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RESEARCH ARTICLE

TIME SERIES ANALYSIS OF HIV/AIDS CARRIERS IN OSUN STATE, NIGERIA

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ABSTRACT

This research work is a statistical analysis of the HIV/AIDS carrier between the periods 2001 – 2011 in Osun state, Nigeria. The data used was extracted from the Osun State Action Committee on AIDS (SACA) records. Time series analysis was employed to analyze, measure, compute variation and fluctuation in the number of HIV/AIDS carriers in Osun state. Trends were obtained from least square method and the Autoregressive model. The criteria of selection of models used were Akaike information Criteria (AIC) and Schwartz Information Criteria (SIC) of which AIC AR(5) was chosen. The standard error was estimated for both predicted HIV/AIDS carrier rate using least square method and autoregressive model. Based on the fact from the analysis made, it could be concluded that the rate of HIV/AIDS carriers in Osun state fluctuates over the period "t".

INTRODUCTION

The menace of HIV/AIDS has an alarming rate worldwide giving concerns to governments, non-governmental organizations and researchers. There has been numerous efforts by individuals, groups and organizations in past years to stem the rapid rate of the spread of this infection and some success has been recorded. The first case of AIDS was identified in Nigeria in 1986 and HIV/AIDS prevalence rate rose from 1.8 % in 1988 to 5.8 % in 2001. However in Osun state, the first case of HIV/AIDS was in 1991 at Ile-Ife in three (3) people. Currently, lle-ife and its environs have the highest number of HIV/AIDS and it is connected with the large number of youths in the area. In 2004, it was estimated that there were 30,000 deaths from AIDS and 2 million AIDS orphans. There are large increases in the number of HIV positive children recently, 90% of which contact the virus from their mothers. In 2008, the estimate was that there were 30 million adults living with HIV/AIDS in Nigeria, and 57% of these were women. While the national prevalence rate has dropped to 5%, the state prevalence rate vary from 1.2% in Osun state to 12% in Cross-Rivers state.

A wide range of variation was observed in the HIV/AIDS carriers detected and recorded in various hospitals in Osun state both at government and private hospitals. Each victim (HIV/AIDS carriers) detected was recorded against the month and year. In reducing the number of HIV/AIDS carriers in the state, the government has put some groups in place for research on prevention and necessary cure for carriers under the supervision of the ministry of health. Since 1991, the Federal Ministry of Health has carried out a national HIV/Syphilis sentinel seroprevalance survey every two years. Currently, few Nigerians have access to basic HIV/AIDS prevention, care, support, or treatment services. Around 52,000 thousand people are estimated to require ART (Anti-retroviral therapy) and only 37,000 are currently receiving treatment. At present, there are 50 treatment sites for HIV/AIDS in Nigeria

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Mode of Transmission and Clinical Features of HIV/AIDS

Hellen O. Nwagwu (1999) stated that HIV/AIDS is being contracted in various ways among which are: Blood transfusion; unsterilized piercing instruments; infected mother/parent transmission; and Sexual intercourse (most common in Nigeria). HIV is classified as retrovirus, the genetics blue print of HIV is in the form of RNA (Ribonucleic Acid) and not DNA (Deoxyribonucleic Acid). HIV belongs to a specific sub -groups of retroviruses known as lentiviruses because it can be latent for a lengthy period before serious symptom of diseases manifests. On entrance of the virus into the human body, it contends with the T and B cells of the white blood cells.

MATERIAL AND MODEL

Source of Data

The data used for this work is secondary data. The various hospitals in the state (both public and private) that do HIV/AIDS test recorded the number of persons positive to the test and look it to the state ministry of health on monthly basis, and this data was taken and analyzed.

Statistical Tools Used For Time Series Analysis

The data was analyzed by considering the least square method, moving average method, Levinson Durbin Algorithm (to know the order) and auto-covariance generating function. The first method, as well as other various methods and functions used are stated and/or discussed below.

