International Scholars Journals

African Journal of Malaria and Tropical Diseases ISSN 4123-0981 Vol. 3 (9), pp. 245-259, September, 2015. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Meeting the Millennium Development Goal for malaria by 2015: A time series analysis of malaria cases in Ogun State, Nigeria

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Accepted 9 September, 2015

This study was aimed at investigating the changes in the trend of malaria cases and to know if Ogun state in Nigeria will be able to meet the millennium development goal for malaria by 2015 (which is malaria morbidity and mortality are reduced by 75% in comparison with 2005. Using a 10 year malaria historical data from 2004 to 2013, a trend analysis was performed on the malaria cases and rates to know if there is a monthly or yearly increase or decrease in malaria incidence and a time-series analysis (ARIMA model) was conducted to forecast malaria cases for 2014 and 2015. The results indicated a monthly increase in malaria cases by 0.7 percent and a yearly increase of 9.0 percent and a monthly rate of 1.749 cases per 100,000 people to a yearly rate of 20.98 cases per 100,000 people. The ARIMA model forecasted about 164.9% increase in cases compare to the 2005 malaria cases. In conclusion, Ogun State will likely not meet the millennium development goal for malaria by 2015.

Keywords: Malaria, Ogun State, Nigeria, forecasting, ARIMA, time series analysis.

INTRODUCTION

Malaria is indeed a great global health problem affecting approximately 106 countries, with half of the world's population at risk (3.3 billion people) (WHO, 2014). The World Health Organization report on malaria in 2013 estimated that there are approximately about 207 million cases of malaria in 2012 (with an uncertainty range of 135 million to 287 million). More than 80% of estimated malaria deaths in 2012 occurred in just 17 countries, and 80% of cases occurred in 18 countries, with the Democratic Republic of the Congo and Nigeria together accounting for 40% of the estimated global total. Most deaths occurred among children in Africa. It is estimated that a child dies every minute from malaria and about 460000 African children died before their fifth birthday (WHO, 2013).

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In Nigeria, 97% of the population is at risk and with more deaths due to malaria than any country in the world. There is an estimated 100 million malaria cases with over 300,000 deaths per year. This compares with 215,000 deaths per year from HIV/AIDS. Malaria contributes to an estimated 11% of maternal mortality, (Nigeria Malaria Fact Sheet, 2011). According to the Nigeria Malaria Control Program Strategic Plan 2009-2013, about 60% of outpatient visits and 30% of hospitalizations are due to malaria. It is the leading cause of death in children under five accounting for 225,000 deaths. Malaria also contributed to 11% of maternal mortality and 10% of low birth weight annually. Although no official data exist on the overall malaria cases in Ogun state but several studies have been done on different cities and regions in the state to evaluate the distribution of malaria transmission in the state. Ojo, (2003) conducted an epidemiological study of malaria and typhoid infections in the state capital, Abeokuta. Using both cross-sectional and longitudinal studies, he concluded that the overall prevalence of infection was 59.9% (*Plasmodium falciparum* accounted for 89.7% and Plasmodium malariae 10.3%). The prevalence of infection among females (64.3%) was greater than males (56.1%) (P = 0.05). More children aged 0 - 5 years were infected (83.1 %) than other age groups. More children were infected in the high population density areas (64.3%) than low density areas. Ojo, and Mafiana (2005) investigated the seasonal pattern of malaria fever among children in Abeokuta, Ogun state. Carrying out a longitudinal study between October 2000 and September 2001, it was found out that of the 3,997 feverish cases reported, 82.4% was due to malaria. Idowu, Mafiana, and Dapo (2006) conducted a study to investigate the prevalence of malaria cases among pregnant women who were enrolled in two hospitals and traditional birth home (TBH) in Abeokuta. A total of 466 pregnant women were recruited for the study. The prevalence of malaria was 57.4%, and was higher among women in the TBH. The prevalence of malaria in the first, second and third trimesters of pregnancy were 37.5%, 47.3% and 47.5% respectively. At the time of the first antenatal visit 35.6% of the women were already parasitaemic, with a high frequency observed among primigravids**.** Okonko el al, 2009 conducted a study to know the prevalence of malaria plasmodium in Abeokuta, Ogun state between 2002 and 2004. Out of the 708 of patients examined 577 (81.5%) of the patients were Plasmodium-positive. The prevalence of infection among female subjects (42.4%) was slightly more than the males (41.9%) however this was not statistically significant. Olasehinde, Ajayi, Adekeye, and Adeyeba (2010) conducted a study to ascertain the prevalence and management of falciparum malaria among infants and children (0-12 years) in Ota, a suburb area of the state. The study concluded that 80.5% of the children investigated were found to have malaria infection. Mogaji et al, (2012) conducted a survey of the prevalence of malaria caused by plasmodium in residents of four randomly selected rural communities in Ogun state between May 2011 and May 2012. A total of 405 residents volunteered to participate. The overall prevalence of malaria cases was 53% for all the four randomly selected communities. The range was 82.6% in the highest community to 38.2% for the least prevalent population. Olasunkanmi et al, 2013 carried out a study in Abeokuta, Ogun state between April 2013 and August 2013 among 76 subject to determine the prevalence of malaria in children within the age of 10 years attending a medical center in the capital city. The study concluded that twenty four (31.6%) of the blood samples showed presence of Plasmodium. Sam-Wobo and Asiwaju (2014) conducted a study on the prevalence of falciparum malaria in some granite mining communities located in a rural area of the state between July, 2008 and February, 2009. Seventy-two percent of the participants were positive for *Plasmodium falciparum.* Sam-Wobo et al, 2014 conducted another study on the prevalence of malaria parasites in primary health facilities attendees in Ogun state between October, 2012 and January 2013. From the 284 participants examined, 273 (71.1%) were positive with malaria parasites.

Forecasting malaria incidence and knowing the trend of malaria incidence in any population would help in understanding the overall pattern of malaria cases, to compare malaria cases from one time period to another, to compare malaria cases among one population to another, to make future projection of malaria cases, which is a means of monitoring progress towards a malaria prevention objective and goals and also to help policy makers to reevaluate their policy and make necessary planning if needed. Our aim was to investigate if there are any significant changes in the monthly and yearly malaria cases and rates in Ogun State and to know if Ogun State in Nigeria will meet the Millennium Development Goal set for malaria by the Roll Back Malaria (RBM) Abuja Targets global strategic plan 2005-2015 (that is malaria morbidity and mortality are reduced by 75% in comparison with 2005, not by national aggregate but particularly among the poorest groups across all affected countries). (Roll Back Malaria Partnership, 2005).

