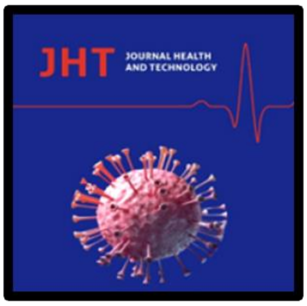

v.2, n.2, 2023

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

STATISTICAL ANALYSIS ON IMPACT OF MEASLES AMONG CHILDREN IN OBUDU LOCAL GOVERNMENT AREA OF CROSS RIVER STATE

ANÁLISE ESTATÍSTICA DO IMPACTO DO SARAMPO EM CRIANÇAS NA ÁREA DE GOVERNO LOCAL DE OBUDU DO ESTADO DE CROSS RIVER

ANÁLISIS ESTADÍSTICO SOBRE EL IMPACTO DEL SARAMPIÓN ENTRE LOS NIÑOS EN EL ÁREA DEL GOBIERNO LOCAL DE OBUDU DEL ESTADO DE CROSS RIVER

Charity Ebelechukwu Okorie[1], Collins Chibuzo Ilomuanya[1], Olateju Alao Bamigbala[1]

e2236
https://doi.org/10.47820/jht.v2i2.36

RECEIVED: 03/20/2023 APPROVED: 04/20/2023 PUBLISHED: 05/04/2023

ABSTRACT
*Measles is an infectious illness caused by the rubeola virus. It spreads either through direct contact with a person who has the virus or through droplets in the air. The study sought to determine the linear trends of reported cases of measles, if there is seasonal effect of measles, to also determine the gender that suffer most on the reported cases of measles occurrence in Obudu Local Government Area of Cross River state and forecast future occurrence of the disease. Data used for the study was entirely secondary which was gathered from recorded quarterly data of measles cases obtained from General Hospital Obudu clinical record unit from the year 2000 to 2020. Descriptive Statistics where calculated for each variable which shows the values of minimum, maximum, mean and standard deviation of each of the variable. The trend analysis for immunized case of measles shows a positive trend which implies increase in immunization. The trend equation for the disease is given by Yt = 367.1-2.89094*t. and trend analysis for reported cases of measles shows a negative trend which implies that cases of measles is decreasing. The trend equation of the disease is given by Yt=93.16-1.24131*t. the trend for the gender that suffer most shows that female suffer most in the reported cases of the disease. The stationarity of the series was tested using time series plots followed by the Augmented Dickey Fuller (ADF) test which show the stationarity of the data. Auto regressive integrated moving average (ARIMA) (1, 0, 1) and (2, 1, 0) was used for forecasting for the future occurrence of the disease for the years 2021 to 2025 in Obudu Local Government Area. For the general pattern, of the forecast for reported cases shows 2021 recorded the highest number of cases whereas 2025 could be recorded the lowest cases.*

KEYWORDS: Measles. Immunization and vaccination. Moving Average (Ma). Stationary.

RESUMEN
El sarampión es una enfermedad infecciosa causada por el virus de la rubéola. Se propaga a través del contacto directo con una persona que tiene el virus o a través de gotitas en el aire. El estudio buscó determinar las tendencias lineales de los casos reportados de sarampión, si hay un efecto estacional del sarampión, para determinar también el género que más sufre en los casos reportados de sarampión en el área del gobierno local de Obudu del estado de Cross River y pronosticar la aparición futura de la enfermedad. Los datos utilizados para el estudio fueron totalmente secundarios, que se obtuvieron de los datos trimestrales registrados de casos de sarampión obtenidos de la unidad de registro clínico del Hospital General de Obudu desde el año 2000 hasta 2020. Se calculan estadísticas descriptivas para cada variable que muestra los valores de mínimo, máximo, media y desviación estándar de cada una de las variables. El análisis de tendencias para el caso inmunizado de sarampión muestra una tendencia positiva que implica un aumento de la inmunización. La ecuación de tendencia para la enfermedad está dada por Yt = 367.1-2.89094 * t. y el análisis de tendencias para los casos reportados de sarampión muestra una tendencia negativa que implica que los casos de sarampión están disminuyendo. La ecuación de tendencia de la enfermedad viene dada por Yt=93,16-1,24131*t. La tendencia para el género que más sufre muestra que las mujeres sufren más en los casos reportados

[1] Department of mathematics and Statistics Federal University, Wukari.

de la enfermedad. La estacionariedad de la serie se probó utilizando gráficos de series temporales seguidos de la prueba Augmented Dickey Fuller (ADF) que muestra la estacionariedad de los datos. La media móvil integrada autorregresiva (ARIMA) (1, 0, 1) y (2, 1, 0) se utilizó para pronosticar la aparición futura de la enfermedad para los años 2021 a 2025 en el área del gobierno local de Obudu. Para el patrón general, el pronóstico para los casos notificados muestra que 2021 registró el mayor número de casos, mientras que 2025 podría registrar los casos más bajos.

PALABRAS CLAVE: Sarampión. Inmunización y vacunación. Media móvil (Ma). Estacionario.

RESUMO

O sarampo é uma doença infecciosa causada pelo vírus da rubéola. Ela se espalha pelo contato direto com uma pessoa que tem o vírus ou por meio de gotículas no ar. O estudo buscou determinar as tendências lineares dos casos notificados de sarampo, se há efeito sazonal do sarampo, para também determinar o gênero que mais sofre com os casos notificados de ocorrência de sarampo na Área de Governo Local de Obudu do estado de Cross River e prever a ocorrência futura da doença. Os dados utilizados para o estudo foram inteiramente secundários, coletados a partir de dados trimestrais registrados de casos de sarampo obtidos na unidade de registro clínico do Hospital Geral Obudu do ano de 2000 a 2020. A Estatística Descritiva foi calculada para cada variável que apresenta os valores de mínimo, máximo, média e desvio padrão de cada uma das variáveis. A análise de tendência para o caso imunizado de sarampo mostra uma tendência positiva que implica aumento na imunização. A equação de tendência para a doença é dada por Yt = 367,1-2,89094*t. e a análise de tendência para os casos notificados de sarampo mostra uma tendência negativa que implica que os casos de sarampo estão diminuindo. A equação de tendência da doença é dada por Yt=93,16-1,24131*t. A tendência para o sexo que mais sofre mostra que as mulheres sofrem mais nos casos notificados da doença. A estacionariedade das séries foi testada por meio de gráficos de séries temporais seguidos pelo teste de Dickey Fuller Aumentado (ADF), que mostram a estacionariedade dos dados. A média móvel integrada autorregressiva (ARIMA) (1, 0, 1) e (2, 1, 0) foi utilizada para a previsão da ocorrência futura da doença para os anos de 2021 a 2025 na Área de Governo Local de Obudu. Para o padrão geral, a previsão de casos notificados mostra que 2021 registrou o maior número de casos, enquanto 2025 poderá registrar os menores casos.

