T.R.N.C

TURKISH REPUBLIC OF NORTHERN CYPRUS

NEAR EAST UNIVERSITY

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APPLICATION OF TIME SERIES ANALYSIS TO DISEASES BURDEN: CASE STUDIES OF MORTALITY RECORDS (OF CANCER, KIDNEY, TUBERCULOSIS AND DIABETES) FROM SELECTED COUNTRIES

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THESIS APPROVAL CERTIFICATE

DEDICATION

This project is dedicated to Almighty God for the preserver of life. To my loving mother, siblings and friends, I love you all.

AKNOWLEDGEMENTS

I wish to thank sincerely my very able and erudite supervisor, PROF. IIKER ETIKAN whose constructive criticisms, teachings, correction and invaluable advice at every stages of this project have contributed in a small measure to bring into fruition its completion. I am grateful indebted to those authors and researchers whose works supplemented by worthy journals have helped a great deal in writing this project.

In addition, grateful acknowledgement is given to all our respondents, obviously their contributions have profited one immensely.

I acknowledge my very good friend; Tolulope Onayemi for support and assistance towards the successful completion of this research work.

I am humble to my parents, Adebayos and my siblings, for the manner in which they have used to bring edification and spiritual enrichment to my life and hundreds of others; I pray that this will continue to be true of your existence.

My greatest debt of gratitude is owned to God for giving me the privilege of healthy living to complete my Masters program and to make this project see the light of the day.

ABSTRACT

Cancer is known worldwide to be a life-threatening disease which most times is uncontrollable especially if detected late. Tuberculosis is another deadly disease caused by Mycobacterium Tuberculosis (MTB) which is characterized by chronic cough, blood in sputum and is highly contagious. Diabetes is as a result of the body's inability to make use of insulin effectively. In simple words, someone with diabetes experience high blood sugar and is required to take shots of insulin to help regulate blood sugar. Kidney disease is characterized by gradual loss of function of the kidneys.

The data for this study was extracted from the previous global data on diseases specifically on cancer, diabetes, tuberculosis and kidney diseases from the year 1990 to the year 2016.The data sample was obtained from the open access repository of the "Our World Data". Time series analysis is a statistical technique that deals with time series data, or trend analysis. Time series analysis will determine the mortality rate of population with cancer, Tuberculosis, Diabetes and kidney diseases. The time series will be used to perform a trend analysis and forecasting of the disease's mortality. The data variable collected will be analyzed using Gretl

Results: This study showed that the mortality rate caused by kidney, Diabetes and Cancer increases every year in USA. In Nigeria, Diabetes, Cancer and Kidney diseases are predicted to increase every year by their mortality rate

Conclusion: Cancer, Diabetes, Kidney diseases and Tuberculosis are diseases that can be life threatening but definitely life changing as they result to a deviation from the normal way of lifestyle and also away from normal body functioning. This study predicts that Diabetes, Kidney diseases and Cancer will continue to increase every year if more preventive and curative measures are not inputted. Tuberculosis on the other hand has been impacted on as it is predicted that the disease will continue to decrease yearly both in Nigeria and United States of America (USA).

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ABBREVIATIONS

DM	-	Diabetes Mellitus
KD	-	Kidney Disease
GBD	-	Global Burden of Diseases
TB	-	Tuberculosis
ARCH	-	Autoregressive Conditional Heteroskedasticity
AR	-	Autoregressive
MA	-	Moving Average
NAR	-	Non-linear autoregressive
USA	-	United States of America
ESRD	-	End Stage Renal Diseases
DNA	-	Deoxyribonucleic Acid
UV	-	Ultra violet
TAR	-	Thresh hold Autoregressive

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Cancer is known worldwide to be a life-threatening disease which most times is uncontrollable especially if detected late (Golemis, 2018). It is defined as development of abnormal cells that divide uncontrollably and have the ability to spread and invade at the same time destroying normal body tissues (Jiang, 2015). It is of many forms and it can develop almost anywhere in the body which can result in mass (tumor) and damage to the immune system. WHO mentioned that Cancer is the second leading cause of death globally, and is responsible for an estimated 9.6 million deaths in the year 2018. Globally, about 1 in 6 deaths is due to cancer and especially in low developing and underdeveloped countries, more than average number of deaths are as a result of cancer. The international agency for research on cancer (2018) stated that the prevalence of cancer has become a great issue as there are risk factors that increase the chance of getting cancer and more risk factors are been discovered with time. It has been associated with social and economic development as in the case in rapidly growing economies, where a shift is observed from cancers related to poverty and infections to cancers associated with lifestyles (food consumed, environment exposed too among others) more typical of industrialized countries (Hruby, 2015).

Tuberculosis is another deadly disease caused by Mycobacterium Tuberculosis (MTB) which is characterized by chronic cough, blood in sputum and is highly contagious (Al-Humadi, 2017). It is defined as an infectious disease that usually affects the lungs. Compared with other diseases caused by a single infectious agent, tuberculosis is the second biggest killer, globally (Mohajan, 2014). Tuberculosis is mostly prevalent in Africa compared to other parts of the world.WHO in 2017 stated that 10 million people fell ill with TB, and 1.6 million died from the disease of which 1 million children became ill with TB and 230 000 children died of TB. It was stated that the sustainable development goal for 2030 is alleviating every form of tuberculosis or all population.

Diabetes is a condition that impairs the body's ability to process blood glucose, otherwise known as blood sugar (Watson &Dokken, 2014). Diabetes is of two types which are Type 1 diabetes and type 2 diabetes; type 1 diabetes is insulin dependent and requires daily insulin shots while type 2 is not insulin dependent (Study group,2017). It is as a result of the body's inability to make use of insulin effectively. In simple words, someone with diabetes experience high blood sugar and is required to take shots of insulin to help regulate blood sugar. The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014 (Roglic,2016). Diabetes has been proven to be a major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation (Hippisley-Cox,2016). In 2016, an estimated 1.6 million deaths were directly caused by diabetes (Chen, 2017).

Kidney diseases are frequently caused by diabetes, hypertension or anything that can cause injury to the kidney (Kristensen et al., 2019). Kidney disease is characterized by gradual loss of function of the kidneys. The most common form of kidney disease is chronic kidney disease (CKD). Groopman (2018) mentioned that the other forms of kidney diseases include Fabry disease, Alport syndrome,Glomerulonephritis, Diabetics Nephropathic among others. Arora et al (2019) explained that not up to an average percent of people survive kidney diseases and it goes as low as 25% survival rate if they have a medical history of diabetes. This research study will be critically looking into these four diseases with a worldview by choosing four countries for generalization considering the economic status and the rate of mortality among the other countries. The countries that were selected for this study are Nigeria and the United States of America (USA). Time series analysis will be done to the data that is extracted from the open access repository of the "Our World Data". Time series analysis is a statistical technique that deals with time series data, or trend analysis. Time series analysis will determine the mortality rate of population with cancer, Tuberculosis, Diabetes and kidney diseases from the year 1990 – the year 2016.

1.2 Statement of the problem

The cancer, diabetes, tuberculosis and kidney diseases are known to be life threatening diseases which in most cases shorten the lifespan of individuals over the years (Daher et al, 2013). Scientific clinical researches are still going on to help control the rate at which these diseases are the causes of death. This research will critically look into the mortality rate in some countries over the years of 1990-2016. These countries were chosen as the global view as they have the records of the highest rate of casualties as a result of the aforementioned diseases.

1.3 Research questions

- What is the most prevalent disease in these countries?
- Which of the selected countries in terms of their socio-economic statuses has the highest rate in the disease categories?
- Is there a decline in the disease rate or an increase in terms of time series analysis?

1.4 Aims and objectives

Aims

The aim of this study is to determine the increase or decrease rate at which these diseases; kidney, diabetes, cancer, and tuberculosis affect the Population of the world, by chosen two countries from the world as a sample.

Objectives

1) To discuss the concept of time series analysis
2) To discover the trend of mortality associated with diseases from these selected countries
3) To forecast the mortality from these diseases for future planning
4)

1.5 Significance of the study

This research specifically looks into Cancer, diabetes, tuberculosis and kidney diseases. These diseases have affected a great number of the world population over the years. In result, the rate mortality has varied over the years. The research analysis of the study will assist in determining whether there is a decrease or an increase trends of the diseases from the year 1990 through 2016. This will show how effective the national governments and the global health organizations in fighting again these diseases burden have been or not.

1.6 Definition of Concepts

Mortality Rate: This is death rate over a given period of time or at a particular place or area

Morbidity: This is the rate of diseased or casualties attained as a result of a disease outbreak or disease infection and contraction

Time series analysis: Time series analysis is a statistical technique that deals with time series data, or trend analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 The concept of Global Burden of Disease (GBD)

To critically look into the health globally, organizations and platforms such as World Health organization, United Nations International Children's fund, National Health Service, National Health Insurance Scheme and most especially World bank data make health records looking at rates of mortality, morbidity and birth rates (Tichenor & Sridhar,2017). The world bank years ago, funded a research work to determine the global disease burden (Gillum et al, 2011). According to Murray & Lopez (2017), the Global Burden of Disease, Injuries, and Risk Factors Study (GBD) is a systematic, comprehensive, and annual effort to quantify the impact of more than 200 diseases and 80 risk factors. The 200 diseases which were outlined by the GBD were categorized into three; non-communicable disease (cancer, cardiovascular diseases), communicable diseases (Tuberculosis, infectious diseases) and injuries (Mohan et al,2019)**.** Kidney disease represents one of the important non-communicable diseases missing from the 2013 action plan and that, given the many social and structural factors that directly affect risks and outcomes of kidney disease, multi-sectoral action to achieve the SDGs will help prevent and control such disease (Griggs et al,2017).

