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# Demonstrating Use of a Machine Learning Technique in Adolescent Health Policy-Making in the Gambia

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***Abstract* - This study uses annual time series data on adolescent fertility rate for the Gambia 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 in forecasting adolescent fertility rate. The neural network model projections revealed that adolescent fertility rate will decline throughout the out of sample period. Therefore, we encourage the government of Gambia to scale up awareness programs in the community, strictly enforce laws that protect sexual and reproductive health rights for women, channel more funds towards youth empowerment programs and promote girl child education.**

***Keywords:*** ANN, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

The adolescence stage is a transition period between childhood and adulthood. An adolescent is therefore an individual in the age category 10-19 years (WHO, 2017). This stage is defined by multiple physiological, emotional and psychological changes which can expose individuals to risky behaviors. This is the stage where children start experimenting on several things such as having sexual intercourse, alcohol and substance abuse and participating in criminal activities (Steinberg *et al.* 2018; Mokdad *et al.* 2018; Patton *et al.* 2016). In addition, it is the stage during which individuals make important life decisions such as choosing sexual partners and planning for future carriers. Parental guidance is crucial at this stage since their contribution has a great impact on the future lives of children. It is unfortunate that some children become single or double orphaned at an early stage and this predisposes them to physical, emotional and sexual abuse at an early stage. Furthermore, orphaned children in some cases are not offered the chance to go to school or they can even drop out of school due to lack of financial support making them vulnerable to sexual abuse and exploitation. Adolescents living in remote resource limited settings may find it difficult to access basic health services including sexual and reproductive health services due to long distances to be travelled to the nearest health facility. Traditional and cultural norms can facilitate early child marriage and pregnancy. Previous studies revealed that adolescent pregnancy is an important health issue because it is known to be associated with poor pregnancy outcomes that can affect the mother and her baby (Aparicio *et al.* 2019; Santelli *et al.* 2019). Problems that can arise include maternal deaths, perinatal deaths, eclampsia, preterm delivery, prematurity and low birth weight (Karataşlı *et al.* 2019; Ogawa *et al.*2019; Ganchimeg *et al.* 2014; Kurth*et al.* 2010; Chen *et al.* 2007). According to the Agenda 2030 for sustainable development adolescent sexual and reproductive health is an essential health intervention for preventing and management of adolescent pregnancy and its complications (WHO. 2019; UN, 2016; UN, 2015). The goal is to prevent teenage pregnancy at all costs through implementation of effective programs at all levels of healthcare. It is also vital to be able to provide necessary medical attention to teenage mothers to minimize the impact of adverse SRH outcomes (Turkay*et al.* 2020; Hubel &Moreland, 2019). Adolescent pregnancy is still a public health issue in the Gambia. According to the World Bank, the country's adolescent fertility declined gradually from around 240 births per 1000 females aged 15-19 in 1960 to 40births per 1000 females aged 15-19 in 2020.

The objective of this paper is to forecast future trends of adolescent fertility in the Gambia using a machine learning algorithm. The findings of this paper are expected to depict the future burden of adolescent fertility in the out of sample period. This will guide policy, planning and allocation of resources to the sexual and reproductive health program 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

 

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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 The Gambia.

**Data Issues**

This study is based on annual adolescent fertility rate in the Gambia 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 | Y |
| Observations | 49 |
| 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 | 0.003557 |
| MSE | 1.026173 |
| MAE | 0.697301 |

Residual Analysis for the Applied Model

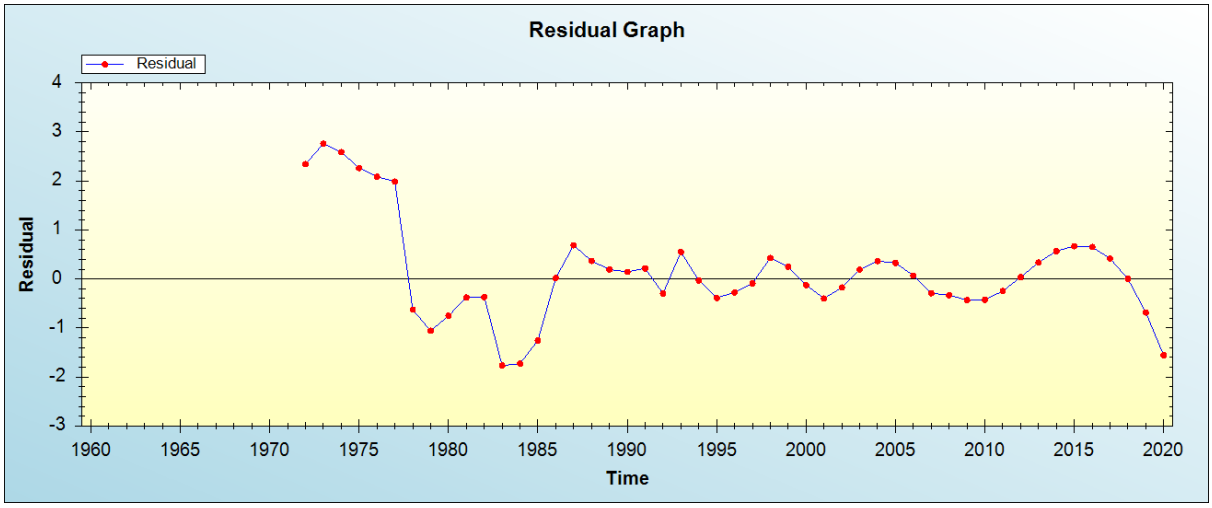


Figure 1: Residual analysis

 

