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EVALUATING THE EFFECT OF MALARIA FEVER IN OSUN STATE USING TIME SERIES APPROACH

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Abstract: A time series approach is used in the study to assess the impact of malaria fever in Osun State. The study's data came from the records of the State of Osun Hospitals Management Board in Ede. Time-series frameworks were established. Several time series tests were performed on the data, the most notable of which was the stationarity test. This was accomplished through the use of the graphic, correlogram, and unit root test approaches. The stationarity test results revealed that the series under consideration was stationary at the first difference. The Akaike information criterion and the Bayesian information criterion both provided the best predictions as a result of the analysis, with the Akaike information criterion performing slightly better than the Bayesian information criterion. Similarly, indices of performance measure show that RMSE and Theil U inequality provide the best measure. Malaria is more associated with the rainy months of the year, stagnant water, and some other factors, according to the forecast. It is suggested that the government take steps to reduce malaria spread by providing health education to its citizens and launching a mosque-to-mosque, church-to-church, and shrine-to-shrine campaign to reduce the spread of this unwanted visitor that has claimed so many lives. These are not to be taken lightly.

Keywords: Malaria, Stationarity test, AIC, BIC, RMSE and Theil U inequality.

1.0 INTRODUCTION

Malaria is an endemic parasitic disease in Africa that can be fatal. It has been identified as a significant health burden throughout the world, particularly in developing countries such as Sub-Saharan Africa. The disease is one of the leading causes of death and illness in many developing countries, affecting mostly children under the age of five and pregnant women (Schapira, 2004). Every year, at least 300 million people suffer from acute malaria, resulting in over a million deaths. Approximately 90% of these deaths occur in Africa, with children under the age of five accounting for nearly two-thirds (Ghosh et al., 2006; WHO, 2002). Children are especially vulnerable to malaria because they lack natural immunity and are more likely to develop severe forms of the disease. Malaria is a major public health concern in Africa's tropical and subtropical countries, with residents of endemic areas at a higher risk of contracting this infectious disease (Birhanie et al., 2014). The protozoan Plasmodium causes this life-threatening disease (Iwuafor et al., 2016). It is a disease spread by a mosquito bite (Obimakinde and Simon-Oke, 2017). Malaria affects half of the global population, with 3.3 billion people affected in 106 countries (Nigeria Malaria Fact Sheet, 2011). Over 300,000 people die each year in Nigeria as a result of an estimated 100 million cases of malaria (Nigeria Malaria Fact Sheet, 2011). As concerning as these statistics are, awareness of the threat posed by this disease is significantly low in developing and underdeveloped countries. This study aims to investigate the pattern of malaria in Nigeria with the goal of forecasting future outbreaks and recommending decisive measures by relevant authorities. Malaria has recently been classified as an epidemic in Africa due to its high incidence, as this disease affects a greater proportion of the African population (Gillet et al. 2010).

Africa accounted for approximately 175 million of the 216 million malaria cases recorded globally (Nigeria Malaria Fact Sheet, 2011). Nigeria and other African countries such as the Democratic Republic of the Congo (DRC), Ethiopia, and Uganda are responsible for nearly half of all malaria deaths worldwide (Nigeria Malaria Fact Sheet, 2011). This epidemic primarily affects Sub-Saharan African countries such as Nigeria, and it is a major public health issue that requires immediate attention. The epidemiology and symptoms of malaria fever are very similar. Malaria is transmitted specifically through the bite of female Anopheles mosquitoes, which thrive in the presence of contaminated water (stagnant water), poor sanitation, and contaminated food (Odikamnoro et al., 2018).