DESCRITORES: Sarampo. Imunização e vacinação. Média móvel (Ma). Estacionário.

INTRODUCTION

In view of the ease with which measles spreads it is regarded as one of the most dangerous of all the childhood diseases. Measles spreads from person to person as a result of respiratory contact and via or nasal secretions. Initial symptoms, which usually appear 10 to 12 days after the initial infection, include high fever, runny nose, bloodshot eyes and tiny white spots on the inside of the mouth. As already indicated measles is highly contagious and may lead to serious complications and even death. These complications may include encephalitis, diarrhea, impaired vision and pneumonia Weber[8]. Measles is the leading cause of death in children in Africa, ahead of AIDS, tuberculosis and measles. It is for this reason that measles vaccination, also known as immunization, is implemented in order to reduce child mortality. Most people who are ignorant of the disease regard measles as a mild illness, often not worse than flu. Parents may welcome it as something inevitable, while for many children it means nothing more than an enforced holiday. It is a disease of which most of us have personal experience and therefore, is of interest. Many of us possibly retain vivid memories of the attack, and the way in which it was treated.

Measles is a highly contagious viral disease caused by Morbillivirus; a member of the Paramyxovirus family, which is transmitted to a susceptible individual through aerosol or by direct contact (WHO[9]). The virus infects the mucous membranes of an exposed individual and then spreads to other parts of the body. Measles is known to infect only humans with no known animal reservoir (WHO[9], Akande[1)].

The mortality rate for measles infection in children is usually 0.2% but may be up to 10% in malnourished children WHO[9] CDC[2]. In cases with complications, the mortality rate may rise to 20-30% CDC[2.]

Measles can be serious. Children younger than 5 years of age and adults older than 20 years of age are more likely to suffer from complications. Common complications are ear infections and diarrhea. Serious complications include pneumonia and encephalitis (CDC[2].)

In the Course of this Write-up, literature search related to the topic was conducted through various electronic databases such as PubMed, Medline, EBSCO, Africa Journal Online, CINAHL for scientific journals for nursing and allied subjects, Health Source on Nursing/Academic Edition for literature and journals with a focus on medical disciplines. The authors searched for peer- reviewed scholarly scientific articles using Google search engine. In addition, publications that relate to this study were accessed from the websites of some international organizations such as the WHO, UNICEF, USAID, UNFPA, UNDP', MDG, and GAVI. Furthermore, lists of references from original research publications and reports were also reviewed.

The list of search terms used in the literature search includes measles, case-based surveillance, outbreaks, vaccination, and case fatality rates. Additional sources of articles obtained and reviewed for this study were electronically from professional journals. There are various studies on the trend of measles, causes of outbreaks, reasons for high vaccination dropout rates by mothers, and lack of awareness on the benefits of vaccination as a whole. In an attempt to understand the trend of measles in Nigeria, this retrospective review examined peer-reviewed articles on measles in Nigeria and other studies conducted in some countries across the globe.

Paul, James, Lakshmi, Walt, Manisha[6], In their study of Measles in the 21st Century: Progress Toward Achieving and Sustaining Elimination observe that The global measles vaccination program has been extraordinarily successful in reducing measles-related disease and deaths worldwide.

Pike, Leidner, Gastanaduy[7], stated that A review of cost estimates of 11 measles outbreaks during the postelimination era in the United States, found that measles costs public health and healthcare institutions a median of approximately $33 000 (US dollars) per case, and $4000 per day of investigation.

Jean Baptiste et al.[10], in their research work on Measles outbreak in complex emergency: estimating vaccine effectiveness and evaluation of the vaccination campaign in Borno State, Nigeria, 2019. Observed that from January to May 2019, large measles outbreaks affected Nigeria. Borno state was the most affected, recording 15,237 suspected cases with the state capital of Maiduguri having 1125 cases investigated and line-listed by March 2019. In Borno state, 22 of the 27 Local Government Areas (LGAs or Districts), including 37 internally displaced persons (IDPs) camps were affected.

Orenstein, Hinman, Nkowane, Olivo, Reingold[5] stated that a Midterm review of the Measles and Rubella Strategic Plan concluded that measles could be eradicated and offered a number of recommendations to try to support eradication.

WHO[9] stated that the surveillance performance is monitored regularly using performance monitoring indicators (i.e. proportion of LGAs with at least 1 suspected measles case reported with a blood specimen in a year, proportion of reported suspected cases from whom blood specimen is collected, non-measles febrile rash illness rate, and incidence of confirmed measles per million population). The measles surveillance system is sufficiently sensitive to identify and confirm measles cases. With one exception (i.e. incidence of confirmed measles per million population), the annual targets for the core measles surveillance performance indicators have been met since 2017.

Ocha[4] stated that last weeks of December 2018 witnessed increased attacks on civilian populations by armed groups and resulted in a massive population dis- placement from security-compromised areas, including inaccessible settlements (communities), into the metro-politan LGAs of the state. By January 2019, more than 700,000 people were living in overcrowded camp-like settings, significantly increasing the risk of epidemics and infectious diseases. As a result, approximately 20% of the population of Borno State are living in IDPs camps in hosted communities.

Patel, Lee, Clemmons, et al[6] stated that The 1282 measles cases reported in the United States in 2019 was the highest annual number of reported cases since 1992.

AIM OF THE STUDY

The aim of this study is to evaluate weather reported case of measles is increasing in the presence of immunization campaign.

METHOD OF DATA COLLECTION

The sources used in collection data in any study or investigation, depends on the type of data needed and the purpose of the investigation. Base on this study we intend using only secondary method of data collection in obtaining data for the study. It relied heavily on time series data from the medical unit of federal medical center Obudu town, Cross River State Nigeria. The data collected are on quarterly basis from 2000-2020.

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

TIME SERIES ANALYSIS

Time series analysis is a very useful aspect in statistics that is helpful and applicable in all field of human endeavor. Its primary purpose is discovering and measuring the various influences for the observed values and data obtained. These are useful in understanding the past behavioral patterns, evaluating current accomplishment, planning future operation and comparing different time series. The study of the past behavior of any observed data enables us to predict future tendencies, to (i.e measles) is therefore of great assistance. For it is with the help and analysis of this data that approximately correct time to carryout immunization in the future will be known. In addition, the knowledge of the behavior of the variable enables statistician to iron out inter-year variation, thus, seasonal fluctuation may be reduced by taking effective decisions or plans before time.

AUTOREGRESSIVE (AR) MODELS

An autoregressive (AR) models specifies that the variable Y_t is a linear combination of (ρ) previous values $Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}$ and a certain random term (shock). It is known as the ρ^{th} order.

