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

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 321-325, March-2021

https://doi.org/10.47001/IRJIET/2021.503055

Forecasting the Annual Incidence of TB in Namibia Using the Multilayer Perceptron

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***Abstract* - Namibia is a high TB burden and high TB incidence country in the SADC region. The government is working very hard in the prevention and control of TB because it has experienced a downward trend in the incidence of TB between 2000-2018 through implementation of effective preventive and control measures. In this research article, the ANN approach was applied to analyze TB incidence in Namibia. The employed 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 Namibia. The results of the study indicate that the country will continue to experience a downward trajectory in the incidence of TB over the period 2019-2023. Amongst other strategies the government of Namibia should intensify TB surveillance and control strategies to significantly reduce TB incidence to below 30 new cases per 100 000 population/year.**

Keywords: ANN, Forecasting, TB incidence.

I. INTRODUCTION

Mycobacterium Tuberculosis (MTB) infection has ravaged developing countries especially those in the Sub-Saharan Africa. In 2018 10 million cases were notified globally of which 24% were reported in the Sub-Saharan region (Lawn et al, 2006; Jones, 2015; WHO, 2019). Namibia has a very high TB burden with a case notification rate of 442 cases per 100 000 population (Namibia Ministry of Health &Social services, 2015; WHO, 2016). The government of Namibia adopted the Directly Observed Treatment Short course (DOTS) strategy in 1995 in order to reduce the incidence of TB (Raviglione & Uplekar, 2006; WHO, 2006). The main goal of the national TB program in Namibia is early TB case detection and optimization of treatment outcomes through DOTS strategy in order to 'END TB' by 2035(WHO, 2016, WHO, 2006). The DOTS strategy has been widely implemented by the government ,however the strategy is faced with setbacks from loss to follow up ,emergence of drug resistant TB and TB/HIV co-infection(Lew et al, 2008; Fastini et al, 2005; Sesay, 2017; Hung, 2015; Wright et al, 2015; Van et al, 2013). The TB epidemic in Namibia is thought to be due to a variety of factors which include poor housing conditions, immune suppression from HIV infection, malnutrition, and lack of access to high quality health services (Namibia, 2006). Poverty has been noted as one of the major causes of the TB epidemic since it is associated with overcrowding and poor ventilation thereby facilitating high transmission (Namibia, 2006). In 2006, Namibia recorded low treatment success of about 76% which is below the WHO target (Namibia 2007). This was as a result of high defaulter rate of 8% (Namibia, 2008). Caminero (2003) stated that the main objective of the TB program in developing nations is to interrupt the chain of transmission by acting on the human reservoir of TB infected patients is necessary in order to curb the transmission to reduce morbidity and mortality.

In Namibia there are no empirical studies which forecasted the incidence of TB, however researchers in other countries have vast experience in doing such studies. Kubuule D et al (2020) investigated the predictors of loss to follow up of TB cases under the DOTS programme in Namibia .The study used a retrospective longitudinal analysis of a nationwide cohort of TB cases in Namibia from 2006 to 2015.The trends and predictors to loss to follow up among cases in the national Electronic TB register of the National TB and Leprosy programme were retrospectively determined by interrupted time series and multivariate logistic regression using R studio software .The study concluded that there were declining trends in lost to follow up in Namibia . Wang et al (2018) applied the SARIMA and SARIMA-GRNN hybrid models to model and forecast TB notification rate in China using data covering the period 2005-2017.Study findings revealed that TB is seasonal disease in China with a predominant peak in spring and the trend of TB decreased by 3.17 %per year. The SARIMA-GRNN model outperformed the SARIMA model in predicting TB incidence. Wang Y et al (2019) did a temporal trends analysis of TB morbidity in mainland China from 1997 to 2025 using the new SARIMA-NARNNX hybrid model. The findings from the study indicated that the hybrid model outperforms other methods and the model should be used to forecast long term patterns of TB. In this paper we applied the artificial neural network ANN (9,12,1) model to model and forecast the annual incidence of TB in Namibia using the data covering the period

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2000-2018.The study findings are expected to reveal future trends of TB incidence in Namibia and thereby facilitating an early response to the TB epidemic.

II. METHOD

The Artificial Neural Network (ANN), which we intend to apply; is just a data processing system consisting of a large number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from an experimental or real data set to describe the nonlinear and interaction dynamics with great accuracy. ANN-based curve fitting technique 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 Namibia as output data for the network. In this piece of work, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on TB incidences (referred to as V series in this study) in Namibia. The annual data covers the period January 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.

III. FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
925.58	974.00	524.00	1260.0
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
257.82	0.27855	-0.12914	-1.4643
5% Perc.	95% Perc.	IQ range	Missing obs.
Undefined	1260.0	516.00	0

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

Table 2: ANN model summary

Variable	V
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	0.008416
MSE	11.842737
MAE	2.935485

Residual Analysis for the ANN model

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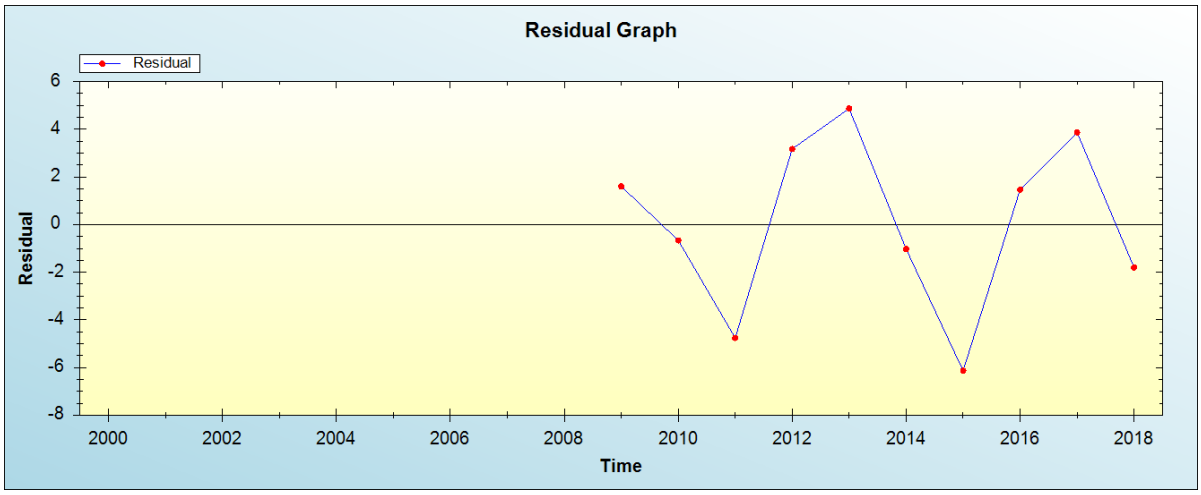

