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Demonstrating the Use of an Early Surveillance Tool for the Detection of Abnormal Future Trends of Adolescent Fertility in Guyana

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***Abstract* - This research article uses annual time series data on adolescent fertility rate for Guyana from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable. The neural network model projections revealed that adolescent fertility is expected to increase and will remain high throughout the out of sample period. Therefore, we encourage the government of Guyana to scale up awareness campaigns among communities, improving girl child education and strictly enforce laws to protect women's rights.**

Keywords: ANN, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Previous studies conducted in developing regions have established that prevention of teenage pregnancy will remain a public health priority all over the world because teen pregnancy is associated with adverse pregnancy and perinatal health outcomes (Monari *et al.* 2022; Sarder *et al.* 2021; World Atlas, 2021;Laelago*et al.* 2019;Raharjo*et al.* 2019; UN, 2019; WHO, 2014; UN, 2013). New global initiatives should achieve the desired outcomes by the end of 2030. All teenage pregnancy prevention programs should attempt to address most of the problems that affect teenagers such as poverty, lack of financial support for their education, gender imbalances, violence against women, cultural norms which promote child marriage and sexual abuse of women, inadequate knowledge on sexual and reproductive health and accessibility and affordability of family planning services. The 1994 International Conference on Population and development inspires the vision of teenage pregnancy prevention as signatories to the conference recognized the importance of sexual and reproductive health as a fundamental human right. The conference declared and upheld sexual and reproductive health rights of every individual particularly SRH rights of adolescent girls and women (UN, 1995). In addition, signatories agreed on addressing gender equality and respecting human rights including women's rights in light of rampant abuse of women in different regions of the world. Women should be offered equal opportunities with their male counterparts especially in education and at work places.

In September 2015, all the United Nations member countries met at the UN Headquarters in New York having a global mandate to end poverty, ensure peace and security, protect the environment from harmful human activities, providing education for all and addressing current health challenges affecting the human race (UN, 2016; UN, 2015). This meeting supported the vision of ending all preventable maternal and under five deaths as highlighted by the third sustainable development goal (SDG-3). Target 3.1 focuses on the substantial reduction of the global maternal mortality ratio to less than 70 maternal deaths per 100 000 live births by 2030 and target 3.2 focuses on the reduction of neonatal mortality to levels as low as 12 deaths per 1000 live births and under five mortality to levels as low as 25 deaths per 1000 live births b 2030 (UN, 2020; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). Adolescent sexual and reproductive health is stated by target 3.7.2. This target provides the direction on how to address adolescent challenges in order to prevent adverse pregnancy outcomes such as unintended pregnancies, unsafe abortions, sexually transmitted infections, HIV, hypertensive disorders, obstructed labour, preterm labour and low birth weight. Ultimately reduction of teenage pregnancy should translate to the reduction of adverse SRH outcomes including maternal and child mortality. Guyana continues to face the problem of teenage pregnancy despite efforts made to address the issue over the past decades. Data from the World Bank indicates that adolescent fertility has declined gradually over the previous decades recording an adolescent fertility of 145 births per 1000 women aged 15-19 in 1960 down to around 70 births per 1000 women aged 15-19 in 2020. These figures show that adolescent pregnancy is still a huge problem in Guyana and there is urgent need to redesign national strategies to

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address child marriages, improve educational levels among women, increase knowledge on sexual and reproductive health and address gender imbalances.

The objective of this paper is to model and forecast future trends of adolescent fertility in Guyana using the artificial neural network approach. The findings of this paper are expected to highlight the future burden of adolescent fertility in the out of sample period. This is anticipated to stimulate an evidence based response to the challenge of teenage pregnancy. Furthermore, this will guide policy, planning and allocation of resources to teenage pregnancy prevention programs with the aim of averting adverse pregnancy outcomes in the country.

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual adolescent fertility rate for Guyana.

Data Issues

This study is based on annual adolescent fertility rate in Guyana for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	W
Observations	
Neural Network Architecture:	
Input Layer Neurons	12
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	0.003629
MSE	0.221025
MAE	0.363839

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Residual Analysis for the Applied Model