The GBD 2015 stated that a great number of people die as a result of kidney failure and there has been an increase of mortality rate over the years as a result of kidney related diseases (Neuen et al,2017). A great percentage of population of people die from acute kidney injury as well as an estimated 5–10 million people die annually from kidney disease (Luyckx et al,2018). Diabetes, Tuberculosis have also had their records of mortality rate in Nigeria and United States of America over the years of 1990-2016 (James et al,2018). Cancer being one of the major leading causes of death is a global concern for health and ways to tackle all forms of cancer are being searched for (Sloan& Gelband,2007). Research comes so as to gain accurate knowledge on these diseases and also determine the way forward to driving global health towards to the optimal point (Heyman et al,2015). This research work will get records from selected countries (Nigeria and United States of America) of Mortality rate from the year 1990-

2016; Kidney diseases, Cancer, Diabetes, Tuberculosis. Time analysis across the years will also be performed.

2.2 Kidney

Kidney disease means kidneys are damaged and can't filter as well. A renal disease can be attributed to a variety of causes which include genetics, injuries and medicine. Kidney (Renal) failure (acute or chronic) occurs when the kidneys no longer function well (Devarajan& Jefferies,2015). There are two major types of kidney disease which are also subdivided into other types of diseases (Matovinović,2009). The major types are Acute and Chronic kidney diseases. Chronic kidney disease presents itself slowly and can go on for a long time leading to permanent kidney failure while acute is abrupt during onset and is most time potentially reversible (Sharpe & Thein,2014). Other types of kidney diseases include; Fabry Disease, Focal segmental Glomerulosclerosis, kidney stones, polycystic kidney disease, Alport syndrome, IgA Nephropathy and Minimal change diseases (Hebert et al,2013).

2.2.1 Causes of Kidney diseases

Causes of kidney diseases are numerous as it varies in the health of individual patient (Chapter 1,2012). Acute kidney disease likely causal factors include; Myocardial Infarction (as a result of muscle breakdown, lack of blood flow to the kidney over a period of time), ingestion of drugs that are toxic to the kidneys, glomerulo-nephritis (Inflammation of the glomeruli in the kidneys), Obstruction in the urinary tract (Makris & Spanou,2016). Chronic kidney disease on the other hand is caused by the following:

- Diabetic Nephropathy (Disease to the kidney as a result of Diabetes)
- Hypertension (Chronic high blood pressure)
- LUPUS (autoimmune disease that damages the kidneys, nerves, skin…)
- Urinary tract Infection or blockage
- Nephrotic syndrome (protein in the urine)
- Alport syndrome (Causes progressive kidney damage) (Escoli et al,2018)

Treatment options for Kidney diseases include; medications, kidney transplantation, dialysis, diet restrictions.

2.2.1 Prevalence of kidney Disease in Nigeria and United states of America (USA) .

Figure 2.1

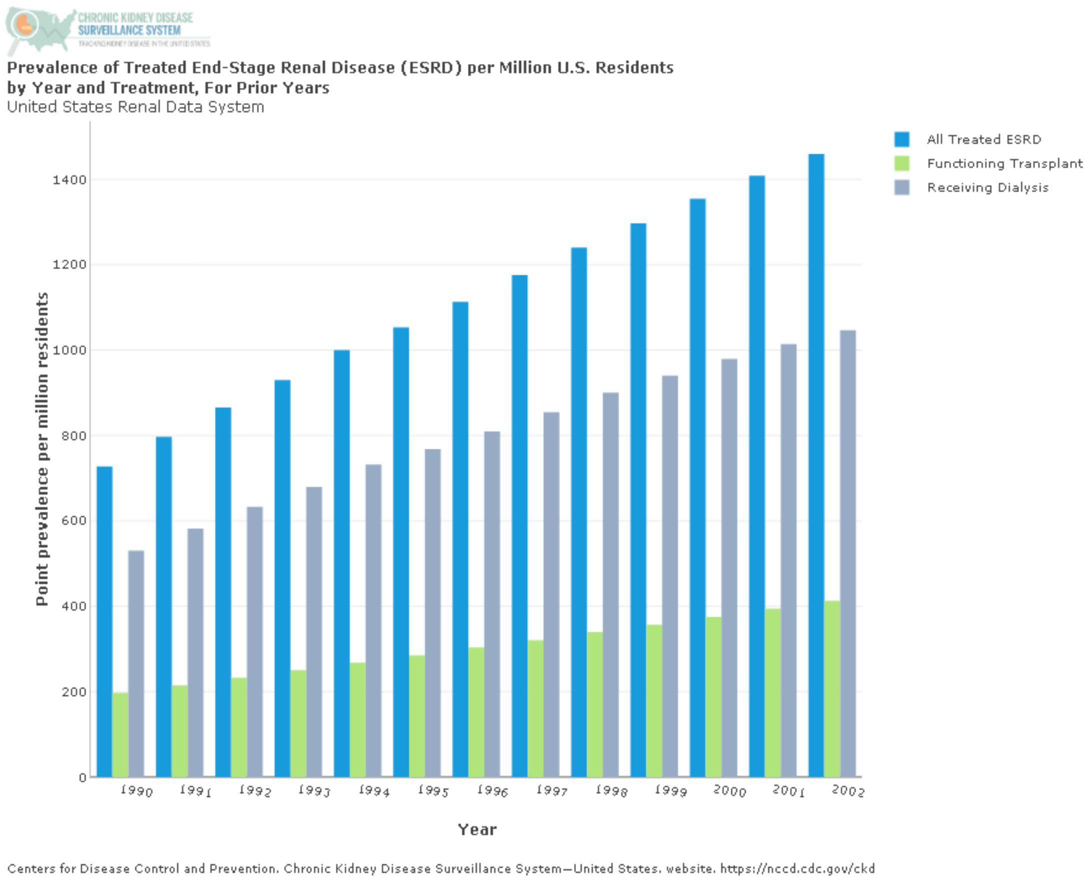


Figure 2.1 shows the prevalence of kidney disease in United State of America per million individuals from the year 1990-2015. (Centre for Disease Control,2015).

Figure 2.2

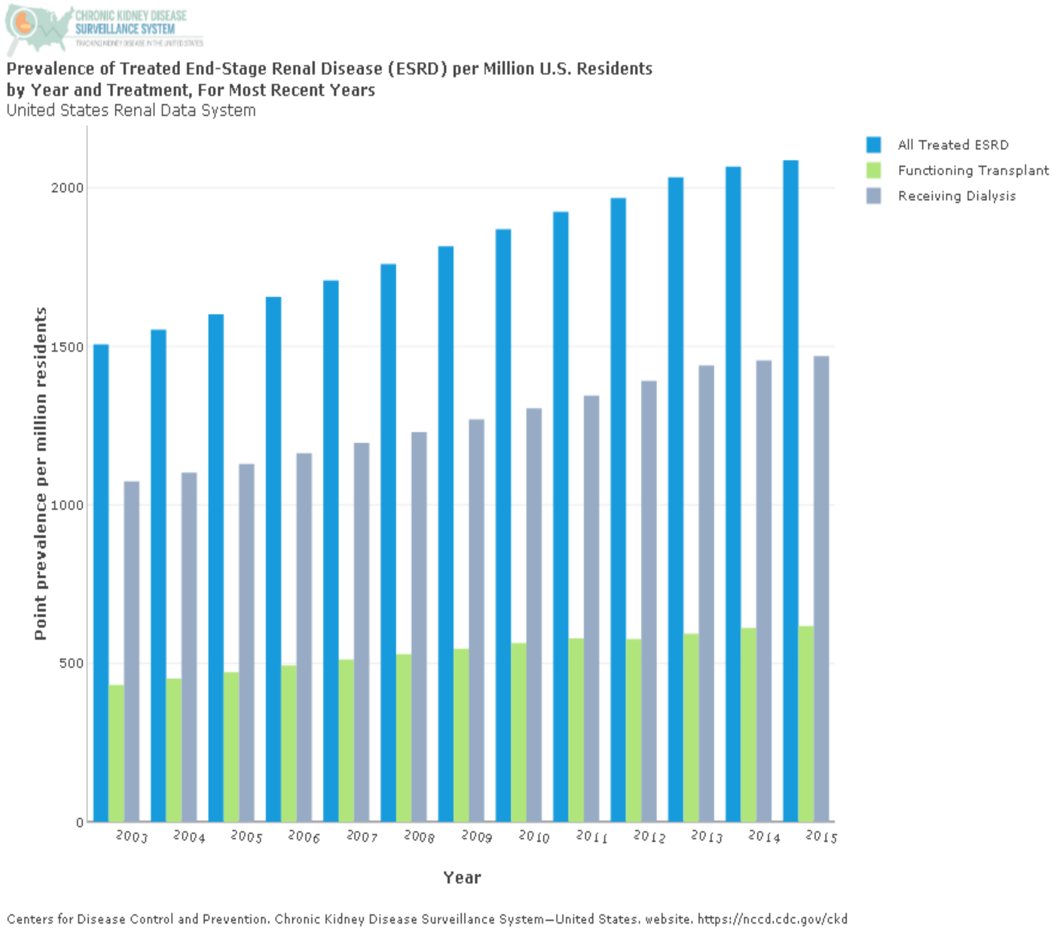


Figure 2.2 shows the prevalence of kidney disease in United State of America per million individuals from the year 1990-2015. (Centre for Disease Control,2015)

There have been incidents of Chronic Kidney disease in Nigeria with the prevalence range of between 1.6% and 12.4% respectively.

