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# USING ARTIFICIAL NEURAL NETWORKS FOR PREDICTING NEW EPILEPSY CASES AT KWEKWE GENERAL HOSPITAL IN ZIMBABWE

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**Abstract:**

Epilepsy is responsible for an enormous amount of "untold" suffering around the globe. Fortunately, effective and cost efficient treatment is available for the management of this neurological disorder. Unfortunately, in developing countries such as Zimbabwe, up to 90% of the people who have this condition, and sometimes even more, are excluded from care and consequently remain in the shadow of this treatment gap. In Zimbabwe, we have all reasons to consider epilepsy a healthcare priority. This study employed monthly time series data on epilepsy cases recorded and managed at Kwekwe General Hospital (KGH) from Janaury 2010 to December 2019, in order to predict epilepsy case-loads over the period January 2020 to December 2021. The popular ANN (12, 12, 1) model was applied. Residual analysis of this model indicated that it was really stable and thus suitable for predicting epilepsy case volumes at KGH over the out-of-sample period. The results of the study indicate that epilepsy cases will generally decline over the out-of-sample period. Amongst other recommendations, the study suggested the need for timely treatment of epileptic patients in order to save life.

## 1.0INTRODUCTION

Epilepsy is a global disease with an unequal distribution (Espinosa-Jovel et al., 2018). It is one of the most common chronic neurologic disorders, affecting nearly 70 million people worldwide (Ngugi et al., 2010). Approximately 80% of the affected individuals reside in low and middle income countries. The incidence and prevalence of epilepsy in low income populations is higher than in the rest of the world, this is partly explained by some risk factors such as head trauma, perinatal injury and CNS infections, which are more common in poor regions, especially in rural areas (Espinosa-Jovel et al., 2018). The cardinal manifestations of epilepsy are epileptic seizures: that is, recurrent paroxysmal events characterized by stereotyped behavioral alterations reflecting the neural mechanisms involved in the epileptic process (Fisher et al., 2017). While many underlying disease mechanisms can lead to epilepsy, the cause of the disease is still unknown in approximately 50% of all global cases (Neligan et al., 2012). Epilepsy is a treatable condition, characterised by high rates of therapeutic response. Approximately 70% of patients with epilepsy are

controlled with antiepileptic drugs (AED) (Brodie et al., 2012). However, despite this apparently "benign" prognosis, 73.3% of patients with active epilepsy in rural areas of developing countries do not receive treatment or receive it inappropriately. This is called epilepsy treatment gap (TG) and is associated with several psychosocial complications such as impaired quality of life (QoL), social stigma and labor discrimination (Mbuda et al., 2008). The TG is also associated with higher rates of mortality, and in some developing countries of Africa, the standardized mortality ratio can be up to six times higher than in developed countries (Murray et al., 2012).

The prevalence of epilepsy in Zimbabwe is approximately 1% (Saburi et al., 2006). Epilepsy is reffered to as zvipusha (meaning that: a condition that is infectious!) in Shona, Zimbabwe's main vernacular language. Other names exist to describe seizures, for example, pfari (jerking), kugwinha (fitting) and tsviyo (minor sound) (Mugumbate, 2011). These words or names, unfortunately, add to stigma and misunderstanding of people with epilepsy in the country (Lim et al., 2012). A significant number of people in Zimbabwe believe that epilepsy is caused by witchcraft and evil spirits. This is the reason why they end up opting for traditional medicine and spiritual remedies (Mutanana & Mutara, 2015). In fact, people with epilepsy in Zimbabwe face numerous challenges including poor understanding of the disease, impaired access to treatment, predisposition to burns and injuries, prejudice that affects socialization, marriage, school and work, resulting in impaired quality of life and socioeconomic status (ESF, 2007). This study will model and forecast epilepsy cases for Kwekwe General Hospital (KGH). The study is very important for planning purposes, especially with regards to maintaining a consistent supply of anti-epileptic drugs and ensuring availability of other control measures.