Autoregressive model, defined the

$$Yt = C + \sum_{i=1}^{p} \varphi_t Y_t + \varepsilon_t \qquad (1)$$

Where the parameters of the equation (1) are $\varphi_i, \ldots, \varphi_p$ is a constant and ε_t is the white noise (error term). The AR parameter $\varphi_i, \ldots, \varphi_p$ must lie within the stationary bounds $-1 < \varphi_i < 1$ to be wide sense stationary.

MOVING AVERAGE (MA) MODEL

The moving average model which was originally invested by Yule (1927) specifies a univariate time series modeling approach which the output depends linearly on the present and past white noise error terms or random shocks of the series. The phrase moving average (MA) is not the normal moving smoothing methods which consist of arithmetic mean of past historical data, rather the moving average of the error series. The errors at each point in the series are assumed to be independent and identically distributed with zero mean and constant variance. The moving average of order (q) is defined by:

$$Y = \mu + \varepsilon_t + \sum_{i=1}^{q} \Theta_1 \varepsilon_{t-1} \qquad (2)$$

Where (μ) is the mean of the series often assumed to be zero, the parameters of the model are $\theta_1,.....\theta_q$ while $\varepsilon_1,...,\varepsilon_q$ are the white noise error term. The MA (q) must be within the invertible bound -1< θ_t <1

AUTOREGRESSIVE MOVING AVERAGE (ARMA) MODEL

The approach popularized by Box-Jenkins, which combines the autoregressive and the moving average approaches together (Box-Jenkins, 1971; and Reinsel (1994), the model formed as a result of the combination is known as the autoregressive moving average (ARMA) model, given that the series assumed to be stationary. The autoregressive moving average of order ((p, q) is a mixed stochastic process which combines the autoregressive (AR) and the moving average models together is expressed as:

$$Y= c + \varepsilon_t \sum_{i=1}^{p} \quad +\sum_{i=1}^{q} \Theta_1\varepsilon_{t-1} \tag{3}$$

Where all the element of ARMA (p, q) are as defined in the autoregressive model of order (p) and the moving average model of order (q). The order of ARMA (p, q) model is facilitated by simple Autocorrelation function (ACF) and partial autocorrelation function (PACF) plots of the time series. The parameter estimates of the autoregressive moving average model which minimizes the error term are derived using the maximum likelihood estimation. The autoregressive moving average model can be generalized in other ways, such as the integrated ARMA model, if the series show evidence of non-stationary and seasonal effects requires differencing.

STATIONARY AND NON-STATIONARY TIME SERIES

A stationary time series has a zero mean, a constant variance and a constant autocorrelation structure over time with no specific fluctuations (seasonality). Whereas non-stationality in a series may follow from the presence of the one of these conditions: outliers, random walk, drift, deterministic trend, or non-constant variance. Most economic and business observed time series are not stationary. There are several kinds of stationary stochastic process whose Joint Probability Distribution does not change when shifted in time. A series is believed to be strictly stationary if in addition to a fixed mean and constant variance, it also has a constant auto covariance structure. While a weak stationary series, also called a second-order stationary has its mean and variances remains constant over time while the auto covariance depends on the series lags. A time series data can be non-stationary with respect to the mean or the variance, such series can often be transformed to stationarity by differencing the original series either once (linear trend), fitting a straight line through the series or stabilizing the series variance using either the log or Square - Root transformation techniques.

UNIT ROOT AND STATIONARY

The unit root test is used to determine if a series is non-stationary and require differencing.

AUGMENTED DICKEY-FULLER (ADF) UNIT ROOT TESTS

The dickey-fuller test investigates the presence of unit root in a time series using a regression expression that nets the mean, the lagged and deterministic time trend term.

$$Y_t - \rho Y_{t-1} + \varepsilon_t$$

Where the variable of the interest is Y_t and (t),(ρ),(ε_t), represent the time index, the parameter coefficient and the residual error (term) respectively. The hypothesis of the ADF testis gives below as:

$$H_0 : \rho = 0$$

$$H_1 : \rho < 0$$

The unit root test is carried out under the null hypothesis $\rho = 0$ I.e the original, series is non-stationary against alternative ($\rho < 0$) I.e the original series is stationary. The statistic is computed by $DF_t = \frac{\hat{\rho}}{se\left(\hat{\rho}\right)}$ and compared to the relevant critical value from the Dickey- Fuller table. If the test fails to reject the null hypothesis, differencing is applied until the ACF shows an interpretable pattern with only a few significant autocorrelations.

ARIMA MODEL

The ARIMA procedure analyzes and forecasts equally spaced univariate time series data, transfer function data, and intervention data using the Auto Regressive Integrated Moving-Average (ARIMA) or autoregressive moving-average (ARMA) model. An ARIMA model predicts a value in a response time series as a linear combination of its own past values, past errors (also called shocks or innovations), and current and past values of other time series.

The ARIMA approach was first popularized by Box and Jenkins, and ARIMA models are often referred to as Box-Jenkins models. The general transfer function model employed by the ARIMA procedure was discussed by Box and Tiao (1975). When an ARIMA model includes other time series as input variables, the model is sometimes referred to as an ARIMAX model. Pankratz (1991) refers to the ARIMAX model as dynamic regression.

ARIMA is an acronym for Auto Regressive Integrated Moving-Average. The order of an ARIMA model is usually denoted by the notation ARIMA(p,d,q), where

P is the order of the autoregressive part

d is the order of the differencing

q is the order of the moving-average process

If no differencing is done (d = 0), the models are usually referred to as ARMA(p,q) models. The final model in the preceding example is an ARIMA (1,1,1) model since the IDENTIFY statement specified d = 1, and the final ESTIMATE statement specified p = 1 and q = 1.

Measles incidence in the Obudu was forecasted using Autoregressive Integrated Moving Average (ARIMA) model employed in many fields to construct models for forecasting time series. ARIMA (p,d,q) model is used to forecast the data pattern of diseases for the next fourteen years. Time series predictions are basically based on the changes over time in historical data sets and can produce mathematical models by using statistical data that can be extrapolated. The ARIMA (p,d,q) model is defined as follows:

$$X_t = \Phi_1 X_{t-1} + \ldots + \Phi_p X_{t-p} + a_t - \Theta_1 a_{t-1} - \ldots - \Theta_q a_{t-q} \quad (4)$$

where:

Φ's (phis) introduces the autoregressive parameters for estimation, Θ's (thetas) represents the moving average parameters, the main series is represented by X's, and the a's were the unknown random errors which are assumed to follow the normal probability distribution.

AKAIKE'S INFORMATION CRITERION

Akaike's information criterion (AIC) compares the quality of a set of statistical models to each other. For example, you might be interested in what variables contribute to low socioeconomic status and how the variables contribute to that status. Let's say you create several regression models for various factors like education, family size, or disability status; The AIC will take each model and rank them from best to worst. The "best" model will be the one that neither under-fits nor over-fits.