2.3 Cancer

Cancer is a group of disease which are characterized by the abnormal growth and spread of diseases from one part of the body to another. The cells multiply uncontrollably and invade parts of the body system causing destruction of the affected area (Abbas & Rehman,2018). Cancer is of many types. Some of which are as follows:

- Breast Cancer
- Prostate Cancer
- Leukemia
- Skin Cancer
- Ovarian Cancer
- Lung Cancer
- Brain Cancer
- Bone Cancer
- Adrenal Cancer
- Anal Cancer
- Oral Cancer.

2.3.1 Causes of Cancer

The causes of Cancers are numerous and new causes of cancer are being discovered with each health case that is being presented regarding cancer (Blackadar,2016). Cancer is caused by changes (mutations) to the DNA within cells**.** The cell contains the DNA which is the set of instructions that guides the cell on when to divide and when to multiply. It also contains characteristics of traits. The major causes of Cancer are;

- Lifestyle/habits (smoking),
- Obesity and weight,
- Sun and UV,
- Infections such as Human Papilloma Virus increases susceptibility,
- Mutated DNA (Genes),
- Environmental factors contribute also (air pollution, workplace hazards) (Parsa, 2012).

2.3.1 Mortality Rate of Cancer in Nigeria and United states of America (USA)

Figure 2.3

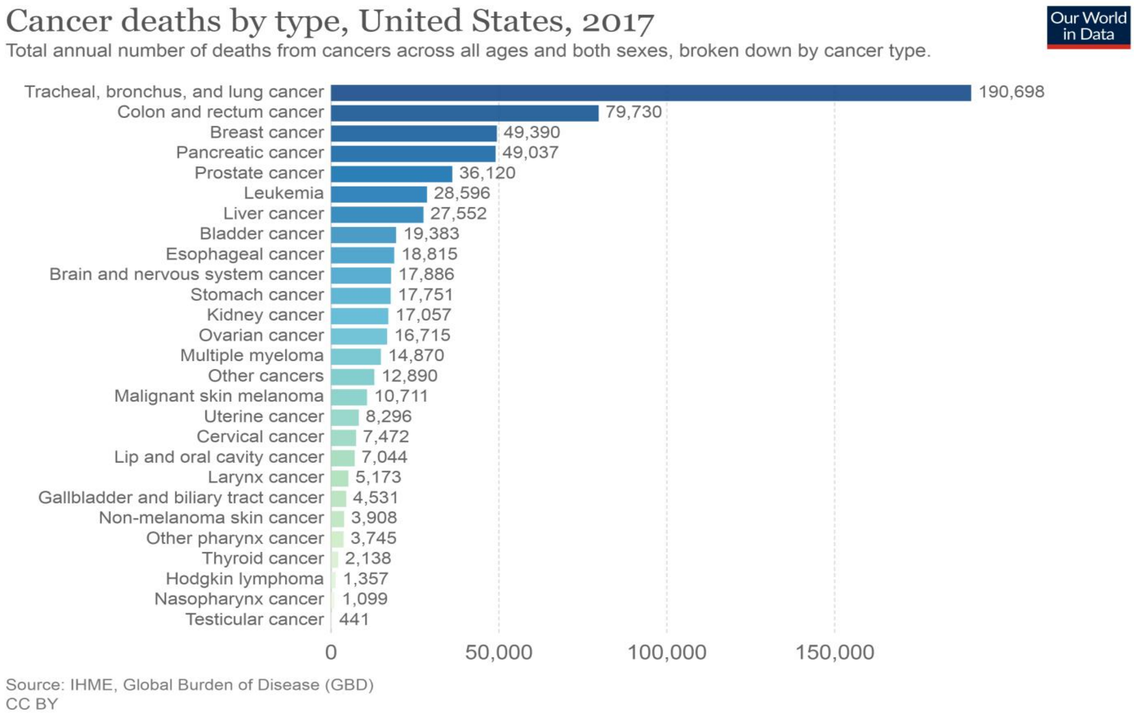
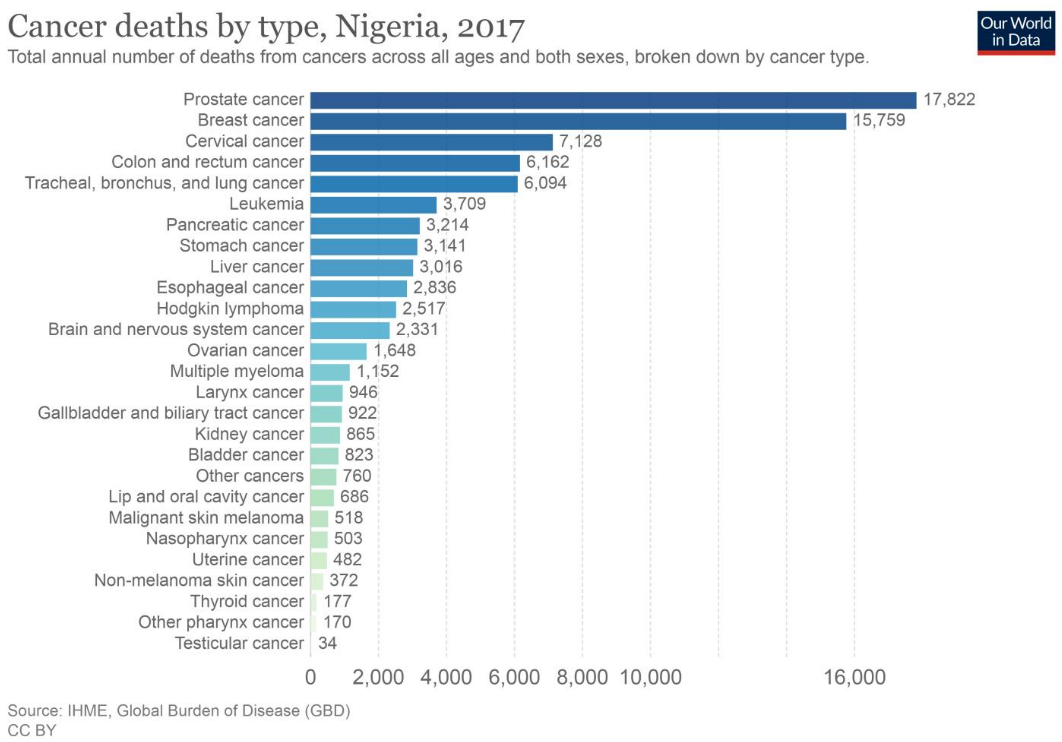


Figure 2.4



The charts above, figure 2.3 and figure 2.4 we see cancer death rates, expressed as the number of cancer deaths per year per 100,000 individuals. Note that these rates have been age-standardized which aims to correct for differences in the age structure of a population. The mortality rate of cancer diseases is shown form year 1990-2017 for Nigeria and United State of America (USA). (World Bank Data).

2.4 Diabetes (Diabetes Mellitus (DM))

Diabetes is a health condition that involves high glucose or high blood sugar. It occurs when the body is unable to produce insulin which helps to regulate sugar (glucose) in the body which is gotten from foods like carbohydrates. The major types of Diabetes are;

- Diabetes type 1 (which is sometimes called juvenile diabetes for children and for adults over the age of 35 years; it is referred to as Latent Autoimmune Diabetes of Adulthood) is also known to be insulin dependent,
- Diabetes type 2,

- Gestational Diabetes
- Other types include Diabetes as a result of surgery, medication, Maturity onset Diabetes of the young (MODY), Diabetes as a result of other diseases such as pancreatic diseases. (Hoffman & Jialal, 2018).

2.4.1 Causes of Diabetes

The causes of high blood sugar and the inability to produce insufficient insulin or no insulin at all include;

- Genes,
- environmental factors like viruses that might have triggered the condition,
- obesity,
- physical inactivity,
- insulin resistance,
- removal of the pancreas,
- hormonal diseases,
- Consumption of excess sugar without caution (Kumar et al,2012).

2.4.2 The Mortality rate of Diabetes in Nigeria and United State of America (USA).

Figure 2.5

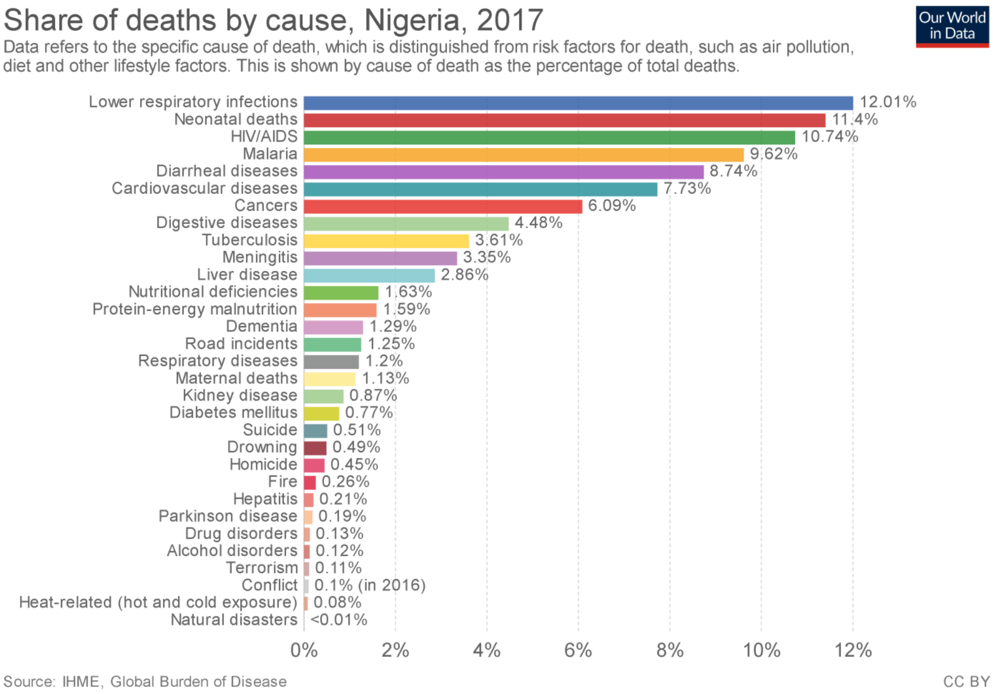


Figure 2.5 shows the mortality rate for various diseases in Nigeria of which Cancer, Kidney Diseases, Diabetes and Tuberculosis are stated clearly on it form 1990-2017. (World Bank Data, 2017)

