

# THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

## Time Series Analysis of Live Birth and Stillbirth in Nigeria: A Case Study of University of Abuja Teaching Hospital Gwagwalada, Abuja, Nigeria (1996 – 2015)

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### **Abstract:**

*This work is design to study the variation in monthly number of live and stillbirth at university of Abuja teaching hospital Gwagwalada, Abuja between 1996 and 2015. To provide a model useful in forecasting live and still birth pattern. The study will give an insight on how stillbirth can be reduced in the hospital. The study will also serve as a guide to pregnant women and the general public to know the cause of stillbirth and how it can be prevented. The study will as well help the government to know the total number of babies that will be given birth to in the years to come (forecast). During the course of this study, it was noted/discovered that the data on live birth and stillbirth had irregular patterns such that, it goes very high at a period and very low at another. Also, the trend estimated showed a positive correlation between the live birth and still birth. Furthermore, the deterministic model was fitted and forecast was made. Probabilistic model identification, fitting of appropriate model and forecast was also carried out. However, the models fitted satisfy stationery condition and also had the minimum Akaike Information Criterion. ARIMA (3 1 2) and ARIMA (2 1 1) which was fitted led to the forecast that live birth increased and then decreased for some time before and then decreased totally. It was also noticed in the original data collected that the total number of live births in august and September 2001 and 2002 and some other months was decreased leading to a decrease in the still birth. Lastly, it was discovered that maybe the number of pregnant women in the labor room at a time out-weighed the number of nursing staff making them inefficient and leading to some of the pregnant women being in labor for too long which lead to death of the fetal in the womb before delivery. Also, some of the nursing mothers were not properly orientated on the kind of health care required during pregnancy and the level of poverty in the country may have contributed to the increase in stillbirth during delivery. Based on this study, ARIMA (3 1 2) and ARIMA (2 1 1) were found appropriately fit to the live birth and stillbirth respectively. Increase in live birth also account for the increase in still birth and showed that as time goes on, more live birth and stillbirth will be noticed. This could be reduced drastically if women are well oriented and have standard good health condition.*

**Keywords:** Stillbirth, forecast, Akaike Information Criterion, live birth, stationary

### **1. Introduction**

Intrauterine fetal death or stillbirth is variously defined in various countries, by gestation or birth weight. The varieties of definitions make comparisons of stillbirth rate difficult. In the United Kingdom (UK), a stillbirth is defined as the delivery of a baby with no signs of life after 24 weeks of pregnancy. However [1] defines a stillbirth as death of a fetus before the complete expulsion or extraction from its mother at term, weighing at least 1000g and occurring after 28 completed weeks of gestation or having at least 35cm body length, which is indicated by the fact that after such a separation, the fetus does not show any evidence of life.

Stillbirths often go unrecorded, and are not seen as a major public health problem. Despite increasing attention investment on maternal neonatal, and child health, stillbirths remain invisible-not recorded in the Millennium Development Goals, not tracked by the United Nations (UN) or in the Global Burden of Disease metrics. Rates of stillbirth closely mirror the use of maternal healthcare services. They are generally higher in economically poorer communities with poor access and/or low utilization of peri-conceptual and antenatal care (ANC) services, compared with economically well-off populations with good access and high utilization of ANC services. Hence majority of stillbirths occur in low and middle countries, and more than half of these happen in rural sub-Saharan Africa.

Based on [2] finding in the study of teratology (study of birth defects and their causes and includes investigations pertaining to both structural and behavioral abnormalities). Young reported that the figures of the incidences in the neonate period represent only a part of the actual incidence of congenital malformations.[3] examined the relationship defect in pregnancy and the development of congenital malformations, in population based retrospective study using birth certificate data for all life born children in his research. Abruptio placentae are one of the leading causes of perinatal deaths. Abruptio placentae increase the neonatal morbidity and mortality. It is one of the recognized causes of low birth weight.[4] examined the risk factors for abruptio placentae together with the maternal and fetal outcome in a large population-based data set. He discovered that an increased risk for abruptio placentae associated with maternal diabetes, hypertension, pre-eclampsia and polyhydramnios and that infant born after abruptio placentae were small for gestational age and had lower Apgar scores than the control infants. in his study to assess the subsequent pregnancy outcome with previous stillbirth discovered similar subsequent rates were found in women with previous stillbirth and live birth (61.1% and 54.6%) respectively [5].

[6] compared the maternal-fetal outcome in pregnant women of advanced age (bigger than 35 years old) with those smaller than 30 years. 268 pregnant women were studied that went for their control and attention of the childbirth, corresponding 134 patients of more than 35 years and 134 patients between 20-29 years (control group). Cases were excluded if presented confounding variables (smoking, obesity, multiparity and maternal illnesses associated to the pregnancy). [7] examine the effects of advanced maternal age, nulliparity, and smoking on risk of stillbirth as gestation advances, and to explore possible clinical mediators of these effects. He found out that Older women (35 years or older), smokers, and nulliparas had elevated risks of stillbirth. The elevated stillbirth risk in smokers was eliminated when women with intrauterine growth retardation, placental abruption, and placenta previa were excluded from the analysis. However, the higher risks in older women and nulliparas persisted even when the analysis excluded women with hypertension, diabetes, placental complications, or growth retardation. Over the course of the third trimester, the age-related risk of stillbirth increased, the smoking related risk decreased, and the higher risk in nulliparas showed no clear trend with gestational age. [8] observed Obstetric outcomes subsequent to intrauterine death in the first pregnancy compared obstetric outcomes in the pregnancy subsequent to intrauterine death with that following live birth in first pregnancy using time series analysis. Time Series Analysis is the best tool, when it comes to future planning and forecasting on future events based on the past events. This is one of the reasons [9] estimated the correlation Analysis of Male and Female live birth using product moment correlation coefficient and likewise that of still birth. Also compare live birth and still birth by finding the correlation between the two and the trend of both live birth and still birth and then concluded by plotting it on Time Plot [10] used both probabilistic and deterministic approach to model the birth and death of infant in the local government [11] partitioned the variation of the live birth time series data, the trend, seasonal index, cyclical variation and irregular variation to forecast. However, in this project, interest will be on modeling the monthly live birth and that of still birth after which a forecast will also be made before given recommendation to the health officials in Gwagwalada and Nigeria in general [12] in their study on major airline disaster in the world from 1960-2013 also fitted an ARIMA model and found out that ARIMA (0 1 1) was the best model in forecasting airline disaster.

