A Statistical Analysis of Tuberculosis Endemic in Nigeria from 1988 – 2007

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Abstract: *Government budgets continue to increase over the years. This is partly due to increasing health issues and ways of eradicating health hazards, and partly due to capital intensive projects. This research work is carried out on the number of reported cases and deaths resulting from tuberculosis. A period of 20 years (1988 to 2007) is considered. A time series analysis performed on this data reveals that tuberculosis infection has been on the rise over the years. The situation is also the same for the number of deaths. A suitable forecast is carried out using appropriate and reliable method which also indicates increase in the two related populations (reported cases and deaths) under study.*

Keywords: *Epidemic, Infectious Diseases, Morbidity, Tuberculosis*

I.   Introduction

In attempt to live and partake in some life activities, man has been faced with certain basic problems of life. These problems include food, shelter, health, clothing and security. Health they say is wealth. Yet to live a healthy or disease free, life also claims this wealth. This is due to the fact that there exists infectious diseases that keep pestering man ever in his bid to remain healthy. In this research work, it is the utmost desire of the researcher to take a critical look at one of the long time life enemies of man in relation to health, the global infectious disease, tuberculosis.

Tuberculosis (TB) is an infectious disease that has plagued humans since the Neolithic times. Physicians in ancient Greece called this illness "Phthisis" to reflect its wasting character. Tuberculosis is caused by two organisms namely mycobacterium tuberculosis and mycobacterium bovid. It is characterized by incessant cough, difficulty in breathing, coughing up blood, general body weakness, loss of appetite, night sweats, fever, chills, unintentional weight loss etc. Record by WHO as cited by [7] has it that during the 17th and 18th centuries, tuberculosis caused up to 25% of all deaths in Europe. This is not to say the infection is limited to one country or continent alone.

However, recent research by [1] reveals that the infection is more pronounced in developing countries. This may be due to the standard of leaving of the people in such countries. A press release by [2], declares that about 80% of tuberculosis cases occur in developing nations that have poor resources and high number of people infected with HIV.

According to [1], high cases of tuberculosis have been observed over the years. He said, despite the effort of the Federal Government of Nigeria, with assistance from the World Health Organization (WHO) and other donor agencies to reduce this plague, it is observed that upto seventeen thousand (17000) cases are recorded annually. This in some way is due to the increase in HIV infections, or other related factors.

This research work is aimed at analyzing the data obtained on reported cases and corresponding deaths of this global endemic, tuberculosis in Nigeria. The results of this analytical work will reveal the situation in Nigeria over the years (1988 to 2007) and give an insight into the future situation through forecasting.

According to [3], a physician described tuberculosis as a disease caused by an infection with the bacteria mycobacterium tuberculosis. He said during the 19th century up to 25% of deaths in Europe were caused by this disease. According to him, the death toll began to fall as living standards improved at the start of 20th century. However, he stated that there are more people in the world with TB nowadays than in 1950s. He rated the death occurrence from this infectious disease at 3 million a year, especially in less developed countries. He further stressed that the disease is more common in areas of the world where poverty, malnutrition, poor general health and social disruption are present.

According to [4], tuberculosis is a disease of the lungs. However, the infection can be spread via blood from the lungs to all organs of the body. This means that one can develop TB in the pleura (the covering of the lungs), in the bones, the urinary tract and sex organs, the intestine and even the skin. The encyclopedia said TB is inhaled in the form of microscopic droplets from an infected person. When coughing or sneezing, the small droplets are expelled into the air. They dry out quickly but the bacteria itself can remain airborne for hours.

In a similar view, [5] confirmed that, after the TB bacteria have been inhaled, they reach the lungs and within approximately six weeks, a small infection appears that rarely gives any symptoms. This is called a primary infection. They pointed out that the symptoms of TB include the following:

i)   Chronic or persistent cough and sputum production which contain blood at advanced stage.
ii) Fatigue
iii) Lack of appetite
iv) Weight loss
v)   Fever
vi) Night sweats

According to [6], it was revealed that TB can mimic many forms of diseases and must always be considered if no firm diagnosis has been made. They said that the doctor cannot always hear enough to make a diagnosis by just using a stethoscope. If aphysician suspects that there is something wrong and that it is not just cold, one may be referred to an outpatient department for people with lungs disease, or to an X-ray department. Stating further, they said that the chest X-ray examination is the most important test.