MATHEMATICAL REPRESENTATION

Akaike's Information Criterion is usually calculated with software. The basic formula is defined as:

AIC = -2(log-likelihood) + 2K (5)

Where:

K is the number of model parameters (the number of variables in the model plus the intercept).

For small sample size (n/K < ≈ 40), use the second-order AIC:
AIC = -2(log-likelihood) + 2K + (2K(K+1)/(n-K-1)) (6)
Where:

- n = sample size,
- K= number of model parameters,
- Log-likelihood is a measure of model fit.

ARIMA FORCASTING MODEL

A view into the future is one of the main objectives of model building. In this study the forecast estimation function for optimal (h) periods ahead is expressed as:

$$\hat{y}_{T+h/T} = -\theta_1 \hat{\varepsilon}_{T+h-1/T} \quad (7)$$

The error is the difference between the actual consumption rate series values and the fitted values from the chosen model in the study. The forecast error $\hat{\varepsilon}_t$ (h) at lead time is given by:

$$\hat{\varepsilon}_t = y_{T+h} - \hat{y}_{T+h/T} \quad (8)$$

were y_{T+h} represent the actual hypertension series value at $T+h$

DATA ANALYSIS AND PRESENTATION OF RESULT

The data were analyzed, using the models in equations. The results of the Autoregressive Moving Average (ARIMA) model are presented. Finally, forecast for future occurrence of the measles disease were made using the selected model. The software use are Stata and Minitab.

DESCRIPTIVE ANALYSIS

The descriptive statistics including the mean, standard deviation, minimum and maximum values of the variables under study are presented in Table 4.1. The results show that the values of Immunized cases ranges from 0 to 710 with a mean value of 244.2381 and standard deviation of 178.911, Immunized male children ranges from 0 to 399 with a mean value of 133.7143 and standard deviation of 105.374, Immunized female children ranges from 0 to 318 with a mean value of 110.5357 and standard deviation of 78.61993, Reported case of measles ranges from 0 to 203 with a mean value of 40.40476 and standard deviation of 49.33635, Reported cases of male ranges from 0 to 91 with a mean value of 18.10714 and standard deviation of 22.28026 while Reported cases of females ranges from 0 to 119 with a mean value of 22.15476 and the standard deviation of 27.73867.

TABLE 1: DESCRIPTIVE STATISTICS OF SERIES OF 2000 TO 2020

Variables	Minimum	Maximum	Mean	Standard Deviation
Immunized cases	0	710	244.2381	179.911
Immunized male children	0	399	133.7143	105.374
Immunized female children	0	318	110.5357	78.61933
Reported cases	0	203	40.40476	49.33635
Reported cases of males	0	91	18.10714	22.28026
Reported cases of females	0	119	22.15476	27.73867

Table 1 shows the mean and the standard of the immunized cases, reported cases of measles.

TIME PLOT:

Time plot which is the first step in data analysis is plotted. i.e. the graph of the original data versus time. The plot is shown in Figure I to VI. The plot in Figure I-VI shows the fluctuation pattern of the Immunized cases, immunized cases of male, immunized cases of females, reported cases, reported cases of male, reported case of female with respect to time. It can be observed, generally, from the figure that increasing trend in the plot is significantly sharp. The datasets, however, took a significant upward and trend over the time downward respectively. The generally increasing pattern in the time graph shows a gradual change of the mean whilst the flattened fluctuation over time shows an unstable variance suggesting the series is not stationary.

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

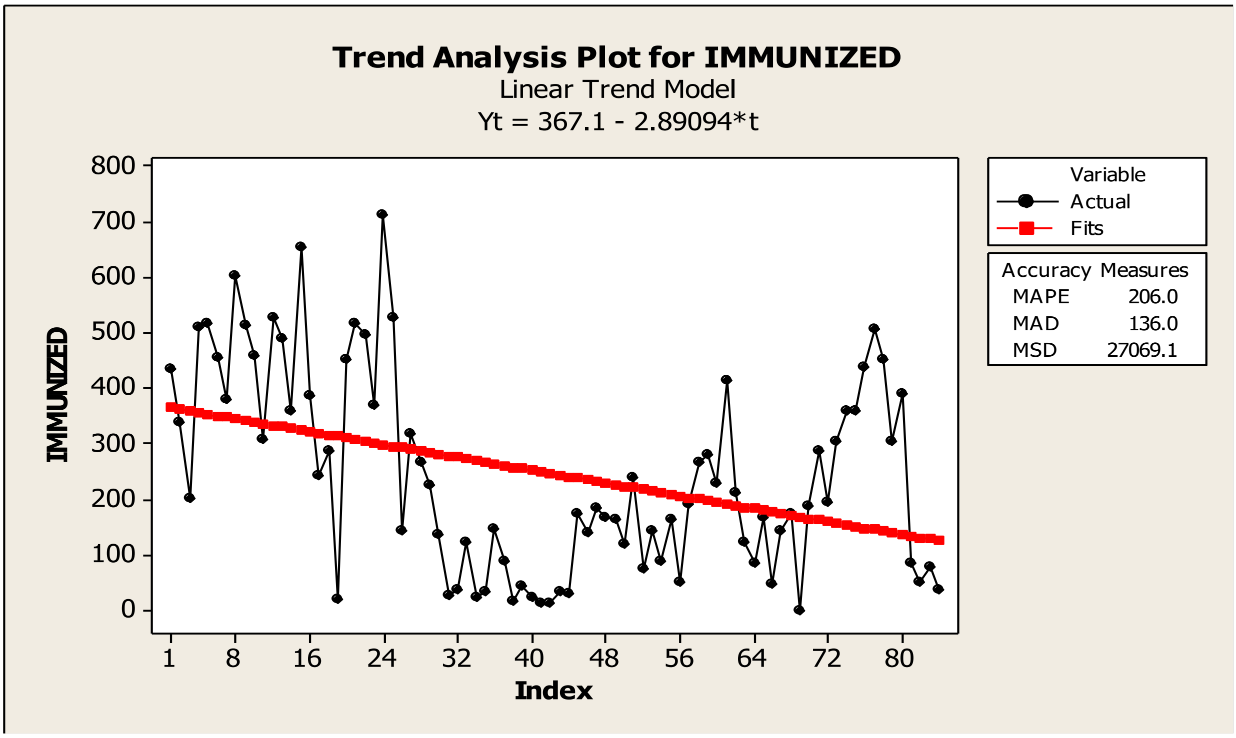

FIG 1: TREND ANALYSIS PLOT FOR IMMUNIZED

The trend analysis for immunized case of measles shows a positive trend which implies increase in immunization. The trend analysis plot shows the movement of immunization coverage over time and the fitted value over the period under study. The trend equation for the disease is given by Yt = 367.1-2.89094*t. Thus, there is decrease in the immunization coverage over the years in Obudu L.G.A of Cross River State.

