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Modelling the Effect of Infant and Maternal Mortalityon the Population of Nigeria

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Abstract:- The goal of this study was to simulate the impact of infant mortality and maternal death rates on the Nigerian population from 1980 to 2021. This study has five particular objectives that were created and used. Relevant related literatures were reviewed based on the factors in the objectives. This study was conducted using a cross-sectional research design. For this study, secondary data was taken from yearly records of Nigerian infant/maternal mortality rates and population from the World Development Indicators- World Bank Data – 2019 and World Bank, and the data was analyzed using a multiple regression model. MINITAB (version 20.0) and Microsoft Excel 2013 were used for all calculations. The series plot results for the variables that affected the Nigerian population show a downward trend across the plot, indicating a linear but negative link between the mortality variables and the Nigerian population. To determine the significant parameters, the Durbin method of estimating a multiple regression model was used; this found that all of the model's parameters were significant at 5%, which appears unbiased. It was discovered that Nigeria's population will continue to grow over the next six years, despite the effects of newborn and maternal mortality on the population. It was suggested that the government and community leaders use the media to inform, educate, and sensitize people about baby and maternal health.

Keywords:- *Infant Mortality, Maternal Mortality, Population, Modelling, Regression Model.*

I. INTRODUCTION

Maternal mortality, often known as maternal death, is still the leading cause of death among women of reproductive age in many countries, and it is a major public health concern, particularly in developing nations (WHO, 2007). According to Shah and Say (2007), a maternal death is defined as the death of a woman while pregnant or within 42 days after termination of pregnancy from any cause connected to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. In 2005, the number of maternal deaths worldwide was predicted to reach 536,000, up from 529,000 in 2000. Every day, 1500 women die from pregnancy or pregnancy-related illnesses, according to the WHO Factsheet (2008).The majority of these deaths occur in developing nations, and the majority of them are preventable. The highest disparity between industrialized and poor countries occurred in maternal mortality, according to the World Health Organization's figures. According to Ujah et al. (2005), whereas 25% of women of reproductive age live in wealthy nations, they only account for 1% of maternal mortality worldwide.

Infant mortality is defined as the death of a child in their first year of life (World Health Organization-WHO, 2011), whereas infant mortality rate is defined as the number of deaths under the age of one year occurring among live births in a given geographical area during a given year per 1,000 live births occurring among the population of the same geographical area during the same year (World Health Organization-WHO, 2011). (Organization for Economic Co-operation and Development-OECD, 2001). Infant mortality has long been recognized as an important instrument for assessing a population's health and health-care system, as well as a barometer for assessing a county's well-being and health-care facilities (Madise et al., 2001). The realization of the importance of infant mortality and the need to reduce its occurrence has led to the fight against mortality in infants both at the national and international level.

Despite significant improvements in child health outcomes during the twentieth century, Nigeria's newborn death rate remains unacceptably high (Adetoro&Amoo, 2014). Nigeria's current infant mortality rate is estimated to be 70 per 1000 live births, suggesting that one in every 15 live births dies before reaching their first birthday (National Bureau of Statistics- NBS, 2017).

The total number of people living in a certain area is known as the population. It could be a neighbourhood, a state, or a country. A population can also be defined as a group of animals, plants, or humans in which interbreeding occur. It can also be defined as a limited or infinite collection of items in the process of being concentrated. A population is the group of people from which a statistical sample is selected for a research in statistics. As a result, a population can be defined as a group of people who are linked by a common characteristic. A sample, not the full population, is a statistically significant fraction of a population. As a result, a statistical study of a sample must report the estimated standard error, because the results from the complete population would have one.

In most cases, the term "global population" refers to a group of people or, at the very least, a group of living creatures. Statisticians, on the other hand, refer to the group they're investigating as a population. The study's population may be Nigerian kids born in 2021, or the total number of IT businesses in Africa in 2000. Nigeria's current population is 211, 400, and 708 people in 2021 (two hundred and eleven million, four hundred thousand, and seven hundred and eight). An rise of 2.55 percent from 2020.In 2020, the

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population was 206,139,589 (two hundred and sixty-one million, three hundred and thirty-nine thousand, five hundred and eighty-nine), up 2.5 percent from 2019. In 2019, Nigeria's population was 200,963,599 (two hundred million, nine hundred and sixty-three thousand, and five hundred and ninety-nine).