Bronchitis, pneumonia, smoker's lung and lung cancer, according to [4], can all show practically the same symptoms as TB. It pointed out that if TB is suspected, test will need to be done to rule out the presence of other diseases.TB frequently occurs in the course of HIV infection, often months to years before other opportunistic infection such as pneumocystis carinii pneumonia [1]. He stated that TB may be the first indication that a person is HIV infected, and often occurs in areas outside the lungs, particularly in the later stages of HIV.

According to [1], WHO estimated that 4.4 million people worldwide are co-infected with TB and HIV. He said that people co-infected with TB and HIV develop active TB at a rate of about 8% each year in the United States. He concluded that diagnosing TB in HIV infected people is often difficult. These patients frequently have conditions that produce symptoms similar to that of TB and may not react to the standard tuberculin skin test because their immune system is suppressed.

In Nigeria, tuberculosis is common. "A Prevalence of 9.2% has been reported in one study and a case fatality rate of 12% in another"[7]. They portrayed that delay in diagnosis of TB and commencement of treatment has been reported to be common in Nigeria and other countries. These delays are attributable both to patients and doctors, and may worsen the disease; increase the risk of death and enhance TB transmission in the community.

Furthermore, Nigeria is one of the few countries in the world where TB control has been slow partly due to patients delay and inefficiencies in the health system. Thus control is one of the major public health challenges facing Nigerians.

Treatment of TB includes antitubercular therapy with daily oral doses of isoniazid, rifampin and pyrazinamide (and sometimes ethambutol) for at least 6 months. According to [1], it was stated that longer courses may be required for patients with AIDS or for patients who respond slowly. After 2 to 4 weeks, the disease generally is no longer infectious. The patient can resume his normal lifestyle while taking medication. He portrayed that patients with a typical mycobacteria disease or drug resistant TB may require treatment with second line drugs such as capreomycin, streptomycin etc. Conclusively, he said that self medication for TB should be discouraged. Professional medical advice must always be sought about any treatment or change in treatment plans.

According to [1], prevention has focused on identifying infected individuals early, especially those who run the highest risk of developing active disease and treating them with drugs in a programme of directly observed therapy. The National Institute of Allergy and Infectious Disease (NIAID) pointed out that in those parts of the world where the disease is common, a vaccine composed of live attenuated mycobacteria (Bacillus Calmette Guerin [BCG]) is given to infants as part of the immunization programme recommended by World Health Organization. In adults, the effectiveness of BCG has varied widely in large scale studies. In addition, positive skin test reactions occur in people who received BCG vaccine, thus limiting the effectiveness of the skin test to identify new infections. As a result, BCG is not recommended for general use in USA. Because of its limitations, more effective vaccines are needed.

Today, the Global Fund to fight AIDS, TB and malaria is disbursing additional resources to prevent and treat HIV/AIDS, TB and malaria. A press release by [2], said that partnership between government, civil societies, the private sector and affected communities represent a new approach to international health financing.However, if the control of tuberculosis must succeeds, causes of delay by patients and doctors should be investigated and minimized.

1.1 Statement of Problem

This research work is embarked upon to analyze one of the global infectious diseases "tuberculosis". Tuberculosis poses a lot of threat to human health and life. This work is primarily targeted at providing reliable and concrete information on the rate of occurrence of this disease and its possible outcome using a statistical tool, known as time series.

1.2 Significance of Study

It is expected that the information provided at the end of this research will broaden the understanding of the readers on the application of statistical tools in analyzing societal issues (health problem) and other related issues of life. The research work is also hoped to serve as a source of information to future researchers as well as health workers.

1.3 Objectives of Study

This research work hoped to achieve the following objectives:

i)   To provide a most concise and accessible information on tuberculosis, its symptoms and possible treatment strategies.
ii) To avail information on current areas of active research in the health sector.
iii) To unravel the outcome of the resource commitment by the government on health issues.
iv) To help Nigerians to understand their position on tuberculosis in the future through forecasting.

II.   Data Analysis

The data collected for this research is a reflection of the annual reported cases of Tuberculosis (TB) and deaths in Nigeria for 20 years.

Table 1: The Original Data On Tuberculosis Infection In Nigeria

YEAR	REPORTED CASES	REPORTED DEATHS
1988	16563	397
1989	15955	245
1990	15575	268
1991	19100	471
1992	14802	16
1993	11601	12
1994	14854	352
1995	10042	407
1996	24558	380
1997	16064	331
1998	19368	454
1999	18737	317
2000	18570	292
2001	14341	317
2002	15175	231
2003	27566	698
2004	9233	144
2005	17855	387
2006	17627	326
2007	16259	278
TOTAL	333843	6323

Source: National Bureau of Statistics, Makurdi,Nigeria.

