xinjiang .The SARIMA $(1,1,2)x(1,1,1)_{12}$ – ARCH model suggested to give TB surveillance by providing estimates on TB morbidity trends in China. Aryee et al (2018) applied the ARIMA model to analyze monthly TB cases reported at KBTH from 2008 to 2017. The ARIMA(1,0,1) was the best model and the model predicted that monthly TB cases in 2018 would range from 53-55.

III. METHOD

The Artificial Neural Network (ANN), which we intend to apply in this paper; is a data processing system consisting of a large number of simple and highly interconnected processing elements resembling a biological neural system. It has that great capability of learning from an experimental or real data set to describe the nonlinear and interaction effects with great accuracy. ANN-based curve fitting model is one of the extensively applied artificial intelligence methods that are used for forecasting and prediction purpose. It consists of basically three layers i.e., input layer, hidden layer, and output layer, the present work includes the number of years as input layer and the annual TB incidence in Somalia as output data for the network. In this research, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on TB incidences (referred to as S series in this study) in all age groups at GPH. The annual data covers the period 2000-2018 while the out-of-sample forecast covers the period 2019-2023. All the data employed in this research paper was gathered from the World Bank online database

IV. FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
281.11	285.00	262.00	286.00
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
7.7237	0.027476	-1.4109	0.46940
5% Perc.	95% Perc.	IQ range	Missing obs.
undefined	286.00	12.000	0

ANN MODEL SUMMARY FOR TB INCIDENCE (new cases per 100 000 population/year) IN SOMALIA

Table 2: ANN model summary

Variable	S
Observations	10 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	9
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	0.056688

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 3, pp 291-295, March-2021
https://doi.org/10.47001/IRJIET/2021.503049