Time Series Analysis

Comedian George Carlin once said that “if there were no such thing as time, everything happens all at once”. Of course, there is a time to everything that happens and events that occur at one time are related to events at another time. An ordered sequence of values of a variable at equally spaced time intervals and the study of the interrelationship between this time-ordered data is called a time series analysis. (Pankratz, 1991). The goals are: (1) Descriptive: Identify patterns in correlated data—trends and seasonal variation, (2) Explanation: understanding and modeling the data, (3) Forecasting: prediction of short-term trends from previous patterns, (4) Intervention analysis: how does a single event change the time series? and (5) Quality control: deviations of a specified size that indicate a problem (Senter, 2004).

Time series analysis has been used in different fields for many years. The basic concept of time series in literature can be dated back to 1880 when T.N. Thiele formulated and analysed a model for a time series consisting of a sum of a regression component, a Brownian motion and a white noise, where he derived a recursive procedure for estimating the regression component and predicting the Brownian motion (Lauritzen, 1981).

In 1901 R.H Hooker used a time series analysis to show the correlation between marriage rates with trade. In 1927 Yule studied the method of investigating periodicities in disturbed series with special reference to

Wolfer's sunspot numbers. R.A Fisher in 1929 tested the significance in harmonic analysis (Brillinger, 2000). The early use of time series over the years has made some surprising discoveries in science. An example is presented by Tufte (1983) who showed a time series plot from the 10th or 11th century AD. This graph is speculated to provide movements of the planets and the sun. The major usage of time series models is to obtain an understanding of the underlying forces and structure that produced the observed data and to fit a model that proceeds to forecasting, monitoring or even feedback and feed forward control. Time series analysis has been utilized in different fields like industry; economics in which it was used initially; and later in public health and medical research.

The use of time series in the field of public health can be dated back to the 20th century when Dr. John Brownlee a public health officer, geneticist, epidemiologist and medical statistician investigated the periodicity of weekly number of deaths from infectious diseases (bronchitis, Pneumonia and influenza) in London between 1876 and 1897, using a mathematical method known as periodogram to found a period of 33 weeks with regard to bronchitis or pneumonia in the absence of influenza (Brownlee, 1919).

Millennium Development Goals

In September 2000, during the United Nation Submit, all the 191 United Nation member states signed a United Nations Millennium Declaration which commits world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. This declaration is known as the Millennium Development Goals. The United Nations Millennium Development Goals are eight goals that all 191 UN member states and at least 23 international organizations have agreed to try to achieve by the year 2015, and all have specific targets and indicators. The eight millennium development goals are to eliminate extreme poverty and hunger, attain universal primary education, promote gender equality and empower women; to reduce child mortality, improve maternal health, to combat HIV/AIDS, malaria, and other diseases, ensure environmental sustainability and develop a global partnership for development, (United Nations, 2014).

The millennium development goal was set up to achieve several important social priorities around the world. The major widespread concerns for these goals are poverty, hunger, disease, unmet schooling, gender inequality, and environmental degradation. These were prioritized into eight achievable and understandable goals, which are measurable and have a time bound objectives. The MDGs help to promote global awareness, political accountability, improved metrics, social feedback, and public pressures. The MDG’s have become a global report card for the fight against poverty for the 15 years from 2000 to 2015 as described by The Bill and Melinda Gates Foundation. This report card as most report cards generates incentives to improve performance, even if not quite enough incentives for both rich and poor countries to produce a global class of straight-A students (Bill and Melinda Gates Foundation, 2008). Although, developing countries have made substantial progress towards achieving these goals but these progress are highly variable across goals, countries and regions. While some countries will achieve all or most of these goals, others will achieve very few. Report has shown that most developing countries as a whole have cut the poverty rate by half between 1990 and 2010. This is attributed to the startling economic growth in china. It is also predicted that by 2015, most of the countries would have made a significant progress towards most of the goals. This is due to the fact that the MDGs have been a major policy debates and national policy planning for most countries, that has been incorporated into the work of government, non-governmental organization and civil society and also taught to students at all levels of education (Sachs, 2012).

Millennium Development Goal 6: Combat HIV/AIDS, malaria, and other diseases

The Millennium Development Goal 6 is to combat malaria, HIV/AIDS and other diseases. This can be achieved by stopping and reversing the spread of HIV/AIDs by 2015 and stopping incidence of malaria and other major diseases by 2015. This can be achieved by mandating the use of condoms by high-risk sex, giving adequate and comprehensive knowledge of HIV/AIDS to proportion of population 15-24 years of age. Provision of malaria preventive measures such as insecticide-treated bed nets to children under 5, appropriate anti-malarial drugs for children under 5 with fever and detection cure of tuberculosis cases under DOTS (Directly Observed Treatment Short Course) (Millennium Development Goal Malaria Summit, 2008).

Millennium Development Goal 6C

In a 2007 resolution, the World Health Assembly and RBM called for a 75% reduction in the global malaria (malaria case incidence rates) burden by 2015. This was also reiterated during the African country meeting in Abuja by developing a global strategic plan 2005-2015 which was to reduce malaria morbidity and mortality by 75% in comparison with 2005, not by national aggregate but particularly among the poorest groups across all affected countries. In order to achieve this goal, The Roll Back Malaria Partnership (RBM) was launched by WHO, UNICEF, UNDP and the World Bank, in an effort to provide a coordinated global response to the disease, this led to development of the Global Malaria Action Plan

(GMAP), which provides a global framework for action around which partners can coordinate their efforts. The GMAP outlines a three-part global strategy which are: 1) control malaria to reduce the current burden and sustain control as long as necessary, 2) eliminate malaria over time country by country and 3) research new tools and approaches to support global control and elimination efforts.

MATERIALS AND METHODS

A trend analysis and a time series analysis of malaria incidence which involved auto regressive integrated moving average (ARIMA) was done to analyse and forecast equally (monthly) spaced malaria cases to describe trends and forecast malaria cases for the next two years. Malaria data were abstracted from the monthly health directorate data from 2004-2013 for Ogun State. This health malaria surveillance database is maintained by the Ogun State Ministry of Health. The malaria data were received from all the primary, secondary and tertiary clinics and hospital from all the 20 local government of the state. This data consist of malaria cases and deaths for all people less than 5 years, 5-14 years and greater than 15 years and malaria cases and deaths for pregnant women. Cases were classified based on severity; (1) Uncomplicated case, which is the malaria attack, lasts 6-10 hours and is considered an outpatient case, (2) Severe cases, in which infections are complicated by serious organ failures or abnormalities in the patient's blood or metabolism and are inpatients. After receiving this data from the hospitals and clinics, the data entry manager calculated the cases by clinic and entered them into the malaria database using the Microsoft Excel software. Reports were generated by using this software. This report is computed and sent to the national malaria surveillance system in Abuja, Nigeria. The data collected from the malaria program database, malaria cases, deaths and severity of malaria cases was compiled monthly from 2004-2013. These data were entered into a Microsoft Excel spreadsheet for cleaning. During cleaning, some cases were found to be missing for year 2009 (July-December), while some did not have sufficient records for further analyses. For the missing values the cubic spline interpolation method was used to interpolate and assign the missing values.

