ARIMA FORECASTING OF THE PREVALENCE OF ANEMIA IN CHILDREN IN MYANMAR

Dr. Smartson. P. NYONI
ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
Mr. Thabani NYONI
Department of Economics, University of Zimbabwe, Harare, Zimbabwe

ABSTRACT

Using annual time series data on the prevalence of anemia in children under 5 years of age in Myanmar from 1990 – 2016, the study makes predictions for the period 2017 – 2025. The study applies the Box-Jenkins ARIMA methodology. The diagnostic ADF tests show that, AM, the series under consideration is an I (0) variable. Based on the AIC, the study presents an AR (4) model, which is also called the ARIMA (4, 0, 0) model. This has been found to be the parsimonious model. The diagnostic tests further reveal that the presented model is quite stable and its residuals are not serially correlated. The results of the research indicate that the prevalence of anemia in children in Myanmar will rise from approximately 54.5% in 2017 to almost 64.8% by 2025. This means that anemia is not yet under control in the country. This is a wake up call to both public health policy makers and nutrition specialists in the country.

1.0 INTRODUCTION

Anemia is a widespread public health problem associated with an increased risk of morbidity and mortality, especially in young children (WHO, 2002). Globally, 1.62 billion people are anemic, while among the pre-school children the prevalence of anemia is 47.4% (Sayed *et al*., 1999). Anemia is a significant public health challenge in Myanmar (Win & Ko, 2018). In fact, the prevalence of anemia in children in Myanmar is amongst the highest in the world (Zhao *et al*., 2015). The prevalence of anemia in some regions of Myanmar is reported to be unacceptably high, at around 70% (Kemmer *et al*., 2003; Zhao *et al*., 2012). Poverty and malnutrition are the main reasons for the high prevalence of anemia in Myanmar. Children, especially those aged below five, are the most vulnerable group. At least 60% of children aged 6-59 months are anemic in the country (Win & Ko, 2018). The presence of anemia in children under five years of age is of particular relevance because it negatively impacts mental development and future social performance (Sayed *et al*., 1999). The main goal of this study is to forecast the prevalence of anemia in children under the age of 5 in Myanmar over the period 2017 – 2025. The findings of this study are envisioned to be very useful for designing public nutrition and other health programs in the country, in addition to serving as a basic instrument for decision makers to implement effective public health interventions to fight against anemia in Myanmar.

2.0 LITERATURE REVIEW

In a local study, Zhao *et al*. (2015) conducted a research to determine the prevalence of anemia in preschool children as well as its risk factors. A multivariate logistic regression was applied. The study established that anemia in children in the country was largely driven by iron deficiency. The paper established that drinking spring water is also an important cause of anemia among children in Myanmar. In another local study, Win & Ko (2018) carried out a secondary analysis of the Myanmar Demographic and Health Survey 2015-16 in order to determine the geographical disparities in prevalence of anemia and related factors among women of reproductive age. Multivariate logistic regression was applied. The results of their study showed that the prevalence of anemia varied by geographical zone and that in overall, anemia among women of reproductive age is a major public health problem in Myanmar and that those in the coastal region were the most vulnerable. To date, there has been no research of this kind in Myanmar. It is this information gap that this paper will fill.

3.0 METHODODOLOGY

3.1 The Box – Jenkins (1970) Methodology

The first step towards model selection is to difference the series in order to achieve stationarity. Once this process is over, the researcher will then examine the correlogram in order to decide on the appropriate orders of the AR and MA components. It is important to highlight the fact that this procedure (of choosing the AR and MA components) is biased towards the use of personal judgement because there are no clear – cut rules on how to decide on the appropriate AR and MA components. Therefore, experience plays a pivotal role in this regard. The next step is the estimation of the tentative model, after which diagnostic testing shall follow. Diagnostic checking is usually done by generating the set of residuals and testing whether they satisfy the characteristics of a white noise process. If not, there would be need for model re – specification and repetition of the same process; this time from the second stage. The process may go on and on until an appropriate model is identified (Nyoni, 2018c). This approach will be used to analyze, AM, the series under consideration.

3.2 The Applied Box – Jenkins ARIMA Model Specification

If the sequence $\Delta^d AM_t$ satisfies an ARMA (p, q) process; then the sequence of AM_t also satisfies the ARIMA (p, d, q) process such that:

$$\Delta^d AM_t = \sum_{i=1}^{p} \beta_i \Delta^d L^i AM_t + \sum_{i=1}^{q} \alpha_i L^i \mu_t + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots [1]$$

where Δ is the difference operator, vector $\beta \in \mathbb{R}^p$ and $\alpha \in \mathbb{R}^q$.