v.2, n.2, 2023

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

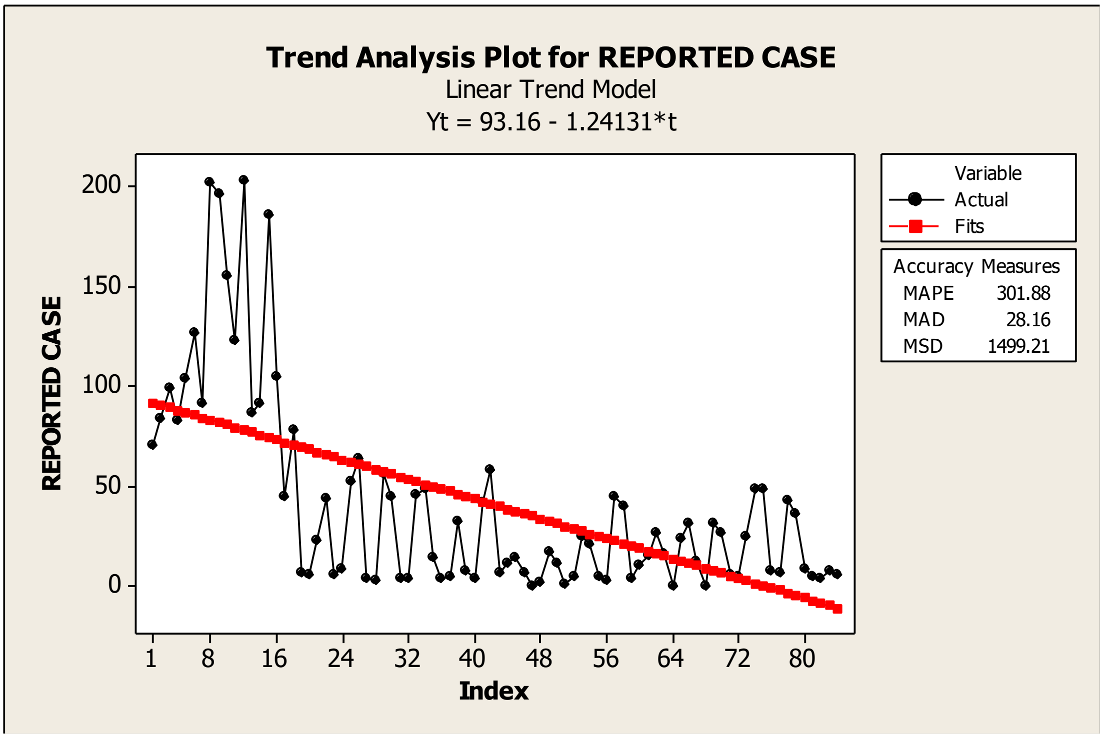

FIG 2: TREND ANALYSIS PLOT FOR REPORTED CASE

The trend analysis for reported cases of measles shows a negative trend which implies that cases of measles is decreasing. The trend analysis plot shows the movement of the disease over time and the fitted value over the period under study. The trend equation of the disease is given by Yt=93.16-1.24131*t

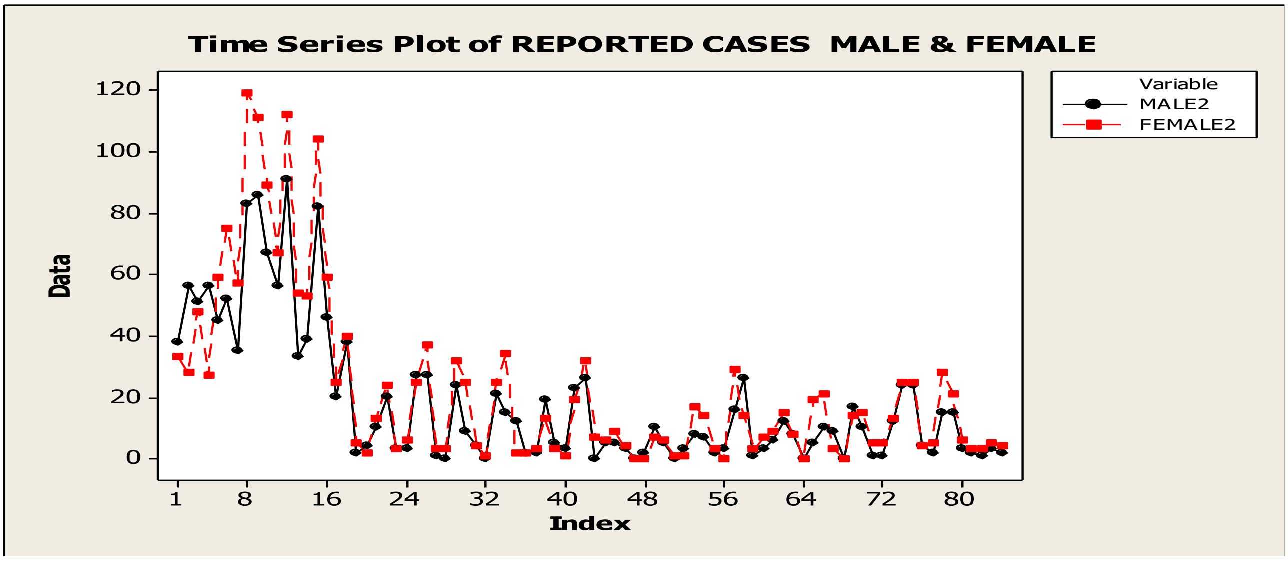

FIG 3: TREND ANALYSIS PLOT FOR REPORTED CASE OF MALE AND FEMALE

From the table above it shows the trend of reported case of male and female, in the 4th quarter of the year 2001 there is high increase in the reported case of both male and female and there was massive decrease in the year 2005, it went on to decrease to the year 2020 where we have fewer case of the measles due to high increase in immunization.