## 2. Material and Method

The research work was carried out on the monthly record of live birth and still birth in university of Abuja teaching hospital Gwagwalada, Abuja, Nigeria, over the period of 1996 and 2015. The University of Abuja is located Gwagwalada in the Federal Capital Territory of Nigeria. It is 350-bed hospital with facility for expansion to 500 beds. The hospital metamorphosed from a specialist hospital in 1982 under the Federal Medical center in 1993 following its transfer to the Federal Ministry of Health.

- Study location: The study was carried out in the Department of Statistics, Faculty of Science, University of Abuja, Nigeria.
- Study Duration: The data was collected on a monthly basis from January, 1996 to December, 2015.

### 2.1. Sample

The collected data for this work is limited to twenty years, i.e. from 1996 – 2015 and is restricted to live birth and stillbirth in University of Abuja Teaching hospital, Gwagwalada, Abuja, Nigeria. The data was collected from the University of Abuja Teaching Hospital Gwagwalada, Abuja, Nigeria.

### 2.2. Statistical Analysis

R console was used to analyze the data. Time plot was plotted and stationarity test was also conducted on the data to know whether the data are stationary or not. The deterministic model was fitted and forecast was made. Probabilistic model identification, fitting of appropriate model and forecast was also carried out. However, the models fitted satisfy stationarity condition and also had the minimum Akaike Information Criterion. In which ARIMA (3 1 2) and ARIMA (2 1 1) was fitted led to the forecast that live birth increased and then decreased for some time before and then decreased totally.

### 2.3. Time Series Analysis

Time series is defined as a collection of data made sequentially in time. Each time series describe a phenomenon as a function of time for example daily stock price could be used to describe the fluctuations in the stock market. It is usually denoted by  $X_t$  where  $X_t$  is the observed value at time t. the time interval may be daily, monthly, quarterly or yearly.

## 2.4. Types of Time Series Data

There are basically two types of time series data which are: -

### 2.4.1. Discrete

A time series is said to be discrete if the observation is recorded in discrete times (either specific time). The time interval can be annually, quarterly, monthly, weekly, daily, hourly etc.

### 2.4.2. Continuous

A time series is said to be continuous if observation is made continuously for example temperature and/or humidity in some laboratory. A continuous time series can be converted to discrete by measuring its constant interval.

## 2.5. Objectives of Time Series

- Time plot: the first step in time series is the time plot. Its help us understand the behavior of the series.
- Predict the future (forecast): given an observed time series data. The future values of the can be generated.
- After time series data have been generated and a stochastic model fitted then the input process is adjusted so as to keep the series on target. In order to get deeper understanding of the mechanism which generated the series, the variation in one series is been used to explain the variation in another series.
- Components of time series
- (i)Trend component: Denoted by  $T_t$ , it is a constant rise or fall (on average) in the value of the series. Trend can be linear or non-linear upward or downward. A time series is said to contain trend if the mean increase or decreases over time.
- Seasonal Variation: This occurs when time series data exhibits the same behavior at corresponding period of every year, month's etc. seasonal variation is usually denoted by  $S_t$ .
- (ii) Cyclical Variation: long term oscillatory of the mean about the trend line. An example of cyclical component is in the business cycle which represents period of prosperity and followed by recession. The pattern may repeat its self over a long period of time like in the case of oil boom in the 80's compared to now, that there is a drop in oil price worldwide usually denoted by  $C_t$ .
- Irregular component: it is the left over in the data upon the removal of the trend, seasonal and cyclical component. There are caused by unpredicted factors such as war, earth etc. denoted by  $I_t$ .

## 3. Results

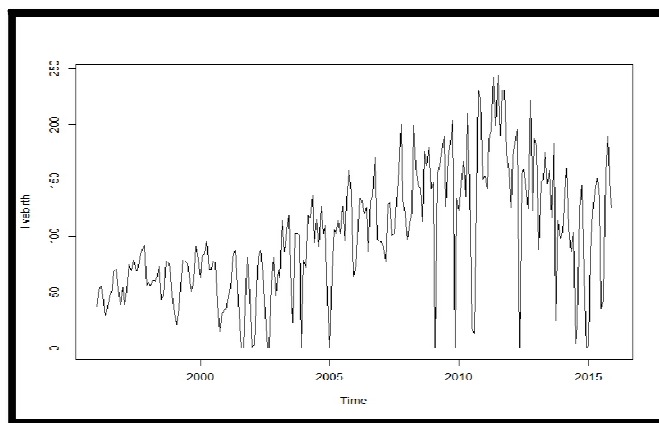


Figure 1: Time Plot of the Original Live Birth Data

From the figure No 1 above it is observed that the series is not stationary since the mean and the variances are not constant over time. A formal test was then carried out to augment the graphical analysis already displayed in figure No 1.