MSE	0.571302
MAE	0.502231

Residual Analysis for the ANN model

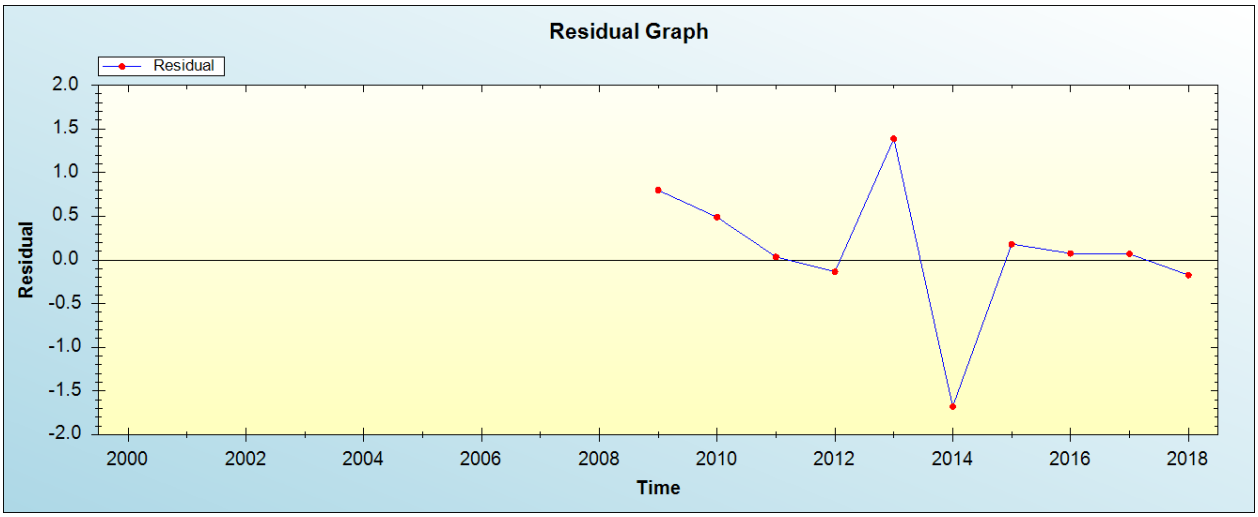

Figure 1: Residual analysis

In-sample Forecast for S

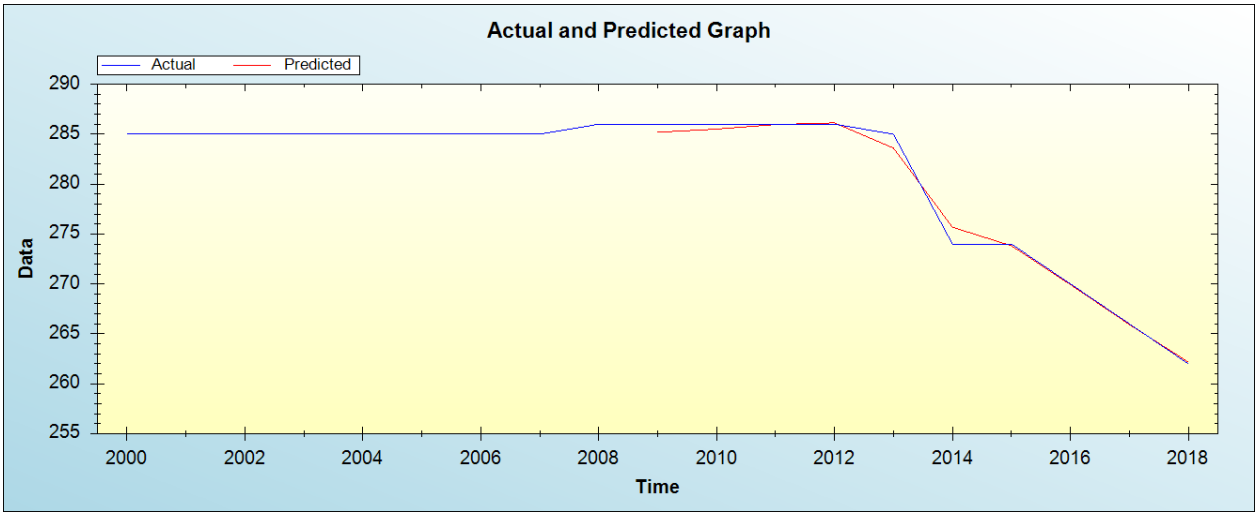

Figure 2: In-sample forecast for the S series

Figure 2 shows the in-sample forecast for S series.

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

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 3, pp 291-295, March-2021
https://doi.org/10.47001/IRJIET/2021.503049

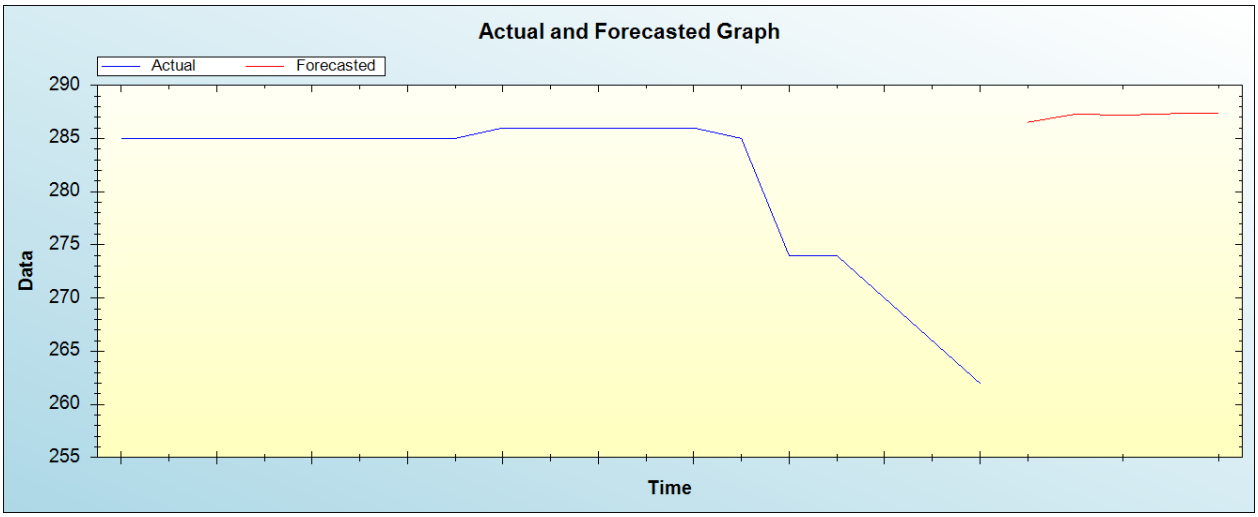

Figure 3: Out-of-sample forecast for S: actual and forecasted graph

Out-of-Sample Forecast for S: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2019	286.5158
2020	287.2867
2021	287.1913
2022	287.3330
2023	287.3333