The cubic spline interpolation is a common numerical curve fitting strategy that fits a "smooth curve" to the known data, using cross-validation between each pair of adjacent points to set the degree of smoothing and estimate the missing observation by the value of the spline. Also, due to inconsistencies in data reporting some variables were missing. For example 2007, 2008 and 2009 only reported malaria severity while in 2004; ages were only reported while the severity was missing.

In order to make the best use of the dataset and to be able to reach an accurate result as possible, variables with inconsistent records were removed from the final analysis. Overall, the final data includes the monthly malaria cases from 2004-2013 for all ages and pregnant women.

Statistical Analysis

The analysis for this study included descriptive, trend analysis and time series analysis (ARIMA).

ARIMA Model

The ARIMA model involves estimating a series of parameters to account for the dynamics of a time series. This includes the trends, and the autoregressive and moving average processes. The autoregressive and moving average parameters that included differencing in the formation of the model was introduced by Box and Jenkins (1976). This model includes three types of orders: There are (p) AR parameters, (I) Integration parameters and (q) MA parameters.

Visual observation of the series shows that the mean and variance of the series is not constant, therefore a logarithmic transformation was applied to the malaria series to assure the normality and homogeneity of the variance of the residuals. The best ARMA process was then selected for the trend of the malaria series using an Akaike Information Criterion (AIC) method of selection. This identifies the best order of a stationary and invertible ARMA process. Using an exponential function, the log transformed malaria series data is then transformed back to its original units of measurement. All the analyses were performed using SAS® Version 9.3 (SAS Institute Inc, Cary, NC).

RESULTS

There were 1,937,601 malaria cases from January 2004 to December 2013 in Ogun state, Nigeria. With an average of 16,147 cases per month, the cases ranged from 7,153 in January 2005 to maximum case of 30,459 in February, 2012. Some of the lowest cases were recorded in February 2004 (8,633 cases), April, 2004 (8,257cases) January, 2005 (7,153 cases), February, 2005 (8,191 cases) and April, 2005 (8,179 cases). The highest cases were recorded in February, 2012 (30,459 cases), June, 2012 (28,754 cases), July, 2012 (27,255 cases), August, 2012(26,388 cases) and November, 2012 (26,959 cases). This high rate of cases coincides with the rainy season in Ogun state which is between March/April to October/November.

The variation of total malaria cases and rate from January 2004 to December 2013 is shown in Figure 1 and 2. The malaria rate was calculated per 1000 people

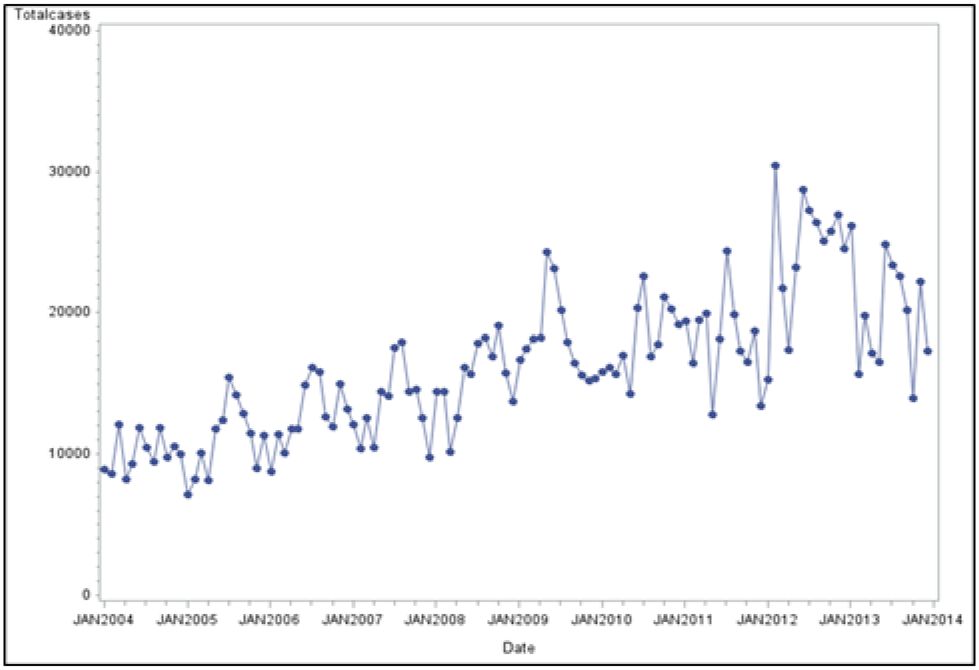

Figure 1. Monthly malaria cases between January 2004 and December 2013.

for each month from January 2004 to December 2013. The average malaria cases was 3.8 cases per 1000 people in Ogun state and ranges from a rate of 1.95 to 6.66 cases per 1000 population.

Trend Analysis

Trend of Malaria Cases and Rates

A trend analysis was performed on the total malaria cases and rates. This analysis was performed to determine if there was a significant change in trend in malaria cases and rates from January 2004 to December 2013 in Ogun State.

Malaria Cases

Based on the methodology described earlier, the best fitting model for the log-transform malaria cases and rates is the one with an AR (1) model (i.e autoregressive model of order 1). Figure 3 shows the trend and correlation analysis of log transformed malaria cases and Table 1 shows the autocorrelation check for white noise of log transformed malaria cases and since a visual assessment of the trend shows that it is not stationary and that there is an autocorrelation between one lag to another (white noise), a linear trend plus the AR (1) model was added to the series.

Linear Trend of Malaria Cases

Monthly Trend of Malaria Cases

Table 2 shows the autocorrelation check of residuals for trend +AR (1) Model for log transformed malaria cases, since the p-value is greater than 0.05. Therefore, the no-autocorrelation hypothesis was not rejected and AR (1) model was an adequate model for the series. Table 3 shows the maximum likelihood estimation for Trend +AR (1) Model for log-transform malaria cases.

