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A Model for Estimation of Vesico Vaginal Fistula in Kebbi State, Nigeria

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Abstract:
This paper examined the monthly reported cases of Vesico Vaginal Fistula (VVF) in Kebbi State, Nigeria between the period of 2009-2014 using Box and Jenkins approach. The result from the estimation of parameters of the model showed that ARIMA (1, 1, 1) is the best model for the data i.e. is appropriate. The initial test statistic value for ADF was -4.2050 which shows that the series has unit root, the KPSS test statistic was 0.839, and however after the transformation by taken the first differencing the series become stationary. The test statistic for portmanteau was 11.8092 which shows there is absent of serial correlation and ARCH-LM test statistic was 2.9973 shows that the series has no ARCH-LM effect is present. Therefore ARIMA (1, 1, 1) model was fit the data, (has verify the model is strength). The forecast showed that the menace of VVF is increase in the next 24 months. This study recommended however, to help eradicate the problem in Kebbi State, that the government shall provide obstetric care Centre's most especially in the rural areas, age of marriage no doubt affects pregnancy and also husbands shall allow and encourage their wives to visit hospital during pregnancy period.

Keywords: *VVF, ARIMA, box-Jenkins approach, ACF, PACF, AIC, SBC and forecast*

1. Introduction

Kebbi is a state in north-western Nigeria with its capital at BirninKebbi. The state was created out of a part of Sokoto State in 1991. Kebbi State is bordered by Sokoto State, Niger State, Zamfara State, Dosso Region in the Republic of Niger and the nation of Benin. It has a total area of 36,800 km². With a latitude, 12.4539, and longitude, 4.1975 respectively, and has a population of 3,238,628 according to the 2006 census. The major local language is Hausa, although the main ethnic groups are Hausa, Fulani, Dakarkari, Kambarawa, Gumbawa and a handful of Zabarmawa. The people are largely Muslims, with a few Christians and some adherents to traditional belief.

Kebbi is traditionally considered by Sarki mythology as the homeland of the Banzabakwai states and Hausa Kingdoms. According to recent research based on local oral traditions, king lists and on the Kebbi chronicle, the state of Kebbi was founded towards 600 BCE by refugees of the Assyrian empire conquered by Babylonian and Median forces in 612 BCE. A major local event was the conquest by Songhai in the second half of the fifteenth century CE.

Vesico vaginal fistula (V.V.F). The term "Vesico" according to the medical profession is called urinary bladder. Vesico vaginal fistula is the abnormal connection between the urinary tract and the vaginal such that there is uncontrollable leakage of urine into the vaginal tract. According to Villey V.J (2006), "VVF is an abnormal communication between the urinary bladder and vaginal that results in the continuous involuntary discharge of urine into the vault" several literatures reveal that the condition has many causes with variation depending on the social and educational status of people. VVF also, is one of the worst associated with delivery. It is an abnormal opening of the vaginal wall to the bladder or rectum or both at the same time, that results in the leakage of urine (VVF) or fasces (Recto vaginal fistula, RVF) or both; VVF and RVF are serious health problems in the development world including Nigeria where it contributes greatly to the country's unacceptable higher maternal mortality (Murphy; 1980 Harrison 1989; kaburuk 1990; Tanko 1994; Chanrasia 2006).

The main causes of VVF in over 85% of cases is in obstructed labour (prolong labour) necrosis is the cutting through the wall of the mother's abdomen before she can deliver a child (kaburuk 1990, Disk and Armaya'u 1993, WHO 1994; 1997; 1999; 2000). The Minister of women Affairs and social Development disclosed that Nigeria has the highest incidences of

VVF in the world that with an estimated 40,000 to 800,000 cases with 20,000 new cases added each year. Other cases of VVF in Nigeria are as a result of early girl marriage. Early marriage in many instances leads to the withdrawal of girls from school and thrusts upon them marital and reproductive responsibility for which they are neither physically nor mentally mature to carry out.

2. Materials and Method

2.1. Model Building

A time series model building is a selection of the appropriate model for the data using Box –Jenkins procedures; the three primary stages in building a Box- Jenkins time series are: Model identification, Model estimation and Diagnostic Checking.