Least Square Method

This involves the process whereby a straight line or curve is fitted to a series of data. The equationis formulated thus:

Let $Y_i = \beta_0 + \beta_t + E_t$

Then,

$\hat{Y} = \text{└} + \beta_t$ is the estimate

Where,

$$\text{└} = \frac{\sum Y}{n} - \frac{\beta \sum t}{n}$$

And

$$\beta = \frac{n\sum Yt - \sum Y \sum t}{n\sum t^2 - (\sum t)^2}$$

Where $Y_1, Y_2, \ldots\ldots\ldots, Yn$ is the set of observations

Moving Average Method

There can be three (3) points moving average (3PTMA), four (4) point moving average (4PTMA) and among others. But in this work twelve (12) points moving average (12PTMA) on monthly basis of the specified years was used. The result for Y set of data was:

$$\frac{Y_1 + Y_2 + \ldots\ldots\ldots\ldots\ldots\ldots + Y_{11} + Y_{12}}{12}$$

$$\frac{Y_2 + Y_3 + \ldots\ldots\ldots\ldots\ldots\ldots + Y_{12} + Y_{13}}{12}$$

$$\frac{Y_3 + Y_4 + \ldots\ldots\ldots\ldots\ldots\ldots + Y_{13} + Y_{14}}{12}$$

The Concept of Differencing

Differencing entails the removal of non-stationary which is simply to differentiate a given series until it becomes stationary. For non-stationary data, first order differencing is usually sufficient for original series ($X_1, X_2, \ldots\ldots\ldots X_n$), the newseries ($Y_1, Y_2, \ldots\ldots\ldots Y_n$) was formed by using the following relation.

$Y_t = X_{t+1} - X = \Delta X_t$

Time Series Model

D.K Shangodoyin and J.F Ojo (2002), identified two ways which the component interact to give rise to time series, namely;

1- Multiplicative Model: Mathematically, the multiplicative model can be written as:

$X_t = T_t \times S_t \times C_t \times I_t$

Where,

T_t = Trend
S_t = Seasonal variation
C_t = Cyclical variation
l_t = Irregular variation

Additive Model: Mathematically written as:
$X_t = T_t + S_t + C_t + I_t$

The General Linear Process

The simplex example of stationary process is white noise process or purely random process (E_t). Thus, as purely random process (E_t) is said to be white noise process if:

$E(Et^2) = \sigma^2$
For all K x O
$E(E_t, E_{t+1}) = 0$

the time series X_t is said to follow general linear process if:

$X_t = \mu + E_t + \Phi E_{t-j}$

Where $\mu = E(X_t)$ and E_t X is a white noise process (μ is usually to be zero).

We then define a general linear process as;

$X_t = \mu + E_t + \Phi E_{t-j}$

A backward shift operator β can be defined as $\beta X_{t-1} = X_{t-1}$ and $\beta X_{t-1} = X_t$, similarly

$\beta t = E_{t-1}$ and
$\beta X_t = E_{t-j}$; j = 0, 1, ……

Autoregressive Process

A stationary process of order p designated by AR (p) if it satisfies the difference equation.

$X_t = \Phi_1 X_{t-1} + \Phi_2 X_{t-2} + \Phi_p X_{t-p} + E_t$

Where E_t is a white noise process $\Phi_1, \Phi_2, \ldots\ldots\ldots, \Phi_p$ is a finite set of weight parameters. Introducing the β notation (Backward shift) we can write the equation as: $E_t = X_t$

Deseasonalisation of Data

A data is said to be deseasonalised when the original data is divided by the appropriate seasonal index. The resulting data (adjusted) shows how things would have been if there was no seasonal fluctuation. Therefore, seasonal variation had to be removed in order to get more data. This data would still include trend, cyclical, irregular variations.