Test type	Test statistic	lag order	p-value
ADF	-2.8081	6	2.36E-01
KPSS	3.366	3	0.01

Table 1: Stationarity Test of Live Birth Data

For ADF test

Hypothesis  $H_0: \mu_1 = \mu_2 = \dots = \mu_k$  (series is stationary) vs  
 $H_1: \mu_i \neq \mu_j$  for at least one (series not stationary)

Decision rule: accept  $H_0$  if p-value greater than 0.05

For KPSS test.

Hypothesis  $H_0: \mu_1 = \mu_2 = \dots = \mu_k$  (series is stationary) vs  $H_1: \mu_i \neq \mu_j$  for at least one (series is not stationary)

- Decision rule: reject  $H_0$  if p-value less than 0.05

From these two tests it is clear that the series is not stationary and will therefore need to be differenced.

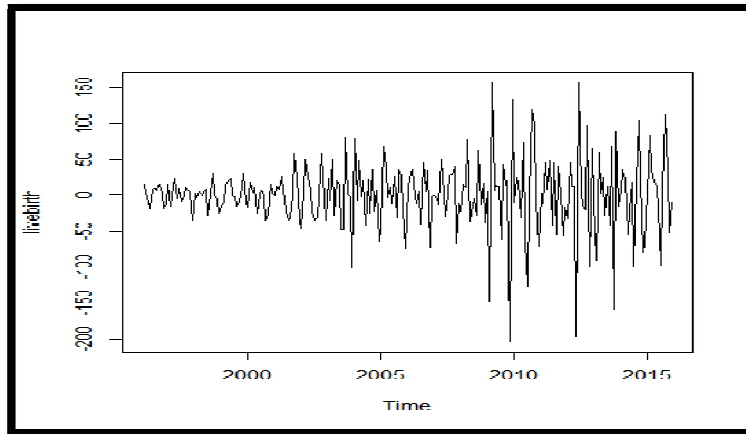


Figure 2: Plot of First Order Difference of Live Birth Data

From the figure No.2 above it is observed that the series is stationary since the mean and variances are unchanged over time after the first difference. A formal test was then carried out to augment the graphical analysis already displayed in figure No.2.

Test type	Test statistic	lag order	p-value
ADF	-2.8081	6	2.36E-01
Kpss	0.012958	3	0.1

Table 2: Stationarity Tests for the Differenced Live Birth Data

For ADF test

Hypothesis:  $H_0: \mu_i \neq \mu_j$  for at least one

$H_1: \mu_1 = \mu_2 = \dots = \mu_k$  vs

Decision rule: reject  $H_0$  if p-value less than 0.05

For KPSS test

Hypothesis:  $H_0: \mu_1 = \mu_2 = \dots = \mu_k$  vs

$H_1: \mu_i \neq \mu_j$  for at least one

- Decision rule: reject  $H_0$  if p-value less than 0.05

From these two tests it is clear that the series is now stationary and can be used for further analysis.

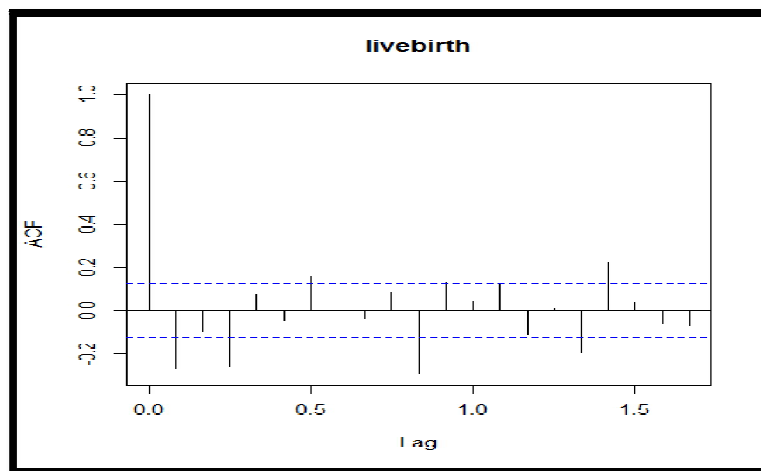


Figure 3: Plot of Autocorrelation Function of the Differenced Series

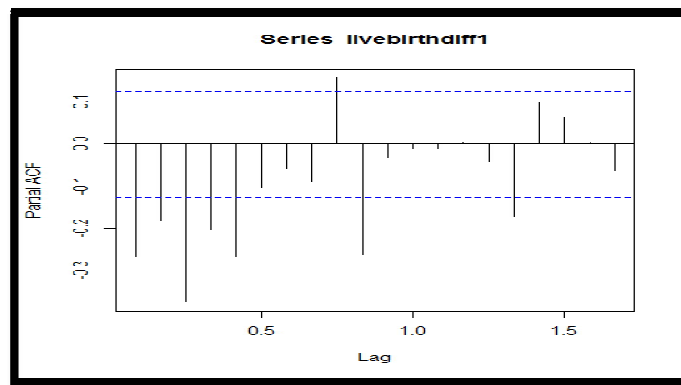


Figure 4: Plot of Partial Autocorrelation Functions of the Differenced Series

Figure No.3 and figure No.4 above represents the autocorrelation and partial autocorrelation functions of the differenced live birth data respectively. The autocorrelation function has a cut off at lag 1,2,4,7 and 10 which suggest a moving average (MA) of order (1 2 4 7 10) while the partial autocorrelation function has a cut off at lag 1,2,3,4, and 5 which suggest an autoregressive (AR) of order (1 2 3 4 5). Hence the numbers of possible models were identified, these models are: ARIMA (1 1 1), ARIMA (1 1 2), ARIMA (1 1 4), ARIMA (2 1 1), ARIMA (2 1 2), ARIMA (2 1 4), ARIMA (3 1 1), ARIMA (3 1 2) and ARIMA (3 1 4), other possible combinations were also tested and found to be insignificant that's why they were not in added list of models. Meanwhile the other nine models were statistically analyzed and the results were summarized in table No 3.