The identification stage is most important and also most difficult. It consists to determine the adequate model for ARIMA (Autoregressive Integrative moving Average), the most general is the Box- Jenkins model which includes difference operators, seasonal autocorrelation and partial autocorrelation. The first step in deploying a Box- Jenkins model is to determine if the series is stationary and if there is any significant seasonality that needs to be modeled. Dickey D.A (1979), in this estimation stage said parameters are estimated for adequate model. The parameters of ARIMA (p d q) model selected can be estimated consistently by least square or Maximum likelihood Estimates (M.L.E). The estimation of the parameters used in the forecasting stage is to calculate new values of the series and the confidence intervals for those predicted values.

Once an appropriate model had been entertained and its parameters estimated, the Box-Jenkins methodology require examining the residuals of the actual values minus those estimated through the model. If such residuals are random, it is assumed that the model is appropriate, if not another model is entertained.

2.2. Augmented Dickey Fuller (ADF) Test

The ADF regression equation due to dickey and fuller (1984). ADF test stationary has been developed in the same manner to check the stationary of the series, in order to make inferences in time series, there must be stationary.

The regression model for the test is given by

$$\Delta y_t = \mu_o + \mu_1 t + \emptyset y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta y_t + \varepsilon_t \ldots \quad (1)$$

Where t = p+1, p+2 ……., T.

Where μ_o the intercept is $\mu_1 t$ represents the trend in case it is present, is the coefficient of the legged depended variable. Δy_{t-j} with coefficients O_j is added to account for serial correlation in the residuals.

The null hypothesis H_O: = 0 is that the series has unit root while the alternative hypothesis H_1: $\neq \mathbf{0}$

The teat Statistic is given by ADF = $\frac{\emptyset}{SE(\widehat{\emptyset})}$ … (2)

2.3. KPSS Test

Kwiatkowski, Philips, Schmidt P. and Shin (1992) proposed a test of the null hypothesis for an observable series is the trend stationary (Stationary around a deterministic trend). The integration properties of $a$series y_t may also be investigated by testing the null hypothesis that the series is stationary against a unit root. Assuming no linear trend term, the data generating the process is given as: -

$$y_t = \mathcal{X}_t + Z_t \ldots \quad (3)$$

Where $\mathcal{X}_t$ is a random walk, $\mathcal{X}_t = \mathcal{X}_{t-1} + V_t$, V_t: iid $(0, \sigma_v^2)$ and Z_t is stationary process

Test Statistic

$$= \frac{1}{T^2} \sum_{t=1}^{r} \frac{S_t^2}{\sigma^2} \ldots$$

… (4)

2.4. Hypothesis Test for KPSS

- H_o: The series is stationary
- H_1: Series is non-stationary

Where $S_t = \sum_{j=1}^{t} \hat{w}j$ with wj = $y_t - \bar{y}$ and σ_∞^2 is an estimator of the long run variance of

$Z_t, \sigma^2_\infty = \lim_{T\to\infty} T^{-1}\ \mathrm{Var}(\sum_{t=1}^{T} \boldsymbol{Z}_t)$ ... (5)

The null hypothesis of the test is $H_o: \sigma_v^2 = 0$ against the alternative hypothesis $H_1: \sigma_v^2 \neq 0$
Reject H_o if the test statistic is greater than the asymptotic critical values.