Figure 1: Residual analysis

In-sample Forecast for V

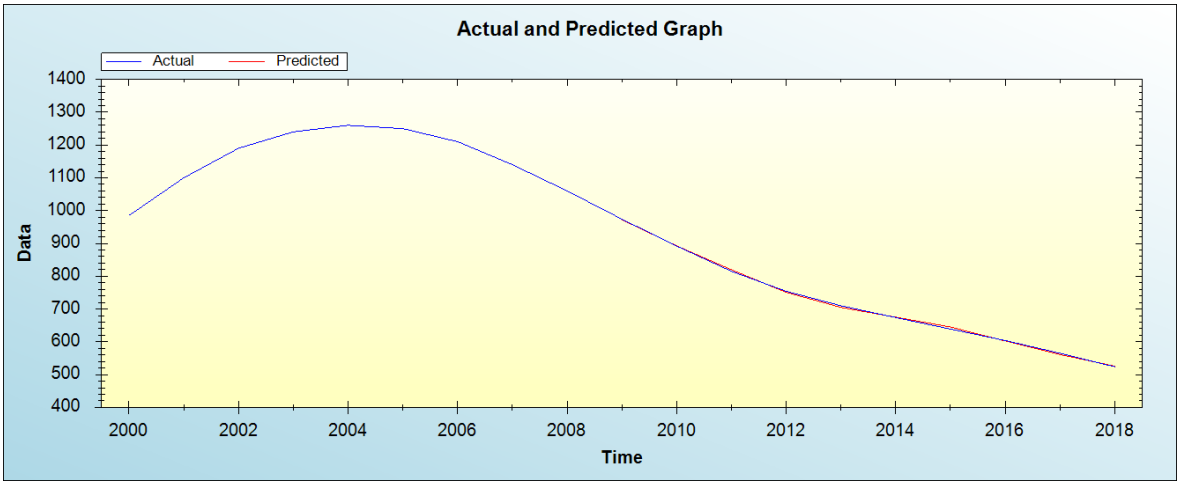

Figure 2: In-sample forecast for the V series

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

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

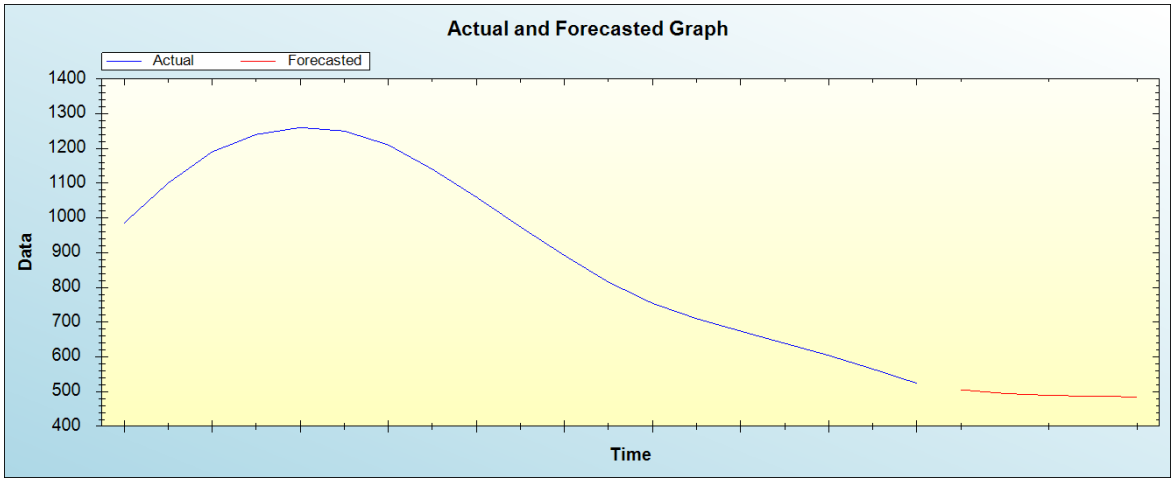

Figure 3: Out-of-sample forecast for V: actual and forecasted graph

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Out-of-Sample Forecast for V: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2019	505.4661
2020	494.5667
2021	489.2077
2022	486.4276
2023	485.1806

Table 1 shows that over the study period 2000-2018, the minimum and maximum TB incidence was 524 and 1260 cases per 100 000 population/year respectively. The average incidence was 926 cases per 100 000 population/year. The applied data is negatively skewed with an excess kurtosis of -1.4643 implying that it is not normally distributed. The residual graph and model evaluation criteria (Error, MSE, MAE) suggest that the ANN (9,12,1) model is stable and suitable to forecast TB incidence in Namibia. In-sample forecast indicate that the model simulates the observed values very well. The predictions from the model suggests that TB incidence will remain very high although a small decline is expected from 505 (in 2019) to 485 cases per 100 000 population/year (in 2023).

IV. CONCLUSION & RECOMMENDATIONS

Namibia is a high TB burden country; however tremendous efforts have been made to control the TB epidemic. Figure 3 shows that robust measures were implemented as the TB incidence has been on a downward trend between 2000-2018 and more encouraging is that this trend is expected to continue from 2019-2023.The government of Namibia should continue to strengthen HIV/TB program linkages with a view to detect and treat cases early and control the spread of TB in the community. Isoniazid prophylaxis for TB should continue as part of the TB prevention strategy. The government ought to intensify TB surveillance and control programs and ensuring the availability of Antiretroviral therapy and anti-TB drugs at all levels of the healthcare system all the time. The government should collaborate more with private healthcare facilities in the provision of HIV/TB services to lessen its financial and human resource burden.

REFERENCES

[1] Caminero JA (2003). A tuberculosis guide for specialist physicians. International Union Against Tuberculosis and Lung Diseases: 24.

[2] Faustini A., Hall A J & Perucci C A (2005). Tuberculosis treatment outcomes in Europe: a systematic review. Eur Respir J; 26: 503–510.

[3] Hung C L., Chien J Y & Ou C Y (2015). Associated factors for tuberculosis recurrence in Taiwan: a nationwide nested case control study from 1998 to 2010. PLOS ONE

[4] Jones CL (2015). HHS public access. Department of Health and Human Services Unites States of America; 33: 395–401.

[5] Lawn L., Myer L., & Bekker LG (2006). Burden of tuberculosis in an antiretroviral treatment programme in sub-Saharan Africa: impact on treatment outcomes and implications for tuberculosis control. AIDS; 20: 1605–1612.

[6] Lew P., Pai M &Oxlade O (2008). Initial drug resistance and tuberculosis outcomes: systematic review and meta-analysis. Ann Intern Med; 149: 123–134.

[7] Namibia (2006) Ministry of Health and Social Services. National Guidelines for the Management of TB, 2nd edition.

[8] Namibia (2015). Republic of Namibia Ministry of Health and Social Services National Tuberculosis and Leprosy Programme Annual Report: 2014–2015. Windhoek Namibia, MoHSS.

[9] Raviglione M C & Uplekar M W (2006). WHO's new STOP TB Strategy. Lancet 2006; 367: 952–955.

[10] Sesay M L (2017). Patient characteristics and treatment outcomes among tuberculosis patients in Sierra Leone. Minneapolis, MN, USA: Walden University.

[11] van Gorkom J, Mavhunga F, Omer O A, et al. TB control in Namibia 2002–2011: progress and technical assistance. Open Infect Dis J 2013; 7 (Suppl 1): 23–29.

[12] WHO (2006). The Stop TB Strategy: building on and enhancing DOTS to meet the TB-related Millennium Development Goals. WHO/HTM/STB/2006.37. Geneva, Switzerland.

[13] WHO (2016). Global Tuberculosis Report 2016. Geneva, WHO, 2016.

[14] WHO (2019). Global Tuberculosis Report. Geneva: World Health Organization. Licence: CCBY-NC-SA3.0IGO.

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https://doi.org/10.47001/IRJIET/2021.503055

[15] Wright C M., Westerkamp L., Korver S & Dobler C C (2015) Community-based directly observed therapy (DOT) versus clinic DOT for tuberculosis: a systematic review and meta- analysis of comparative effectiveness. BMC Infect Dis ;15: 210.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Forecasting the Annual Incidence of TB in Namibia Using the Multilayer Perceptron" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 321-325, March 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.503055

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