In statistical modeling, regression analysis is a set of statistical techniques for estimating the relationship between a dependent variable and one or more independent variables. Several scholars assisted in the development of predictive models. Weibul, Asymptotic Regression/Growth Model, Richards, Gompertz, Hill, Logistic, and S-shaped Curves are only a few examples.These models are known as Sigmoidal Growth Models (Sigmoidal curves) and can be found in a variety of fields, including engineering, bioassay, tree diameter, height distribution in forestry, signal detection theory, agriculture, fire size, high-cycle fatigue strength prediction, earthquake seismological data analysis, and economics.

The unknown variable in a statistical model can be anticipated using maximum likelihood estimation and the least squares approach. The least squares approach is a well-known method for approximating the solution of over determined problems. The overall solution in the least squares approach minimizes the sum squares of error (SSE) made in the outcomes of all single equations. Legendre presented the first concise exposition of the least square approach in 1805.

Regression analysis has numerous advantages: The regression forecasting technique is used for forecasting and determining the causal link between variables, as the name implies. The benefits of linear regression, which is the technique for modeling the value of one variable at the fee(s) of one, are an essential linked practically similar, principle. Understanding the value of regression analysis, the advantages of linear regression, the advantages of regression evaluation, and the regression approach to forecasting can help a small business, or any business, gain a better understanding of the variables (or elements) that may affect its success in the weeks, months, and years ahead.

The significance of regression analysis is that it is all about data: information in the form of numbers and figures that define your business. The advantages of regression analysis are that it allows you to crunch the facts to assist you make better decisions for your business now and in the future. The regression technique to forecasting entails examining the correlations between data components, allowing you to:

- Predict income in the near and lengthy-time period.
- Understand stock stages.
- Understand supply and call for.
- Review and recognize how extraordinary variables impact all of these things.

This study was motivated due to the understanding that knowing trustworthy and accurate projections of infant and maternal death rates is both necessary and significant for the planning of appropriate intervention programs and preventative measures for the reduction of infant and maternal mortality in Nigeria. Several studies have found that if the regression and ARIMA models are appropriately chosen, they may accurately predict future values in the series. In a recent work, Usman et al. (2019) used ARIMA time series techniques to anticipate the prevalence of newborn death in Nigeria between 1990 and 2017.Another research was conducted by Kumar and Anand (2012) used the ARIMA technique to anticipate sugarcane production in India between 2013 and 2017 based on data from the previous 62 years. The ARIMA technique is an acceptable predictive model capable of creating credible forecasts of univariate time series data, according to the results of their research, which went on to statistically verify and validate the forecast errors.

This research uses a regression model to simulate the effects of infant and maternal mortality rates on the Nigerian population, which is different from the other studies stated above.

Time Series Analysis and Forecast of Infant Mortality Rate in Nigeria: An ARIMA Modeling Approach was investigated by Friday and Donalben (2020). Childhood death, in general, and newborn mortality, in particular, has long been a public health concern in Nigeria, according to them. Identified as one of the barometers for measuring any population's condition of health, health facilities, and well-being, relevant government authorities and public health stakeholders have all worked to limit and possibly eliminate its incidence, but with little success. Nigeria was one of the countries that failed to fulfill the Millennium Development Goal (MDG) for a two-thirds decrease in childhood mortality in 2015. After failing to meet MDG 4, genuine worries about the country's ability to meet SDG 3.2 by 2030 prompted an investigation of the country's chances of lowering the rate of childhood death in the first year of life. Using data from the United Nations' Inter Agency Group for Childhood Mortality Estimation, the current study used the Auto-Regressive Integrated Moving Average (ARIMA) model to anticipate infant mortality in Nigeria up to 2030. (UN-IGME). At a 95% confidence interval, the ARIMA (1, 1, 1) model used anticipated a reduction of up to 30% by 2030.