Table 1 shows that over the period 2000-2018 the minimum and maximum TB incidence was 262 and 286 cases per 100 000 population/year. The applied data is negatively skewed and platykurtic with a kurtosis value of 0. 46940. This means that the data is not normally distributed. The residuals and evaluation statistics indicate that the applied ANN (9,12,1) model is stable. Figure 2 indicates that the model simulates the actual (observed) values very well. The model predicts that TB incidence will remain high at a plateau level of 287 cases per 100 000 population/year throughout the period 2019-2023.

V. CONCLUSION & RECOMMENDATIONS

Somalia is one of the African nations which has been ravaged by civil conflict, poverty and hunger. The country has a high TB disease burden and over the period 2000-2013 TB incidence has been around 285 cases/100 000/year. Between 2013 and 2018 the country recorded a sharp decline in the incidence of TB reflecting a response to the effective control measures implemented by the government. However, of concern is that the model predicts that the success achieved by the state will likely be reversed as the model suggests that TB incidence will go up and will be around 287 cases/100 00/year over the period 2019-2023.The government of Tanzania is encouraged to intensify TB surveillance and control programs among other measures in order to reduce new TB infections in the country.

REFERENCES

[1] Ali SA., Mavundla TR., Fantu R & Awoke T (2016). Outcomes of TB treatment in HIV co-infected TB patients in Ethiopia: a cross-sectional analytic study. BMC Infectious Diseases. 2016; 16(1): 640.

[2] Dalbo M &Tamiso A (2016). Incidence and Predictors of Tuberculosis among HIV/AIDS Infected Patients: a five-year retrospective follow-up study. Advances in Infectious Diseases; 6(02): 70-81. Google Scholar

[3] George Aryee., Ernest Kwarteng., Raymond Essuman., Adwoa Nkansa Agyei., Samuel Kudzawu., Robert Djagbletey., Ebenezer Owusu Darkwa & Audrey Forson (2018). Estimating the incidence of tuberculosis cases reported at a tertiary hospital in Ghana: a time series model approach pp 1-8

[4] Jiyang Wang., Chen Wang & Wenyu Zhang. (2018). Data Analysis and Forecasting of Tuberculosis Prevalence Rates for Smart Healthcare Based on a Novel Combination Model Appl. Sci. 8, 1693; doi:10.3390/app8091693

ISSN (online): 2581-3048
Volume 5, Issue 3, pp 291-295, March-2021
https://doi.org/10.47001/IRJIET/2021.503049

[5] Michelle May D. Goroh., Christel H.A. van den Boogaard., Mohd Yusof Ibrahim., Naing Oo Tha., Swe., Freddie Robinson., Khamisah Awang Lukman., Mohammad Saffree Jeffre., Timothy William & Anna P. Ralph (20200. Factors Affecting Continued Participation in Tuberculosis Contact Investigation in a Low-Income, High-Burden Setting Trop. Med. Infect. Dis. 5, 124; doi:10.3390/tropicalmed5030124

[6] Nayereh Esmaeilzadeh., Alireza Bahonar, Abbas Rahimi Foroushani., Mahshid Nasehi & Mohammad TaghiShakeri (2019). Which Type of Univariate Forecasting Methods Is Appropriate for Prediction of Tuberculosis Cases in Razavi Khorasan Province? A Need for Surveillance and Bio surveillance Systems J. Arch.MilMed;7(3): e96229

[7] World Health Organization. Global tuberculosis report. 2013

[8] World Health Organization. Global tuberculosis report. 2016.

[9] World Health Organization. Global tuberculosis report. 2016.

[10] World Health Organization. Global tuberculosis report. 2018.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Somalia Struggling To Control the TB Epidemic: Insight from Artificial Neural Networks" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 291-295, March 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.503049

****