Table 3 shows that the maximum likelihood estimation of a trend + AR (1) model was used to estimate the model. The table indicates that the number of malaria cases increases by a factor of 1.007344 (exponential of 0.0073175) since this is an estimate of the log-transform of malaria cases, the exponential of the malaria cases is calculated by converting the malaria cases to its original scale. The p value is <.0001 which is statistically significant. The trend analysis shows that there is an average increase in malaria cases by a factor of 1.007344 from one month to another which is significant at 0.05 this is about a 0.7% increase per month (This shows that the null hypothesis cannot be rejected, that there is no trend).

Yearly Trend of Malaria Cases

In order to calculate the yearly malaria cases the average monthly value is multiply by the exponential (0.0073175*12). On average, the number of malaria cases will increase in one year by a factor of exponential (12*0.0073175) = 1.091781. This is about a 9.1% increase per year, which seems fairly high and greatly exceeds the projected rate of a population growth of 3.18 percent per year for Ogun state (Ogun State Government, 2014). Therefore, the trend analysis shows that there is an average increase in malaria cases by a factor of 1.091781 from one year to the next which is statistically significant at 0.05. This shows that the null hypothesis cannot be rejected, that

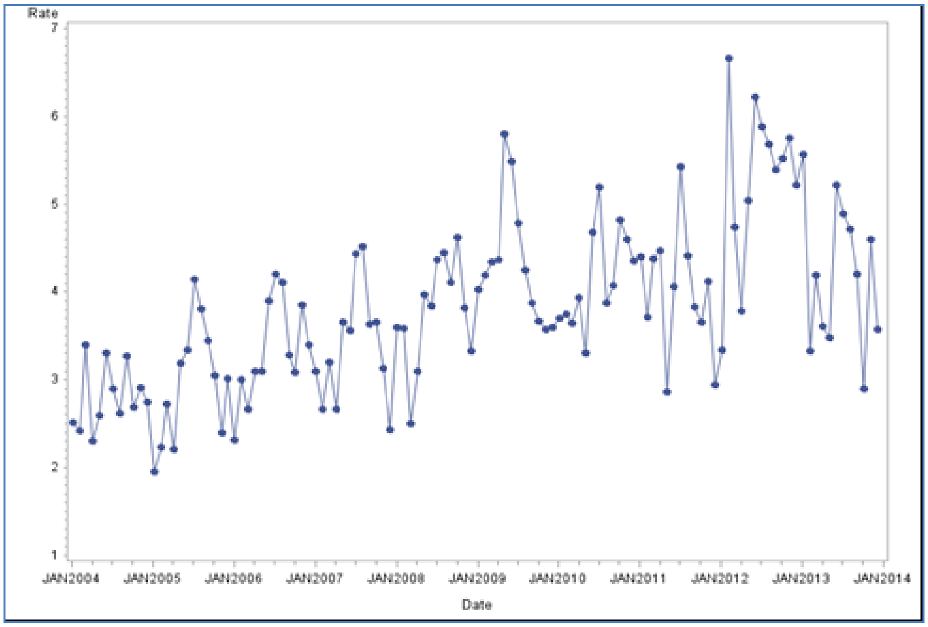

Figure 2. Monthly malaria rates per 1000 population from January 2004 to December 2013.

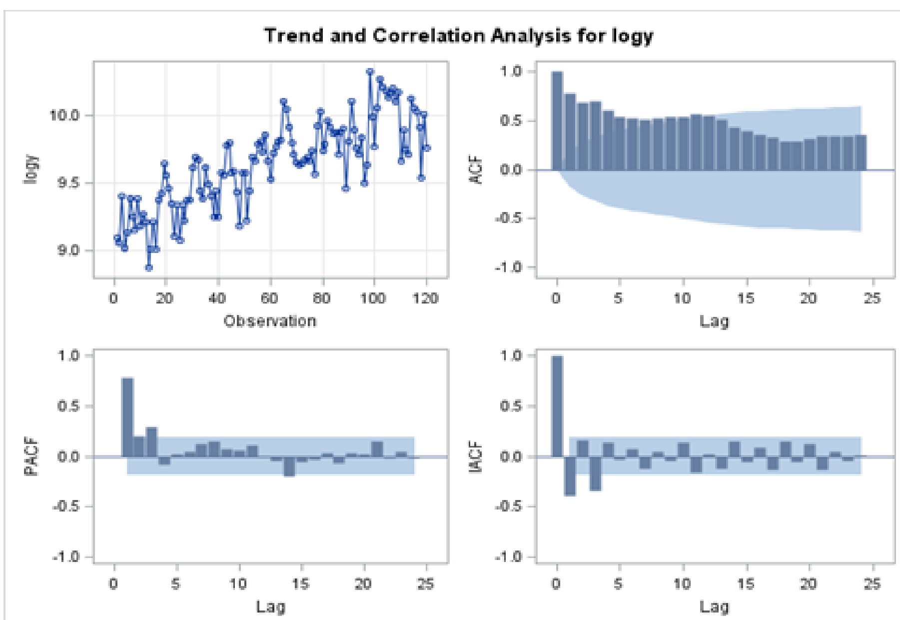

Figure 3. Trend and Correlation Analysis for log- transformed malaria cases including the sample autocorrelation function plot (ACF), the sample inverse autocorrelation function plot (IACF) and the sample partial autocorrelation function plot (PACF) which was used to inspectstationarity of the series.

there is no trend. Figure 4 shows the linear trend of malaria cases from January 2004 to December, 2013

Malaria Rates

Figure 5 shows the trend and correlation analysis of malaria rates and Table 4 shows the autocorrelation check for white noise of log transformed malaria rates and since a visual assessment of the series shows that it is not stationary and that there is an autocorrelation between one lag to another (white noise) at statistically significant values, a linear trend plus the AR (1) model was added to the series.

To Lag	Chi-Square	DF	Pr>ChiSq	Autocorrelations					
6	308.04	6	**<.0001**	0.777	0.682	0.689	0.598	0.536	0.522
12	538.36	12	**<.0001**	0.517	0.530	0.531	0.535	0.566	0.547
18	663.45	18	**<.0001**	0.505	0.433	0.386	0.351	0.322	0.282
24	759.37	24	**<.0001**	0.289	0.306	0.340	0.337	0.343	0.346

Table 1. Autocorrelation Check for White Noise of log Log-transform malaria cases shows that p value is <.0001 that is there is autocorrelation between lags.