3.3 Data Collection

This study is based on annual observations (that is, from 1990 – 2016) on the prevalence of anemia in children under the age of 5 in Myanmar [denoted as AM]. Prevalence of anemia in children under 5 years of age in Myanmar, refers, to the percentage of children under the age of 5 whose hemoglobin level is less than 110 grams per liter at sea level. Out-of-sample forecasts will cover the period 2016 – 2025. All the data was gathered from the World Bank online database.

3.4 Diagnostic Tests & Model Evaluation

3.4.1 The ADF Test in Levels

Table 1: with intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
AM	-5.141996	0.0004	-3.752946	@1%	Stationary
			-2.998064	@5%	Stationary
			-2.638752	@10%	Stationary

Table 1 shows that the series under study is stationary in levels.

3.4.2 Evaluation of ARIMA models (with a constant)

Table 2: Evaluation of ARIMA Models (with a constant)

Model	AIC	U	ME	RMSE	MAPE
ARIMA (1, 0, 0)	95.40588	0.99522	-0.22477	1.6682	2.4379
ARIMA (2, 0, 0)	-10.00002	0.23034	0.1966	1.3509	0.70931
ARIMA (3, 0, 0)	-19.35734	0.21659	0.19985	1.3445	0.65365
ARIMA (4, 0, 0)	-20.28942	0.21376	0.20747	1.36682	0.65329
ARIMA (5, 0, 0)	-18.35452	0.21362	0.21025	1.3784	0.65726

A model with a lower AIC value is better than the one with a higher AIC value (Nyoni, 2018b) Similarly, the U statistic can be used to find a better model in the sense that it must lie between 0 and 1, of which the closer it is to 0, the better the forecast method (Nyoni, 2018a). In this research paper, only the AIC is used to select the optimal model. Therefore, the ARIMA (4, 0, 0) model is finally chosen. This model is indeed the AR (4) model.