ARIMA Structures	Parameter Estimation	p-value	AIC	Sigma <sup>2</sup> estimated
ARIMA (1,1,1)	AR(1)=0.2628 MA(1)=-1.000	2.556272e-05 0.000000e+00	2508.32	2102
ARIMA(1,1,2)	AR(1)=0.3249 MA(1)=1.9053 MA(2)=0.9055	1.163865e-05 0.000000e+00 0.000000e+00	2454.27	1634
ARIMA(1,1,4)	AR(1)=0.6948 MA(1)=0.8038 MA(2)=0.7663 MA(3)=0.1887 MA(4)=0.3816	4.033285e-11 7.004886e-11 4.226839e-06 3.724680e-02 2.355725e-07	2447.1	1556
ARIMA(2,1,1)	AR(1)=0.3113 AR(2)=0.1780 MA(1)=-1.000	1.061780e-06 5.246617e-03 0.000000e+00	2502.67	2032
ARIMA(2,1,2)	AR(1)=0.3328 AR(2)=0.1229 MA(1)=0.18806 MA(2) = 0.8806	6.376973e-06 7.856032e-02 0.000000e+00 0.000000e+00	2453.19	1611
ARIMA(2,1,4)	AR(1)=-1.0040 AR(2)=-0.3490 MA(1)=0.5264 MA(2)=-0.9434 MA(3)=0.1635 MA(4)=0.6333	6.661338e-16 1.110830e-02 3.095926e-07 1.554312e-15 2.601656e-01 1.199041e-13	2444.87	1527
ARIMA(3,1,1)	AR(1)=-0.3803 AR(2)=0.2967 AR(3)=0.3712 MA(1)=1.0000	2.384117e-10 1.691776e-06 5.590535e-10 0.000000e+00	2469.26	1744
ARIMA(3,1,2)	AR(1)=0.1973 AR(2)=0.1124 AR(3)=0.2635 MA(1)=1.7622 MA(2)=0.7622	0.02412059 0.099993645 0.00029130 0.0000000000 0.0000000000	2443.1	1533
ARIMA(3,1,4)	AR(1)=0.0234 AR(2)=0.0719 AR(3)=0.3338 MA(1)=1.5788 MA(2)=0.2838 MA(3)=0.4242 MA(4)=0.1292	9.155621e-01 6.329909e-01 2.246392e-04 4.663159e-12 4.933938e-01 1.543422e-01 3.811753e-01	2446.14	1527

Table 3: ARIMA Model Estimation Results (Live Birth)

Table No.3 above presents the parameter estimates of different ARIMA models as suggested by plot of ACF and PACF. Comparing the different ARIMA models using AIC, ARIMA (3 1 2) was chosen as the best model because the AIC is less than other models AIC. Thus, the mathematical is there given below

$$x_t = \delta + 0.1973y_{t-1} + 0.1124y_{t-2} + 0.2635y_{t-3} + \varepsilon_t - 1.7622\varepsilon_{t-1} - 0.7622\varepsilon_{t-2}$$

coefficient	Estimate	AIC	p-value	S.E
		2443.1		
AR(1)	0.1973		0.02412059	0.0875
AR(2)	0.1124		0.09999365	0.0683
AR(3)	0.2635		0.0002913	0.0727
MA(1)	0.17622		0	0.078
MA(2)	0.7622		0	0.0773

Table 4: Parameter Estimates of ARIMA (3 1 2)

Table No.4 presents the result of the estimation of ARIMA (3 1 2) and confirm that the model is the most suitable for forecasting the live birth data, a formal test was carried out to further check its authenticity of the model which is shown in table 4.6 below.

Test type	Test statistic x^2	Df	p-value
Box-Ljung	0.0037636	1	0.9511

Table 5: Ljung-Box test of ARIMA (3 1 2)

- Hypothesis H<sub>0</sub>: the test is not significant
- H<sub>1</sub>: the test is significant
- Decision reject: H<sub>0</sub> if p-value is less than 0.05.

Table No.5 shows the diagnostic check of the model and the p-value was large (greater than the usually chosen critical level of 0.05), this clearly show that the test is not significant and therefore we do not reject the null hypothesis, thus the residuals appear to be uncorrelated. This indicates that the residuals of the fitted ARIMA (3 1 2) is a white noise and for that reason, the model fit the series quite well.

