

Prediction of Art Coverage in Sri Lanka Using Artificial Neural Networks

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Abstract - In this research article, the ANN approach was applied to analyze ART coverage in Sri Lanka. 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 Sri Lanka. The results of the study indicate that ART coverage will remain below 50% over the period 2019-2023. The government is encouraged to intensify demand creation for HIV testing and ART services among key populations, strengthen TB/HIV collaboration and tracking of loss to follow up clients.

Keywords: ANN, ART coverage, Forecasting.

I. INTRODUCTION

Sri Lanka is a South Asian country with an estimated low HIV prevalence below 0.1 % (Manathunge et al, 2020; UNAIDS, 2020). It is a middle income country with an estimated population of 21.7 million (World Bank, 2020). In 2018, the country recorded an estimated number of new HIV infections which were approximately 350 and at the end of the same year the cumulative number of people living with HIV was about 3500 (UNAIDS, 2020; Annual report, 2018). The HIV epidemic in Sri Lanka is concentrated among the key populations (Bozicevic et al, 2020; IBBS, 2015). HIV testing in key populations is performed in sexually transmitted infections (STI) clinics and at outreach sites (Annual Report, 2018). Increasing HIV testing coverage has been found to increase detection of the number of people living with HIV and subsequently the number of people who are enrolled into antiretroviral therapy (ART) (WHO, 2020). In Sri Lanka the number of both clinic and outreach based HIV testing clinics increased and this had a positive impact on the number of ART initiations, treatment outcomes and HIV prevention at community level (WHO, 2020; Annual report, 2018).

The goal of the ART program is to detect and treat HIV cases early among and to effectively implement the HIV prevention strategy among key populations. The HIV prevention strategy encompasses condom distribution and use, behavior change interventions, Prevention of Mother to Child transmission of HIV (PMTCT), Pre exposure and Post exposure prophylaxis and Voluntary medical male circumcision (WHO, 2017). Female sex workers (FSW) are among the key population and are responsible for driving the HIV epidemic in Sri Lanka. In 2018 the country estimated the population size of FSWs using the mapping and multiplier method and it was found to be 30,000 (Sri Lanka MOH, 2013). HIV prevention strategies are targeting this group. Some studies have shown that condom use with regular partners was significantly lower compared to paying partners (Lafort et al, 2016; Lutchters et al, 2013; Tran et al, 2013; Deering et al, 2011; Wang et al, 2011; Kerrigan et al, 2003). Increasing knowledge on HIV in FSWs is likely to increase HIV testing among FSW and promote consistent use of condoms and behavior change (Chanda et al, 2017).

In this paper we aim to forecast ART coverage in Sri Lanka using the Multilayer Perceptron (MLP), ANN (9, 12, 1) model. The findings of this study will provide a picture of the future trends of ART coverage and progress towards achieving the global targets of ending the HIV epidemic as a public health threat by 2030.

II. LITERATURE REVIEW

Phanuphak et al (2020) studied linkages to HIV confirmatory test and antiretroviral therapy (ART) initiation among Thai MSM and TGW who chose online and/or offline platforms for HIV testing and factors associated with unsuccessful linkages. MSM and TGW were enrolled from Bangkok Metropolitan Region and Pattaya during December 2015 to June 2017 and followed for 12 months. Participants could choose between: 1) offline HIV counseling and testing (Offline group), 2) online pre-test counseling and offline HIV testing (Mixed group) and 3) online counseling and online, supervised, HIV self-testing (Online

group). Socio demographic data, risk behavior and social network use characteristics were collected by self-administered questionnaires. Linkages to HIV confirmatory testing and/or ART initiation were collected from participants who tested reactive/positive at baseline and during study follow-up. Modified Poisson regression models identified covariates for poor retention and unsuccessful ART initiation. The study revealed that online, supervised, HIV self-testing allowed more MSM and TGW to know their HIV status. However, linkages to confirmatory test and ART initiation once tested HIV-reactive are key challenges. Alternative options to bring HIV test confirmation, prevention and ART services to these individuals after HIV self-testing are needed. Nanayakkara & Choi (2020) assessed specific areas of knowledge deficit on HIV/AIDS among 2nd year nursing student in Sri Lanka. In-depth analysis of the knowledge component of the pretest responses of a study assessing the effectiveness of AIDS education program on nursing students' AIDS knowledge and AIDS attitudes in Sri Lanka. The study concluded that correction of these knowledge gaps and improving knowledge on HIV/AIDS among nursing students is very important as they are going to be future nurses and they have a very important role in reducing the discrimination and stigmatization of people living with HIV. Manathunge et al (2020) carried out a study to find evidence on HIV, syphilis and hepatitis B (HBV) prevalence, sexual risk behaviors and utilization of HIV prevention interventions among female sex workers (FSW) in the cities Colombo, Galle, and Kandy. Using respondent-driven sampling (RDS), we recruited a total of 458 FSW in Colombo, 360 in Galle and 362 in Kandy from November 2017 to March 2018. Participants provided biological specimens for testing for infections and completed a behavioral questionnaire. The results of the study revealed that HIV has not yet been firmly established among FSW in three cities in Sri Lanka, but the vulnerability towards HIV and STIs is substantial hence HIV interventions should be intensified by expanding community-based HIV testing approaches, increasing awareness of HIV risks and addressing socio-structural vulnerabilities of FSW to HIV.