2.0 LITERATURE REVIEW

Obimakinde and Simon-Oke (2017) investigated the prevalence of malaria among patients with symptoms who were tested for malaria at the Federal University of Technology, Akure, between January and December 2015. Using the Chi-square method, it was discovered that malaria incidence differed significantly between sexes, socioeconomic status, and age group. Ozofor and Onus (2017) used Parklane Specialist Hospital in Enugu as a case study to conduct a statistical analysis on malaria cases reported in urban areas of Enugu State, Nigeria, between 2009 and 2015. To determine the nature of the relationship between malaria and the time factor, a regression technique was used. The findings revealed a negative linear relationship between malaria prevalence and the years studied, with males experiencing a faster decrease in malaria prevalence than females. It was suggested that areas that serve as malaria breeding grounds be cleaned. Anokye et al. (2018) used secondary data obtained from the Regional Health Directorate between 2010 and 2016 to investigate the pattern of malaria incidence in Kumasi Metropolis. In both monthly and mid-year malaria cases, an increasing quadratic behavior was observed, with the highest and lowest cases occurring in July and January, respectively. Akawu et al. (2018) used secondary data obtained from the Borno State Epidemiological Unit between 2011 and 2013 to study the dimension of malaria incidence in all local government areas in Borno State. The prevalence was divided into four levels based on the number of cases recorded in each of the years studied. Maiduguri Metropolis and Jere had very high incidences in 2011, while Ngala LGA joined the former two LGAs with very high malaria prevalence in 2012 and 2013. Adeboye and Ezekiel (2018) used time series techniques to conduct a statistical analysis of malaria morbidity in Nigeria using the ARIMA model. The study was based on monthly data obtained from the Ilaro State Hospital between 2003 and 2015. ARIMA models (2, 2, 3) were chosen as the most appropriate among the ARIMA models fitted. The ARIMA (2, 2, 3) model forecasts a steady increase in malaria prevalence. From 2011 to 2015, Sekubia and Mensah (2019) investigated the trend of typhoid fever cases in Cape Coast Metropolis. The study relied on secondary data obtained from the District Health Information Management System (DHIMS). For the study's analysis, descriptive statistics were used. The malaria cases' mean and median ages were 27.07 and 28.06, respectively, with the age group for both the mean and median being 20-34 and a standard deviation of 4.15. The results showed that standard deviations were widely distributed across all age groups.

3.0 MATHEMATICAL PRELIMINARIES

The $ARMA(p,q)$ model above can be expressed as

$$(1-\varphi_1\mathrm{B}-\varphi_2\mathrm{B}^2-...-\varphi_p\mathrm{B}^p)y_t=\theta_0+(1+\theta_1\mathrm{B}+\theta_2\mathrm{B}^2+...+\theta_q\mathrm{B}^q)\varepsilon_t \quad (1)$$

where B is the backward shift operation, that is

$$\mathrm{B}^kY_t=Y_{t-k} \text{ for k +ve integer}$$

$$\phi(\mathrm{B})=1-\varphi_1\mathrm{B}-\varphi_2\mathrm{B}^2-...-\varphi_p\mathrm{B}^p \quad (2)$$

The Autoregressive Integrated Moving Average Process is represented using the model

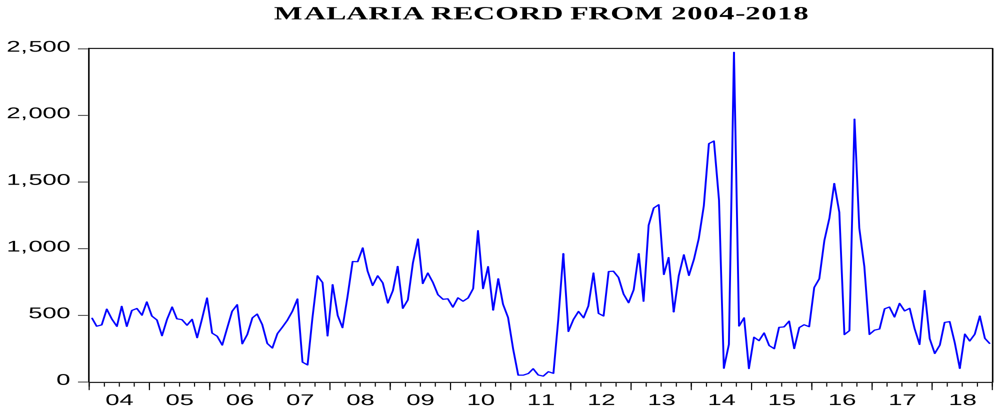
$$\psi(B)X_t=\phi(B)\nabla^dX_t=\theta(B)e_t$$

Where $\phi(B)=1-\phi_1B-\phi_2B^2.......-\phi_pB^p$

$$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 .... - \theta_q B^q$$

4.0 DATA ANALYSIS AND INTERPRETATIONS

The data for the study covers the period of 2004 to2018 and was obtained from the archive of state government of Osun State and was analysed using Econometrics-view software



TIME PLOT OF THE RAW DATA

Vividly looking at the raw data, it seems as if the data is stationary, however this claim will be supported with the Augmented Dickey-Fuller Test under the identification testing.

UNIT ROOT TEST

Unit root test is a test statistic that test for the stationarity assumption of the data; the decision rule is as below: Decision Rule: (Reject H0 if t* > ADF, otherwise do not reject)

H_0: Series has unit root (data is non-stationary) vs

H_1: Series has no unit root (data is stationary)

UNIT ROOT TEST OF THE ORIGINAL DATA

Null Hypothesis: MALARIA_RECORD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.370388	0.0000
Test critical values:	1% level	-3.466994	
	5% level	-2.877544	
	10% level	-2.575381	

*MacKinnon (1996) one-sided p-values.