To Lag	Chi-Square	DF	Pr>ChiSq	Autocorrelations					
6	7.62	5	0.1785	-0.008	-0.026	0.181	-0.054	-0.121	-0.097
12	10.07	11	0.5245	-0.076	-0.001	-0.042	-0.029	0.086	0.052
18	14.98	17	0.5972	0.068	-0.043	-0.074	-0.041	-0.044	-0.138
24	25.05	23	0.3475	-0.065	-0.036	0.073	0.013	0.138	0.191

Table 2. Autocorrelation Check of Residuals for Trend +AR (1) Model for log transform malaria cases.

Parameter	Estimate	Standard Error	t Value	Approx Pr> |t|	Lag	Variable	Shift
MU	9.19500	0.05271	174.46	<.0001	0	logy	0
AR1,1	0.39774	0.08589	4.63	<.0001	1	logy	0
NUM1	0.0073175	0.0007544	9.70	<.0001	0	time	0

Table 3. Maximum Likelihood Estimation for Trend +AR (1) Model for Log-transform.

Malaria cases shows the maximum likelihood used to estimate the model with a linear trend plus the AR (1) model. The mean term MU is estimated to be 9.19.; the autoregressive parameter is labelled AR1, 1; the coefficient of lag value of the log-transform of malaria is estimated to be 0.39774; while coefficient of time is estimated to be 0.0073175. The t-values for the autoregressive parameter and time are 4.63 and 9.70 respectively, which is significant at p <.0001. The t-value for MU indicates that the mean terms add more to the model. The time variable is the month number (starting with January 2004=1). Including time in the model as an input variable puts a linear trend term in the model.

Linear Trend of Malaria Rates

Monthly Trend of Malaria Rates

Table 5 shows the autocorrelation check for white noise to check to know if there is a series correlation between the series and the table shows that there is no serial correlation between the series. Therefore, the no-autocorrelation hypothesis was not rejected and Trend + AR (1) model was an adequate model for the series.

Table 6 shows the maximum likelihood estimates of the parameters in the Trend + AR (1) model. The table shows that the rate of malaria cases increases every month by 0.01749 cases per 1000 people or 1.749 malaria cases per 100,000 people in Ogun state (0.01749*100). The p value is <.0001 which is less than 0.05 and is significant. The trend analysis shows that there is an average increase in malaria cases by 1.749 malaria cases per 100,000 people in Ogun state from one month to another which is statistically significant at 0.05. This shows that the null hypothesis cannot be rejected, that there is no trend. Figure 6 shows the linear trend of monthly malaria rates between January 2004 and December 2013.

Yearly Trend of Malaria Rates

The trend was calculated for monthly malaria rates. To calculate the yearly increase in the malaria rate the monthly increase in rate is multiplied by 12 which is (12*1.749) = 20.988. The trend analysis shows that there is an average increase in malaria cases by 21.0 per 100,000 people in Ogun State from one year to another which is statistically significant at 0.05. This shows that

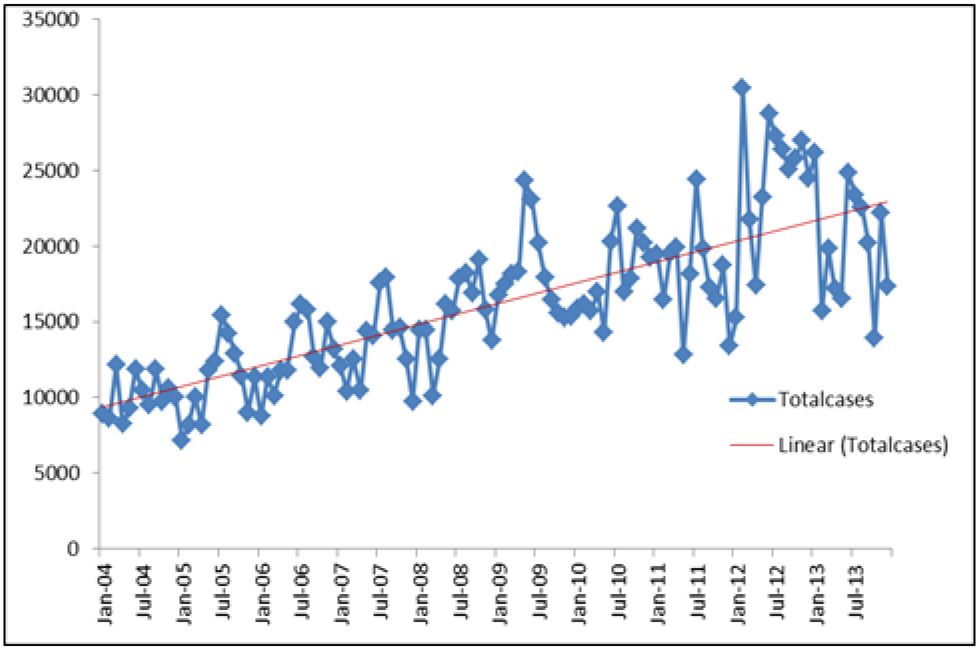

Figure 4. Linear trend of malaria cases.

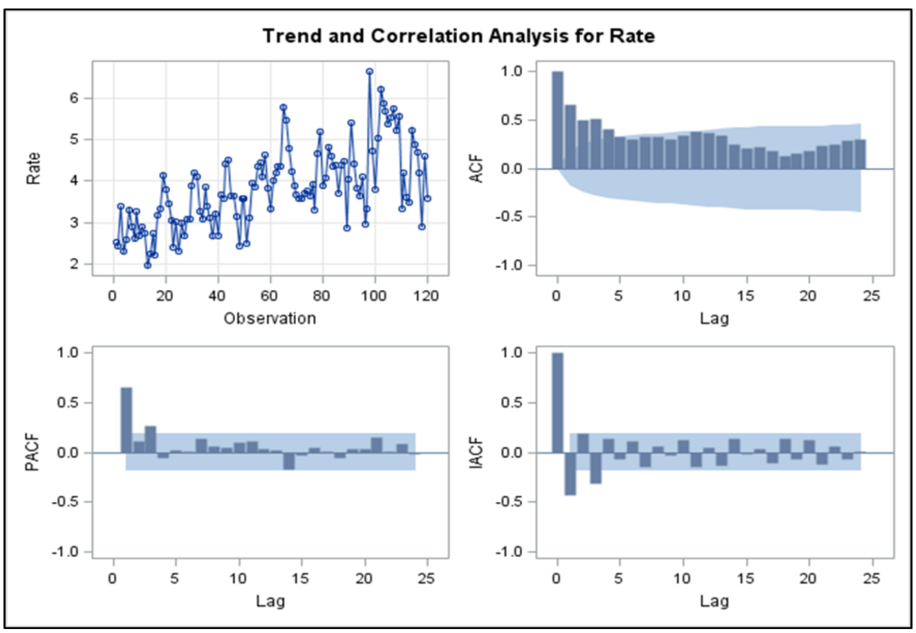

Figure 5. Trend and Correlation Analysis for malaria rate including the sample autocorrelation function plot (ACF), the sample inverse autocorrelation function plot (IACF) and the sample partial autocorrelation function plot (PACF) which was used to inspectstationarity of the series.

the null hypothesis cannot be rejected, that there is no trend.