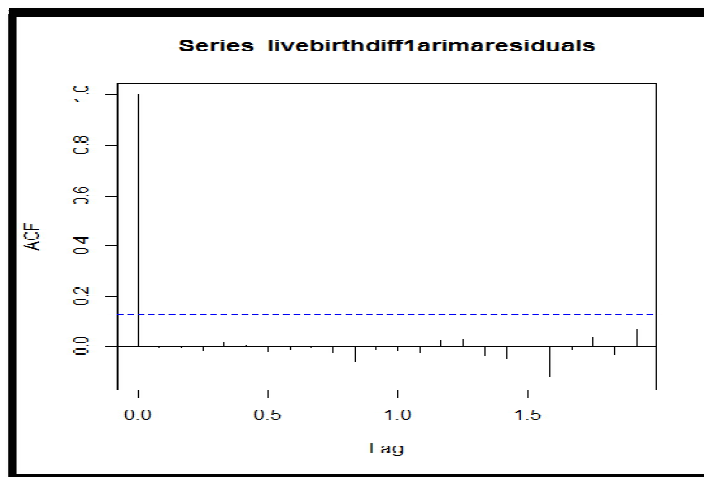


Figure 5: Autocorrelation Function of the Live Birth Residual

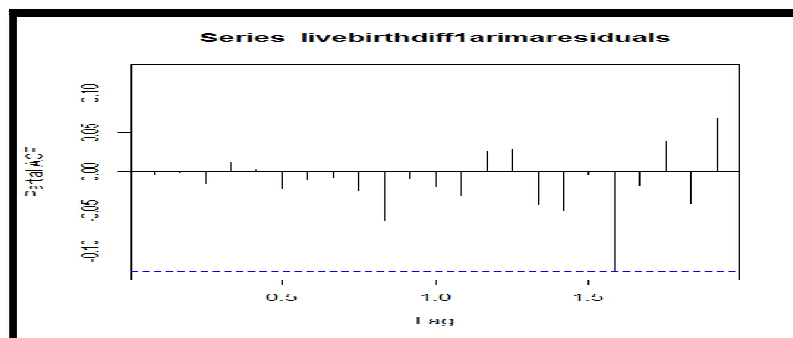


Figure 6: Partial Autocorrelation Function of the Live Birth Residual

Figure No.5 and figure No.6 shows the time plots of the autocorrelation function and the partial autocorrelation function of live birth residuals respectively, the time plots the residuals appears to be randomly scattered, no correlation between the error term. The residuals therefore conceived of an independently distributed sequence with zero mean and constant variance. The ACF and PACF plots of the residuals also shows no great evidence of significant spike indicating the uncorrelation between the residuals indicating that the residuals of ARIMA (3 1 2) is a white noise, therefore ARIMA (3 1 2) is the best model that can be used for forecasting the live birth series.

Point	Forecast	Lo 95	Hi 95
Jan-16	-24.613	-101.527	52.302
Feb-16	10.601	-77.573	98.777
Mar-16	7.862	-81.950	97.675
Apr-16	7.216	-84.526	98.957
May-16	-1.883	-94.132	90.366
Jun-16	-2.884	-95.532	89.764
Jul-16	-1.889	-94.707	90.929
Aug-16	0.817	-92.030	93.665
Sep-16	1.503	-91.402	94.408
Oct-16	1.073	-91.850	93.994
Nov-16	0.197	-92.727	93.122
Dec-16	-0.108	-93.041	92.825
Jan-17	0.044	-92.892	92.980
Feb-17	0.339	-92.598	93.275
Mar-17	0.460	-92.477	93.397
Apr-17	0.411	-92.526	93.348
May-17	0.310	-92.627	93.247
Jun-17	0.264	-92.674	93.201
Jul-17	0.279	-92.659	93.216
Aug-17	0.314	-92.624	93.251
Sep-17	0.331	-92.607	93.269
Oct-17	0.327	-92.611	93.264
Nov-17	0.315	-92.623	93.252
Dec-17	0.308	-92.630	93.246

Table 6: Forecasts Results with the Fitted ARIMA (3, 1, 2) Model

Table No.6 shows the forecast values of live birth data of (2016 and 2017) with 95% confidence interval i.e. lower confidence limit (LCL) and upper confidence limit (UCL) were summarized in table No.5 while the corresponding figure No.7 below shows the forecast plot of live birth in university of Abuja teaching hospital Gwagwalada Abuja. The values of the forecast show that the occurrence of live birth will decrease at some point and also increase but not at a constant rate.

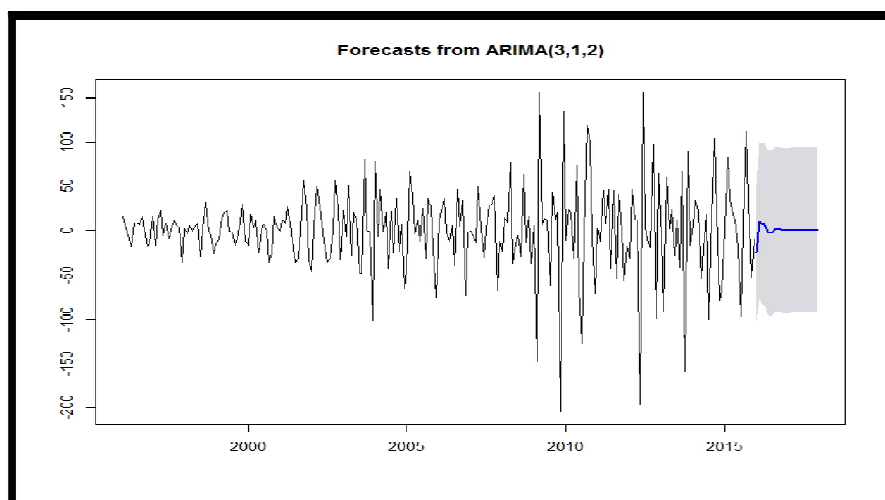


Figure 7: Plot of the Forecast from ARIMA (3 1 2)

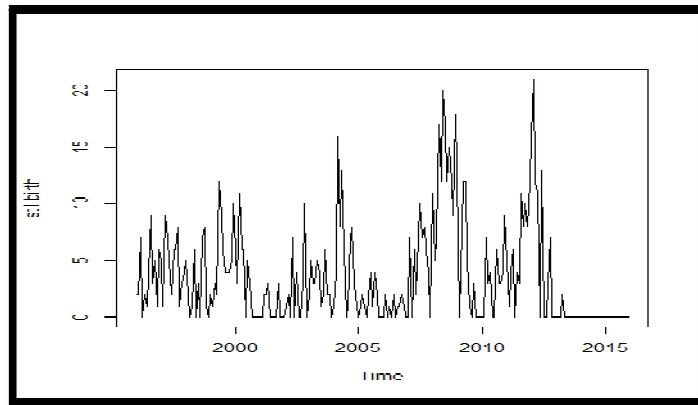


Figure 8: Time Plot of the Original Stillbirth Data

From figure No.8 above shows that the stillbirth data is not stationary since the mean and variances are not constant over time a formal test was also carried out to augment the graph already displayed in figure No.8.