According to Mojekwu (2005), due to the difficulty of reliably monitoring maternal mortality, even countries with complete vital registration systems find it a difficult task. Maternal mortality is difficult to assess since it necessitates knowledge about deaths of reproductive (15-49)-year-old women, the cause of death, and whether or not the women were pregnant at the time of death or had recently been pregnant. Despite this, few countries keep track of births and deaths, even fewer keep track of the cause of death, and even fewer keep track of pregnancy status on death certificates. Maternal deaths may be misclassified for a variety of causes, including underreporting, illiteracy, and cultural conventions. When vital registration systems are missing or weak, survey approaches might be used to estimate maternal mortality. Typically, high-mortality counties lack adequate registration systems and the resources to rely on surveys.

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Adejumo et al. (2013) used binary logit models to explore tuberculosis: a study of patients in Nigeria. Using binary logit modeling, this study will look at the impact of age, state, and year on the gender of Tuberculosis patients. From 2006 to 2009, data sets of registered Tuberculosis cases were used to create binary logit models. Males have a higher risk of tuberculosis than females in all age categories, states, and years, according to the findings. There was also risk variance across age groups, states, and years. This research helps researchers better understand Tuberculosis patients in Nigeria by age, state, year, and gender.

A article on Maternal Mortality and Maternal Care was published by Shah and Say (2007), WHO reproductive health researchers. The authors found that maternal death reductions between 1990 and 2005 were small and unequal, and that countries with high maternal mortality ratios shared issues such as high fertility and unwanted pregnancies, poor health facilities, and a shortage of medical personnel.

In a ten-year retrospective study of maternal mortality at the Central Hospital in Benin City, Nigeria, Omo-Aghoja et al (2008) examined the number and pattern of obstetric fatalities over a ten-year period and identified frequent causes of maternal deaths. Sepsis, hemorrhage, obstructed labor, and pre-eclampsia/eclampsia were the primary direct causes of maternal mortality, whereas institutional issues and anemia were the leading indirect reasons. Low literacy, high poverty levels, extremes of parity, and non-use of maternity facilities were also linked to maternal mortality, according to the study. The MMR (Maternal Mortality Ratio) was 518 per 100,000. Unbooked patients had 30 times the MMR of booked patients, and 60 percent of maternal fatalities occurred within 24 hours of admission.

Ibe (2008) did a study on service utilization and poor mortality index in Nigeria's Anambra state. In a cross-sectional study, a multistage sampling technique was used to analyze the usage of maternity services in Anambra state, and it was discovered that the problem of maternal death in the country may not necessarily lie with utilization, but with service quality. This finding tends to back up Taiwo et alargument's that the problem of maternal death in Nigeria may not be due to a failure to use maternal care, but rather that the health-care system has to be repositioned to meet the requirements of modern obstetric treatment.

Mairiga et al. (2008) conducted a population-based qualitative study in two urban and two rural villages in Borno state, Nigeria, to learn about community members' knowledge and perceptions about maternal mortality and morbidity, as well as how to prevent the scourge. The study established through focus group discussions that maternal mortality and morbidity are prevalent and well-known in the communities examined, and that the ramifications are well understood. The study discovered that the causes of maternal death were thought to be medical, cultural, and socioeconomic, but that there were severe misconceptions that had grave effects for maternal mortality.

II. PROBLEM STATEMENT

Despite all of the laws, declarations, conferences, and other efforts targeted at lowering the scourge of maternal and newborn deaths around the world, very minor improvements in maternal mortality appear to have been made in many nations over the last 20 years (Shah & Say, 2007). Africa may have actually lost ground, while many developing countries have fallen far short of the World Health Organization's Safe Motherhood Initiative goals. In Nigeria, the Federal Ministry of Health chose the year 2006 as the target year for a 50% reduction in infant and maternal mortality. However, not only were these goals not met, but Nigeria's baby and maternal health situation has deteriorated significantly in recent years (Ujah et al, 2005). Previous efforts in Nigeria to reduce baby and maternal death ratios focused on making direct improvements to the health system. These efforts have not been backed up by sufficient resources to effectively reduce newborn and maternal mortality in the country.

Given this lack of success, Shiffman and Okonofua (2007) concluded that the country's high maternal and newborn mortality must be addressed by creating enough political priority for governments to allocate sufficient resources to successfully reduce maternal mortality in Nigeria. This research gathered some of the elements that contribute to the country's high maternal mortality rate and utilized a regression model to model the consequences of infant and maternal mortality rates on the Nigerian population.