Forecasting Model

The ARIMA model was used to forecast the malaria series series with the AR (1) model (i.e autoregressive model of order 1) used for the trend analysis. Figure 7 and Table 7 show the ARIMA model for the forecasted malaria cases from January 2014 to December 2015 with the low and upper confidence interval at 95%. The identification and estimated stage with ARMA error used for the log trans-

To Lag	Chi-Square	DF	Pr>ChiSq	Autocorrelations					
6	162.88	6	**<.0001**	0.653	0.493	0.514	0.411	0.332	0.303
12	254.55	12	**<.0001**	0.325	0.322	0.301	0.338	0.382	0.361
18	297.89	18	**<.0001**	0.341	0.249	0.200	0.215	0.177	0.127
24	348.61	24	**<.0001**	0.157	0.185	0.233	0.242	0.285	0.294

Table 4. Autocorrelation Check for White Noise of Malaria rate shows that p value is <.0001 that is there is autocorrelation between lags.

Table 5. Autocorrelation Check of Residuals for AR (1) Model for malaria rates.

To Lag	Chi-Square	DF	Pr>ChiSq	Autocorrelations					
6	6.91	5	0.2272	0.011	-0.075	0.169	-0.018	-0.086	-0.112
12	9.11	11	0.6121	-0.017	-0.012	-0.112	-0.026	0.053	-0.013
18	15.93	17	0.5286	0.061	-0.083	-0.127	0.012	-0.044	-0.140
24	24.02	23	0.4025	-0.044	-0.030	0.055	-0.007	0.130	0.175

Maximum Likelihood Estimation for malaria rates with a Trend + AR (1, 1) Model

Parameter	Estimate	Standard Error	t Value	Approx Pr> |t|	Lag	Variable	Shift
MU	2.75510	0.20711	13.30	**<.0001**	0	Rate	0
AR1,1	0.41273	0.08543	4.83	**<.0001**	1	Rate	0
NUM1	0.01749	0.0029641	5.90	**<.0001**	0	time	0

Table 6. Maximum Likelihood Estimation for Trend +AR (1) Model for Log-transform Malaria cases shows the maximum likelihood used to estimate the model with a linear trend plus the AR (1) model. The mean term MU; is estimated to be 2.75510. The autoregressive parameter is labelled AR1, 1; the coefficient of lag value of the log-transform of malaria is estimated to be 0.41273; while coefficient of time is estimated to be 0.01749. The t-values for the autoregressive parameter and time are 4.83and 5.90 respectively, which is significant at p <.0001. The t-value for MU indicates that the mean terms add more to the model. The time variable is the month number (starting with January 2004=1). Including time in the model as an input variable puts a linear trend term in the model.

formed malaria cases were forecasted. Forecasts were obtained by exponentiating the forecasts of the logs of the malaria cases obtained by using the Trend + AR (1) model. The y axis shows the number of cases and the x axis shows the forecasted period for two years.

Table 8 shows the comparison of malaria cases forecast for 2015 by the ARIMA model to the actual malaria cases in 2005. The table shows that in 2005, the number of malaria cases was 125,229 compared to the ARIMA model forecasted number of cases of 331,683 afterwards for 2015. The rates per 1000 population is 33.4 per 1000 people in Ogun state while the forecasted rate will be 66.5 per 1000 people for the ARIMA model in Ogun State. The predicted increase based on the ARIMA model was 164 percent.

DISCUSSION, RECOMMENDATIONS, CONCLUSIONS

Achieving the goals set by the 189 United Nations members state has become necessary since the establishment of the millennium development goals by the United Nations in 2000. Although, studies have evaluated the progress and prospect of each of the different eight goals and its related targets for different countries. Based on our extensive search of the literature, to date, the effect of the malaria incidence on achieving the millennium development goals by 2015 has not been thoroughly evaluated. While few studies were done in Africa and other parts of the world, none has actually looked at the impact of malaria incidence in achieving the millennium development goals set by 2015 in Ogun State. In order to assess the impact of malaria incidence on the possibility of achieving the millennium development goals, this study investigated the monthly and yearly trend of malaria, and the possibility of meeting the goals by 2015 by forecasting the incidence of malaria cases in Ogun State.

In this study we investigated the change in the monthly and yearly trends of malaria incidence in Ogun State from 2004 to 2013 to determine if there is any increase or decrease in malaria cases. A trend analysis was applied

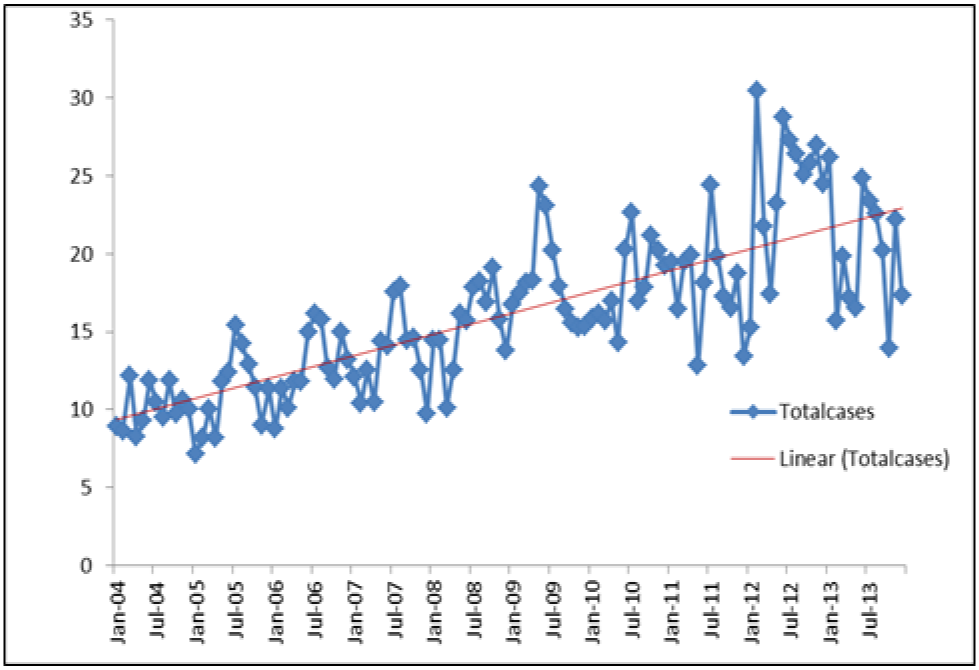

Figure 6. linear trend of monthly malaria rates between January 2004 and December 2013.