III. METHOD

The Artificial Neural Network (ANN), which we intend to apply in this study; is a data processing system consisting of a huge number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from any 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 Sri Lanka as output data for the network. In this research paper, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on annual ART coverage (referred to as S series in this study) in all age groups in Sri Lanka. The 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
10.684	5.0000	0.00000	45.000
Std. Dev.	C.V.	Skewness	Ex. kurtosis
13.346	1.2491	1.3465	0.71764
5% Perc.	95% Perc.	IQ range	Missing obs.
undefined	45.000	17.000	0

Ann Model Summary for Art Coverage in Sri Lanka

Table 2: ANN model summary

Variable	S
Observations	10(After Adjusting Endpoints)
Neural Network Architecture:	

Input Layer Neurons	10
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	0.029724
MSE	0.552182
MAE	0.669441

Residual Analysis for the ANN model

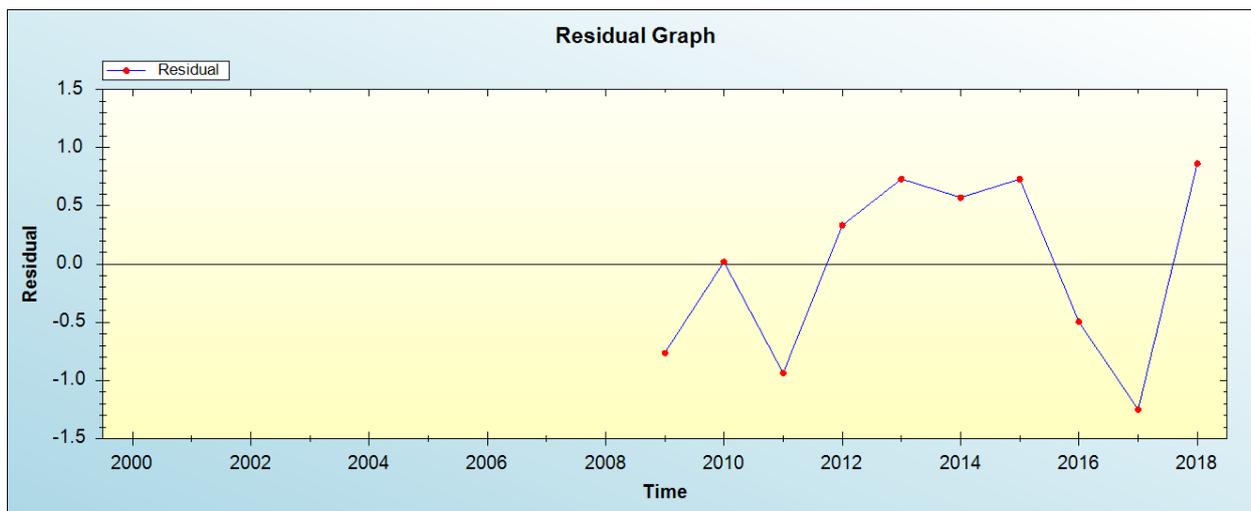


Figure 1: Residual analysis