A. *Purpose of the Study*

The purpose of this study is to model the effect of infant mortality and maternal mortality rates on the population of Nigeria. The specific objectives are;

- To obtain the trend of the variables (population, infant mortality and maternal mortality).
- To estimate the parameters of the regression models (β_0, β_1, β_2)
- To obtain the residual sum of square, R-square values AIC and BIC of the models.
- To build the required model and perform the diagnostic measures using (leverages and variance inflation factor)
- To forecast the population of Nigeria for a period of 6 years using the estimated model.

B. *Scope and Limitation of the study*

The study's focus is on modeling the impact of infant and maternal mortality rates on Nigeria's population: a regression model approach to building a best fit regression model that will be used to forecast the trend of the various series data under this study, specifically, annual records data on infant/maternal mortality rates and Nigeria's total population matching the data length of 42 based on the number of cases reported from 1980 to 2021.

However, due to a lack of time, knowledge, and related literature, the researcher focuses on the yearly records of infant/maternal mortality rates and total population of Nigeria utilizing secondary records from the World

Development Indicators- World Bank Data – 2021 and world bank data (web: www.childmortality.org).

III. METHODS AND MATERIALS

A. *Research Design*

This study used a cross-sectional research methodology to model the influence of newborn mortality and maternal mortality rates on the Nigerian population using a regression model approach. This study will employ the approach of the basic linear regression model (OLS) and multiple linear regression models.

B. *Nature and Source of Study Data*

The recorded data for this study will be secondary statistical data extracted from Nigerian survey information on annual records of infant/maternal mortality rates and total population from the World Development Indicators- World Bank Data – 2021 and the World Bank (web: www.childmortality.org), 1980-2021.

C. *Data Analysis Tools*

MINITAB (version 18.0), Gretl (version 32), and Microsoft Excel 2010 are the programs that are used to estimate the parameters that make up the models. The parameters for simple regression models (OLS) and multiple linear regression models were be estimated using Microsoft Excel 2010 and MINITAB (version 18.0). The AIC, BIC, Hannan-Quinn, R^2, R^2-Adj., SSE, and MSE values were estimated using the Gretl (version 32) tool.

D. *Model Specification*

Suppose we have regression models of the form

$$y = f(x)$$

$$y = \alpha_0 + \alpha_1 x + \varepsilon_i = (x'x)^{-1} x'y \qquad (1)$$

Equation (3.1) is a simple linear regression model and

$$y = f(x_1, x_2)$$

$$Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon_i \qquad (2)$$

$$= (x'x)^{-1} x'y$$

We outline the size errors and as follows:

$$\delta_i = \bar{X}_1 - X_1 \text{ and } \delta_j = \bar{X}_2 - X_{21} \qquad (3)$$

Where,

$\bar{X}_1$ = The estimated mean value for the infant mortality rate and

$\bar{X}_2$ = The estimated values for maternal mortality.

Since we've two explanatory variables; its miles assured that X_1 and X_2 are the original values of the explanatory variables.

Thus, $X_1 = \bar{X}_1 - \delta_i$, $X_2 = \bar{X}_2 - \delta_j$ (4)

The version said above may additionally appear like an everyday regression model with predictor variables $\bar{X}_{i1}$ and $\bar{X}_{i2}$ with errors $(\varepsilon_i - \beta_1\delta_i - \beta_2\delta_j)$ however, this isn't always. The explanatory variables observations and are random variables which are correlated with the error term $(\varepsilon_i - \beta_1\delta_i - \beta_2\delta_j)$. We can employ additional factors for the purpose of this study that are known to be connected with the explanatory variables but not with the size errors. Instrumental variables are variables of this type. The incorporation of instrumental variables allows for the generation of stable regression parameter estimators. This method was used in this study.

Variable	Model	Description	Mathematical Formulation
Regression Models	A	Simple Regression 1	$y_i = \alpha_0 + \alpha_1 x_1 + \varepsilon_i$
	B	Simple Regression 2	$y_i = \beta_0 + \beta_1 x_2 + \varepsilon_i$
	C	Multiple Regression	$y_i = \omega_0 + \omega_1 x_1 + \omega_2 x_2 + \varepsilon_i$

Table 1: Model Specification

The models that will be utilized in the investigation to obtain the important independent parameter estimations are summarized in Table 1.