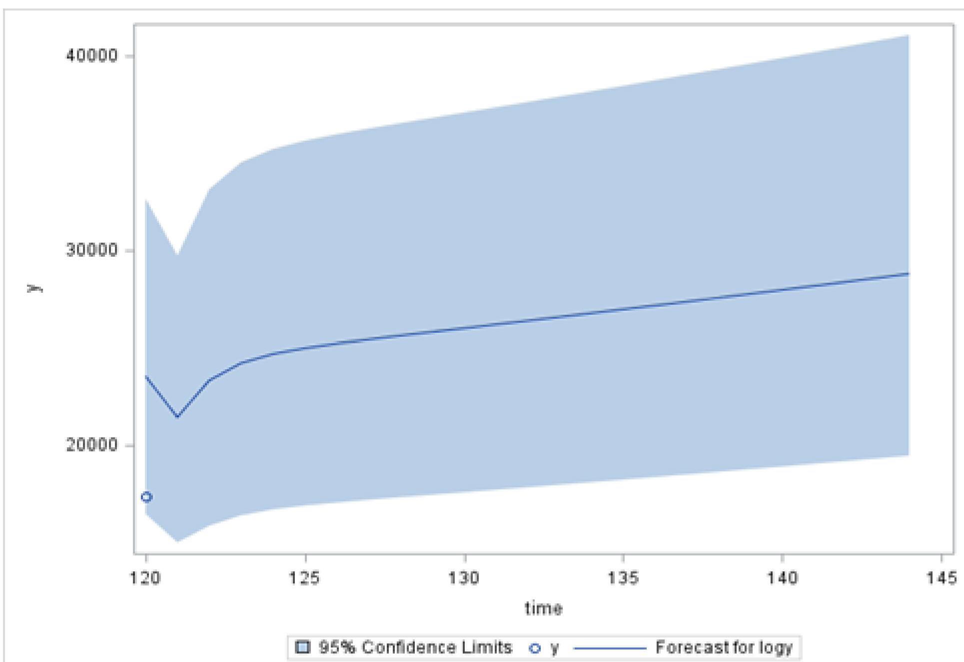

Figure 7. ARIMA model showing the forecasted malaria cases from January 2014- December 2015 with the confidence intervals.

to both the monthly malaria cases and rates with both fitted to their appropriate ARIMA model. The monthly malaria cases showed an increase in cases by 0.7 percent and a yearly increase by 9.0 percent and a monthly rate of 1.749 cases per 100,000 people to a yearly rate of 20.98 cases per 100,000 population. This shows a monthly and yearly increase of malaria cases between 2004 and 2013 which is oppose to the hypothesis

Month	Forecast	L95	U95
Jan2014	21406.01	14952.4	29718.4
Feb2014	23296.49	15814.1	33120.1
Mar2014	24186.38	16346.8	34508.8
Apr2014	24655.86	16652.7	35198.5
May2014	24954.49	16852.6	35628.0
June2014	25184.96	17007.9	35957.5
July2014	25388.85	17145.6	36248.7
Aug2014	25582.90	17276.6	36525.8
Sep2014	25773.83	17405.5	36798.4
Oct2014	25964.34	17534.2	37070.4
Nov2014	26155.52	17663.3	37343.3
Dec2014	26347.81	17793.2	37617.9
Jan2015	26541.39	17923.9	37894.3
Feb2015	26736.35	18055.5	38172.6
Mar2015	26932.72	18188.2	38453.0
Apr2015	27130.53	18321.7	38735.4
May2015	27329.79	18456.3	39019.9
June2015	27530.51	18591.9	39306.5
July20105	27732.70	18728.4	39595.2
Aug2015	27936.38	18866.0	39886.0
Sep2015	28141.55	19004.5	40178.9
Oct2015	28348.23	19144.1	40474.0
Nov2015	28556.43	19284.7	40771.2
Dec2015	28766.16	19426.3	41070.7

Table 7. ARIMA model for forecasted malaria cases from January 2014- December 2015.

that monthly and yearly malaria cases will decrease with time. This increase may be due to improve reporting system over time, non-usage of mosquito nets by owners and low socioeconomic status of the population. We also investigated the possibility of meeting the millennium development goal for Ogun State in 2015 by forecasting malaria cases for 2014 and 2015 which shows that by 2015, the total number of predicted number of malaria cases will be 331,683 and increase in malaria cases by 164 percent compare to 2005. This is contrary to expected millennium development goal set for malaria by the Roll Back Malaria Initiative of reduction of malaria morbidity by 75 percent in 2015. This result shows that Ogun State in Nigeria will likely not meet the millennium development goal set for malaria by the Roll Back Malaria (RBM) Abuja Targets global strategic plan 2005-2015. This is oppose to the hypothesis that Ogun State will meet the millennium development goal for malaria by 2015 which may be due to multifaceted community supply system, price of malaria medication and mosquito nets ownership and usage.

Public Health Importance of the study

The results from this study will help in understanding the overall pattern of malaria cases in Ogun State over time. This is to know if malaria cases have increased or decreased overtime, and if it has, how quickly or slowly and what appropriate public health surveillance program should be put in place. It can be used to compare malaria cases from one time period to another time period. This can be useful to evaluate the public health preventive program for malaria in Ogun state. It allows for comparing malaria cases in Ogun State to other states in Nigeria

Month	ACTUAL 2005	ARIMA 2015
January	6579	26541.39
February	7537	26736.35
March	9526	26932.72
April	7814	27130.53
May	11174	27329.79
June	11801	27530.51
July	14811	27732.7
August	13550	27936.38
September	12154	28141.55
October	10944	28348.23
November	8533	28556.43
December	10806	28766.16
Total Malaria Cases	**125229**	**331682.7**
Total Population	3749202	4984232
Rate per 1000 population	**33.40151**	**66.54641**
% Increase Total Malaria Case		**164.9%**
% Increase Total Rate per 1000 population		**99.2%**

Table 8. Summary of Actual and Forecasted Malaria Cases for 2005 and 2015 comparison of malaria cases forecast for 2015 by the ARIMA model to the actual malaria cases in 2005.

over a long period of time. This will provide a more precise comparison of the two areas. It also allows for comparing malaria cases among one population to another in Ogun State. Knowing this will provide sufficient information about the changing rates and changing disparity in rates. It aids in making future projection of malaria cases in Ogun State, which is a means of monitoring progress towards a malaria prevention objective and goals. It could also help policy makers to reevaluate their policy and make necessary planning if needed. Lastly, it will help to save more lives which is the ultimate goal of every public health practitioners by early detection of malaria outbreak.

