

Forecasting Art Coverage in Egypt Using Artificial Neural Networks

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

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Department of Economics, University of Zimbabwe, Harare, Zimbabwe

Abstract - In this research article, the ANN approach was applied to analyze ART coverage in Egypt. 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 ART coverage in Egypt. The results of the study indicate that ART coverage will remain very low in Egypt over the period 2019-2023. The government is encouraged to intensify demand creation for HIV testing and ART services amongst other strategies.

Keywords: ANN, ART coverage, Forecasting.

I. INTRODUCTION

Antiretroviral therapy (ART) coverage is defined as the proportion of people living with HIV who are on antiretroviral treatment. The goal of ART is to suppress the replication of the HIV virus, improve quality of life, prolong life and reduce the transmission of the HIV virus. Low and middle income countries get their funding mainly from the Global funding for Malaria, TB and AIDS and PEPFAR (PEPFAR, 2018; PEPFAR, 2019). Many of these nations have the dual epidemic of TB and HIV hence it is imperative to collaborate TB and HIV programs to optimize treatment outcomes and costs of treatment (WHO, 2018; PEPFAR, 2019). The World Health Organization recommends that all HIV positive patients must be commenced on ART irrespective of clinical staging and CD4 T cell count (WHO, 2018). African nations have adopted the WHO test and treat approach to reduce the time between HIV diagnosis and ART initiation with the aim of improving treatment outcomes through early ART initiation and follow up of ART patients (WHO, 2018; PEPFAR, 2019; WHO, 2016; Rosen & Fox, 2011). Combination HIV prevention strategies are key in the control of the HIV epidemic and these include condom distribution and use, voluntary medical male circumcision, Prevention from Mother to Child transmission of HIV (PMTCT), pre and post exposure prophylaxis (PEPFAR, 2018). Scale up of ART services should target high risk groups such as sex workers, men who have sex with men (MSM) and injecting drug users. In several countries pediatric ART initiations are lagging behind due to many reasons which include social and economic problems faced by children and their caregivers, healthcare worker related issues and health system associated barriers (Urassa et al, 2018; NACP, 2012). It is important for governments to address these barriers for accessing ART so as to achieve the UNAIDS global targets by 2030 of ending HIV as a public health threat. Increasing HIV testing in key populations will boost the number of diagnosed HIV positive people who are eligible for ART initiation. Healthcare worker training in both adult and pediatric HIV management is necessary to ensure that clinical staff is fully equipped to handle pediatric HIV cases. Paediatric ART management poses a challenge to many clinicians due to the changing ART medicine classes and doses for particular age groups and body weight, reliance on caregivers to ensure that children take their medication according to prescription and adolescents tend to default ART medication because of several social reasons which include stigma and discrimination, drug side effects, alcohol and drug abuse, inappropriate disclosure of HIV status by caregivers and denial of HIV status. In this study we applied the artificial neural network model, ANN (9, 12, 1) to project ART coverage in Egypt. The findings of this study are expected to reveal the future trends of ART coverage and provide an insight of the progress towards achieving the global 95-95-95 targets by 2030.

II. LITERATURE REVIEW

Kabbash et al (2018) investigated the potential facilitators and barriers to antiretroviral therapy in Egypt. Focus groups discussions (FGDs) were conducted with 33 people living with HIV and AIDS (PLWHA) representing most of Egyptian geographical areas. Discussions were designed to cover socio-demographic characteristics of participants, routine investigations, monitoring & follow up measures, problems associated with drug intake, PLWHA needs, stigma, and relevant future concerns. The findings of the study showed that lack of accurate information about HIV and ART, inadequate Monitoring and follow up

measures, drug side effects and stigmatizing practices against Egyptian PLWHA represent the most common barriers to ARV therapy. Marukutira et al (2019) conducted community case finding and HIV testing were in home and mobile venues in 15 intervention communities from October 2013-September 2017. In this secondary analysis, the study compared HIV positivity, knowledge of positive HIV-status, and ART status among all citizens and non-citizens assessed at intake in the intervention communities. The study concluded that although non-citizens were less likely to know their HIV-positive status compared to citizens, there were no differences in treatment uptake among non-citizens and citizens who knew their status. Designing interventions for non-citizens that provide HIV testing and treatment services commensurate to that of citizens as well as targeting communities with the largest number of non-citizens may help close a meaningful gap in the HIV care cascade and ensure ethical treatment for all HIV-positive persons. In another study, Johnson et al (2017) assessed South Africa’s progress towards the 2020 targets and variations in performance by province .A mathematical model was fitted to the HIV data for each of South Africa’s provinces and for the country as a whole .The study results revealed that ART coverage varied between 43% in Gauteng and 63 % in Northern Cape and most provinces face challenges in reaching the remaining two 90% targets. A mathematical modelling approach was also applied by Hontelez et al (2013).In the study nine mathematical models were developed for South Africa’s HIV epidemic elimination. All models confirmed previous predictions that the HIV epidemic in South Africa can be eliminated through universal testing and immediate treatment at 90 % coverage. Adam &Johnson (2009) estimated adult antiretroviral treatment coverage in South Africa using the Markov model. The findings of the study showed that ART coverage in 2008 varied between Provinces from 25.8% in the Free State to 71.7%.