Test type	Test statistic	Lag order	p-value
ADF	-3.4063,	6	0.0542

Table 7: Stationarity Test of Stillbirth Data

ADF test

Hypothesis:  $H_0: \mu_i \neq \mu_j$  for at least one (series not stationary)

$H_1: \mu_1 = \mu_2 = \dots = \mu_k$  (series stationary)

- Decision rule: reject  $H_0$  if p-value less than 0.05

From table No.7 clearly shows that the series is not stationary and will need to be differenced before further analysis can be done.

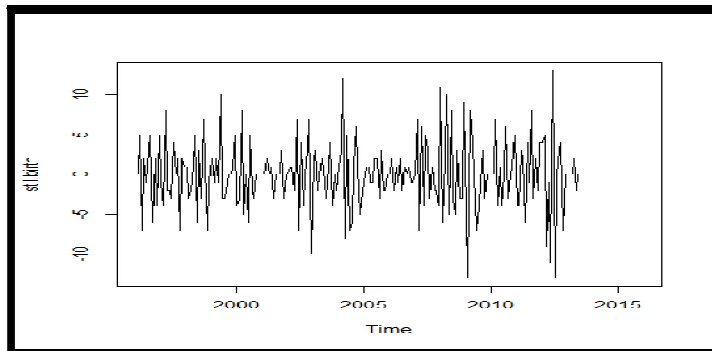


Figure 9: First Order Difference of Stillbirth Data

Figure No.9 above shows the plot of the differenced series and it is observed that the series is now stationary with constant mean and variances after the first difference; hence the data can now be used for further analysis. A formal test was carried out to augment the graph displayed in figure No.9.

Test type	Test statistic	lag order	p-value
ADF	-7.4077	6	1.00E-02

Table 8: Stationarity Test of the Differenced Stillbirth Series

Hypothesis:  $H_0: \mu_i \neq \mu_j$  for at least one (series not stationary) vs

$H_1: \mu_1 = \mu_2 = \dots = \mu_k$  (series stationary)

- Decision rule: reject  $H_0$  if p-value less than 0.05

Now from the estimates of the ADF test above the null hypothesis is rejected in favor of the alternative hypothesis which also proves the stationarity of the series.



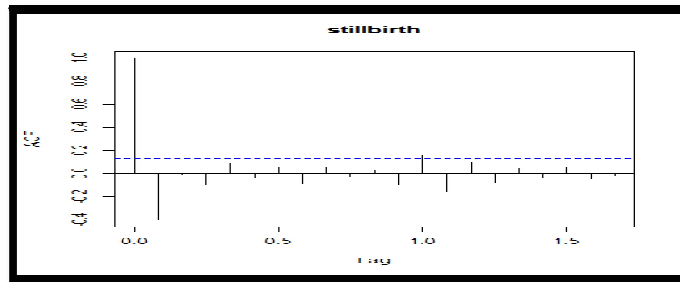


Figure 10: Plot of the Autocorrelation Function of the Differenced Series

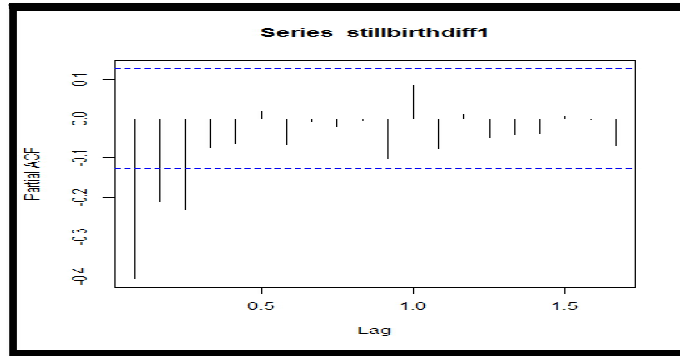


Figure 11: Plot of the Partial Autocorrelation Function of the Differenced Series

ARIMA Structures	Parameter Estimation	p-value	AIC	Sigma <sup>2</sup> estimated	Log likelihood
ARIMA(1,1,1)	AR(1)=0.4034 MA(1) -1.000	8.82E-12 0.00E+00	1306.16	13.44	-650.08
ARIMA(1,1,2)	AR(1)=0.0928 MA(1)=1.6568 MA(2)=0.6568	3.90E-01 0.00E+00 5.55E-15	1285.3	12.13	-638.65
ARIMA(1,1,0)	AR(1)=0.6399	0	1461.49	26.68	-728.74
ARIMA(2,1,1)	AR(1)=0.4889 AR(2)=0.2079 MA(1)=-1.000	1.22E-14 1.04E-03 0.00E+00	1297.67	12.84	-644.84
ARIMA(2,1,2)	AR(1)=0.1011 AR(2)=0.0087 MA(1)=1.6656 MA(2)=0.6656	4.73E-01 9.30E-01 0.00E+00 1.45E-07	1287.29	12.13	-638.65
ARIMA(2,1,0)	AR(1)=0.9005 AR(2)=0.4073	0.00E+00 6.43E-12	1420.56	22.24	-728.74
ARIMA(3,1,1)	AR(1)=0.5372 AR(2)=0.3192 AR(3)=0.2263 MA(1)=-1.000	0.00E+00 3.76E-06 3.43E-04 0.00E+00	1287.23	12.15	-638.61
ARIMA(3,1,2)	AR(1)=0.1729 AR(2)=0.1396 AR(3)=0.1472 MA(1)=1.3871 MA(2)=0.3871	5.08E-01 3.46E-01 1.41E-01 1.57E-07 1.43E-01	1287.56	12.05	-637.78
ARIMA(3,1,0)	AR(1)=1.0683 AR(2)=-0.776 AR(3)=0.4111	0.00E+00 0.00E+00 3.11E-12	1378.55	18.44	-685.27

Table 9: ARIMA Model Estimation Results (Stillbirth)

Table No.9 shows the estimation of the different ARIMA models that can be used in forecasting the series. Now comparing the different ARIMA models in other to choose the most suitable model for forecasting the stillbirth series, it is discovered that ARIMA (1 1 2) is the most suitable model since it has the lowest AIC. A formal test was carried out to further check the authenticity of the model.