In-sample Forecast for S

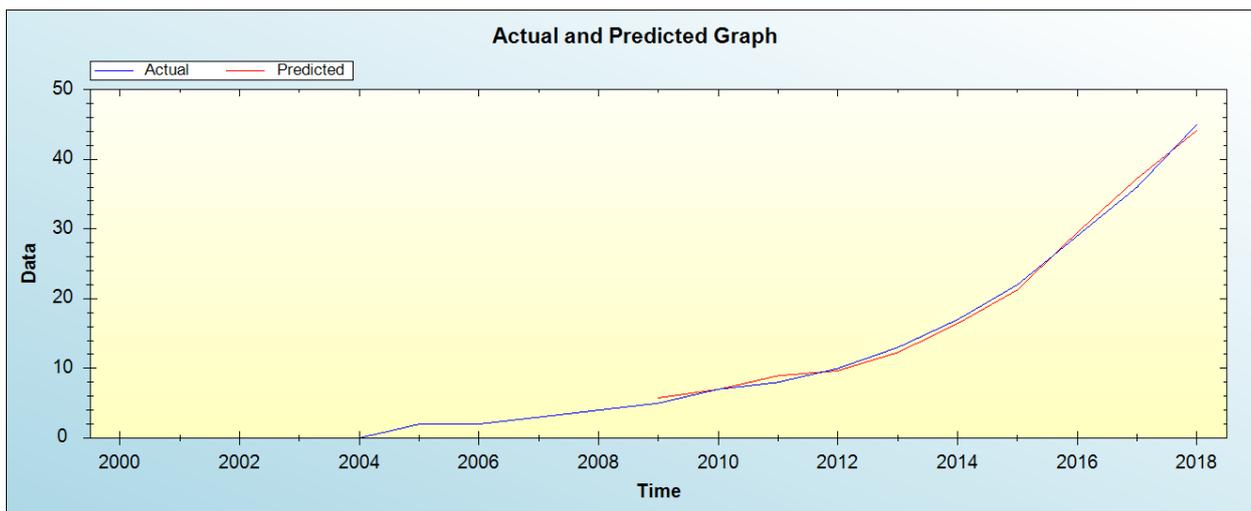


Figure 2: In-sample forecast for the S series

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

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

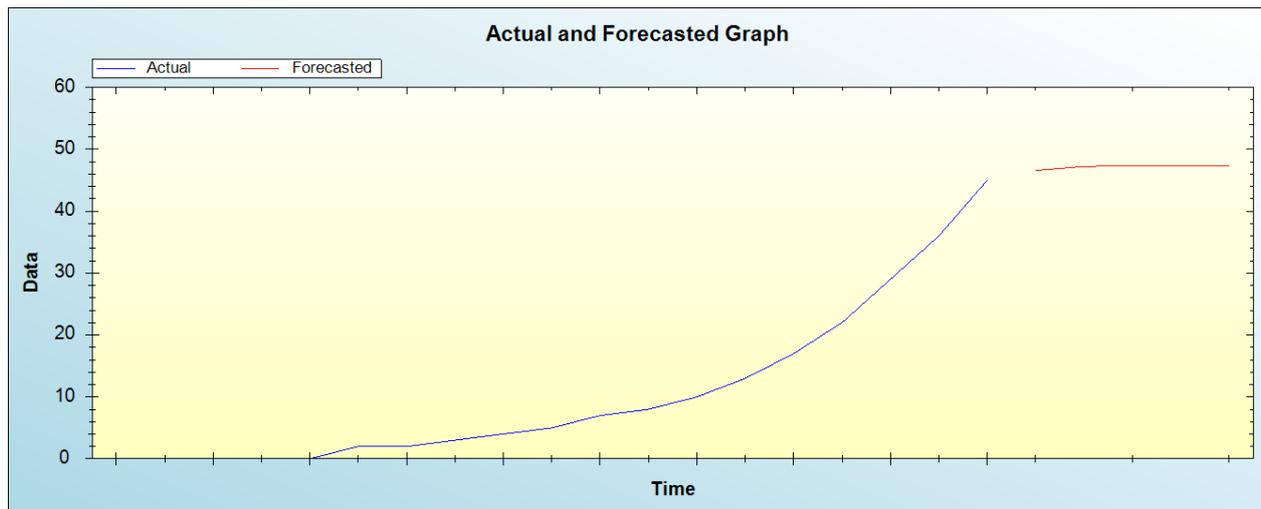


Figure 3: Out-of-sample forecast for S: actual and forecasted graph

Out-of-Sample Forecast for S: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasted ART coverage
2019	46.5659
2020	47.2268
2021	47.3405
2022	47.3782
2023	47.3657

Over the study period the minimum and maximum ART coverage was 0 and 45 % respectively. The data used in this study is positively skewed with an excess kurtosis of 0.71764 meaning that the data is not normally distributed. The residual graph and model evaluation criteria (Error, MSE, MAE) indicate that the applied ANN model is stable and suitable for forecasting ART coverage in South Africa. Figure 2 indicates that the neural network model simulates the observed data, generally, accurately. Model predictions suggest that ART coverage will remain below 50 % over the period 2019-2023.

