Forecasting TB Incidence in Myanmar Using the Multilayer Peceptron Neural Network

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Abstract - **Myanmar is a high TB burden country and forecasting methods can assist uncover the future evolution of the epidemic. In this research paper, the ANN approach was applied to analyze TB incidence in Myanmar. The employed annual data covers the period 2000-2018 and the out-of-sample period ranges over the period January 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 Myanmar. The results of the study indicate that TB incidence will remain high at constant level of 326 cases per 100 000 population/year over the period 2019-2023. In order to contribute significantly to the national control strategy of a TB-free Myanmar, the government should, among other things, intensify TB surveillance and control programs.**

Keywords: ANN, Forecasting, TB incidence.

I. INTRODUCTION

Mycobacterium Tuberculosis is the commonest cause of respiratory disease among HIV positive patients worldwide (Gupta et al, 2015; WHO, 2016). According to WHO, 215 of the new TB cases are undiagnosed and more country specific actions are required to detect missing cases to achieve the global goal of ending TB epidemic by 2035 (WHO, 2014). Tracing TB contacts is a critical component of the TB program in any country in order to increase case finding. Early detection of new cases through active case finding will effectively reduce the transmission of the TB epidemic (Khaparde et al, 2015; Fox, 2013; Kranzer et al, 2012). Myanmar is a high TB burden country with an estimated TB incidence of 365 TB cases per 100 000 population and a high death rate of 49 per 100 000in 2015 (WHO, 2015). According to WHO guideline, the diagnosis of TB involves taking a clinical history, physical examination and confirmatory tests namely the Acid fast Bacilli smear and Chest X-ray (WHO, 2018). Myanmar is also considered as one of the countries with high HIV prevalence rates among high risk populations in South East Asia. In 2014, HIV prevalence was 6.3% among female sex workers, 6.6% in men who have sex with men (MSM) and 23% among injection drug users (WHO, 2016). In 2016 the general population HIV prevalence was 0.6% (National AIDS Programme, 2016). HIV prevalence in 2014 was found to be 8,5% among new TB patients (National AIDS Programme, 2016). The government of Myanmar adopted the WHO approach of integrating TB and HIV services. All patients are screened for TB and HIV under one roof. ART services are available for free at all levels of care.

II. LITERATURE REVIEW

Several empirical studies on TB were done in Myanmar. Zaw et al (2019) conducted a 12-year retrospective follow up study among 3598 TB-HIV co-infected patients aged 15 years and above enrolled on antiretroviral therapy (ART) from July 1, 2005 to December 31, 2016. Hazard rate was estimated using the Cox Proportional hazards model. Survival rates at the beginning of ART were calculated using the Kaplan Meir Method. The survival rate of TB -HIV co-infected patients was 82% at 5years and 58.1% at 10 years. Risk factors for mortality were being bedridden, HR 2.70, having low baseline CD4 count baseline HR 1.53 and being on second line ART HR 8.12. The study concluded that two out of five TB-HIV co-infected patients died within 10 years after ART initiation. In 2016, Htin L. A et al conducted a study involving genome sequencing of multidrug resistant mycobacterium tuberculosis isolates in Myanmar. All the 14 isolates were Multidrug resistant TB (MDR-TB) consistent with the results of phenotypic Beijing lineage predominant. Based on WGS results 9 out of 14 isolates were potentially resistant to at least one of the drugs used in the standard MDR-TB regimen but for which phenotypic DST is not conducted in Myanmar. The study highlighted the need for the introduction of second line DST as part of routine TB diagnosis in Myanmar as well as new classes of TB drugs to construct effective regimens. In another study ,Ei et al (2017) carried out a cross sectional retrospective study to determine the proportion of extensively drug resistant TB (XDR-TB) cases among MDR-TB cases and the mutations that cause resistance to second line drugs in Myanmar. The findings from the study revealed that 12 out of 89 MDR-TB isolates were XDR-TB and 24

were pre -XDR-TB,with 21 resistant to fluoroquinolones(FQs) and 3 to second line injectable agents .There was high cross-resistance among second line drugs .