## 1.1 OBJECTIVES OF THE STUDY

i. To assess new epilepsy cases at KGH over the period January 2010 to December 2019.
ii. To predict epilepsy cases for KGH over the period January 2020 to December 2021.
iii. To determine whether epilepsy cases are increasing or decreasing for KGH over the out of sample period.

## 2.0 RELATED STUDIES

In a door-to-door survey, Ndoye et al. (2005) investigated the prevalence of epilepsy 4500 people within the Pikine Health District of Senegal. The study established that prevalence was 14.2/1000, and that 23.4% of all people with epilepsy had never received appropriate treatment. Using the technique of random coefficients, Kim et al. (2013) proposed a coercively adjusted Autoregression (CA-AR) method that forecasts future values from a multivariable epilepsy EEG time series. Experimental results of the study indicated that, when compared to previous methods, the proposed method can forecast faster and accurately. Based on an analytic cross-sectional study, Dewa et al. (2014) examined the

attendance pattern of epileptic patients, prevalence of non-attendance and the associated factors. The findings of the study basically indicated that a high number of epileptic patients miss their review visits mainly owing to shortage of drugs, and long distances from health facilities. Employing qualitative research methods, Mutanana & Mutara (2015) carried out an investigation on the health seeking behaviours of people with epilepsy in a rural community of Zimbabwe. The study found out that rural communities of Zimbabwe believe that epilepsy is caused by witchcraft and evil spirits. In a recent study carried out in the Kingdom of Saudi Arabia, Rabie et al. (2016) analyzed the prevalence of epilepsy as well as its risk factors among school students aged 6 up to 18 years. 20 cases of epilepsy were detected among the studied group. The study also found out that major etiological factors of the epilepsies were cerebral trauma and febrile convulsions. Despite the fact that epilepsy has been widely studied around the globe, literature review indicates that forecasting models in this area are indeed scanty. The current papers will apply the Artificial Neural Networks (ANNs) in order to forecast monthly epilepsy case-loads for KGH.

## 3.0 METHODOLOGY

The study applies the Artificial Neural Network (ANN) approach in modeling and forecasting monthly epilepsy cases at KGH. According to Fischer & Gopal (1994), no strict rules exist for the determination of the ANN structure; and therefore the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function.

### 3.1 Data Issues

This study is based on newly diagnosed monthly cataract cases [all-age-groups] (reffered to as E series in this study) at KGH. The data covers the period January 2010 to December 2019 while the out-of-sample forecast covers the period January 2020 to December 2021. All the data employed in this paper was gathered from KGH Health Information Department.