Graph 1: 5- Year Moving Average for Reported Cases of TB
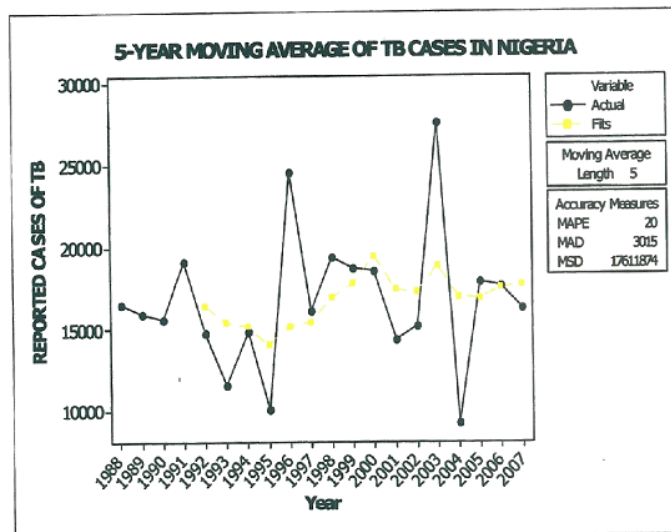
The method of moving averages was used to analyze the data on reported cases of TB. Graph 1 represents the result of a 5-year moving average on reported cases of TB. In the graph, it is observed that the actual value plots have no definite pattern of occurrence. There are fluctuations in cases of TB in Nigeria. However, increase is noticed in 1991 and 1996, with 2003 having the highest number of reported cases. The fluctuation also results to decrease in number of cases as can be seen in 1993 and l995, with the least number recorded in 2004. The 5-years moving average tries to smoothen the curve thereby eliminating the extreme points off the trend curve. However, even with moving average curve, fluctuations are noticed, and the curve shows a growth in the population under study (number of reported TB cases) over the years. It is also observed that, as the curve is smoothen by 5-years moving average, the number of reported cases of TB is now seen to alternate (though notgreatly) between the values 14,000 and 20,000. The least value is 14,079(in 1995) andthe highest value is 19,459 (in 2000).

The fluctuations observed in the moving averages arecharacteristics of a time series which represent the time seriescomponents (especially seasonal, cyclical and irregular movements).
In this research, these fluctuations (that tend to increase thepopulation) were discovered to be due to:
- Poverty
- Increased HIV cases
- Malnutrition
- Delay by patients and doctors
- Ignorance and
- Lack of control.

While the decrease in number of affected people could be attributedto:
- Awareness on prevention
- Improved living standard ofthe people.
- Quick response to suspected cases.

The least square method was also used to analyze the data. As alreadystated previously, the least square method uses a linear equation given by
$$Y_t = \propto + \beta x.$$
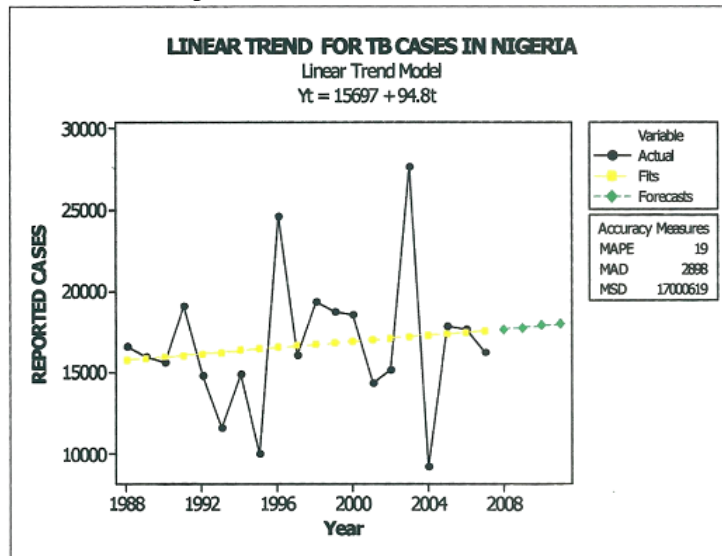The minitab estimates Y_t as,
$$Y_t = 15697 + 94.8t.$$
Here X is replaced in the receding equation by **t**. Also this is to say;
$\propto = 15697$ and $\beta = 94.8$.
The fitted equation is therefore $Y_t = 15697 + 94.8t$ as given bythe Minitab.

Graph 2: Under trend for TB i=Infection

The graph of this equation (Graph 2) shows that the trend is linearrising steadily (indicating increase) from 15792 in 1988 to 17593 in 2007.