Figure 2.6

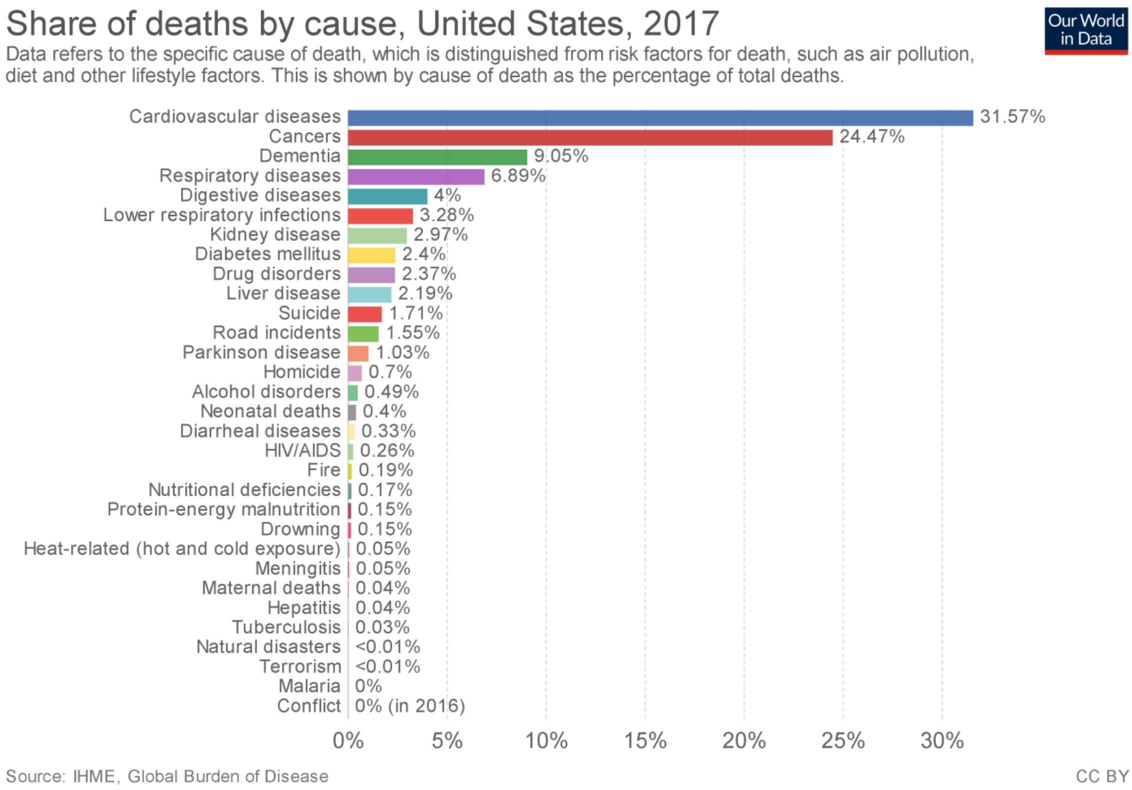


Figure 2.6 depicts the share of deaths in United State of America (USA) with Tuberculosis disease. causal factors being Cancer, Kidney Diseases, Diabetes and Tuberculosis across Years 1990-2017 with Diabetes having an increase of 2.4% over the years. (World Bank Data, 2017).

2.5 Tuberculosis (TB)

Tuberculosis is an infectious disease as it’s transmissible and specifically affects the lungs. According to World Health Organization (WHO), Tuberculosis affects 9 million people annually and TB is among the top 3 causes of death for women aged 15 to 44 (Mohajan,2014). Tuberculosis is either active or latent and is characterized by cough, night sweat, weight loss, blood in sputum and many other symptoms (Cudahy & Shenoi,2016). The latent tuberculosis is still in the inactive phase so it hasn’t become transmissible until when left untreated and it becomes active.

2.5.1 Causes of Tuberculosis

Tuberculosis is mainly cause by an airborne pathogen which is called ‘mycobacterium tuberculosis’ and is transmitted from an infected person to another in ways such as coughing, sneezing, laughter, singing, yawning (Nardell,2016).

2.5.2 The Mortality rate of Tuberculosis in Nigeria and United States of America (USA) from the year 1990- 2017.

Figure 2.7

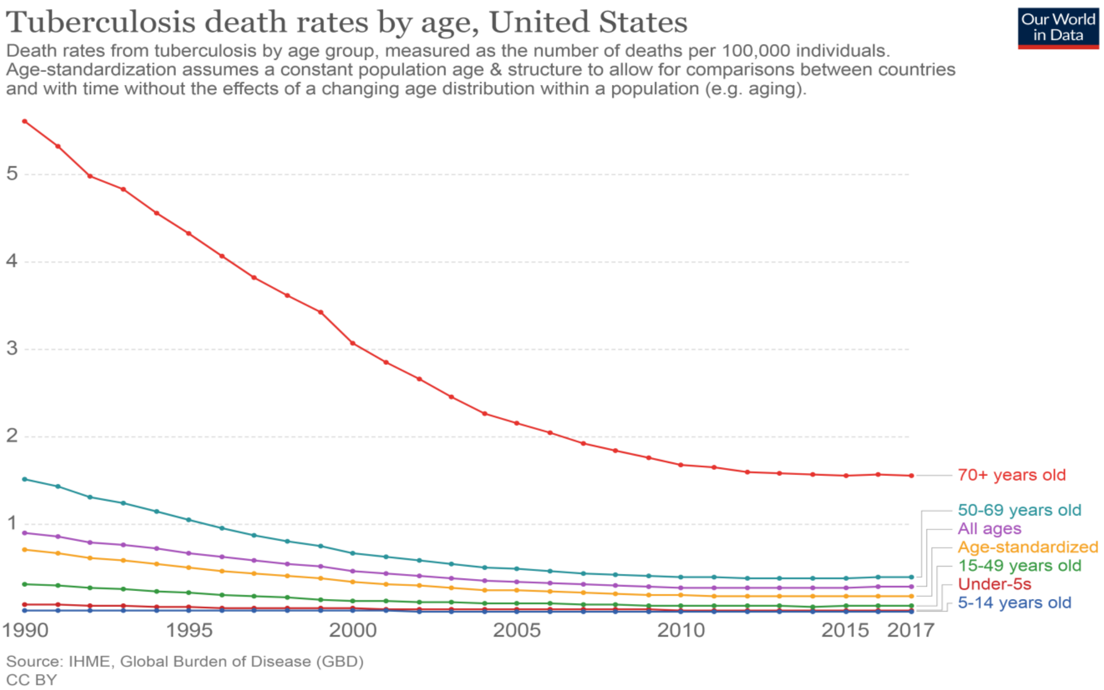


Figure 2.8

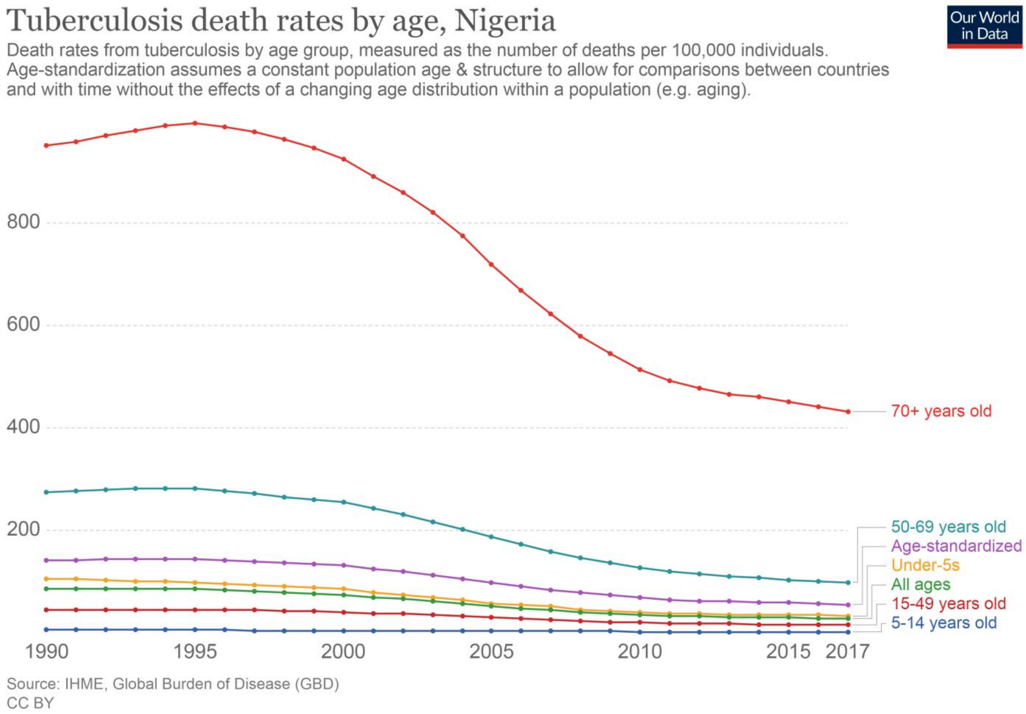


Figure 2.7 and figure 2.8: illustrate the mortality rate of Tuberculosis from the year 1990-2017 of the selected countries; Nigeria and United State of America per 100.00 individuals. (World Bank Data, 2017).