## 4.0 FINDINGS OF THE STUDY

### 4.1 DESCRIPTIVE STATISTICS

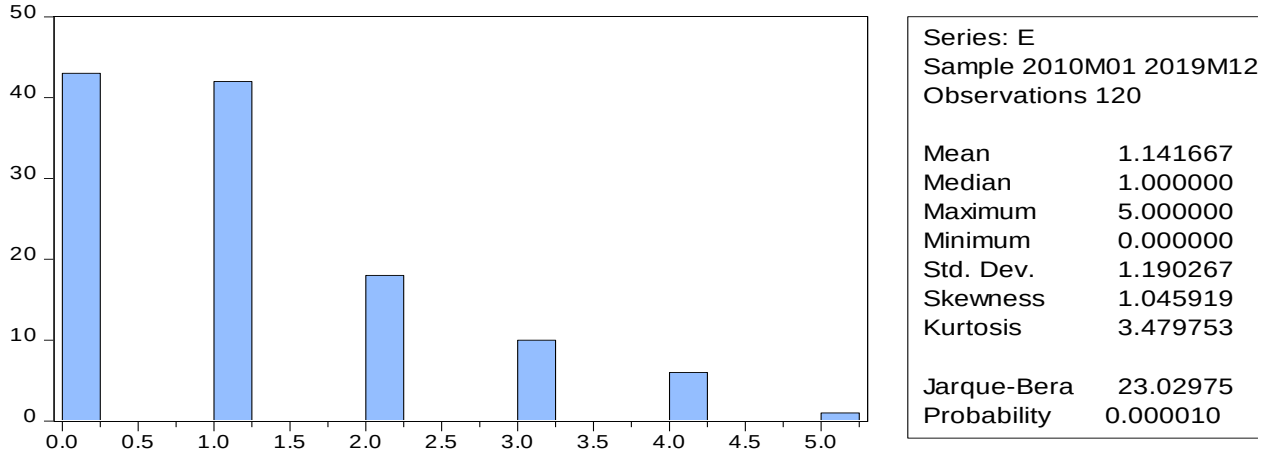


Figure 1: Descriptive statistics

## 4.2 ANN Model Summary

Table 1: ANN model summary

| Variable | E |
|---|---|
| Observations | 108 (After Adjusting Endpoints) |
| 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 | 0.130309 |
| MSE | 0.009654 |
| MAE | 0.002512 |