III. METHOD

The Artificial Neural Network (ANN) is just a data processing system which consists 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 effects 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 Myanmar as output data for the network. In this paper, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on TB incidences (referred to as W series in this study) in Myanmar. 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
482.47	525.00	338.00	555.00
Std. Dev.	C.V.	Skewness	Ex. kurtosis
76.598	0.15876	-0.66031	-1.0932
5% Perc.	95% Perc.	IQ range	Missing obs.
Undefined	555.00	138.00	0

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

Table 2: ANN model summary

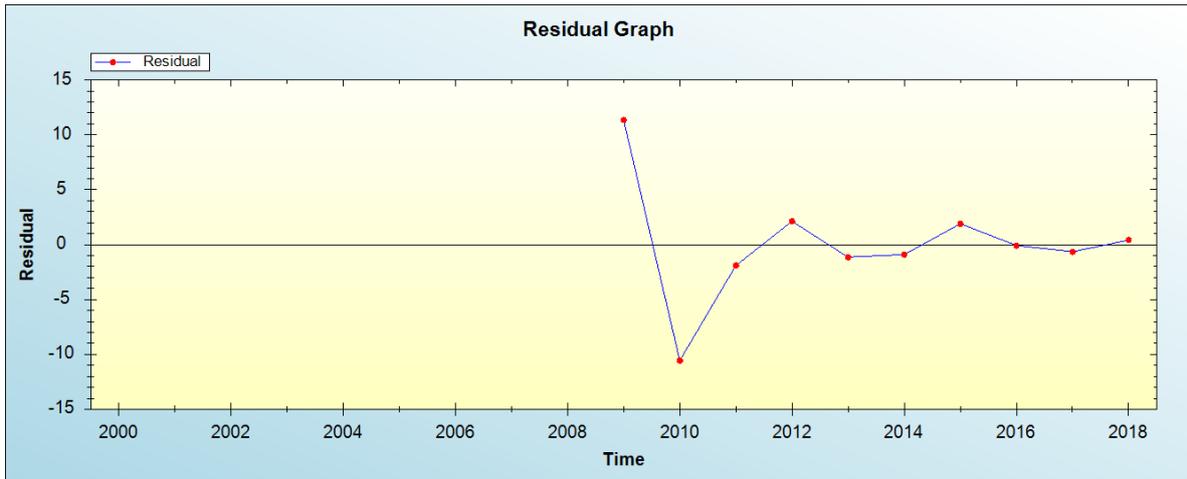| Variable	W
Observations	10 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	9
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.041908
MSE	25.525723
MAE	3.106054