Autocovariance of Lag K

$$C_K = \frac{\sum (X_t - X)(X_{t+k} - X)}{N}$$

$$X = \frac{\sum X_t}{N}$$

Autocorrelation of Lag K

$\rho = X_k$
X_0
X_0 = variance of the process

$$\rho = \frac{1/N \sum (X_t - X)(X_{t+k} - X)}{1/N \sum (X_t - X)^2}$$

$X = 1/N \sum X_t$

Autocovariance Generating Function for General Linear Process

The A.G.F function is defined by:

$X_{(B)} = \sum X_k \beta^k$
$X_{(B)} = \sigma^2 \psi_{(B)} \psi^1_{(B)}$

RESULTS

Below, in a tabular form is the set of the first 10 data results using the Least Square Method, showing all values in the functions and its corresponding trend.

The Trend Equation is:
23.44431 – 0.10329t

Results From Estimation of Trend Using Least Square Method

Table 1. First Ten (10) Data Set Trend Using Least Square Method

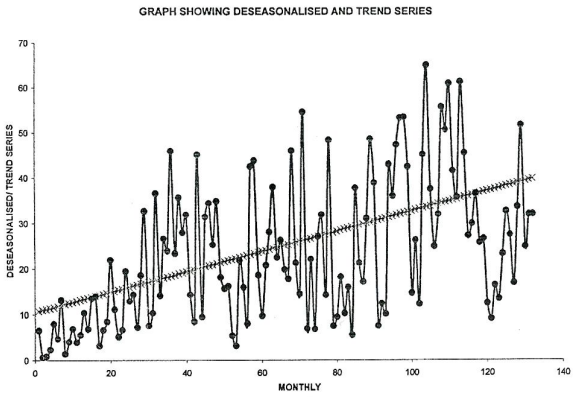
T	Xt	t^2	TXt	Trend
-131	6.497726	17161	-851.20208	9.913151
-129	0.684838	16641	-88.344062	10.11973
-127	0.903179	16129	-114.70376	10.32632
-125	2.329373	15625	-291.17167	10.5329
-123	7.960516	15129	-979.14345	10.73948
-121	4.740685	14641	-573.62283	10.94606
-119	13.17647	14161	-1568	11.15265
-117	1.461134	13689	-170.95266	11.35923
-115	4.053506	13225	-466.15322	11.56581
-113	6.873443	12769	-776.69903	11.77239
-111	3.995206	12321	-443.46784	11.97898

Deseasonalised Series

This the original data divided by seasonal index. That is:

$$X_t = \frac{X_t}{S_I}$$

This was used to identify the components of time series. The trend obtained from least square deseasonalisation is shown below.



Graph 1. Deseasonalized Variations Trends

FINDINGS AND DISCUSSIONS

The basic purpose of this work has been fully executed by analyzing the data on HIV/AIDS carriers in Osun state between the periods of 2001 - 2011. It was discovered that the HIV/AIDS carriers' rate fluctuated between the periods. The time plot shows a trend in the data, the least square model indicates the trend that HIV/AIDS carriers rate decreases along the years 2001 to 2011. The least square trend shows a decaying series which tends to the origin, while the moving average values reveals the natural fluctuations inherent in the data and the seasonal indices show the monthly HIV/AIDS carriers frequency has been affected by the seasonal factor. Furthermore, from the estimation of component of time series; Trend, Cyclical, irregular, and Seasonal variation, deseasonalised was used to bring normality to the trend which gives;

T_t = 23.44431- 0.10329t with the equation; $T_t = a + bt$.
(Where a = 23.44431 and b = - 0.10329)

Conclusion

From the time series analysis carried out on the data of the past HIV/AIDS carriers rate, we can see that statistics is an efficient tool for analyzing HIV/AIDS carriers data and relevant prediction can be made which serves as a link to looking into the future. The influence of statistics has been spread to all areas of life because of its usefulness and proven accuracy. Furthermore, we could see that the use of trend to produce a forecast and autoregressive to produce prediction is an example of what we can refer back to or a statistician can adapt for forecast prediction. Finally, it enables us check the accuracy of the forecast and prediction we have and it has helped to calculate the values of the next trend figures.

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