Coefficient	Estimate	AIC	p-value	S.E
		1285.3		
AR(1)	0.0928		3.90E-01	0.108
MA(1)	1.6568		0.00E+00	0.0846
MA(2)	0.6568		5.55E-15	0.0841

Table 10: ARIMA (1 1 2) Results

Table No.10 shows the result of the estimation of ARIMA (1 1 2) and to confirm that the model is the most suitable for forecasting the live birth data, a formal test was carried out to further check its authenticity of the model which is shown in table No.11 below.

Test type	Test statistic $\chi^2$	Df	p-value
Box-Ljung	0.61428	1	0.4332

Table 11: Ljung-Box test of ARIMA (1 1 2)

- Hypothesis  $H_0$ : the test is not significant
- $H_1$ : the test is significant
- Decision reject:  $H_0$  if p-value is less than 0.05.

Table No.11 shows the diagnostic check of the model and the p-value was large (greater than the usually chosen critical level of 0.05), this clearly show that the test is not significant and therefore we do not reject the null hypothesis, thus the residuals appear to be uncorrelated. This indicates that the residuals of the fitted ARIMA (1 1 2) is a white noise and for that reason, the model fit the series quite well.

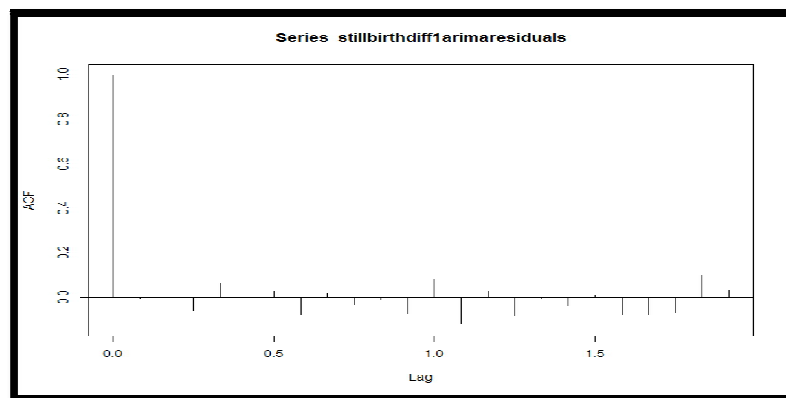


Figure 12: Autocorrelation Function of the Fitted Stillbirth Residual

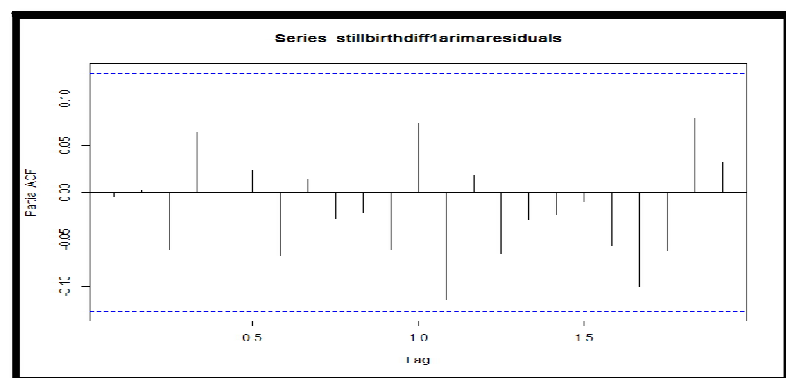


Figure 13: Partial Autocorrelation Function of the Fitted Stillbirth Residual

Figure No.12 and figure No.13 shows the time plots of the autocorrelation function and the partial autocorrelation function of live birth residuals respectively, the time plots the residuals appears to be randomly scattered, no correlation between the error term. The residuals therefore conceived of an independently distributed sequence with zero mean and constant variance. The ACF and PACF plots of the residuals also shows no great evidence of significant spike indicating the uncorrelation between the residuals indicating that the residuals of ARIMA (3 1 2) is a white noise, there ARIMA (3 1 2) is the best model that can be used for forecasting the live birth series.

Point	Forecast	Lo 95	Hi 95
Jan-16	-0.019	-7.056	7.019
Feb-16	-0.010	-7.830	7.811
Mar-16	-0.010	-7.834	7.813
Apr-16	-0.012	-7.860	7.837
May-16	-0.011	-7.866	7.844
Jun-16	-0.011	-7.866	7.844
Jul-16	-0.011	-7.867	7.844
Aug-16	-0.011	-7.866	7.845
Sep-16	-0.011	-7.867	7.845
Oct-16	-0.011	-7.867	7.845
Nov-16	-0.011	-7.867	7.845
Dec-16	-0.011	-7.867	7.845
Jan-17	-0.011	-7.867	7.845
Feb-17	-0.011	-7.867	7.845
Mar-17	-0.011	-7.867	7.845
Apr-17	-0.011	-7.867	7.845
May-17	-0.011	-7.867	7.845
Jun-17	-0.011	-7.867	7.845
Jul-17	-0.011	-7.867	7.845
Aug-17	-0.011	-7.867	7.845
Sep-17	-0.011	-7.867	7.845
Oct-17	-0.011	-7.867	7.845
Nov-17	-0.011	-7.867	7.845
Dec-17	-0.011	-7.867	7.845