3. Data Analysis

Visual Representation of the time plot

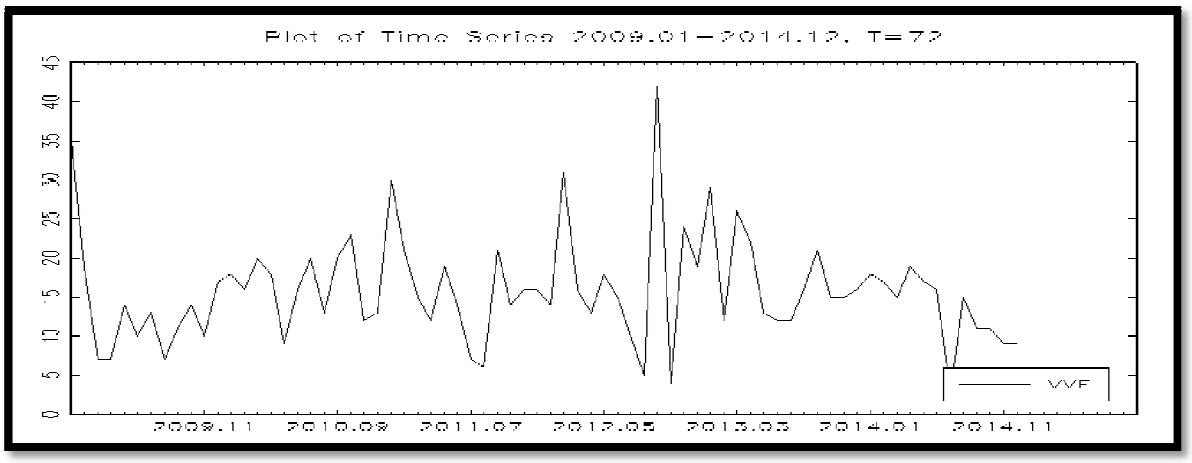

Figure 1: Time Series Plot of the Monthly Reported Cases of VVF in Kebbi State 2009-2014

The time series plot clearly shows the variability of the series appears to be changing with time and the mean and variance are not constant, suggesting that the series is not stationary.