CORRELOGRAM OF THE ORIGINAL DATA

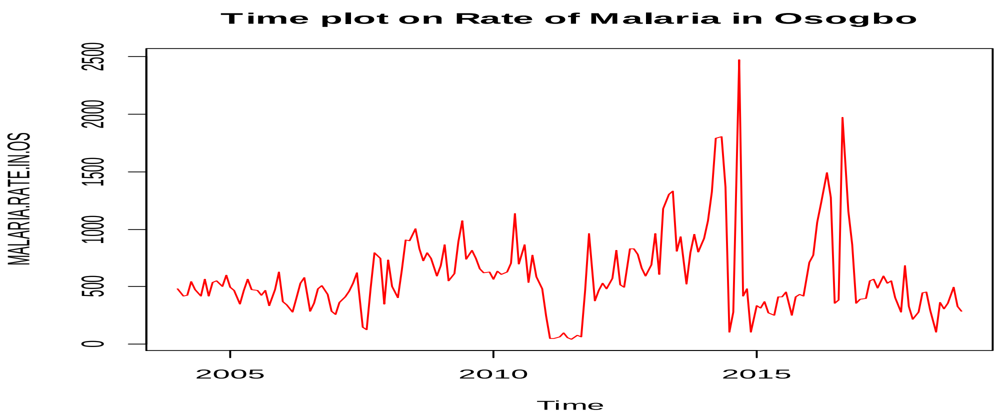
Correlogram of MALARIA_RECORD

Date: 11/05/19 Time: 11:14
Sample: 2004M01 2018M12
Included observations: 180

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.526	0.526	50.715	0.000
		2	0.314	0.051	68.867	0.000
		3	0.314	0.181	87.166	0.000
		4	0.373	0.195	113.11	0.000
		5	0.336	0.069	134.25	0.000
		6	0.251	0.001	146.08	0.000
		7	0.140	-0.096	149.81	0.000
		8	0.065	-0.109	150.61	0.000
		9	0.059	-0.039	151.28	0.000
		10	0.072	0.006	152.27	0.000
		11	0.037	-0.007	152.54	0.000
		12	-0.018	-0.014	152.60	0.000

INTERPRETATION

The first output above is the unit root test for the original data while the graph above is the correlogram. From the first output, we can deduce that the absolute Augmented Dickey-Fuller Test statistic is 7.370388 which is far greater than the critical value at the 5% level of significant (-2.877544), also the p-value (0.0000) is less than 0.05 indicating that the null hypothesis cannot be accepted; (i.e. the data is stationary).



From the time plot above it can be seen that the time series could be described using an addictive model since the random fluctuations in the data are roughly constant in size over time.

From the time plot it is revealed that there was high rate at which patients was diagnosed of Malaria in the year 2014 and there was least patient diagnosed of the disease as the year goes by.

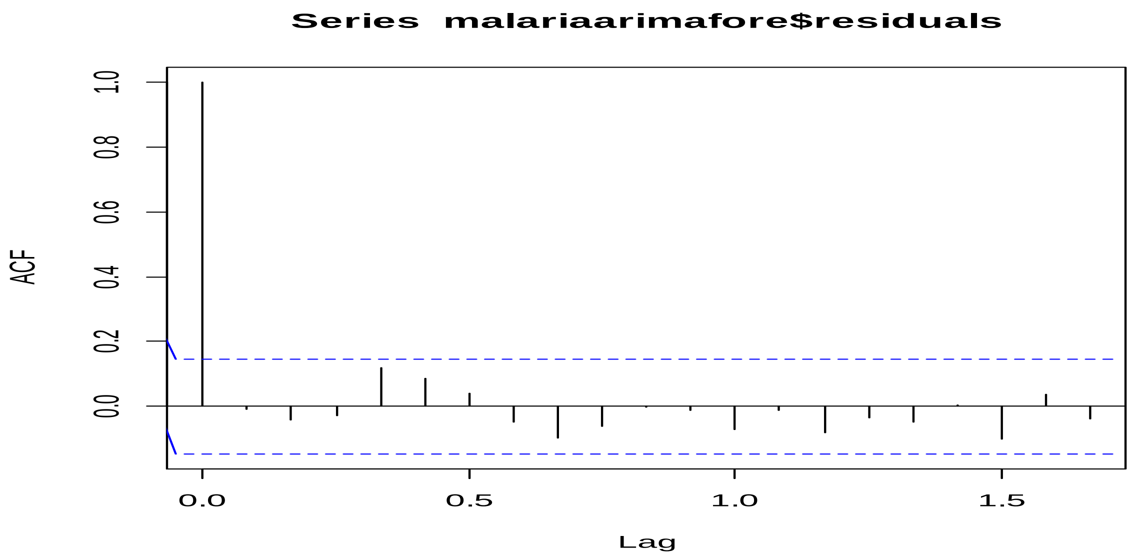
From the time plot, there is presence of Seasonal and Random Variation.