3.5 Residual Tests

3.5.1 Correlogram of the Residuals of the ARIMA (4, 0, 0) Model

Figure 1: Correlogram of the Residuals

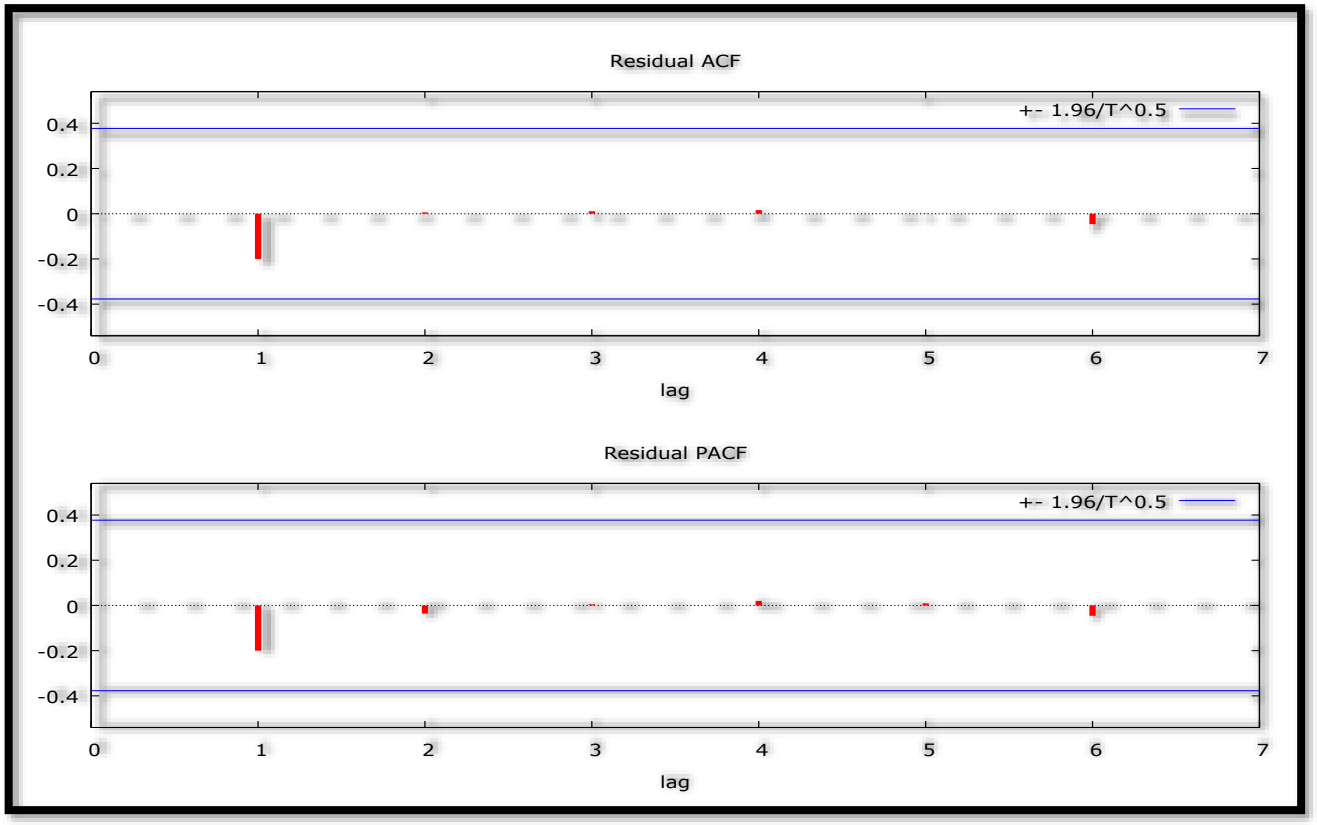

Figure 1 indicates that the estimated optimal model is adequate since ACF and PACF lags are quite short and within the bands.

4.0 FINDINGS OF THE STUDY

4.1 Results Presentation[1]

Table 3: Main Results

ARIMA (4, 0, 0) Model:

The chosen optimal model, the ARIMA (4, 0, 0) model can be expressed as follows:

$$AM_t = 55.1561 + 1.12529AM_{t-1} + 0.343531AM_{t-2} - 0.159118AM_{t-3} - 0.350822AM_{t-4} \ldots \ldots [2]$$

Variable	Coefficient	Standard Error	z	p-value
constant	55.1561	0.101449	543.7	0.0000***
β_1	1.12529	0.198441	5.671	0.0000***
β_2	0.343531	0.307662	1.117	0.2642
β_3	-0.159118	0.304760	-0.5221	0.6016
β_4	-0.350822	0.196728	-1.783	0.0745*

Table 3 shows the main results of the ARIMA (4, 0, 0) model.