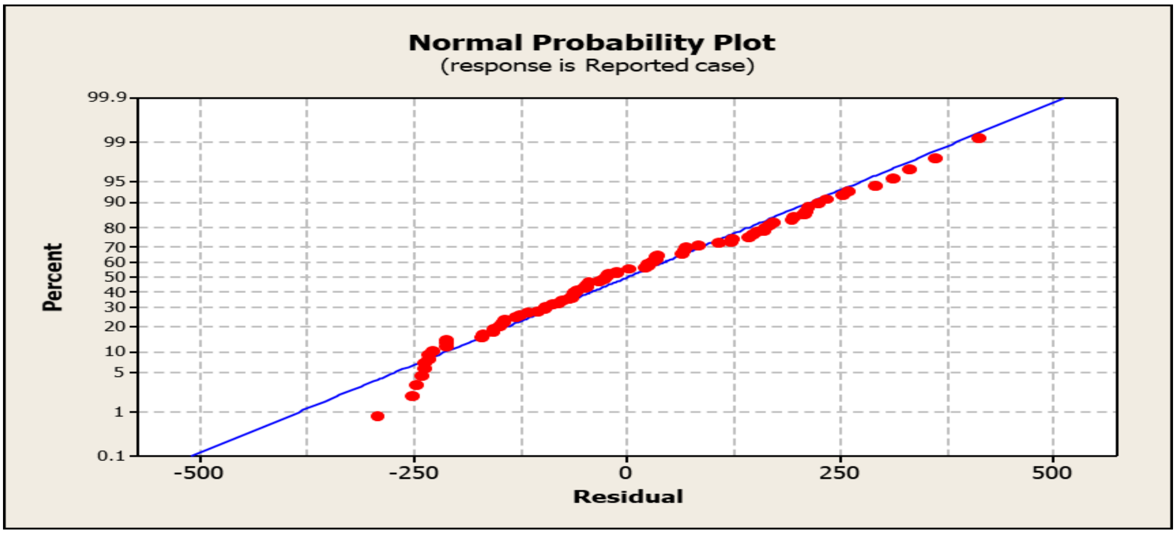

FIG 4: NORMALITY PLOT FOR REPORTED CASE

From fig 4: Shows that the plotted points are on the normality line or close to the plotted line which shows that the data is normal.

JOURNAL HEALTH AND TECHNOLOGY - JHT
ISSN 2764-7625

STATIONARY TEST ANALYSIS

Preliminary tests for stationary property (that is the series remains at a constant level over time) before attempting to fit a suitable time series model were conducted. However, if a trend exists, the series is not stationary. This is examined graphically as well as using the Augmented Dickey-Fuller (ADF) tests: The variables have to be checked for unit roots and the order of integration of each series must be determined. The stationarity of the series was tested using time series plots followed by the Augmented Dickey Fuller (ADF) test and Philip Perrons (PP) test. The null (H_o) and alternative hypothesis (H_1) are:

H_o: The series is not stationary

Versus

H_1: the series is stationary

TABLE 2: STATIONARITY TEST FOR IMMUNIZED CASE, IMMUNIZED CASE OF MALE, IMMUNIZED CASE OF FEMALE, REPORTED CASES, REPORTED CASE OF MALE, REPORTED CASE OF FEMALE.

Series	Augmented Dickey-Fuller (ADF) Test		Philip Perrons (PP) Test		Remarks
Variable	Test statistics	P-Value	Test Statistics	P-Value	
Immunized case	-3.791635	0.0044	-3.643	0.0050	Stationary at 0 diff
Male immunized case	-3.731269	0.0052	-3.556	0.0067	Stationary at 0 diff
Female immunized case	-4.207818	0.0012	-4.133	0.0008	Stationary at 0 diff
Reported cases	-13.33173	0.0146	0.0001	0.0382	Stationary at 1 diff
Male reported case	-12.98182	0.0001	-3.050	0.0305	Stationary at 1 diff
Female reported case	-12.44772	0.0001	-2.963	0.0385	Stationary at 1 diff

From Table 2, the p-value for the ADF test are all less than the significance level of α = 0.05. Therefore, we do not accept the null hypothesis and conclude that there is an indication of stationary per test hypotheses provided above which shows that the dataset for immunized case, immunized case of male, immunized case of female, are stationary at zero (0) differencing while for reported cases, reported case of male, reported case of female are stationary at one (1) differencing.
Using (ADF) test it shows that the p-value of immunized case (0.004), male immunized case (0.005) and female immunized case (0.0012) are less than α=0.05 level of significant which means that it is stationary at zero (0) difference. It also shows that the p-value of reported case (0.014), male reported case (0.0001) and female reported case (0.0001) are less than α=0.05 level of significant which means that it is stationary at one (1) difference.

TABLE 3: MODEL SELECTION USING ALKAIKE INFORMATION CRITERION (AIC)

Model ARIMA	**Total number of immunized**	**Total number of Male immunized**	**Total number of female immunized**
(1,0,0)	1060.787	967.0738	934.5124
(1,0,1)	1056.943**	962.6738**	931.1184**
(1,0,2)	1058.926	964.6719	932.9474
(0,0,1)	1082.008	992.1154	947.7383
(0,0,2)	1076.787	983.3695	946.5867
(2,0,0)	1058.629	964.1424	932.9944
(2,0,1)	1058.938	964.6726	933.0873
FOR REPORTED CASE, MALE REPORTED CASE AND FEMALE REPORTED CASE			
Model ARIMA	**Total number of Reported case**	**Total number of Male reported**	**Total number of female reported**
(1,1,0)	821.5116	693.5479	727.1213
(0,1,1)	808.8074	677.0038	717.2208
(1,1,1)	810.1417	678.6102	718.7844
(2,1,0)	792.1178**	668.0931**	704.1963**
(0,1,2)	806.3546	677.3283	716.2181
(2,1,1)	794.0879	668.7706	706.2557

Table 3 show the model that were run to select the best fitted model for the data using AIC.

The ARIMA (1 0 1) & (2 1 0) model shows least AIC value than the other model which is the best fitted model for the immunized case, male immunized, female immunized, reported case, male reported case and female reported case.

TABLE 4: PARAMETERS ESTIMATES OF IMMUNIZED CASE, MALE IMMUNIZED, AND FEMALE IMMUNIZED, OF BEST FIT MODEL OF ARIMA (1 0 1)

Immunized case best fit model					
Type	**Coeff**	**SE coeff**	**Z**	**P**	**Decision**
AR1	0.874827	.0760318	11.51	0.000	Highly Significant
MA1	-0.3678909	.1400493	-2.63	0.009	Highly Significant
CONSTANT	241.5665	78.90264	3.06	0.002	Highly Significant
Male Immunized case best fit model					
AR1	0.8899458	0.070712	12.59	0.000	Highly Significant
MA31	-0.3843787	0.1293115	-2.97	0.003	Highly Significant
CONSTANT	134.3851	48.36624	2.78	0.005	Highly Significant
Female Immunized case best fit model					
AR1	0.845078	0.92321	9.15	0.000	Highly Significant
MA1	-0.375325	0.1594915	-2.35	0.019	Highly Significant
CONSTANT	108.0068	30.93706	3.49	0.000	Highly Significant

Table 4 above shows the best selected model; ARIMA (1 0 1) parameter estimate which shows that all the p-values are less than α=0.05 level of significant which means that there are highly significant.