ARIMA FORECAST

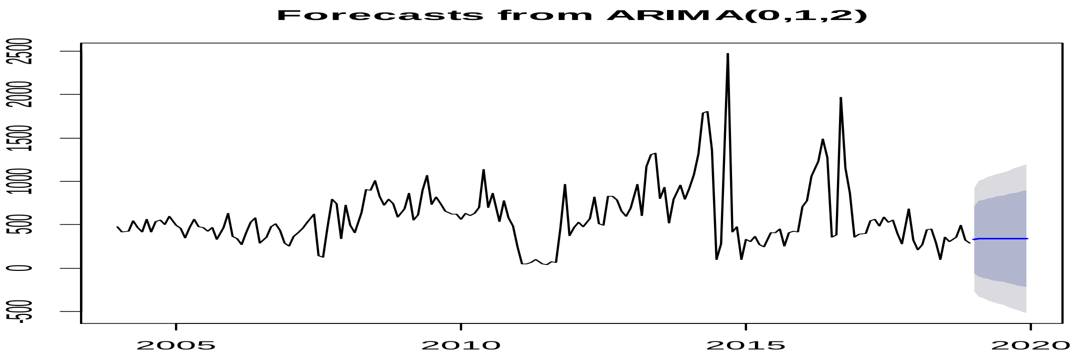
	Point	Forecast	Lo 80	Hi 80	Lo 95	Hi 95
Jan	2019	329.4411	-58.722	717.6042	-264.203	923.0854
Feb	2019	340.6386	-95.4397	776.717	-326.286	1007.563
Mar	2019	340.6386	-109.154	790.4312	-347.26	1028.537
Apr	2019	340.6386	-122.462	803.7396	-367.613	1048.89
May	2019	340.6386	-135.399	816.676	-387.398	1068.675
Jun	2019	340.6386	-147.993	829.27	-406.659	1087.936
Jul	2019	340.6386	-160.27	841.5475	-425.435	1106.713
Aug	2019	340.6386	-172.254	853.5312	-443.763	1125.04
Sep	2019	340.6386	-183.964	865.2412	-461.672	1142.949
Oct	2019	340.6386	-195.418	876.6955	-479.19	1160.467
Nov	2019	340.6386	-206.633	887.9101	-496.341	1177.618
Dec	2019	340.6386	-217.622	898.8994	-513.148	1194.425

Interpretation

The Lo 80 and Lo 95 signify the 80% and 95% prediction interval for the forecast respectively. From the forecast seen above, it is seen that their rate at which patients will be diagnosed or treated for malaria will be on a minimal rate, if necessary, precautions are being taken in place.



The ARMA(3,0) model has 3 parameters, the ARMA(0,2) model has 2 parameters and the ARMA(p,q) model has at least 2 parameters. Therefore, using the principle of parsimony, the ARMA(0,2) model and ARMA(p,q) model are equally good candidate models.



Interpretation

Above time plot show that malaria rates is non-stationary. It implies that the malaria rates data are unstable [i.e. fluctuating or moving up and down significantly from 2004 to 2020.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

1. This study went through several procedures, and all necessary statistical analysis was used to analyze the data. The analysis shows that one of the project's goals, estimating the trend, was met. The best trend line is obtained by calculating the trend using the least squares method. The fitting result, a straight line, indicated that there had been an increase in malaria cases as reported by the State of Osun Hospitals Management Board, State Hospital Ede.

The moving average graph shows that the rate at which malaria kills people fluctuates. Aside from seasonal variations, malaria is a serious health problem. It fluctuates in size. Malaria is also more prevalent during the rainy season. This is due to dense vegetation, stagnant water, and a variety of other factors.

5.2 CONCLUSION

According to the findings of the analysis, malaria is a common disease that affects people on a regular basis, which can be attributed to stress, what people eat, the nature of the body, insect bites, and so on. Malaria is prevalent at the State Hospital Ede, as can be concluded. The infection is increasing on a monthly basis. The government should do everything possible to fund the health sector and implement the recommendations.

5.3 RECOMMENDATION

According to the analysis' predicted values, there will be an increase in malaria in the near future, but this can be mitigated if the following recommendations are followed: The government should provide adequate health care facilities for the people, and the general public should be educated on proper diet. The government should embark on health education and public awareness about the causes of malaria; additionally, the government should provide adequate treatment for affected patients; and finally, an insecticide-treated net should be provided to the populace to combat the mosquito menace.

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