The graph also possesses similar characteristics to that of movingaverages in that its values lie between 14,000 and 20,000. However, itshows a difference as its values do not alternate unlike those of moving average.

Forecast

For a study on situations such as Tuberculosis, its occurrence andoutcome, it is necessary to estimate or make an assumption of what thefuture possibly holds. For the purpose of this research, the least square method is adopted by the researcher to give a forecast for a period of four (4) years.

The forecast values are given below.

2008 forecast value is 17687.3

2009 forecast value is 17782.0

2010 forecast value is 17782.8

2011 forecast value is 17971.6

This is to say that approximately 17687 people will be infected with TB in 2008, 17782 willbe infected in 2009, 17783 will be infected in 2010, while by 2011, 17972 willbe infected.

An analysis was also carried out on the outcome of this infectious disease (TB). It is discovered that TB hasclaimed a lot of lives during theperiod of this research.

The original data plots ondeaths cases, shows that there have beenfluctuations in the number of deaths caused by TB.

Graph 3: 5- Year Moving Average For Deaths By TB
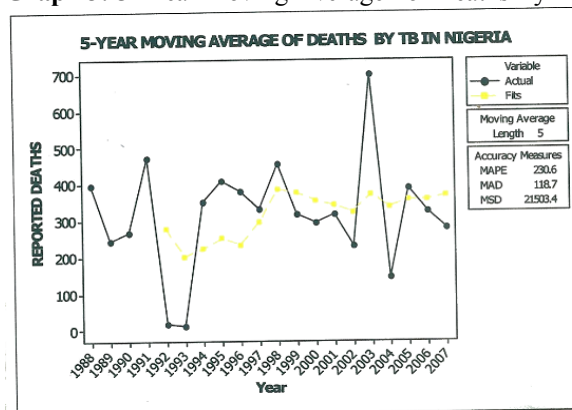
Graph (3) shows that there was an increase in deathcases in 1991 with a heavy drop in 1992with approximately the same figure in 1993. An increase was also noticedin 1994 while 2002 had the highest number of deaths.A 5 year moving average performed on this data approximatelysmoothen the curved. However, fluctuation in death cases is still noticedwith the moving average curve. But generally, the curve appears to growover the years. This implies that there has been increase in death casesresulting from TB within the time covered in this work.

The least square method of estimating growth was also employed.

The Minitab estimated the linear trend equation to be

$Y_t = 274.8 + 3.94t$

This implies $\alpha = 274.8$ and $\beta = 3.94$

The fitted linear curve also shows growth which implies there has beenincrease in the number of deaths by TB within the period under study.The linear curve however reveals that, the number of death casesresulting from this infectious disease (TB) lie between 260 and 400even though the curve rises linearly steady.

Forecast.

The death cases caused by this infectious enemy of health (TB) needs tobe forecast in order to ascertain the situation in the nearest future. Theresearcher uses least square method from the fitted equation to make aforecast of four (4) years. The forecast values are given below.

2008 forecast value is 357.495

2009 forecast value is 361.432

2010 forecast value is 365.370

2011 forecast value is 369.308

This implies approximately 357 people Will die of TB by 2008, 361 will die by 2009,365 will die by 2010 and up to 369 People will die of TB by 2011.

2.1 Contribution

It is necessary to apply the theoretical aspect of the course to real life situations, so as to affirm the functionality of existing statistical tools.

In this research Work, the application of time series has been critically shown by the researcher in analyzing a health problem facing the country (Nigeria).

2.2 Suggestions

With reference to the agenda of the National Institute of Allergy and Infectious Diseases (NIAID), the following suggestions were made for possible improvement:

- There should be new ways to educate health Workers and the public about TB prevention in Nigeria.
- There should be a way of improving the general way of living of Nigerians.
- Foreign-born people coming to Nigeria from countries where TB is common should be properly checked and considered for preventive therapy.
- Infants should be immunized with BCG to prevent TB
- Causes of delay by patients and doctors should be investigated and minimized.
- Measures should be taken against any symptoms of TB to avoid advancement of the TB bacteria.

2.3 Conclusion

The data collected on reported cases and deaths of TB in Nigeria from l988 to 2007 have been critically examined and analyzed using time series. The analysis shows that there has been an increase in the number of reported cases of TB in Nigeria, The analysis on deaths also revealed that there has been increase in the number of deaths resulting from this infectious disease (TB) within the time under study.

Forecasts for both cases of TB were also made to show that the situation of TB in Nigeria will be high in2011.

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