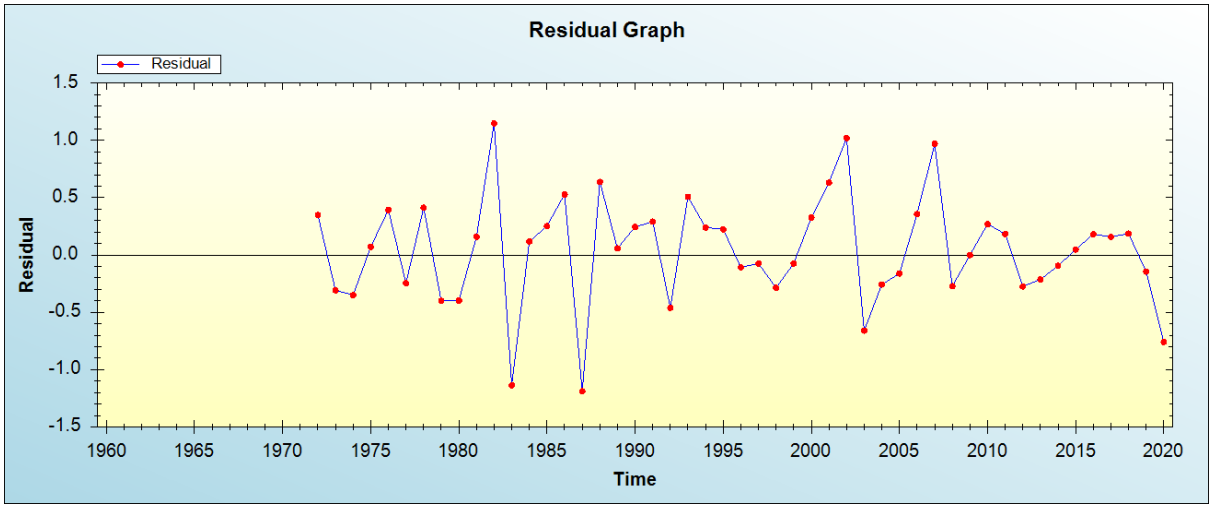

Figure 1: Residual analysis

In-sample Forecast for W

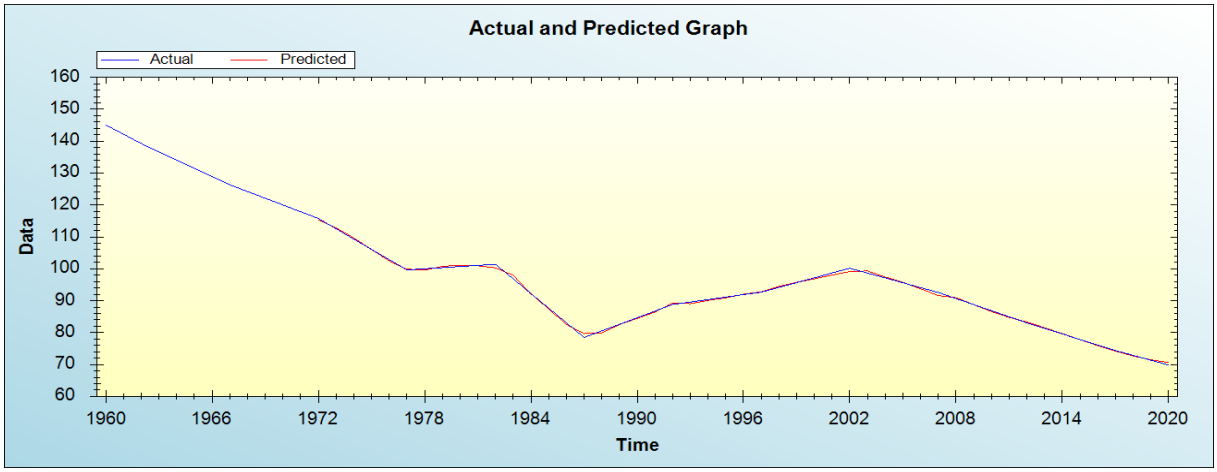

Figure 2: In-sample forecast for the W series

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

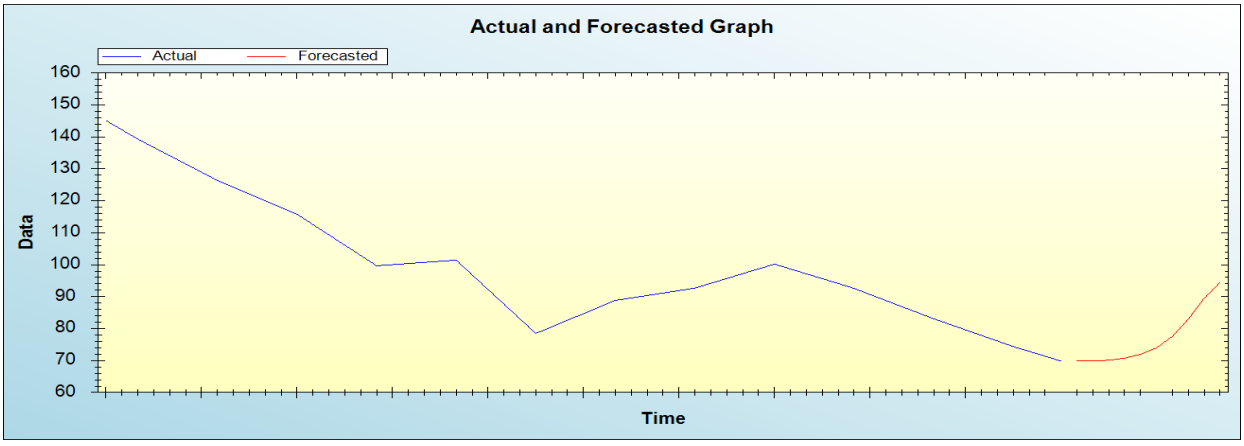

Figure 3: Out-of-sample forecast for W: actual and forecasted graph

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Out-of-Sample Forecast for W: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted adolescent fertility rate
2021	69.9373
2022	69.8494
2023	70.0995
2024	70.7597
2025	71.9594
2026	73.9739
2027	77.5639
2028	82.9527
2029	89.5276
2030	94.4714

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual adolescent fertility rate is expected to increase and remain high throughout the forecast period.

IV. POLICY IMPLICATION & CONCLUSION

Guyana continues to face the problem of teenage pregnancy despite efforts made to address the issue during the previous decades. Adolescent fertility has declined gradually over the previous decades reporting an adolescent fertility of 145 births per 1000 women aged 15-19 in 1960 down to around 70 births per 1000 women aged 15-19 in 2020. These figures indicate that adolescent pregnancy is still a huge problem in Guyana and there is urgent need to redesign national strategies to address child marriages, improve educational levels among women, increase knowledge on sexual and reproductive health and address gender imbalances. This study applied a machine learning algorithm to forecast future trends of adolescent fertility for Guyana. We established that adolescent fertility is likely to increase and also will remain high in the out of sample period. Therefore, we encourage authorities in Guyana to scale up awareness campaigns among communities, improving girl child education and strictly enforce laws to protect women's rights.

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