Residual Analysis for the Model Presented Above

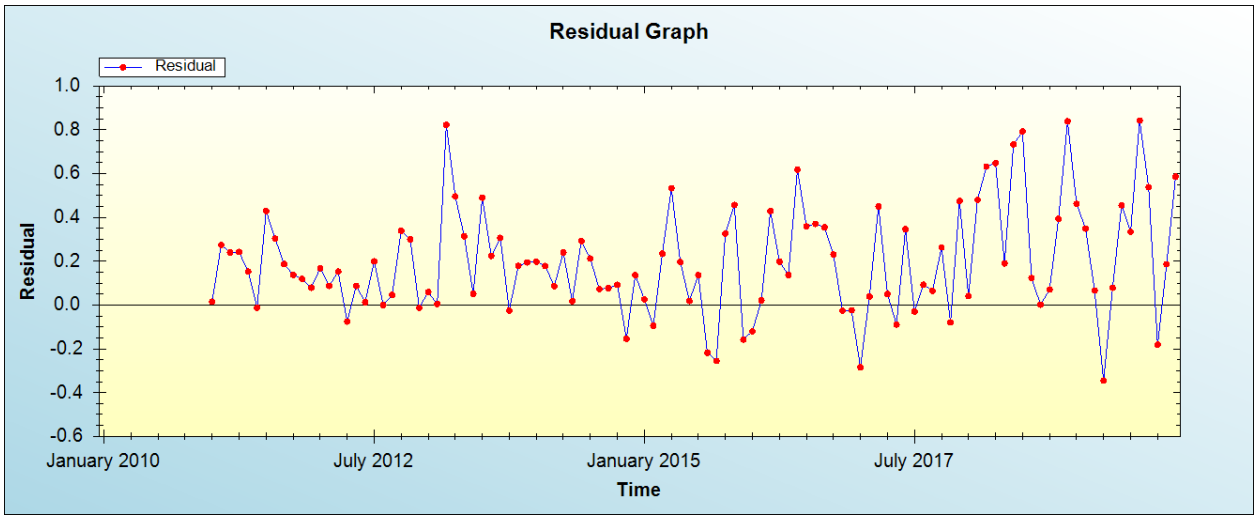


Figure 2: Residual analysis

In-sample Forecast for E

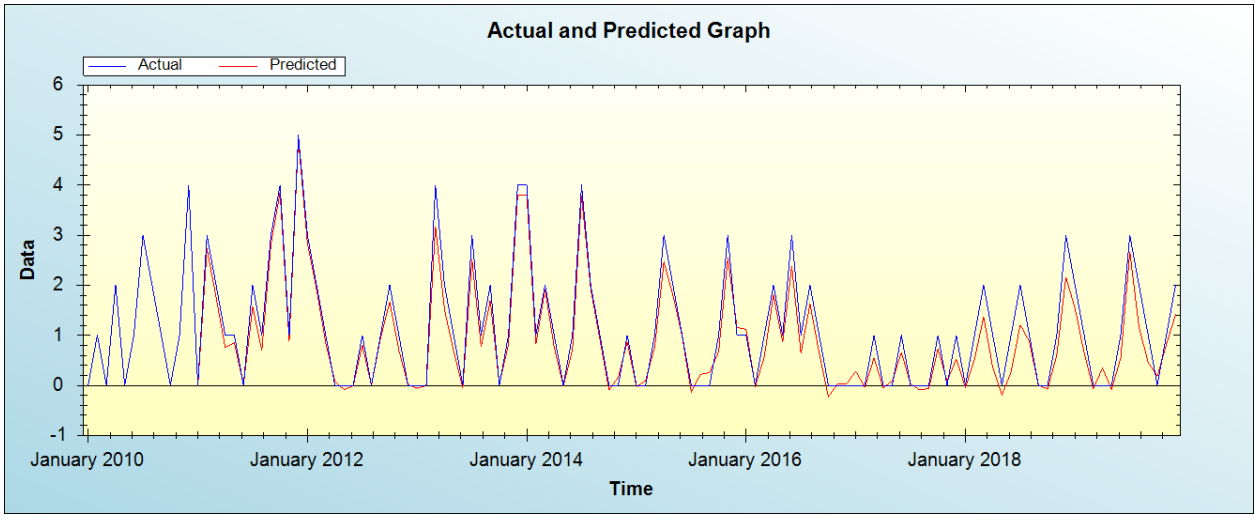


Figure 3: In-sample forecast for the series, E

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

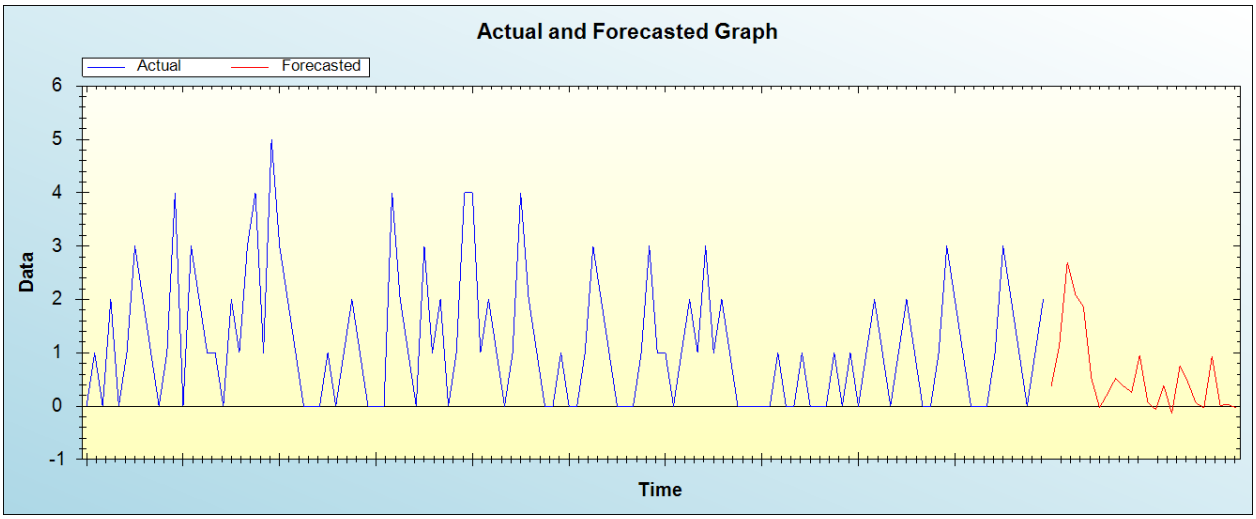


Figure 4: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| Month/Year | Forecasted E |
|---|---|
| January 2020 | 0.3666 |
| February 2020 | 1.1337 |
| March 2020 | 2.6952 |
| April 2020 | 2.0920 |
| May 2020 | 1.8644 |
| June 2020 | 0.5166 |
| July 2020 | -0.0255 |
| August 2020 | 0.2317 |
| September 2020 | 0.5228 |
| October 2020 | 0.3731 |
| November 2020 | 0.2570 |
| December 2020 | 0.9553 |
| January 2021 | 0.0722 |
| February 2021 | -0.0661 |
| March 2021 | 0.3834 |
| April 2021 | -0.1353 |
| May 2021 | 0.7542 |
| June 2021 | 0.4479 |
| July 2021 | 0.0575 |
| August 2021 | -0.0314 |
| September 2021 | 0.9345 |
| October 2021 | 0.0120 |
| November 2021 | 0.0321 |
| December 2021 | -0.0359 |