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In-sample Forecast for Y

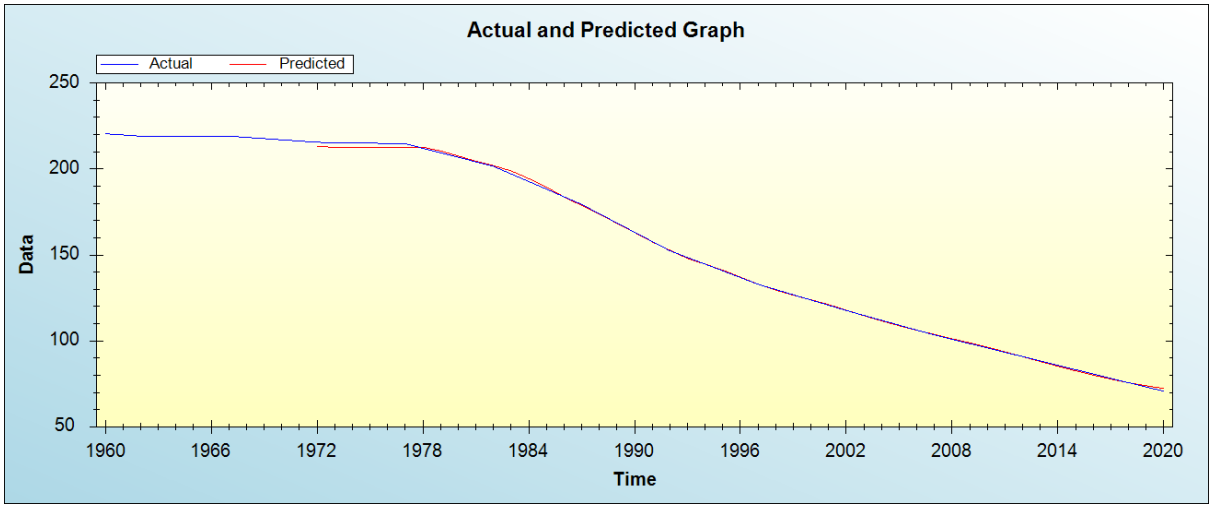


Figure 2: In-sample forecast for the Y series

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

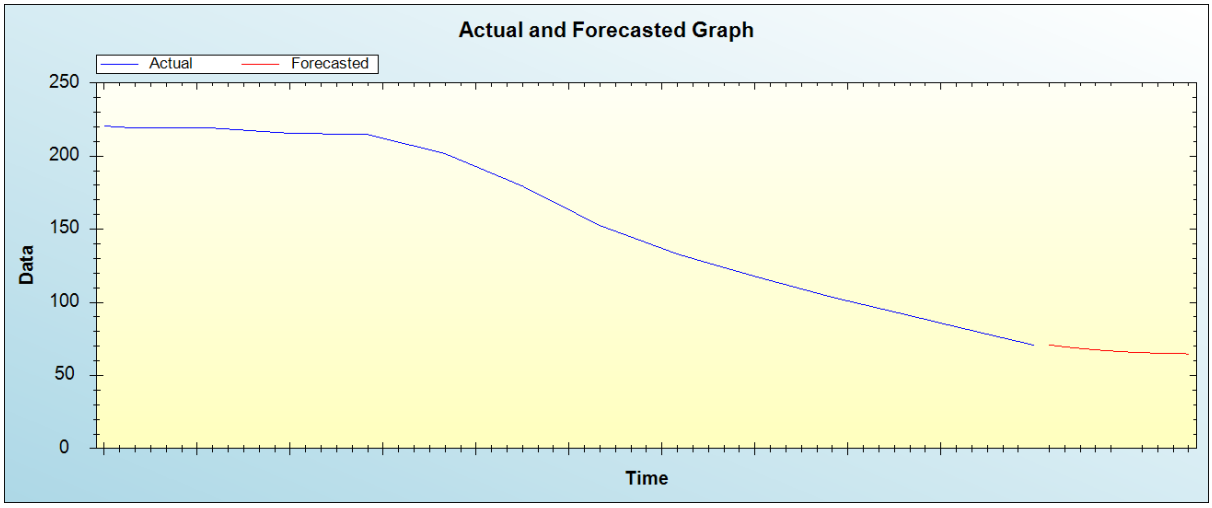


Figure 3: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 70.8864 |
| 2022 | 69.5866 |
| 2023 | 68.5121 |
| 2024 | 67.5452 |
| 2025 | 66.7443 |
| 2026 | 66.0870 |
| 2027 | 65.5954 |
| 2028 | 65.2719 |
| 2029 | 64.9657 |
| 2030 | 64.7734 |

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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 will decline throughout the out of sample period.

## IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy is still a public health issue in the Gambia. According to the World Bank, the country's adolescent fertility declined gradually from around 240 births per 1000 females aged 15-19 in 1960 to 40 births per 1000 females aged 15-19 in 2020. This huge decline is partly attributed to the national family program, improvements in the education sector and increased SRH knowledge among adolescents. This study applied a machine learning algorithm to forecast future trends of adolescent fertility for the Gambia. Our findings revealed that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage the government to scale up awareness programs in the community, strictly enforce laws that protect sexual and reproductive health rights for women, channel more funds towards youth empowerment programs and promote girl child education.

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