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E. Regression Model

X is the matrix of explanatory variables and is of the form:

$$X = \begin{bmatrix} 1 & X_{11} & X_{12} \\ 1 & X_{21} & X_{22} \\ \vdots & \vdots & \vdots \\ 1 & X_{n1} & X_{n2} \end{bmatrix} \quad (5)$$

Y and β are of the form:

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, \ \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_n \end{bmatrix}$$

Where

$$x'x = \begin{bmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 x_2 \\ \Sigma x_2 & \Sigma x_1 x_2 & \Sigma x_2^2 \end{bmatrix} \quad (6)$$

$$x'y = \begin{bmatrix} \Sigma y \\ \Sigma x_1 y \\ \Sigma x_2 y \end{bmatrix} \quad (7)$$

The matrix form of the model is giving by:

$$x'y = \begin{bmatrix} \Sigma y \\ \Sigma x_1 y \\ \Sigma x_2 y \end{bmatrix} = \begin{bmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 x_2 \\ \Sigma x_2 & \Sigma x_1 x_2 & \Sigma x_2^2 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix}$$

$$\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = (x'x)^{-1} x'y = \begin{bmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 x_2 \\ \Sigma x_2 & \Sigma x_1 x_2 & \Sigma x_2^2 \end{bmatrix}^{-1} \begin{bmatrix} \Sigma y \\ \Sigma x_1 y \\ \Sigma x_2 y \end{bmatrix}$$

and $v(\hat{\beta}_{iv}) = MSE(x'x)^{-1} x'y$ (8)

The middle phrase can be removed if n is odd.The estimators are constant when using this method, but they are quite likely to have a significant variance.

F. Model Selection Criteria

The model choice criterion is used to determine the optimal manufacturing feature. The excellent model is the one that minimizes the criterion. Several criteria for selecting various models have been developed in recent years, and it takes the form of residual sum of squares errors (SSE) compounded by a penalty factor that relies on the model's complexity. Some of these criteria are mentioned further down:

a) Akaike Information Criteria (AIC)

Akaike (1974) devised a method known as Akaike Information Criteria. The format of this data is as follows:

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$$AIC = n \ln\left[\frac{SSE}{n}\right] + 2(k) \tag{9}$$

Where;

- N = Sample size
- K = Number of parameter and
- SSE = Sum of square error.

b) SCHWARZ Bayesian Information Criterion (BIC)

Craven and Wahba (1978) proposed the SCHWARZ (BIC) criteria, which is now widely used. This method's format is as follows:

$$BIC = n \ln\left[\frac{SSE}{n}\right] + k \ln(n) \tag{10}$$

If there are at least eight observations, the charge for SCHWARZ (BIC) will also be reduced (Ramanathan, 1995).

c) Hannan-Quinn Criteria (HQC)

The HQC is a model selection criterion that includes making choices from a limited number of options. The HQC is determined by

$$HQC = n \ln\left[\frac{SSE}{n}\right] + k \ln(\ln(n)) \tag{11}$$

d) Coefficient of Determination (R^2)

R^2 is a crucial statistical metric that is employed in decision-making and statistical judgments. It's a method for determining the proportion of one or more variables' outcomes that outnumber the others.

This procedure is depicted in the following way::

$$R^2 = \frac{SSR}{SST} \tag{12}$$

Where; SSR= Sum of square Residual

SST= Sum of Square Total

e) Fisher Value (F)

At least one of the coefficients is not equal to zero if the estimated F-value is bigger than the F-value from the F-distribution. The p-value is calculated using the F-value. The formula for calculating the F-value is as follows:

$$F = \frac{MS_{Regression}}{MS_{Error}} \tag{13}$$

f) p-value (P)

Used in hypothesis tests to determine if a null hypothesis should be rejected or not. If the null hypothesis is true, the p-value is the probability of getting a test statistic that is at least as extreme as the actual computed value. The 0.05 cut-off for the p-value is commonly used. If the estimated p-value of a test statistic is less than 0.05, for example, you reject the null hypothesis.