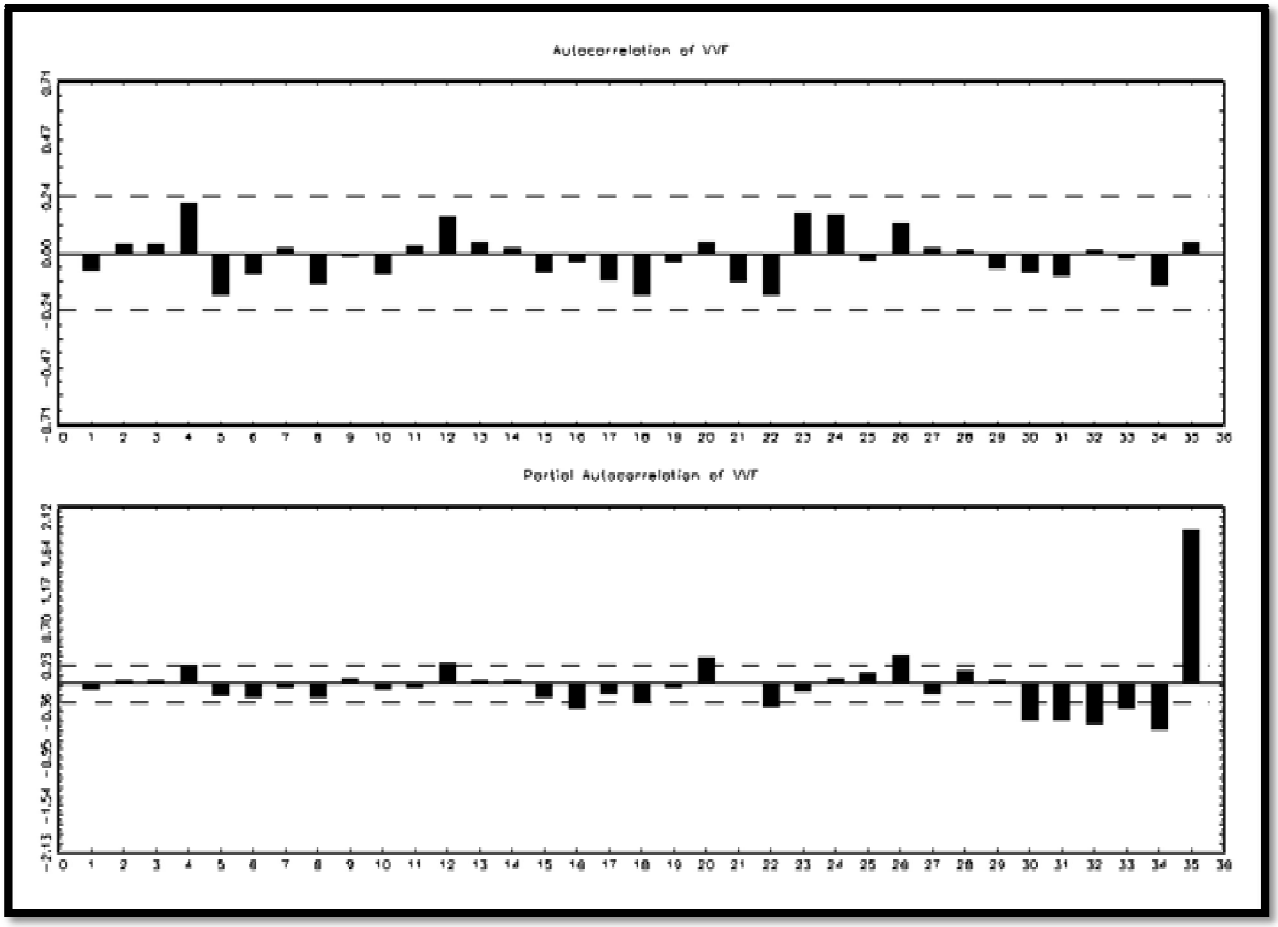

Figure 2: ACF and PACF of the VVF Series before differencing

The plot of the ACF and PACF clearly shows that the mean and variance are not constant, suggesting that the series is not stationary.

Variable	Mean	Min	Max	STD Dev.
VVF	15.70	3.00	42.00	16.85900

Table 1

3.1. Augmented Dickey-Fuller (ADF) For VVF Test of Hypothesis

- H_0: The series has unit root
- H_1: The series is stationary

1%	5%	10%
-3.43	-2.86	-2.57

Table 2: Asymptotic Critical Values

3.1.1. Value of Test Statistic: -4.2050

The ADF test statistic is -4.2050 and the critical values at 1%, 5% and 10% are -3.43, -2.86 and -2.57 respectively shows that the test statistic is greater than all the critical values, if we take the absolute value, then there is no evidence to reject the null hypothesis that the series has unit root.

3.2. Test of Hypothesis for KPSS Test

- H_0: $\sigma = 0$ (The series is stationary)
- H_1: $\sigma > 0$ (Series is non-stationary)

KPSS test based on $\gamma(t) = a + e(t)$ (level stationary)

1%	5%	10%
0.347	0.463	0.739

Table 3: Asymptotic Critical Values

3.2.1. Value of Test Statistic: 0.839

In this case the value of test statistic is 0.839 and the level of significance at 10%, 5% and 1% are 0.347, 0.463 and 0.739 respectively, which show that the test statistic is greater than all the critical values which indicated that there is no stationary in the series i.e. the series is not stationary.

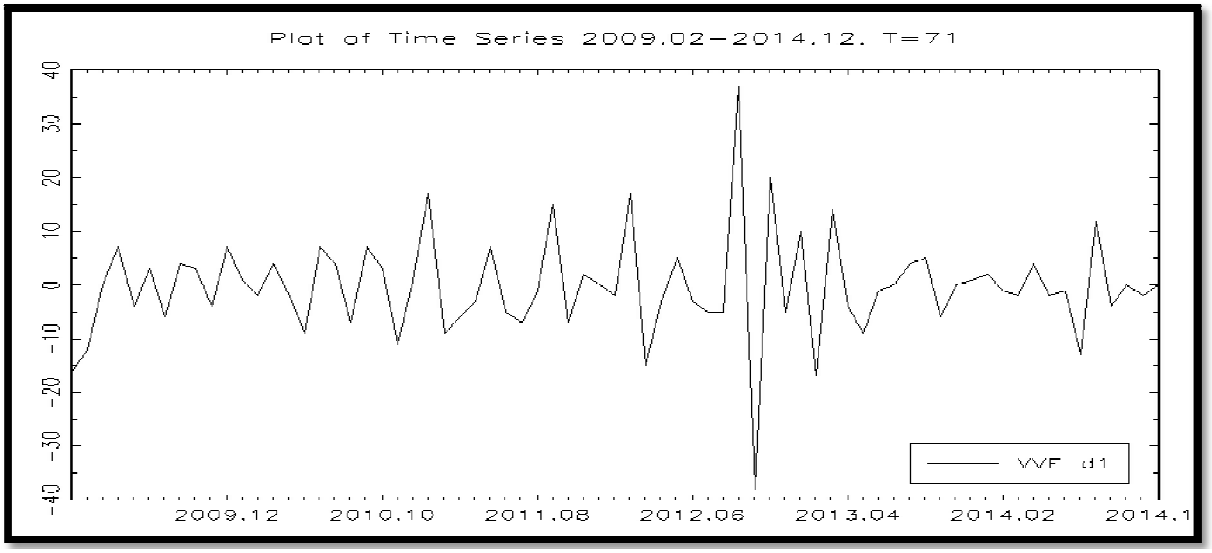

Figure 3: Plot VVF Series after the First Differenced

The plot clearly suggests that the mean and variance appeared to be constant. Therefore, the series is stationary since the mean and variance are constant.