2.6 Time series analysis

Time series entails data which is extracted and collated for a period of time while time series analysis is the value of data that is taken at equally time spaced intervals. Conducting a time series analysis is of two objectives and these are; to point out the natural occurrences that are stated out by consecutive observations and records, to predict data values for the future (Adhikari& Agrawal,2013). These goals require much observation as well as taking records of data with time too. After this is done, data is now interpreted and put together with other forms of data to come to a conclusion about it. There is the pattern of time series analysis which can be explained in two ways such as ; the trend and seasonality (Olarenwaju et al,2017).

The trend points out the components of the data that change with time and does not repeat its occurrence especially with the stated time range for the data (Jebb et al,2015). Seasonality as a pattern repeats itself in a systematic way and can also be interpreted and predicted for future occurrences. This trend can apply to natural disasters after an episode of occurrence, the features such as magnitude of occurrence, duration of occurrence among others are looked into and data records are take then interpretations and predictions follow after (Han et al, 2016).

These two patterns are may also work hand in hand for real life data instead of separately as each a different pattern of its own. There are various forms of time series models; but the two majorly use linear time series models are the autoregressive and moving average models. These two easily understood and easily implemented models are also combined in research studies but they are the basic linear models. Examples of non-linear models include the autoregressive conditional heteroskedasticity (ARCH), the threshold auto-regressive (TAR, the non-linear autoregressive (NAR) and the non-linear moving average. Non- linear models are models that are used for predicting volatility changes in economic and financial time series.

2.6.1 Time Series Trends

There are trends of time series analysis and these are Linear, quadratic and exponential trends.

- **For the linear trend**; it is a forecasting model for time series analysis and it helps in the interpretation of data. It is also known as trend-line model. The linear trend model expresses time series on a linear function of which the equation is stated below;

$$Y(t) = \alpha + \beta t$$

Given that t= Index of time (independent variable)

α and β = *defining the slope and interception of the line for the trend.*

Y = dependent variable

Alternatively, the linear trend can also be stated to be;

$$Y_t = \beta_0 + \beta_1 t + e_t$$

Given that

β_0= constant

β_1= average change from one period to the next

t= value of the time unit

e_t=the error term.

- **The quadratic trend** however, is another model of time series analysis that is used in regression analysis. The equation for the quadratic trend for time series analysis is as follows:

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + e_t$$

Given that;

β_0 is the constant,

β_1 and β_2 are the co-efficient

t is the unit of time,

e_t is the error term.

- **Exponential growth** as a model of time series analysis is responsible for growth or delay which occurs exponentially. It is otherwise called exponential smoothing. Exponential trend is a powerful model for forecasting. It is also known to be a rule of thumb technique for time series data analysis using the exponential window function. The formula is written below:

$$Y_t = \beta_0 \beta_1 t + e_t$$

Given that;

β0= constant,

β1=co-efficient,

t= unit of time,

et= term for error.

For log-exponential smoothing,

The exponential model to be used is $\boldsymbol{y = \alpha e^{\beta x}}$

In order to develop the log-exponential smoothing for forecasting time series data,

Log of both sides of the equation: $\boldsymbol{y = \alpha e^{\beta x}}$

Gives the log equation below:

$\boldsymbol{\ln y = \ln \alpha + \beta x}$

Considering the above explanation of the models of time series, the components and the trends; time series can simply be said to be a statistical technique that deals with time series data, or trend analysis. For this research work, time series analysis will be done to the data that is extracted from the open access repository of the "Our World Data".

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

This chapter is the research methodology. Research methodology entails the process and techniques that were applied to identify, select, process, and analyze information for this research work. These include; study design, data sampling, instrument, data collection and data analysis.

3.2 Study Design

This study is a secondary research study

3.3 Sample Selection

For this research, stratified random-sampling was employed for choosing the two countries; in terms of their socio-economic status. United State of America representing the developed countries and Nigeria representing the developing countries looking into their economic status on “World Population Review” dated 2019.

3.4 Study Instrument

The data for this study was extracted from the previous global data on diseases specifically on cancer, diabetes, tuberculosis and kidney diseases from the year 1990 to the year 2016.The data sample was obtained from the open access repository of the “Our World Data”. The research analysis of the study will assist in determining whether there is a decrease or an increase trends of the diseases from the year 1990 through 2016.

3.5 Data Collection

The data was collected using web data and was obtained from the open access repository of the “Our World Data”. The data of prevalence (mortality) from Cancer, Kidney diseases, Tuberculosis and Diabetes from two countries will be extracted for this research study.

3.6 Analysis of Data

Various statistical methodologies consisting of the uni-variate, bi-variate and multivariate analytical methods will be adopted in the study. Majorly, the time series will be used to perform a trend analysis and forecasting of the disease's mortality. The data variable collected will be analyzed using Gretl.

Gretl is an open source statistical package, mainly for econometrics. The name is an acronym for Gnu Regression, Econometrics and Time-series Library. In Gretl, the best model for the prediction is determined by the model with the lowest mean square error (MSE).

Akaike criterion compares the quality of a set of statistical models of each other.

R-square is a statistical measure of how close the data are to the fitted regression line. It represents the proportion of the variance for a dependent variable that's explained by an independent variable or variables in a regression model.

P-value, is said to be statistically significant when $p < 0.05$.

CHAPTER 4

RESULTS

This chapter gives the results of the time series analysis carried out on data gotten on Kidney diseases, Cancer diseases, Diabetes and Tuberculosis. The data for the mortality record of these four diseases for the countries Nigeria and United States of America were extracted for the analysis is from the year 1990-2016.

TABLE 4.1: DEATH CAUSED BY KIDNEY DISEASE IN USA

VARIABLES	MEAN SQ. ERROR	AKAIKECRITERION	R.SQUARE	P-VALUE
LINEAR	2.3432e+06	482.61	0.988	1.22e-23 ***
QUADRATIC	6.6544e+05	441.81	0.998	1.16e-27 ***
EXPONENTIAL	1.5209e+06	−139.5407	0.997	2.45e-63 ***

Table 4.1 gave the summary descriptive models of death caused by kidney disease in USA. The mean square error (MSE) for linear regression is 2.3432e+06, while for quadratic is 6.6544e+05 and the exponential is 1.5209e+06. The Akaike criterion for linear is 482.61, 441.81is for quadratic and −139.5407 for exponential. Linear regression with the R-square 0.988, 0.998 and 0.997 for quadratic and exponential respectively. The p-values for linear, quadratic and exponential are 1.22e-23, 1.16e-27 and 2.45e-63 respectively. According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the quadratic model.

Table 4.2: EXPONENTIAL MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: KIDNEY

Variables	coefficient	std. error	t-ratio
Const	10.3495	0.00697554	1484
time	0.0374883	0.000435405	86.10

Yt = ln y= ln α+βx

In y= *In* 10.3495 + (0.0374883)x

= Exp(10.3495) + Exp(0.0374883)x

=31,241(1.038)x

TABLE 4.3: FORCAST

YEAR	Expα+ (*β*))	Expα+ (*β*)^*x*	Forecast
2017	31,241(1.038)	31,241(1.038)^27	85,518.35
2018	31,241(1.038)	31,241(1.038)^28	88,768.05
2019	31,241(1.038)	31,241(1.038)^29	92,141.24
2020	31,241(1.038)	31,241(1.038)^30	95,642.60

Table 4.3: It is said to predict that in four years' time, the mortality rate caused by kidney disease increases every year.

Figure 4.1

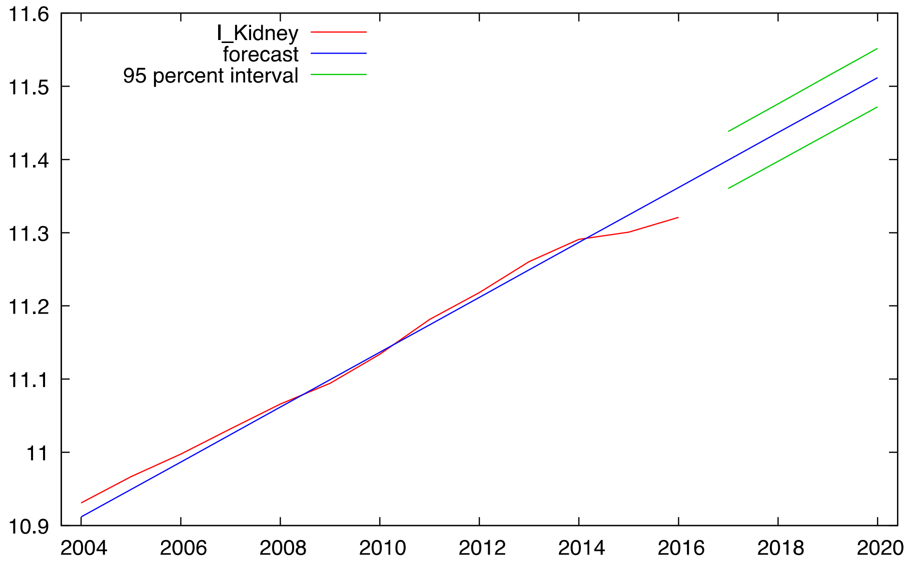


TABLE 4.4: DEATH CAUSED BY TUBERCULOSIS DISEASE IN USA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	13867	360.7975	0.866374	**6.68e-21 *****
QUADRATIC	35108	269.3882	0.995799	**3.23e-35 *****
EXPONENTIAL	172.39	−41.57478	0.906725	**1.80e-40 *****

The table 4.4 above shows the descriptive statistics models of mortality rate caused by tuberculosis. The linear model has a mean square of 13867, 35108 and 172.39 of quadratic and exponential model respectively. Linear model with Akaike criterion of 360.7975, 269.3882 as the quadratic and exponential with the negative criterion of −41.57478. The R-square linear model of 0.866374, quadratic with R-square of 0.995799 and 0.906725 has the R-square of exponential model. The p-values shows that there is a significant difference in the three models, but to consider the best models to be used for our predictions, we are said to consider the models with the lowest mean square error, therefore, the best model for prediction is the exponential model.