III. METHOD

The ANN, which we intend to employ; is 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 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 ART coverage in Egypt as output data for the network. In this research article, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on annual ART coverages (referred to as X series in this study) in all age groups in Egypt. 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
8.7895	6.0000	0.00000	31.000
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
9.0036	1.0244	0.98581	0.24083
5% Perc.	95% Perc.	IQ range	Missing obs.
undefined	31.000	14.000	0

ANN MODEL SUMMARY FOR ART COVERAGE IN EGYPT

Table 2: ANN model summary

Variable	X
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	0.018297
MSE	0.099300
MAE	0.259510

Residual Analysis for the ANN model

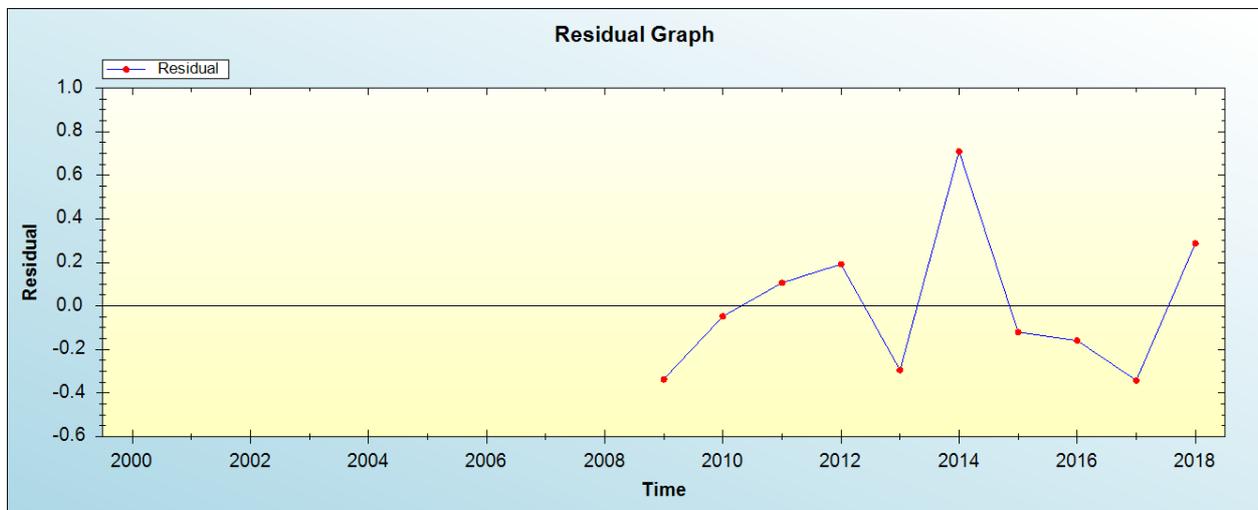


Figure 1: Residual analysis

In-sample Forecast for X

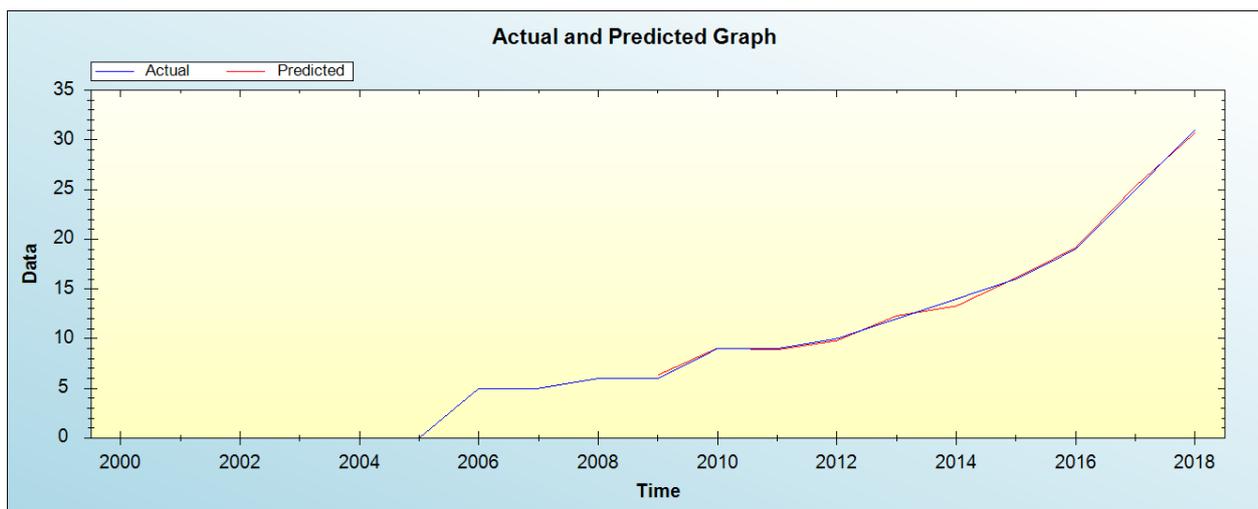


Figure 2: In-sample forecast for the X series

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

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

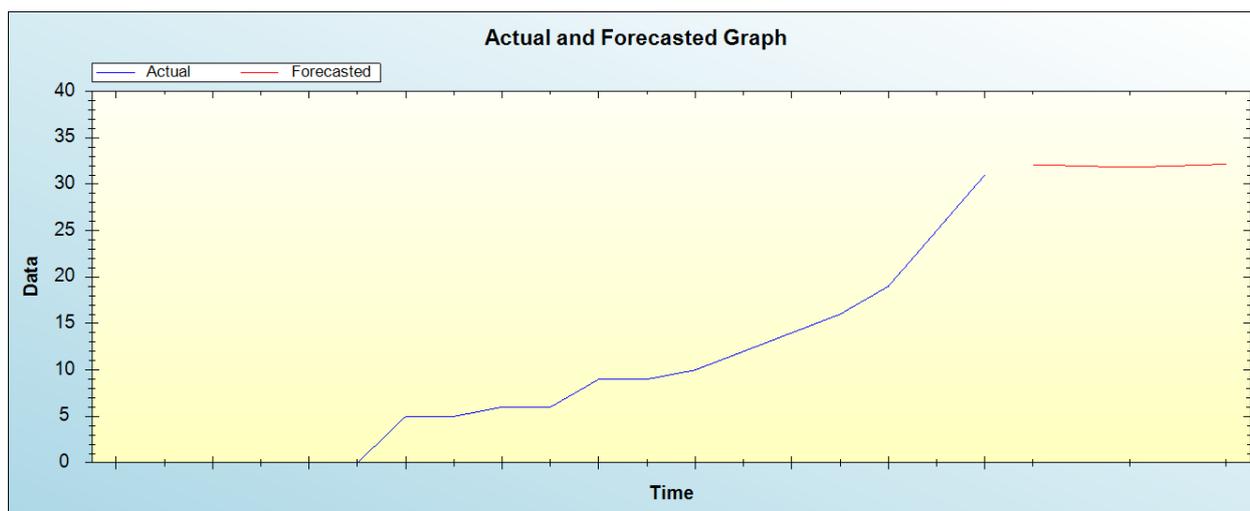


Figure 3: Out-of-sample forecast for X: actual and forecasted graph

Out-of-Sample Forecast for X: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasted ART coverage
2019	32.1129
2020	31.9631
2021	31.8165
2022	31.9900
2023	32.1659

Over the study period the minimum and maximum ART coverage recorded was 0 and 31 % respectively. The country recorded zero values of ART coverage over the period 2000-2005 because the National ART program was rolled out in 2006. The average was 8.79 %. The data is positively skewed with an excess kurtosis of 0. 24083. The residual graph and model evaluation statistics (Error, MSE, MAE) indicated that the applied ANN model is stable and suitable for forecasting ART coverage in Egypt. The applied model simulates the observed data very well. The projections from the model reveal that ART coverage will remain low in the country with values around 32 % throughout the forecast period 2019-2023.