RECOMMENDATIONS FOR MEETING THE MILLENNIUM DEVELOPMENT GOALS

Our recommendations are to develop ways of tackling the challenges associated with malaria preventive program in Nigeria. These challenges and possible recommendations are:

Challenges: The multifaceted community supply system, which is built around the needs for specific project and diseases at the federal levels, remains a huge challenge. These include lack of reliable consumption data from all levels in the reporting system, variable supply chains between and within states and weak logistics management systems.

Recommendation: Malaria prevention program can work at the state level to develop innovative approaches that will expand coverage at the local government areas. State malaria program can collaborate with different funding organization at the local level to enable for better coordination and pooled distribution of malaria commodities at the state level.

Challenges: Managing malaria cases is a huge challenge, since most Nigerians including children under five first seek care for fevers from the private sectors (MIS, 2010). These private medical vendors, although, have some informal training to recognize uncomplicated malaria, but many are not aware of the national malaria guidelines for malaria treatment and they are not empowered to diagnose malaria.

Recommendation: Malaria prevention program can incorporate educational programs that provide sufficient and adequate education to all private medical vendors on national guidelines for malaria treatment. Also, greater empowering of the private medical vendors with the required tools to diagnose the disease.

Challenges: The price of malaria medication (Artemisinin-based combination therapy) is higher than many patients can afford, this may lead to many patients not receiving optimal treatment.

Recommendation: Universal coverage for all population most especially the population at risk by providing malaria medication for free for population at risk and subsidizing malaria medication to not at risk population. Also, coverage can include locally appropriate malaria control interventions and supported by strengthened health systems.

Challenges: Mosquito nets ownership and usage is also a big challenge even with the over 60 million LLIN nets distributed since 2009, while mosquito nets ownership has shown a slow progress from 8% in 2008 to 42% in 2010 and 55.3% in 2013 80% which is far below the 80% target for 2013. Mosquito nets usage for population at risk has declined from 30% in 2010 to 18.3% in 2013 for children under five years and 34.5% in 2010 to 17.9% in 2013 for pregnant women (DHS, 2013).

Recommendation: Some of the contributing factors associated with non-usage of mosquito nets by owners are discomfort due to heat, perceived low mosquito density, social factors, such as sleeping elsewhere, or not sleeping at all, technical factors such as unable to hang or finding it inconvenient to hang and temporary unavailability of mosquito nets due to someone else using it (Pulford et al., 2011). Malaria prevention program in Nigeria can increase mosquito net usage among the population through education and behavior change communication strategies which focus on improving mosquito net availability, encouraging mosquito nets hanging and encouraging the use of existing mosquito nets by targeted population. This will not change the physical properties of the mosquito nets (Vanden, et al, 2010).Also, social factors can be addressed by promoting the use of mosquito repellants by people not in bed during the night time (Rowland, et al, 2004).

Lastly, insecurity and civil unrest in some parts of the country can be a major issue. This could threaten the government and various donor funded programs. Travel restrictions could limit the movement of staff to certain parts of the country.

Dichlorodiphenyltrichloroethane (DDT) vs. Mosquito nets

For mosquito nets to have an effective significant impact in malaria, the vector levels must be brought down significantly. Since mosquito nets protect one or two people under the net and not the entire household enforcing the use of the nets can be a major issue. This was acknowledged according to the former director of Nigerian Institute of Medical Research stating that "distributing the net is one thing, getting people to use it is another thing as there is evidence that most recipients of the net do not use it on the grounds that it causes heat". While treated bed-nets cannot easily replace DDT spraying without substantial increase in incidence of malaria, it could permit a substantial reduction in the amount of DDT spraying" (Onuoha, 2010). Although, current malaria control program in Nigeria do not include the use of DDT, evidence based studies have shown its efficacy and effectiveness in malaria control program in other Africa countries which includes South Africa, Zimbabwe and Swaziland (Lubrick, 2007). The recent adoption of the use of DDT by the Nigeria government in 2013 (Premium times, 2013) attracted many controversies from experts who argue its association with human diseases such as breast cancer which could be a major public health concern owing to a wide acceptance and use of DDT in the country. Although, this arguments have also been made by different experts around the world, but WHO report on the use of DDT in malaria vector control in 2011 have reinstated that there is no epidemiological data to support these findings in humans. WHO recommends the use of DDT only for indoor residual spraying and can be used by countries as long as necessary in the quantity needed provided WHO and Stockholm Convention guidelines and recommendations are met (WHO, 2011). Also, since there is no known alternative for DDT that guarantee equivalent efficacy and operational feasibility in high-transmission areas like Nigeria; DDT is still needed and should be used.

Future Research

This study was restricted to only the general population without differentiating between the age groups in the population. Therefore, future analysis is necessary to examine malaria cases in different age groups, most especially the vulnerable populations (children less than five and pregnant women) to see if the millennium development goal for malaria can be met in this population.

CONCLUSION

This study demonstrates a monthly and yearly increase in malaria incidence in Ogun State. Nigeria and the Millennium Development Goal set for malaria by the Roll Back Malaria (RBM) Abuja Targets global strategic plan 2005-2015 will likely not be achieved in Ogun State.

ACKNOWLEDGEMENTS

We acknowledge the support of Ms. Adeyinka, the malaria program coordinator for Ogun State, Mr. Adeyemi, the Data Analyst for the malaria program in Ogun State and Mr. Joseph Alozie, General Manager Climate Services, Nigerian Metrological Agency (NiMet) for their tireless effort in making sure this research is a monumental success. Special thanks Dr. Huffer, Dr. Onubogu, Dr. Beker, Dr. Rahman, and Dr. Rahman for been generous with their time and to the Florida A&M University Institute of Public Health for given us the opportunity to conduct this research.

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