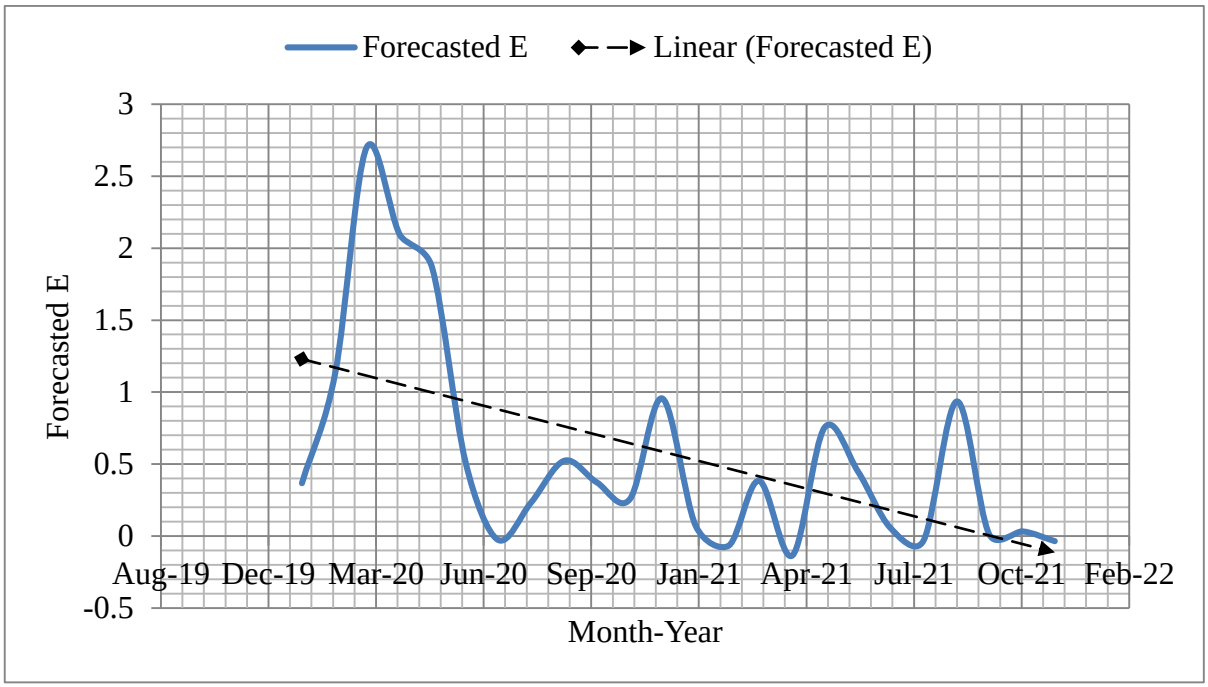


Figure 5: Graphical presentation of out-of-sample forecasts

## 4.3 DISCUSSION OF THE RESULTS

Table 1 is a mere ANN model summary and basically shows the ANN (12, 12, 1) neural network model, which has been based on the hyperbolic tangent function as its activation function. The "criteria" or simply the evaluation statistics indicate the model is adequate. Figure 1 shows that approximately 1 epileptic patient per month has been managed at KGH on average over the study period. Figure 2 are the residuals of the model and since the residuals are as close to zero as possible, the model is stable and acceptable for generating forecasts of the variable under consideration. Figure 3 shows the in-sample forecast of the model and it is clear that the model fits well with data. Figure 4, table 2 and figure 5 are out of sample forecasts. A striking feature of our forecast is that the epilepsy cases will generally trend downwards over the out-of-sample period.