Table 4.5: EXPONENTIAL MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: TUBERCULOSIS

Variables	coefficient	std. error	t-ratio
Const	7.72659	0.0428024	180.5
time	−0.0416493	0.00267167	−15.59

Mathematical equation***: ln y= ln α+βx***

$$In\ y = In\ 7.72659 + (-0.0416493)x$$

$$= \text{Exp}(7.72659) + \text{Exp}(-0.0416493)x$$

$$=2,267.9(0.96)x$$

Table 4.6: FORCAST

YEAR	Expα+ (β)	Expα+ (β)^x	Forecast
2017	2,267.9(0.96)	2,267.9(0.96)^27	748
2018	2,267.9(0.96)	2,267.9(0.96)x)^28	726
2019	2,267.9(0.96)	2,267.9(0.96)x)^29	703
2020	2,267.9(0.96)	2,267.9(0.96)^30	658

According to the table 4.6, it is reviewed that the mortality rate of the population in the USA caused by Tuberculosis is predicted to decrease yearly.

Figure 4.2

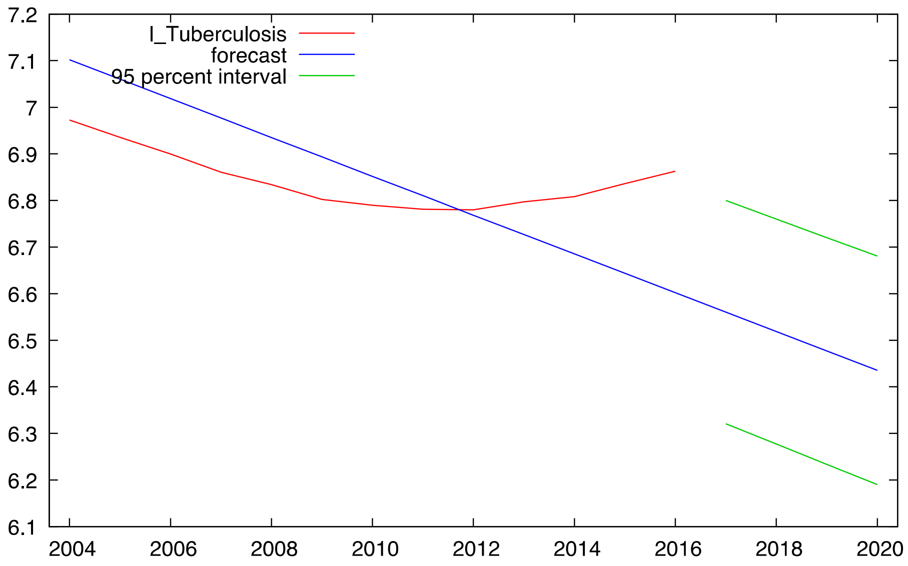


Table 4.7: DEATH CAUSED BY CANCER DISEASE IN USA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	2.5014e+08	586.2901	0.919658	8.11e-353***
QUADRATIC	1.0892e+08	577.4000	0.946325	3.40e-31 ***
EXPONENTIAL	2.2020e+08	−137.1378	0.934264	1.85e-65 ***

This table gave the summary descriptive models of death caused by **Cancer** disease in USA. The mean square error (MSE) for linear regression is2.5014e+08, while for quadratic is 1.0892e+08and the exponential is 2.2020e+08. The Akaike criterion for linear is 586.2901, 577.4000is for quadratic and −137.1378for exponential. Linear regression with the R-square of 0.919658, 0.946325and 0.934264for quadratic and exponential respectively. The p-values for linear, quadratic and exponential are **8.11e-353**, **3.40e-31**and **1.85e-65** respectively. According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the quadratic model.

Table 4.8: QUADRATIC MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: CANCER

Variables	coefficient	std. error	t-ratio
Const	531036	6298.73	84.31
time	1591.79	1036.78	1.535
sq_time	124.090	35.9367	3.453

Mathematical equation

Yt = β0 + β1 t + β2 t^2 + et

= 531036 + 1591.79(t) + 124.090(t)^2

Table 4.9: FORCAST

YEAR	**Quadratic(*Yt*)**	**Time(*t*)**	**Forecast**
2017	531036 + 1591.79(t) + 124.090(t)^2	27	672892.84
2018	531036 + 1591.79(t) + 124.090(t)^2	28	681557.78
2019	531036 + 1591.79(t) + 124.090(t)^2	29	690470.91
2020	531036 + 1591.79(t) + 124.090(t)^2	30	699632.21

Table 4.9 depicts a graph of the mortality rate for the population in the USA caused by cancer increases every year as predicted by the best fit model, Quadratic.

Figure 4.3

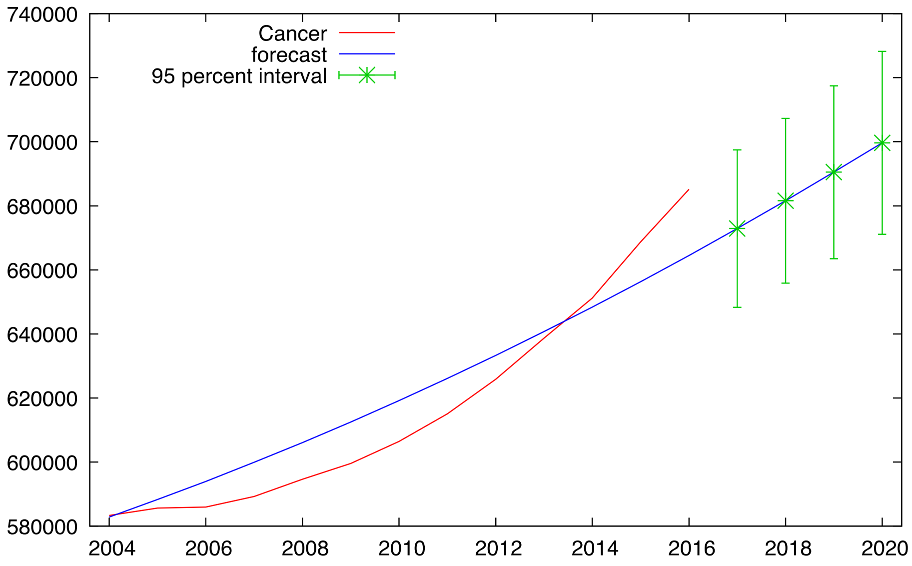


Table 4.10: DEATH CAUSED BY DIABETES DISEASE IN USA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	8.6940e+06	521.6498	0.983433	**5.85e-31*** **
QUADRATIC	7.7987e+06	501.4920	0.992708	**1.12e-28 *** **
EXPONENTIAL	2.5339e+06	−99.10738	0.961239	**1.79e-56 *** **

The table 4.10 above shows the statistical descriptive of death caused by diabetes in the USA, with the use of three different models. the linear models with the mean square of 8.6940e+06 Akaike criterion of 521.6498 R-square of 0.983433 By using the quadratic model, the mean square of 7.7987e+06, Akaike criterion of 501.4920 and R-square of 0.992708. The exponential model with the mean square of 2.5339e+07, Akaike criterion of −99.10738 and he R-square of 0.961239.According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the exponential model.

Table 4.11: EXPONENTIAL MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: DIABETES

Variables	coefficient	std. error	t-ratio
Const	11.6306	0.0147	788.6
time	0.0229	0.00092	24.90

Mathematical equation: $\boldsymbol{ln\ y = ln\ \alpha + \beta x}$

$$In\ y = In\ 11.6306 + (0.0229)\text{x}$$

$$= \text{Exp}(11.6306) + \text{Exp}(0.0229)\text{x}$$

$$= 112{,}487.7(1.0232)\text{x}$$

Table 4.12: FORCAST

YEAR	Expα+ (β)	Expα+ (β)^x	Forecast
2017	112,487.7(1.0232)	112,487.7(1.0232)^27	208,948.58
2018	112,487.7(1.0232)	112,487.7(1.0232)^28	213,796.18
2019	112,487.7(1.0232)	112,487.7(1.0232)^29	218,756.25
2020	112,487.7(1.0232)	112,487.7(1.0232)^30	223,831.40

Table 4.12 shows that by using the best model fit for the data of Diabetes disease, that is quadratic regression. it is said to predict that in four years' time, the mortality rate caused by Diabetes disease increases every year.