Forecast Graph

Figure 2: Forecast Graph – In & Out-of-Sample Forecasts

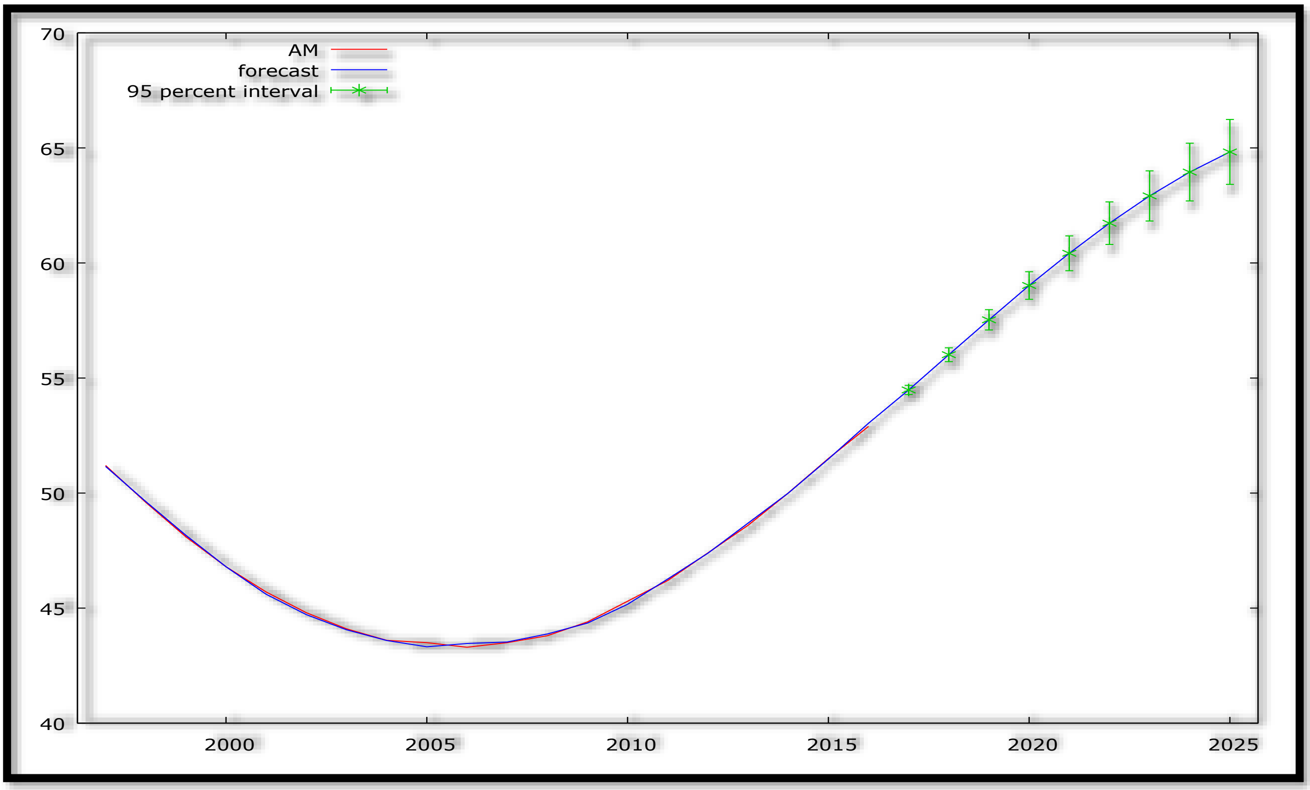

Figure 2 shows the in-and-out-of-sample forecasts of the series, AM. The out-of-sample forecasts cover the period 2017 – 2030.

Predicted AM– Out-of-Sample Forecasts Only

Table 4: Predicted AM

Year	Predicted AM	Standard Error	95% Confidence Interval
2017	54.4818	0.101923	(54.2820, 54.6816)
2018	56.0129	0.153437	(55.7122, 56.3136)
2019	57.5302	0.224643	(57.0899, 57.9705)
2020	59.0208	0.306028	(58.4210, 59.6206)

[1] *The *, ** and *** imply statistical significance at 10%, 5% and 1% levels of significance; respectively.*

2021	60.4208	0.386589	(59.6631, 61.1785)
2022	61.7298	0.472034	(60.8046, 62.6550)
2023	62.9142	0.556801	(61.8229, 64.0055)
2024	63.9510	0.639665	(62.6972, 65.2047)
2025	64.8251	0.719681	(63.4145, 66.2356)