IV. RESULTS AND DISCUSSION

- Series Plots for the Trend of the variables

The series plots of the annual population (y), infant mortality (x1), and maternal mortality (x2) were done in this part to analyze the correlations, trend component, and seasonality effect, if they were present in the data sets.

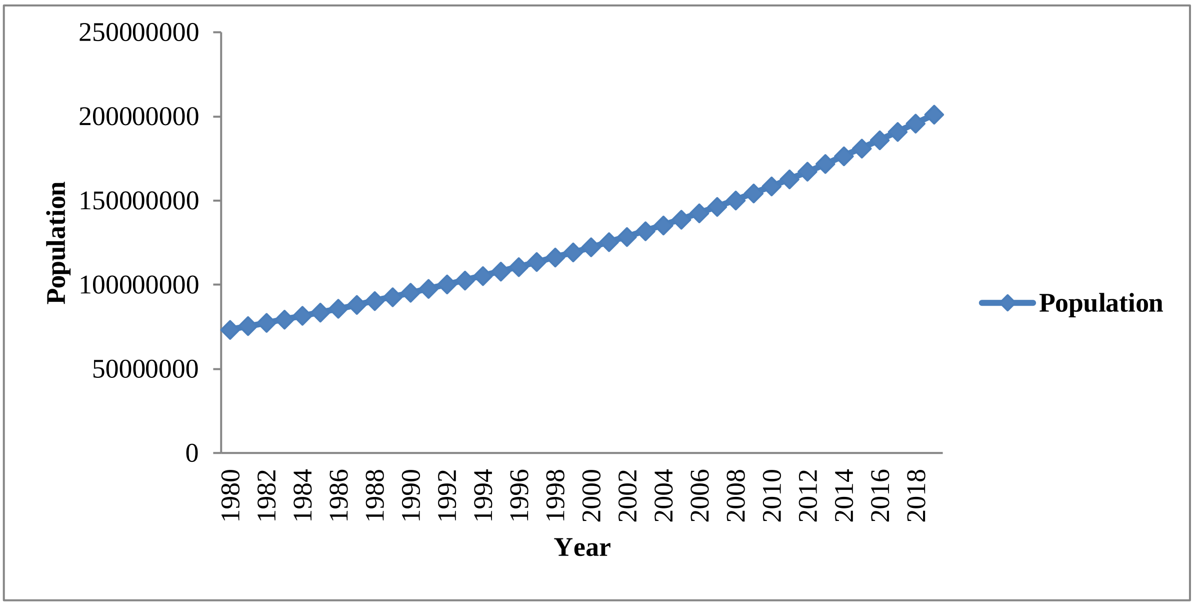

Fig.1: Series Plot of the Population of Nigeria (Yearly)

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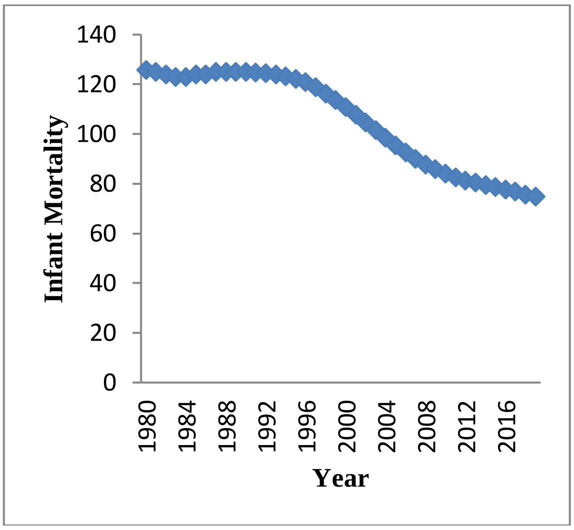