V. CONCLUSION & RECOMMENDATIONS

Egypt has long way to go in controlling the HIV epidemic. Over the period 2000-2018 the country recorded low ART coverage which is below 50%. The model predicted that this situation is likely to persist over the period 2019-2023. The government must aggressively attend to antiretroviral therapy access issue in the country. A significant number of people living with HIV are not accessing antiretroviral therapy due to various reasons which raises a red flag. The government must intensify demand creation for ART and HIV testing services and allocate resource for health to meet the increased demand. The authorities must also strengthen TB/HIV collaboration amongst other measures.

REFERENCES

- [1] David P. Urassa., Sarah Matemu & Bruno F Sunguya (2018).Antiretroviral therapy clinic attendance among children aged 0-14 years in Kahama district, Tanzania: a cross-sectional study Tanzania Journal of Health Research Doi: <http://dx.doi.org/10.4314/thrb.v20i1.8> Volume 20, Number 1, January 2018
- [2] National HIV and AIDS Health Sector Research and Evaluation Agenda (2011 - 2015). National AIDS Control Program, Tanzania. NACP
- [3] Rosen S & Fox MP (2011). Retention in HIV care between testing and treatment in sub-Saharan Africa: a systematic review. PLoS Med. 8(7): e1001056. <https://doi.org/10.1371/journal.pmed.1001056> PMID: 21811403
- [4] WHO (2016). Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva.

- [5] WHO (2018). Access to antiretroviral and direct-acting antiviral medicines, and HIV diagnostics. 2016 update. WHO: Geneva.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, “Forecasting Art Coverage in Egypt Using Artificial Neural Networks” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 156-160, March 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.503027>