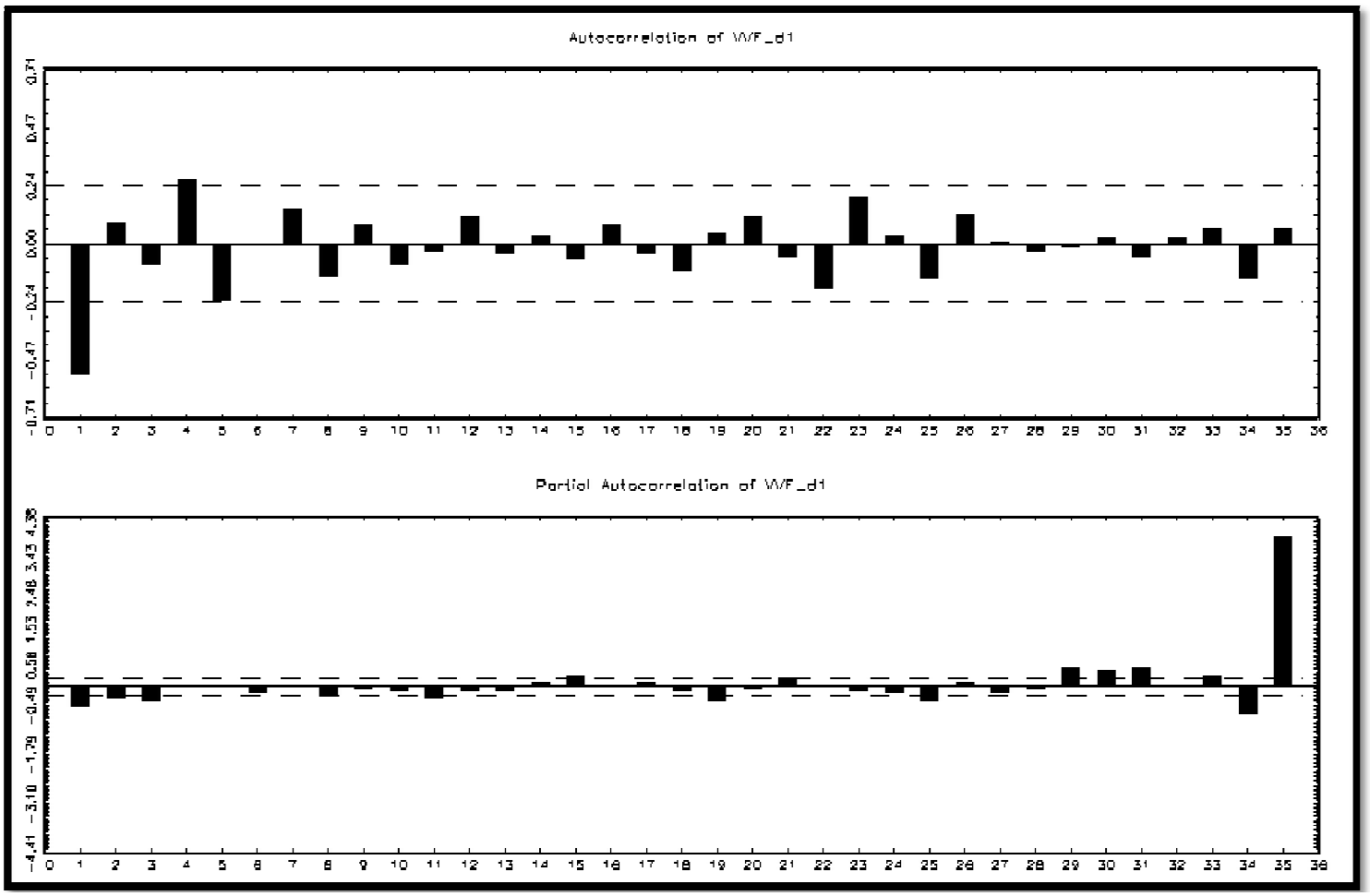

Figure 4: the ACF and PACF of First differencing of VVF cases in Kebbi State

ACF shows that there is no correlation function after the first differencing clearly indicating the series is stationary. The PACF shows that there is no correlation function after the first differencing and the series indicates the presence of AR and MA Process models.