V. CONCLUSION & RECOMMENDATIONS

Sri Lanka has a lot of work to do in order to improve access to ART for people living with HIV. The country recorded an upward trend in ART coverage over the period 2000-2018. The model predictions indicate that ART coverage will remain below 50 % in the out of sample period. Therefore, the state needs to intensify demand creation for HIV testing & ART services among key populations, strengthen TB /HIV collaboration and strengthen the tracking of loss to follow up ART patients.

REFERENCES

- [1] Annual Report 2018. Colombo: National STD/AIDS Programme, Ministry of Health, Sri Lanka; 2018.
- [2] Bozicevic I., Manathunge A., Dominkovic Z., Beneragama S., & Kriitmaa K (2020). Estimating the population size of female sex workers and transgender women in Sri Lanka. PLoS One 15:e0227689. <https://doi.org/10.1371/journal.pone.0227689> PMID: 31940404.
- [3] Chanda M M., Perez-Brumer A G., Ortblad K F., Mwale M., Chongo S., Kamungoma N (2017). Barriers and Facilitators to HIV Testing Among Zambian Female Sex Workers in Three Transit Hubs. AIDS Patient Care STDs. 31:290–6. <https://doi.org/10.1089/apc.2017.0016> PMID: 28581820.

- [4] Deering KN., Bhattacharjee P., Bradley J., Moses SS., Shannon K., & Shaw SY (2011). Condom use within non-commercial partnerships of female sex workers in southern India. *BMC Public Health*. 11 Suppl 6:S11. <https://doi.org/10.1186/1471-2458-11-S6-S11> PMID: 22376171.
- [5] Integrated biological and behavioral surveillance (IBBS) survey among key populations at higher risk at HIV in Sri Lanka (2015). Colombo: National STD/AIDS Programme, Ministry of Health, Sri Lanka.
- [6] Kerrigan D., Ellen JM., Moreno L., Rosario S., Katz J., & Celentano DD (2003). Environmental-structural factors significantly associated with consistent condom use among female sex workers in the Dominican Republic. *AIDS*. 17:415–23. <https://doi.org/10.1097/00002030-200302140-00016> PMID: 12556696.
- [7] Lafort Y., Greener R., Roy A., Greener L., Ombidi W., Lessitala F (2016). HIV prevention and care-seeking behavior among female sex workers in four cities in India, Kenya, Mozambique and South Africa. *Trop Med Int Health*. 21:1293–303. <https://doi.org/10.1111/tmi.12761> PMID: 27479236.
- [8] Luchters S., Richter ML., Bosire W., Nelson G., Kingola N., & Zhang X-D (2013). The contribution of emotional partners to sexual risk taking and violence among female sex workers in Mombasa, Kenya: a cohort study. *PLoS One*. 8:e68855. <https://doi.org/10.1371/journal.pone.0068855> PMID: 23950879
- [9] Sri Lanka MOH (2013). *Laws Concerning Commercial Sex and HIV AIDS Prevention*. Colombo: National STD/AIDS Programme.
- [10] The World Bank. Sri Lanka | Data 2020. <https://data.worldbank.org/country/sri-lanka>.
- [11] Tran BX., Nguyen LT., Nguyen N P., & Phan HTT (2013). HIV voluntary testing and perceived risk among female sex workers in the Mekong Delta region of Vietnam. *Glob Health Action*. 6:20690. <https://doi.org/10.3402/gha.v6i0.20690> PMID: 23866916
- [12] UNAIDS 2019 Data. Geneva: UNAIDS, 2020.
- [13] Wang Y., Li B., Pan J., Sengupta S., Emrick C B., & Cohen MS (2011). Factors associated with utilization of a free HIV VCT clinic by female sex workers in Jinan City, Northern China. *AIDS Behav*. 15:702–10. <https://doi.org/10.1007/s10461-010-9703-2> PMID: 20458528.
- [14] WHO (2017). WHO, CDC, UNAIDS, FHI 360. *Bio behavioral Survey Guidelines for Populations at Risk for HIV*. Geneva.
- [15] WHO (2019). *Consolidated guidelines on HIV testing services for a changing epidemic*. Geneva.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, “Prediction of Art Coverage in Sri Lanka Using Artificial Neural Networks” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 91-95, March 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.503017>