## 5.0 CONCLUSION & RECOMMENDATIONS

Indeed, epilepsy is one of the most common and serious brain disorders in the world. Unfortunately, the disease has not received adequate attention in existing national plans, not only in Zimbabwe but also in many other developing countries. This study basically applied an ANN (12, 12, 1) model to predict epilepsy cases at GPH. The study used a monthly data set covering the period January 2010 to December 2019. The following policy suggestions are put forward:

i. KGH strengthen obstetric and essential newborn care in order to prevent cerebral palsy (CP) which is a risk factor for epilepsy in paediatric patients.

ii. There is need for provision of anti-epileptic drugs, free of charge, as most patients cannot afford to buy the drugs given their low socio-economic status.
iii. KGH should empower communities in its catchment area with appropriate knowledge on epilepsy.

## REFERENCES

1) Brodie, M. J., et al. (2012). Patterns of Treatment Response in Newly Diagnosed Epilepsy, Neurology, 78: 1548 – 1554.
2) Dewa, E., et al. (2014). Non-attendance of Treatment Review Visits Among Epileptic Patients in a Rural District, Zimbabwe, Journal of Public Health in Africa, 5 (351): 73 – 76.
3) ESF (2007). Pfari Mu Zimbabwe, ESF, Harare.
4) Espinosa-Jovel, C., et al. (2018). Epidemiological Profile of Epilepsy in Low Income Populations, Seizure, 56: 67 – 72.
5) Fischer, M. M., & Gopal, S. (1994). Artificial Neural Networks: A New Approach to Modeling Interregional Telecommunication Flows, Journal of Regional Science, 34 (4): 503 – 527.
6) Fisher, R. S., et al. (2017). Operational Classification of Seizure Types by the International League Against Epilepsy, Epilepsia, 58: 522 – 530.
7) Kim, S., Faloutsos, C., & Yang, H. (2013). Coercively Adjusted Auto Regression Model for Forecasting in Epilepsy EEG, Computational and Mathematical Methods in Medicine, pp: 1 – 13.
8) Lim, K. S., et al. (2012). Name of Epilepsy: Does it Matter? Neurology Asia, 17 (2): 87 – 91.
9) Mbuba, C. K., et al. (2008). The Epilepsy Treatment Gap in Developing Countries: A Systematic Review of the Magnitude, Causes and Intervention Strategies, Epilepsia, 49: 1491 – 1503.
10) Mugumbate, J. (2011). Social Aspects of Epilepsy, WHO, Geneva.
11) Murray, C. J., et al. (2012). Disability-adjusted Life Years (DALYs) for 291 Diseases and Injuries in 21 Regions, 1990 – 2010: A Systematic Analysis for the Global Burden of Disease Study 2010, Lancet, 380: 2197 – 2223.
12) Mutanana, N., & Mutara, G. (2015). Health Seeking Behaviours of People With Epilepsy in a Rural Community of Zimbabwe, International Journal of Research in Humanities and Social Studies, 2 (2): 87 – 96.
13) Ndoye, N. F., et al. (2005). Prevalence of Epilepsy, its Treatment Gap and Knowledge, Attitude and Practice of its Population in Sub-urban Senegal an ILAE/IBE/WHO Study, Seizure, 14: 106 – 111.

14) Neligan, A., Hauser, W. A., & Sander, J. W. (2012). The Epidemiology of the Epilepsies, Clinical Neurology, 107: 113 – 133.
15) Ngugi, A. K., et al. (2010). Estimation of the Burden of Active and Life-time Epilepsy: A Meta-analytic Approach, Epilepsia, 51: 883 – 890.
16) Rabie, F. M., et al. (2016). Prevalence and Determinants of Epilepsy Among School Children in Aseer Region – KSA, Journal of Educational and Practice, 7 (21): 149 – 153.
17) Saburi, G. L., Mapanga, K. G., & Mapanga, M. B. (2006). Perceived Family Reactions and Quality of Life of Adults With Epilepsy, Journal of Neurology and Nursing, 28 (3): 21 – 28.