3.3. ODEL Identification

To identify the best model, four models are chosen, ARIMA (0, 1, 0), ARIMA (0, 1, 1), ARIMA (1, 1, 0) and ARIMA (1, 1, 1). The autoregressive integrated moving Average of order (p, d, q), ARIMA (p, d, q) is use to choose the best model out of the four models so as to obtained which has the lowest AIC, (Akaike's Information Criterion), SBC (Schwarz Bayesian Criterion) and log likelihood Function.

3.4. Estimation

MODEL	AIC	SBC	LOG
ARIMA (0,1,0)	518.175643	520.424138	−258.087821
ARIMA (0,1,1)	469.729177	476.226167	−232.864588
ARIMA (1,1,0)	490.563904	495.060894	−243.281952
ARIMA (1,1,1)	469.258777	474.004263	−231.629389

Table 4: Order of Estimation

ARIMA (1, 1, 1) was chosen as our best model for the series, because it has the minimum AIC and SBC.

3.5. Parameter Estimates of the Model

Having identified the appropriate p, d and q model the next stage is to estimate the parameters of the model. The minimum value of AIC (Akaike's Information Criterion), and SBC (Schwarz's Bayesian Criterion) may be regarded as the best fitted model. The result of the parameter estimates of the best model ARIMA (1, 1, 1) are shown below:

Sample range: [2009 M2, 2014 M12], T = 70
Model: ARIMA (1, 1, 1)

3.5.1. Final Results

Iterations until Convergence: 6
Log Likelihood -231.629389 Number of Residuals: 70
AIC : 469.258777 Error Variance : 44.777684717
SBC : 474.004263 Standard Error : 6.691613013 s
DF: 67 Adj. SSE: 3586.305631941 SSE: 3377.479240268

Dependent Variable: VVF				
	Coefficients	Std. Errors	T-Ratio	Approx. Prob
AR1	-0.22649715	0.13597582	-1.66572	0.10044
MA1	0.82807142	0.09013984	9.18652	0.00000
CONST	-0.00094615	0.12246823	-0.00773	0.99386

Table 5

3.6. Model Diagnosis

Having chosen the best model, there is need to evaluate the adequacy of the estimated model or does the model fit the data? The following tests are being applied, which include:
PORTMANTEAU TEST: - This test is used to determine whether there is serial correlation in a time series.
The model is good if there is no serial correlation between the residual.
ARCH LM TEST: - This test for neglected conditional heteroskedasticity
(ARCH) the null hypothesis is that there is no conditional heteroskedasticity.

3.7. Portmanteau Test

(with 12 lags)

- H_O: None of the Autocorrelation coefficients up to lags are different from Zero
- H_1: At least one of the Autocorrelation coefficients up to lags is different from Zero

PORTMANTEAU TEST with 16 lags
Portmanteau: 11.8092
P-Value (Chi^2): 0.3782
Ljung& Box: 13.5659
P-Value (Chi^2): 0.2580

3.7.1. Decision Rule

The null hypothesis is rejected for the portmanteaus test since the test statistics 11.8072>p -value 0.3782 and the alternative hypothesis is accepted, then, we conclude that at least one of the Autocorrelation coefficients up to lags are different from Zero.
ARCH-LM TEST (With 2 lags):
H_O: $\alpha_O = \alpha_1$-------$\alpha_P = 0$ (The series has no ARCH effect)
H_1: $\alpha_O \neq \alpha_1$-------$\alpha_P \neq 0$ (At least coefficient is non-zero and we say the series has ARCH-LM effects)
ARCH-LM TEST with 4 lags:
Test statistic: 2.9973
P-Value (Chi^2): 0.5583
F statistic: 0.7850
P-Value (F): 0.5394
Decision rule: The null hypothesis is accepted since the test statistic 2.9973> p-value 0.5583and we conclude that the series has no ARCH-LM effect is present.