Figure 4.4

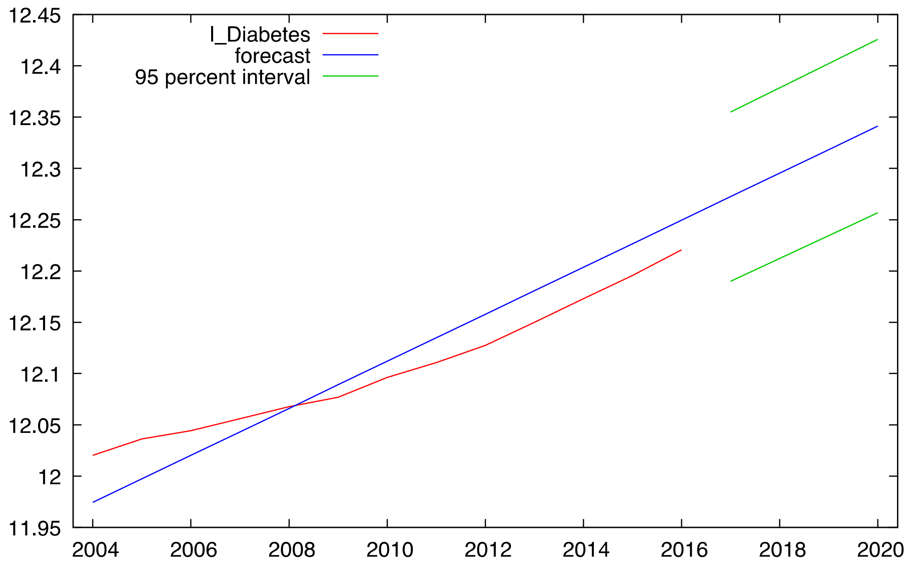


Table 4.13: DEATH CAUSED BY KIDNEY DISEASE IN NIGERIA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	7440.9	325.8791	0.913116	**7.53e-32 *** **
QUADRATIC	10133	326.5237	0.917370	**5.11e-26 *** **
EXPONENTIAL	6311.9	−113.8107	0.903159	**1.89e-55 *** **

Table 4.9 gave the summary descriptive models of death caused by kidney disease in Nigeria. The mean square error for linear regression is 7440.9, while for quadratic is 10133 and the exponential is 6311.9. The Akaike criterion for linear is 325.8791, 326.5237is for quadratic and −113.8107for exponential. Linear regression with the R-square of 0.913116, 0.917370 and 0.903159 for quadratic and exponential respectively. The p-values for linear, quadratic and exponential are **7.53e-32**, **5.11e-26** and **1.89e-55** respectively. According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the exponential model.

Table 4.14: EXPONENTIAL MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: KIDNEY

Variables	Coefficient	std. error	t-ratio
Const	8.06052	0.0112334	717.6
time	0.0107065	0.000701175	15.27

Mathematical equation: ***ln y= ln α+βx***

$$In\ y = 8.06 + (0.01)^{\wedge}x$$

$$Y = Exp(8.06)Exp(0.01)^{\wedge}x$$

$$3{,}165.3(1.01)^{\wedge}x$$

Table 4.15: FORCAST

YEAR	**Expα+ *(β)***	**Expα+ *(β)*^*x***	**Forecast**
2017	3,165.3(1.01)	3,165.3(1.01)^27	4,141
2018	3,165.3(1.01)	3,165.3(1.01)^28	4,182
2019	3,165.3(1.01)	3,165.3(1.01)^29	4,224
2020	3,165.3(1.01)	3,165.3(1.01)^30	4,266

According to the table 4.15, it is reviewed that the mortality rate of the population in the Nigeria caused by kidney is predicted to increase every year by the best fit model, Exponential.

Figure 4.5

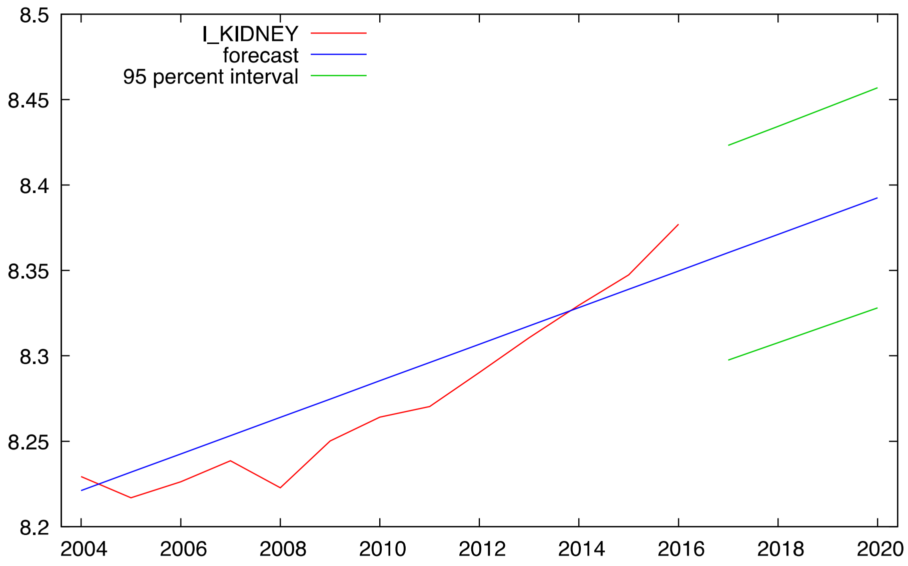


Table 4.16: DEATH CAUSED BY TUBERCULOSIS DISEASE IN NIGERIA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	1.6126e+07	555.2853	0.792093	**7.21e-21 *** **
QUADRATIC	2.3377e+07	532.5721	0.916755	**2.31e-18 *** **
EXPONENTIAL	1.7051e+07	−30.46613	0.796817	**2.06e-42 *** **

The table 4.11above shows the descriptive statistics models of mortality rate caused by tuberculosis Nigeria. The linear model has a mean square of 1.6126e+07, 2.3377e+07 and 1.7051e+07of quadratic and exponential model respectively. Linear model with Akaike criterion of 555.2853, 532.5721as the quadratic and exponential with the negative criterion of −30.46613. The R-square linear model of 0.792093, quadratic with R-square of 0.916755 and 0.796817 has the R-square of exponential model. The p-values shows that there is a significant difference in the three models, but to consider the best models to be used for our predictions, we are said to consider the models with the lowest mean square error, therefore, the best model for prediction is the linear model.

Table 4.17: Tuberculosis forecast coefficient

Variables	coefficient	std. error	t-ratio
Const	79123.3	2702.15	29.28
time	−1646.07	168.665	−9.759

MATHEMATICAL EQUATION

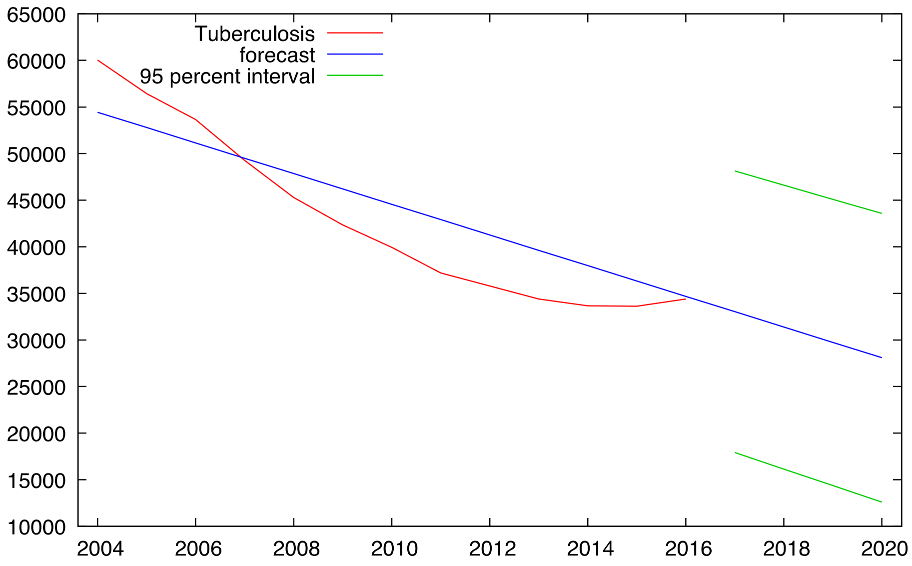
$$Yt = \beta 0 + \beta 1\ t + et$$

$$= 79123.3 + (-1646.07)(t)$$

Table 4.18: FORCAST

YEAR	Linear(*Yt*)	Time(*t*)	Forecast
2017	79123.3+(−1646.07)(t)	27	33034
2018	79123.3+(−1646.07)(t)	28	31387
2019	79123.3+(−1646.07)(t)	29	29741
2020	79123.3+(−1646.07)(t)	30	28095

Figure 4.6



By using the best model fit for the data of Tuberculosis disease, that is linear model. it is said to predict that in four years' time, the mortality rate caused by Tuberculosis disease decreases each year.

Table 4.19: DEATH CAUSED BY CANCER DISEASE IN NIGERIA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	5.1001e+06	486.0014	0.922382	**2.85e-29 *** **
QUADRATIC	3.0225e+06	484.2704	0.932399	**1.58e-24 *** **
EXPONENTIAL	4.0126e+06	−111.8017	0.932662	**3.22e-58 *** **

This table gave the summary descriptive models of death caused by Cancer disease in Nigeria. The mean square error for linear model is5.1001e+06, while for quadratic is 3.0225e+06 and the exponential is 4.0126e+06. The Akaike criterion for linear is 486.0014, 484.2704is for quadratic and −111.8017 for exponential. Linear regression with the R-square of 0.922382, 0.932399 and 0.932662 for quadratic and exponential respectively. The p-values for linear, quadratic and exponential are **2.85e-29**, **1.58e-24** and **3.22e-58** respectively. According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the quadratic model.