Table 12: Forecast Values of the Differenced Stillbirth Series

Table No.12 shows the forecast values of live birth data of (2016 and 2017) with 95% confidence interval. The values of the forecast show that the occurrence of live birth will decrease at some point and also increase but not at a constant rate. The equation of the forecast used is given as:  $x_t = \delta + 0.0928y_t + \varepsilon_t - 1.6568\varepsilon_{t-1} - 0.6568\varepsilon_{t-2}$

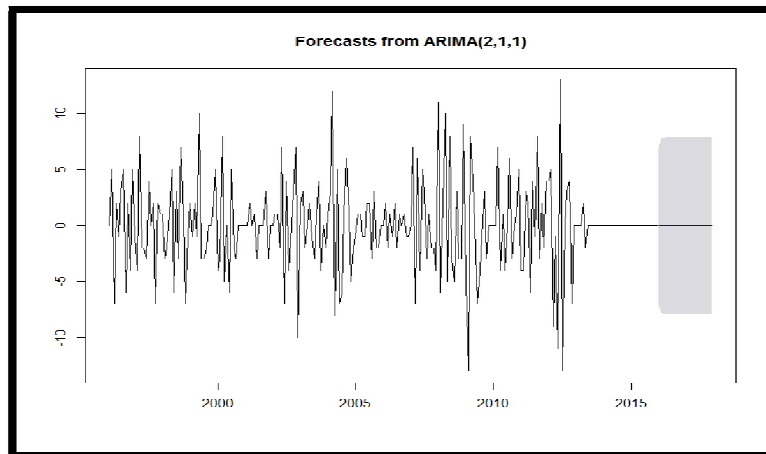


Figure 14: Plot of the Forecast from ARIMA (2 1 1)

### 3.1. The Models

The behavior of ACF and PACF may not give sufficient insight regarding the model to be estimated. We therefore, make different specification among the class of AR (p), MA (q) or the combination of both models. The criterion for the choice of a model is based on the minimum Akaike Information Criterion (AIC). It supposed that the model entertained have the parameters that are significance. ARIMA (3 1 2) and ARIMA (2 1 1) were found suitable for the two variables that is, live birth and stillbirth respectively which are given as:

$$(i) \text{ Live birth: } x_t = \delta + 0.1973y_{t-1} + 0.1124y_{t-2} + 0.2635y_{t-3} + \varepsilon_t - 1.7622\varepsilon_{t-1} - 0.7622\varepsilon_{t-2}$$

$$(ii) \text{ Stillbirth: } x_t = \delta + 0.0928y_t + \varepsilon_t - 1.6568\varepsilon_{t-1} - 0.6568\varepsilon_{t-2}$$

## 4. Discussion

During the course of this study, it was noted/discovered that the data on live birth and stillbirth had irregular patterns such that, it goes very high at a period and very low at another. Also, the trend estimated showed a positive correlation between the live birth and still birth.

Furthermore, the deterministic model was fitted and forecast was made. Probabilistic model identification, fitting of appropriate model and forecast was also carried out. However, the models fitted satisfy stationarity condition and also had the minimum Akaike Information Criterion. In which ARIMA (3 1 2) and ARIMA (2 1 1) was fitted led to the forecast that live birth increased and then decreased for some time before and then decreased totally. It was also noticed in the original data collected that the total number of live births in August and September 2001 and 2002 and some other months was decreased leading to a decrease in the still birth.

Lastly, it was discovered that maybe the number of pregnant women in the labour room at a time out-weighed the number of nursing staffs making them inefficient and leading to some of the pregnant women being in labour for too long which lead to death of the fetal in the womb before delivery.

Also, some of the nursing mothers were not properly orientated on the kind of health care required during pregnancy and the level of poverty in the country may have contributed to the increase in stillbirth during delivery.

## 5. Conclusion

Based on this study, ARIMA (3 1 2) and ARIMA (2 1 1) were found appropriately fit to the live birth and stillbirth respectively. Increase in live birth also account for the increase in still birth and showed that as time goes on, more live birth and stillbirth will be noticed. This could be reduced drastically if women are well oriented and have standard good health condition.

## 6. Reference

- i. (WHO, 2009): still birth as a destroyer.
- ii. Young (1992): Birth defects and their causes and including investigations pertaining to both structural and behavioral abnormalities).
- iii. Salder (1990): Relationship defect in pregnancy and the development of congenital malformations
- iv. Saudi Med J (2004): Risk factors of Abruption Placentae
- v. J. Reprod (2007). Subsequent pregnancy outcome with previous stillbirth
- vi. Ginecol Obstet Mex. (1999) Maternal-fetal outcome in pregnant women of advanced age (bigger than 35 years old) and smaller than 30 years.
- vii. Br J Obstet Gynaecol (1994) The effects of advanced maternal age, nulliparity, and smoking on risk of stillbirth as gestation advances, and clinical mediators of these effects.
- viii. B. JOG (2008) obstetric outcomes subsequent to intrauterine death in the first pregnancy
- ix. Agboola O.J. (2005): Statistical Analysis of Childbirth (A case study of Adeoyo Maternity Hospital, Ibadan (Project)
- x. Odularu, (2007) probabilistic and deterministic approach of birth and death of infant in a local government.
- xi. Gbadamosi (1998) variation of live birth time series data
- xii. Nasiru M. O and Olanrewaju S. O (2013) time series analysis of major airline disaster in the world from 1960-2013