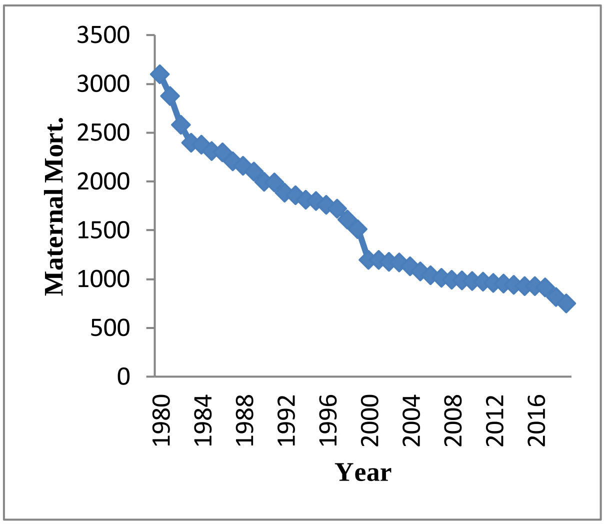

Fig. 2: Series Plot of the X_1 cases (Yearly) Fig.3: Series Plot of the X_2 cases (Yearly)

Figure 1 depicts the population of Nigeria over time, with the peak occurring in 2021 and the lowest being in 1980. However, the annual population statistics show an increase from 1980 to 2019 (or a tilt upward). Figure 2 depicts the yearly trend in infant mortality, with the highest rate in 1980 and the lowest rate in 2021. The yearly infant mortality series, on the other hand, shows a drop from the start (or swing downward); 1980 to 1985, then a fluctuating increase and decline from 1986 to 2021. Figure 3 depicts the annual trend in maternal mortality, with the highest rate in 1980 and the lowest rate in 2021. However, the yearly maternal mortality series show a decrease from the beginning (or swing downward); 1981 to 2021.

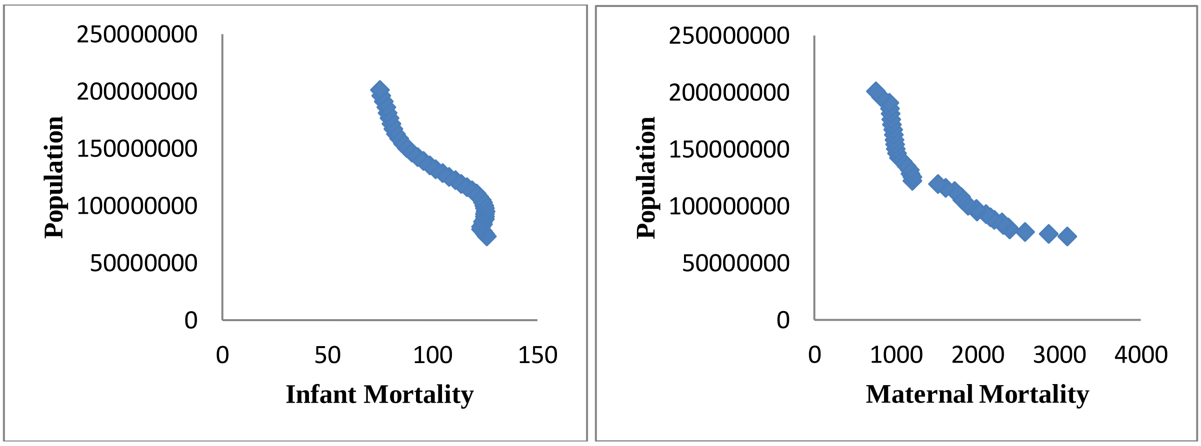

Fig. 4: Scatter Plot of the mortality variables against population of Nigeria

The entire plot in Figure 4 demonstrates a declining trend. These findings point to a linear or negative association between mortality factors and Nigerian population. As a result, the significant parameters were determined using the Durbin method of estimating a multiple regression model.

- Descriptive statistics of the mortality variables and the population Nigeria

This section focuses on descriptive statistics of the mortality variables and the population Nigeria; infant mortality and maternal mortality.

Variable	Mean	SE Mean	St.Dev	Minim.	Q1	Median	Q3	Maximum.	Skewness	Kurtosis
Infant (x_1)	105.67	3.05	19.29	74.9	84.55	112.3	124	126	-0.38	-1.6
Mater.(x_2)	1562	101	637	754	980	1357	2074	3101	0.61	-0.69
Pop. (y)	126593916	5979520	37817802	73423633	93394133	120771957	157458631	200963599	0.39	-1.01

Table 2: Descriptive statistics of the mortality variables and the population Nigeria

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Table 2 show the mean of the mortality variables and the population Nigeria, where the expected value is 105.67 for infant mortality, 1562 for maternal mortality and 126593916 for total population of Nigeria.