EQUATION OF THE MODELS

$$\hat{y}_t = \varepsilon_t - 241.5665 + 0.874827\Phi t - 1 - 0.36789090\Theta t - 1$$

$$\hat{y}_t = \varepsilon_t - 134.3851 + 0.8899458\Phi t - 1 - 0.38437870\Theta t - 1$$

$$\hat{y}_t = \varepsilon_t - 108.0068 + 0.845078\Phi t - 1 - 0.3753250\Theta t - 1$$

TABLE 5: PARAMETERS ESTIMATES OF THE BEST FIT MODEL OF ARIMA (2 1 0)

Reported case best fit model					
Type	**Coeff**	**SE coeff**	**Z**	**P**	**Decision**
AR1	-0.3939654	.0898813	-4.38	0.000	Highly Significant
AR2	-0.5553571	.0898813	-6.18	0.000	Highly Significant
CONSTANT	-0.9301962	1.63732	-0.57	0.001	Highly Significant
Male Reported case best fit model					
AR1	-0.4611744	0.993678	-4.64	0.000	Highly Significant
AR2	-0.5278636	0.0905369	-5.83	0.000	Highly Significant
CONSTANT	-0.5352381	0.7639187	-0.70	0.006	Highly Significant
Female Reported case best fit model					
AR1	-0.398035	0.0875605	-4.55	0.000	Highly Significant
AR2	-0.5058756	0.0937559	-5.40	0.000	Highly Significant
CONSTANT	-0.392021	0.9691857	-0.40	0.012	Highly Significant

Table 5 shows the best selected model; ARIMA (2 1 0) parameter estimate which shows that all the p-values are less than α=0.05 level of significant which means that there are highly significant.

EQUATION OF THE MODELS

$$\hat{y}_t = \varepsilon_t - 0.9301962 - 0.3939654\Phi t - 1 \; - \; 0.5553571\Phi t - 2$$

$$\hat{y}_t = \varepsilon_t - 0.5352381 - 0.5278636\Phi t - 1 \; - \; 0.5352381\Phi t - 2$$

$$\hat{y}_t = \varepsilon_t - 0.392021 - 0.398035\Phi t - 1 \; - \; 0.5058756\Phi t - 2$$

TABLE 6: **FORECASTING FOR IMMUNIZED CASE OF MEASLES FROM 2021 TO 2025**

Period	**Quarter**	**Forecast**	**95% limits**	
			Lower	**Upper**
2021	1	88.897	-157.794	335.589
	2	106.318	-170.985	383.620
	3	121.747	-177.385	420.880
	4	135.414	-179.788	450.880
2022	1	147.519	-179.738	474.775
	2	158.240	-178.171	494.651
	3	167.736	-175.686	511.158
	4	176.147	-172.676	524.970
2023	1	183.597	-169.406	536.600
	2	190.195	-166.052	546.443
	3	196.040	-162.733	554.812
	4	201.216	-159.525	561.957
2024	1	205.801	-156.477	568.079
	2	209.862	-153.617	573.341
	3	213.459	-150.959	577.878
	4	216.645	-148.509	581.799
2025	1	219.467	-146.263	585.196
	2	221.966	-144.214	588.147
	3	224.180	-142.354	590.714
	4	226.141	-140.670	592.952

From this Table 6, it shows that there is increase in the immunization cases. For instance, first quarter of 2022 had a total of 147.519. But in 2025, immunization cases will be having about 219.467 in the first quarter.

TABLE 7: **FORECASTING FOR REPORTED CASE OF MEASLES FROM 2021 TO 2025**

Period	Quarter	Forecast	95% limits	
			Lower	Upper
2021	1	2.690	-51.362	56.742
	2	3.313	-59.759	66.385
	3	3.114	-60.804	67.031
	4	1.005	-70.226	72.237
2022	1	0.126	-79.518	79.770
	2	-0.158	-82.778	82.462
	3	-1.378	-87.708	84.952
	4	-2.563	-94.487	89.360
2023	1	-3.230	-99.102	92.641
	2	-4.124	-103.263	95.015
	3	-5.222	-108.378	97.935
	4	-6.109	-113.086	100.868
2024	1	-6.964	-117.186	103.257
	2	-7.952	-121.519	105.614
	3	-8.905	-125.885	108.074
	4	-9.797	-129.923	110.329
2025	1	-10.733	-133.903	112.437
	2	-11.686	-137.927	114.554
	3	-12.607	-141.818	116.604
	4	-13.531	-145.602	118.540

From Table 7 above, it shows that the reported cases of measles would decrease. For instance, the first quarter of 2022 had a total of 0.126 while the first quarter of 2025 would be -10.733.

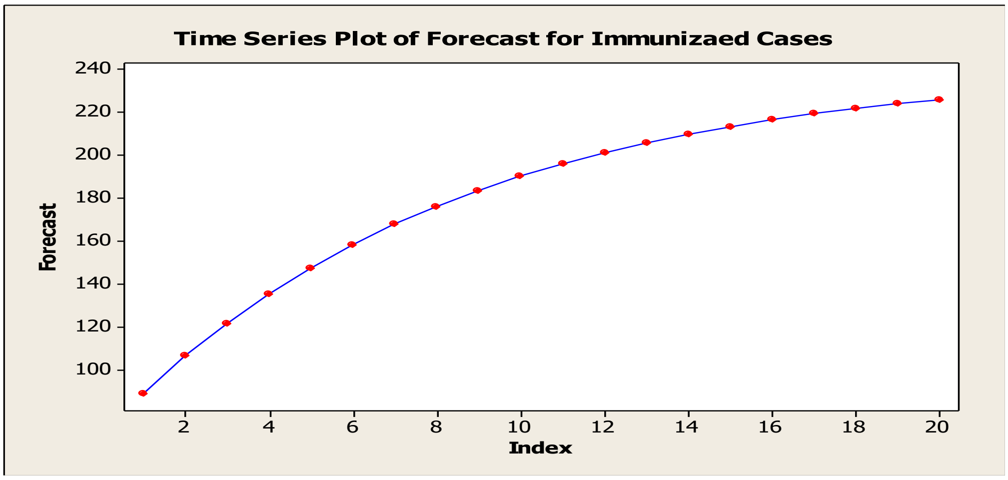

FIG 5: GRAPH OF THE FORECAST OF IMMUNIZED CASES

Figure 5 shows the time series plot of forecast for immunized case which shows that there is increase in the immunization coverage.