Residual Analysis for the ANN model

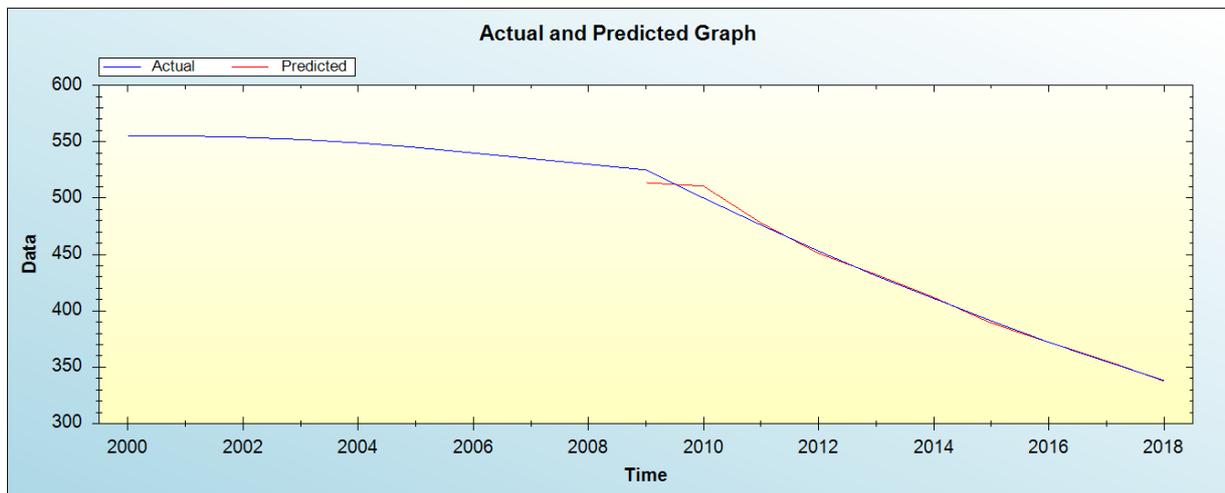**Figure 1: Residual analysis**

In-sample Forecast for W

Figure 2: In-sample forecast for the W series

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

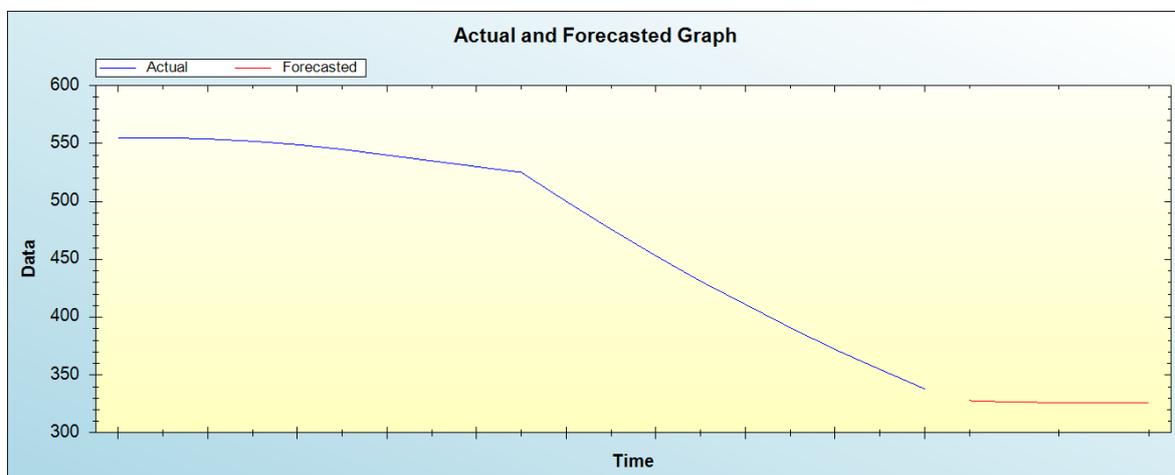*Out-of-Sample Forecast for W: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for W: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2019	327.9968
2020	326.5949
2021	326.2913
2022	326.1616
2023	326.0942

Over the study period 2000-2018 the minimum and maximum TB incidence was 338 and 555 cases per 100 000 population /year respectively. The sharp decline observed between 2009 and 2018 was a response to the robust measures implemented by the government and its partners in the TB program to prevent and control TB. The applied data is negatively skewed with excess kurtosis of -1.0932, meaning that the data is not normally distributed. The residual graph and evaluation statistics reveal that the model is adequate and stable. In-sample forecasts suggest that the applied model ANN (9,12,1) simulates observed data very well. This model predicts that over the period 2019-2023 incidence of TB in the country will remain high at a constant level of around 326 cases per 100 000 population/year.

V. CONCLUSION & RECOMMENDATIONS

Myanmar is one the countries in the world with high TB incidence. However, the country made significant strides in order to control the spread of the TB in the community. Over the period 2000-2018 the nation recorded a down trend of TB incidence which reflects the government's commitment to end TB by 2030.The model predictions suggest that TB incidence will remain high at a constant level of 326 cases per 100 000 population over the period 2019-2023. Therefore we encourage the government to intensify TB surveillance and control programs, allocate more resources towards TB/HIV programs and continuous health education at all levels in the government and community.

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