3.7.2. Forecasting

Forecast of future occurrence of VVF cases in Kebbi State from 2015-2016
Forecast range: [2015 M1, 2016 M12], T = 24

TIME	LOWER CI	FORECAST	UPPER CI
2015 M1	1.9959	15.9116	29.8274
2015 M2	1.7032	15.6309	29.5586
2015 M3	2.0780	16.0281	29.9781
2015 M4	2.0519	16.0021	29.9523
2015 M5	2.0807	16.0309	29.9812
2015 M6	2.0840	16.0343	29.9845
2015 M7	2.0914	16.0417	29.9919
2015 M8	2.0973	16.0475	29.9977
2015 M9	2.1034	16.0536	30.0038
2015 M10	2.1094	16.0596	30.0099
2015 M11	2.1154	16.0657	30.0159
2015 M12	2.1215	16.0717	30.0219
2016 M1	2.1275	16.0777	30.0280
2016 M2	2.1335	16.0837	30.0340
2016 M3	2.1395	16.0898	30.0400
2016 M4	2.1456	16.0958	30.0460
2016 M5	2.1516	16.1018	30.0521
2016 M6	2.1576	16.1079	30.0581
2016 M7	2.1637	16.1139	30.0641
2016 M8	2.1697	16.1199	30.0702
2016 M9	2.1757	16.1260	30.0762
2016 M10	2.1818	16.1320	30.0822
2016 M11	2.1878	17.1380	30.0883
2016 M12	2.1938	17.1440	30.0943

Table 6

The data above shows the rate at which the Vesico Vaginal cases will be in the next 24 Months in Kebbi State.

4. Results and Discussion

This paper examined the reported cases of VVF (Vesico Vaginal Fistula) between the period of 2009-2014 using the time series methodology (Box and Jenkins approach) the initial inspection of the time plot shown in Figure 1 that the cases of VVF in Kebbi state has seasonality pattern, the variability of the series appears to be changing with time, the mean and variance are not constant. Fig. (2a) and b shows the ACF and PACF indicate that there is no stationary in the series and there is need to attained stationary. The mean average number of VVF cases is 15.70 as shown in Table 1 and the minimum number of people affected with VVF is 3 and the maximum number of people affected with the disease is 42 which indicate that the diseases is very rampant around September 2012 in kebbi state. Hence the data was transformed and some statistical test like ADF in Table 2 and KPSS in Table 3 is carried out to ascertain the stationary of the data. The initial test statistic value for ADF was -4.2050 is greater than all the critical values at 1%, 5%, and 10% taken the absolute value which showed that the series has unit root, the same was observed for KPSS as shown in Table 3 where test statistic 0.839 is greater than all the critical values which indicate that there is no stationary in the series. However, after the transformation by taken the first differencing the series become stationary, as it shown in Figure 3, to confirm the stationary in the residual analysis the ACF and PACF was used in Fig.(4a) and b which shows there is no correlation function after the first differencing, clearly indicating that the series is stationary, ARCH-LM test and Portmanteau test are used to test if the series has serial correlation in residual, the test statistic for Portmanteau was 11.8092 and P-value was 0.3782 which showed that at least one of the autocorrelation is different from zero, while in case of ARCH-LM test, the test statistic was 2.9973 and P-value 0.5583 which showed that the series has no ARCH-LM effect is present. Table 4 is an order of estimation with 4 parameters was suggested i.e. ARIMA (0, 1,0), ARIMA (0,1,1), ARIMA (1,1,0) and ARIMA (1,1,1), after the estimation the ARIMA (1,1,1) model was found to be the best model that fit the data which has the minimum AIC and SBC. The result of the forecast showed that the menace of VVF in Kebbi state has increase in the next two years (Twenty four Months).

5. Conclusion

In this research, the developed model that best fit the data for Vesico vaginal Fistula in Kebbi state is found to be ARIMA (1, 1, 1) and from the result of the forecast showed that there is increase in the rate of VVF in Kebbi State in the next two years (Twenty-four months), therefore there is need for Government and community interventions so as to reduce the menace.

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