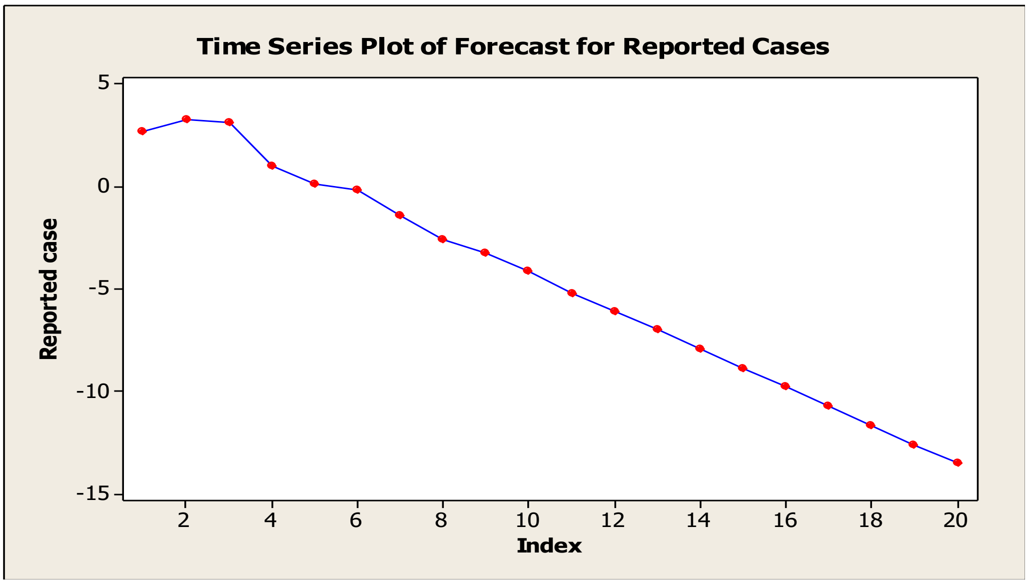

FIG 6: GRAPH OF THE FORECAST OF REPORTED CASES

From figure 6, it shows that there is decrease on the time series plot of forecast for reported case.

DISCUSSION OF THE RESULTS

The ARIMA (1, 0, 1) & (2, 1, 0) model was used for forecasting the number of expected quarterly Immunized cases of measles and Reported cases of measles. The model was used to predict a five year lead period of measles cases from 2021-2025. This model is recommended to the metropolitan health directorate and researchers who would want to monitor the measles reported cases in the metropolis and other parts of the world.

The time series plots were plotted, the linear plot was the best for accuracy. The trend equation for the reported cases of measles is given by $y_t = 93.16 - 1.24 *t$ indicating a decrease in the number of reported cases of measles. The coefficient x = 1.24 is the gradient of the slop of the line. 93.16 is the intercept on the Y axis, that is the beginning of each quarter of the year, the number of reported cases of measles is 1.24. the time plot shows a gradual reduction decrease in the reported cases of measles in Obudu Local Government of Cross River State. From fig2. The trend analysis plot for reported cases shows that there is no seasonal effect of measles. From fig2. The trend analysis plot for reported cases shows that there is no seasonal effect of measles hence it can occur at any given time of the year, though it occurs infrequently due to immunization (i.e it is on a decrease).

However, there was a high increase in the reported cases of measles in the year 2001 and decrease in the year 2005, and there were low cases of measles in the 2020 due to immunization and the awareness of the parents. Also, in fig 3. From the trend analysis plot for reported case of male and female, it was shown that the male gender suffers measles most only on four quarter of the first year, after which in the remaining of the years, female gender suffers measles the most, conclusively this means that female gender suffers the measles the most. Generally, from the graph, the period of 20 year of study from 2000-2020, it was discovered that the Reported cases of measles in General Hospital Obudu was higher in the year 2001 and decrease in the year 2005, and there were low cases of measles in the 2020 due to immunization and the awareness of the parents. Also gender of cases has no significant effect on the number of reported cases while season (quarters) has no significant effect on the reported cases of measles. From fig 5 and fig 6, time series plot of immunized and reported cases of measles shows that there is increase in immunization which leads to decrease in reported cases of measles, this is as the immunization of children increases, the number of reported cases of measles reduces.

Unit root test was carried out using Augmented Dickey-Fuller (ADF) and Philip Perrons (PP) to test the stationarity of the data with the p-value less than the significant level of $\alpha = 0.05$. there we reject Null hypothesis and conclude that stationarity exist. The descriptive statistics shows the value of minimum, maximum, mean and standard deviation.

CONCLUSION

Measles is one of the world's most contagious diseases that spread mainly by coughing and sneezing, close personal contact/direct contact with infected nasal or throat secretions. Measles is still common in many developing countries, particularly in parts of Africa with Nigeria inclusive despite the immunization exercises that go on all over the country. This prompted this research and in order to carry out the research, we introduced the bases of time series analysis. We defined time series and also explaining the model of ARIMA. The results of this analysis answered the research questions in chapter one. The study examined the appropriate model that fits the measles reported cases in the studied area between the stated periods. From the results it was discovered that the forecasted values from the selected model revealed that reported case of measles deceases from year to year.

DECLARATION OF COMPETING INTEREST: The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENT

We are grateful to Obudu General Hospital in Cross River State for making the data used in this research available for us. We also give our gratitude to the Federal University, Wukari for providing a wonderful and enabling environment for us which makes it possible for this work to be a reality.

ROLE OF FUNDING

This research did not obtain any funding from any agencies.

REFERENCES

[1] Akande. Online consumer complaint behaviors: The dynamics of service failures, consumers' word of mouth, and organization-consumer relationships. International Journal of Strategic Communication. 2017;6:59-76.

[2] CDC - Centers for Disease Control and Prevention. Program operations guidelines for STD prevention: Community and individual behaviour change interventions. Atlanta, GA: CDC; 2021.

[3] Dubray C, Gerstl S, Schimmer B, Ihekweazu C. High Morbidity and Mortality Related to a Measles Outbreak in Cross River State, Nigeria, Tenth European Programme for Intervention Epidemiology Training (EPIET) Scientific Seminar Mahon, Menorca, spain; 2015. p. 13-15.

[4] OCHA. Humanitarian Snapshot: New Displacement in Borno State since 1 Nov 2018. 2019.

[5] Orenstein WA, Hinman A, Nkowane B, Olive JM, Reingold A. Measles and Rubella Global Strategic Plan 2012–2020 midterm review. Vaccine 2018;36:A1–34.

[6] Gastañaduy Paul A, Goodson James L, Panagiotakopoulos Lakshmi, Rota Paul A, Orenstein Walt A, Patel Manisha. Measles in the 21st Century: Progress Toward Achieving and Sustaining Elimination. The Journal of Infectious Diseases. 2021;224(S4):S420–8 DOI: 10.1093/infdis/jiaa793.

[7] Pike J, Leidner AJ , Gastanaduy PA . A review of measles outbreak cost estimates from the US in the post-elimination era (2004–2017): estimates by perspective and cost type . Clin Infect Dis. 2020;71:1568–76.

[8] Weber DJ. Advances in Vaccinology, Med@Consulting BVBA. Belgium: World health organization WHO; 2017a. measles. WHO fact sheet N0 286 Revise January 2007.

[9] World Health Organization WHO Measles and Rubella Surveillance Data. Genebra: WHO; 2020. Available from: https://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/active/measles_monthlydata/en/. Cited 2020 Sep 21.

[10] Baptiste Jean et al. Measles outbreak in complex emergency: estimating vaccine effectiveness and evaluation of the vaccination campaign in Borno State, Nigeria, 2019. BMC Public Health. 2021;21:437 https://doi.org/10.1186/s12889-021-10436-1.