Figure 3: Graphical Analysis of Out-of-Sample Forecasts

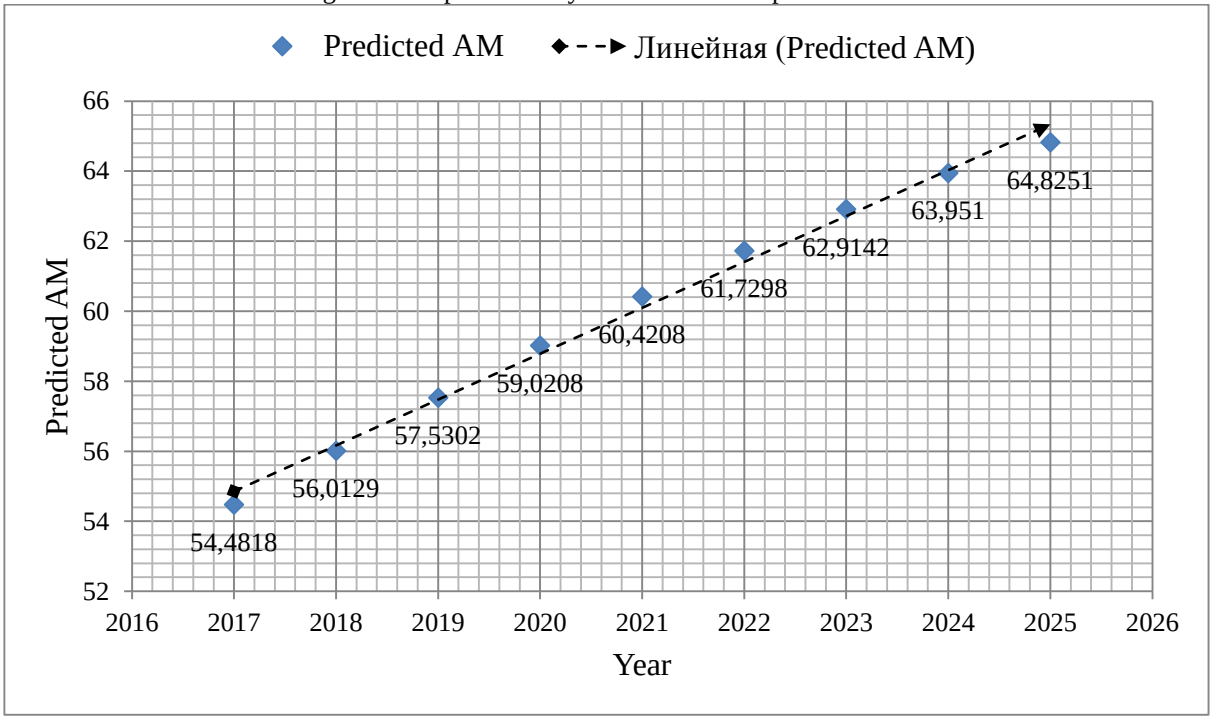

Table 4, just like figure 3 shows the out-of-sample forecasts only. The prevalence of anemia in children in Myanmar is projected to rise from the estimated 54.5% in 2017 to approximately 64.8% by 2025.

5.0 CONCLUSION

The study shows that the ARIMA (4, 0, 0) model is not only stable but also the most suitable model to predict the prevalence of anemia in children in Myanmar over the period 2019 – 2030. The model suggests that there is will an increase of the prevalence of anemia in children in the country over the out-of-sample period, up to as high as 64.8% by 2025. This points to the argument that anemia in children in Myanmar is far from being under control in the country. The study recommends that the government of Myanmar should intensify nutritional supplementation and food fortification programmes, especially in rural areas where larger groups of households are economically disadvantaged. Furthermore, people in Myanmar should be discouraged from drinking spring water and in this regard health education promotional campaigns, particularly on balanced diet, ought to be conducted throughout the country. Last but not least, the government of Myanmmar should continue to strengthen pediatric HIV/TB collaborative programs in order to reduce the incidence of HIV-related anemia.

REFERENCES

[1] Kemmer, T. M., *et al*. (2003). Iron Deficiency is Unacceptably High in Refugee Children From Burma, *Journal of Nutrition*, 138: 2534 – 2536.

[2] Nyoni, T (2018b). Modeling and Forecasting Inflation in Kenya: Recent Insights from ARIMA and GARCH analysis, *Dimorian Review*, 5 (6): 16 – 40.

[3] Nyoni, T. (2018a). Modeling and Forecasting Naira/USD Exchange Rate in Nigeria: A Box-Jenkins ARIMA Approach, MPRA Paper No. 88622, *University Library of Munich*, Munich, Germany.

[4] Nyoni, T. (2018c). Box – Jenkins ARIMA Approach to Predicting net FDI inflows in Zimbabwe, MPRA Paper No. 87737, *University Library of Munich*, Munich, Germany.

[5] Sayed, N. E., *et al*. (1999). Assessment of the Prevalence and Potential Determinants of Nutritional Anemia in Upper Egypt, *Food & Nutrition Bulletin*, 20: 417 – 421.

[6] WHO (2002). Reducing Risks, Promoting Healthy Life, *WHO*, Geneva.

[7] Win, H. H., & Ko, M. K. (2018). Geographical Disparities and Determinants of Anemia Among Women of Reproductive Age in Myanmar: Analysis of the 2015 – 2016 Myanmar Demographic and Health Survey, *WHO South-East Asia Journal of Public Health*, 7 (2): 107 – 113.

[8] Zhao, A., *et al*. (2012). Prevalence of Anemia and its Risk Factors Among Children 6-36 Months Old in Burma, *American Journal of Tropical Medicine and Hygiene*, 87: 306 – 311.

[9] Zhao, A., *et al*. (2015). Potential Contribution of Iron Deficiency and Multiple Factors to Anemia Among 6 to 72 Month Old Children in the Kokang Area of Myanmar, *American Journal of Tropical Medicine and Hygiene*, 93 (4): 836 – 840.