Table 4.20:QUADRATIC MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: CANCER

Variables	coefficient	std. error	t-ratio
Const	49715.4	1122.69	44.28
time	467.617	184.796	2.530
sq_time	12.0796	6.40536	1.886

MATHEMATICAL EQUATION:

$Yt = \beta 0 + \beta 1t + \beta 2\ t^2 + et$

$$= 49715.4 + 467.617(t) + 12.0796(t)^2$$

Table 4.21: FORCAST

YEAR	Quadratic(Yt)	Time(t)	Forecast
2017	49715.4 + 467.617(t) + 12.0796(t)^2	27	72279
2018	49715.4 + 467.617(t) + 12.0796(t)^2	28	73435
2019	49715.4 + 467.617(t) + 12.0796(t)^2	29	74615
2020	49715.4 + 467.617(t) + 12.0796(t)^2	30	75820

Figure 4.7

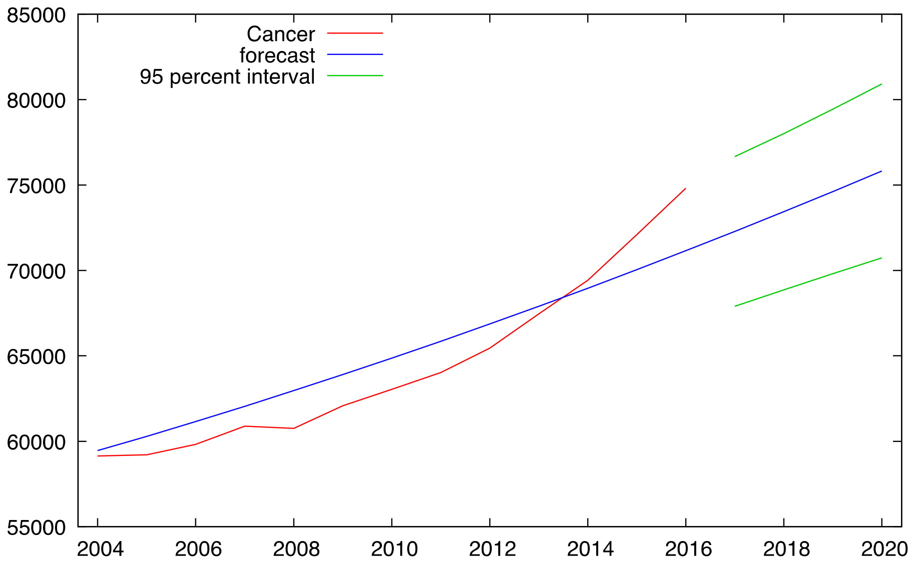


Figure 4.21 shows that the mortality rate of the population in Nigeria caused by cancer increases every year as predicted by the best fit model, Quadratic**.**

Table 4.22: DEATH CAUSED BY DIABETES DISEASE IN NIGERIA

VARIABLES	MEAN SQ. ERROR	AKAIKE CRITERION	R. SQUARE	P-VALUE
LINEAR	8.1049e+05	462.0793	0.133473	**2.46e-29 *** **
QUADRATIC	1.1886e+06	462.9262	0.169700	**1.49e-23 *** **
EXPONENTIAL	7.9040e+05	−97.14148	0.138104	**8.35e-55 *** **

The table 4.15above shows the statistical descriptive of death caused by diabetes in the Nigeria, with the use of three different models. the linear models with the mean square of 8.1049e+05 Akaike criterion of 462.0793 R-square of 0.133473 By using the quadratic model, the mean square of 1.1886e+06, Akaike criterion of 462.9262 and R-square of 0.169700. The quadratic model with the mean square of 7.9040e+05, Akaike criterion of −97.14148 and he R-square of 0.138104. According to the p-values, it shows that there is a significant difference in the three models, but to consider the best models to be used in forecasting, we are said to consider the models with the lowest mean square error, therefore the best model for prediction is the quadratic model.

Table 4.23: QUADRATIC MODEL: OLS, USING OBSERVATION 1990-2016 (T = 27)

DEPENDENT VARIABLE: DIABETES

Variables	coefficient	std. error	t-ratio
Const	30458	756.134	40.28
time	182.519	124.641	1.466
sq_time	-4.41461	4.31403	-1.023

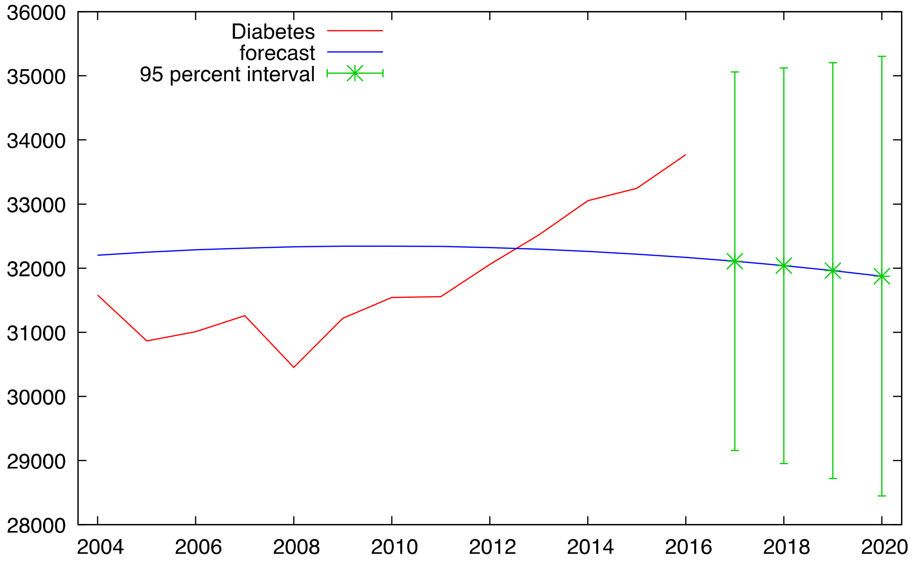
Mathematical equation: $Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + e_t$

$$= 30458 + 182.519(t) + (-4.41461)(t)^2$$

Table 4.24: FORCAST

YEAR	Quadratic(*Yt*)	Time*(t)*	Forecast
2017	30458+ 182.519(t) + (-4.41461)(t)^2	27	32107.82
2018	30458+ 182.519(t) + (-4.41461)(t)^2	28	32038.71
2019	30458+ 182.519(t) + (-4.41461)(t)^2	29	31960.76
2020	30458+ 182.519(t) + (-4.41461)(t)^2	30	31873.99

Figure 4.8



According to the table, it is reviewed that the mortality rate of the population in the Nigeria caused by Diabetes is predicted to decreases every year by the best fit model, Exponential.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Facts

Cancer is known worldwide to be a life-threatening disease which most times is uncontrollable especially if detected late (Golemis,2018). It is defined as development of abnormal cells that divide uncontrollably and have the ability to spread and invade at the same time destroying normal body tissues (Jiang,2015). Tuberculosis is another deadly disease caused by Mycobacterium Tuberculosis (MTB) which is characterized by chronic cough, blood in sputum and is highly contagious (Al-Humadi,2017) and the sustainable development goal for 2030 is alleviating every form of tuberculosis or all population. Diabetes is a condition that impairs the body's ability to process blood glucose, otherwise known as blood sugar (Watson &Dokken, 2014). Diabetes has been proven to be a major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation (Hippisley-Cox, 2016). Kidney diseases are frequently caused by diabetes, hypertension or anything that can cause injury to the kidney (Kristensen et al.,2019). Kidney disease is characterized by gradual loss of function of the kidneys. The countries that were selected for this study are Nigeria and the United States of America (USA). Time series analysis was done with mortality rate records of these diseases for both Nigeria and United States of America as extracted from ‘‘Our World Data”.

5.2 Summary of Findings

1. The p-values for linear, quadratic and exponential are 1.22e-23, 1.16e-27 and 2.45e-63 respectively for kidney disease in USA. It is said to predict that in four years’ time, the mortality rate caused by kidney disease increases every year. (**Figure 4.1**)
2. The mortality rate of the population in the USA caused by Tuberculosis is predicted to decrease yearly. **(Table 4.4**).
3. The p-values for linear, quadratic and exponential are **8.11e-353**, **3.40e-31**and **1.85e-65**respectively for Cancer. The mortality rate for the population in the USA

caused by cancer increases every year as predicted by the best fit model, Quadratic. **(Figure 4.2**)

4. By using the quadratic model, the mean square of 7.7987e+06, Akaike criterion of 501.4920 and R-square of 0.992708 for diabetes diseases in USA. The mortality rate caused by Diabetes disease increases every year (**Figure 4.3**).
5. The p-values for linear, quadratic and exponential are **7.53e-32**, **5.11e-26** and **1.89e-55** respectively for Kidney disease in Nigeria. **Table 4.10** shows the mortality rate of the population in the Nigeria caused by kidney is predicted to increase every year by the best fit model, Exponential.
6. The R-square linear model of 0.792093, quadratic with R-square of 0.916755 and 0.796817 has the R-square of exponential model. The mortality rate caused by Tuberculosis disease decreases each year in Nigeria (**Figure 4.4**).
7. Linear regression with the R-square of 0.922382, 0.932399and 0.932662 for quadratic and exponential respectively.The mortality rate of the population in Nigeria caused by cancer increases every year as predicted by the best fit model, Quadratic**(Figure 4.5**).
8. By using the quadratic model, the mean square of 1.1886e+06, Akaike criterion of 462.9262 and R-square of 0.169700 for diabetes in Nigeria. The mortality rate of the population in the Nigeria caused by Diabetes is predicted to decreases every year by the best fit model, Quadratic **(Table 4.17).**

5.3 Recommendations and Suggestions

1. This research should be a head start to the application of time series analysis on the mortality rate of other major diseases which include HIV/AIDS, neurological conditions and many others which present themselves in countries.
2. Further studies are needed not only in Nigeria and United States of America but in other disease affecting countries to predict and tackle disease and minimize their mortality rates.
3. Further studies should also be conducted in order to determine the application of time series analysis to disease burden from the year 2016-2019**.**

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