- Regression Model

The researcher will code the data on the numerous variables under investigation into the statistical tools used for data analysis in this phase. The regression model was built using data from 1980 to 2021. All model parameters, accuracy measures, and significance variable checks were completed here as well.

n_1=40, Σx_1=4226.8, Σx_2=62489, $\Sigma y_1 = 5.064\times 10^9$, $\Sigma x_1 x_2$=7027061.6, Σx_1^2=461153.7, Σx_2^2=113471007, $\Sigma x_1 y_1 = 5.07\times 10^{11}$, $\Sigma x_2 y_1 = 7.044\times 10^{12}$,

$$x'x = \begin{bmatrix} 40 & 4226.8 & 62489 \\ 4226.8 & 461153.7 & 7027061.6 \\ 62489 & 7027062 & 113471007 \end{bmatrix}, \quad x'y = \begin{bmatrix} 5.064\times 10^9 \\ 5.07\times 10^{11} \\ 7.044\times 10^{12} \end{bmatrix}$$

$$x'y = \begin{bmatrix} 5.064\times 10^9 \\ 5.07\times 10^{11} \\ 7.044\times 10^{12} \end{bmatrix} = \begin{bmatrix} 40 & 4226.8 & 62489 \\ 4226.8 & 461153.7 & 7027061.6 \\ 62489 & 7027062 & 113471007 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix}$$

$$\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = (x'x)^{-1}x'y = \begin{bmatrix} 40 & 4226.8 & 62489 \\ 4226.8 & 461153.7 & 7027061.6 \\ 62489 & 7027062 & 113471007 \end{bmatrix}^{-1} \begin{bmatrix} 5.064\times 10^9 \\ 5.07\times 10^{11} \\ 7.044\times 10^{12} \end{bmatrix}$$

$$\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = (x'x)^{-1}x'y = \begin{bmatrix} 1.465565 & -0.02014 & 0.00043995 \\ -0.02014 & 0.000315 & -8.429E-06 \\ 0.00044 & -8.4E-06 & 2.885E-07 \end{bmatrix} \begin{bmatrix} 5.064\times 10^9 \\ 5.07\times 10^{11} \\ 7.044\times 10^{12} \end{bmatrix}$$

$$\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = (x'x)^{-1}x'y = \begin{bmatrix} 294498511 \\ -1303923 \\ -19348 \end{bmatrix}$$

Model	Parameter $\pm$ SE	t-test	P	Remark
β_0	294498511 $\pm$ 9513435	30.96	0.000**	Significant
β_1	-1303923 $\pm$ 132014	-9.88	0.000**	Significant
β_2	-19348 $\pm$ 3797	-5.10	0.000**	Significant

Table 3: Descriptive Statistics of the Model

Footnote: **= Significant at p< 0.05, **Durbin-Watson statistic** = 0.105372

- The required estimated model is

$$\hat{y}_i = 294498511 - 1303923x_1 - 19348x_2 \quad (14)$$

For infant mortality, maternal mortality, and Nigerian population, Table 3 summarized parameter estimates, t-test, p-value, and standard error of the Durbin method. Similarly,

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the collected findings of parameters revealed that all of the parameters are significant at 5%.

MODEL	PARAMETER ESTIMATES β_0 (p-value) t-test	β_1 (p-value) t-test	β_2 (p-value) t-test	S VIF DWS	MSE	R^2	$R^2(c$	AIC	BIC	HQC	F
Model	294498511 $\pm$ 9513435 (0.000**) 30.96	-1303923 $\pm$ 132014 (0.000**) -9.88	-19348 $\pm$ 3797 (0.000**) -5.10	76571088 4.111 0.105372	5.863×10^{15}	95.9 %	95.7 %	1.45×10^{3}	1.46×10^{3}	1.45×10^{3}	433.98

Table 4: Regression Analysis Summary of the Parameter Estimates

Footnote: **= Significant at p< 0.05

The results in Table 4 shows a summarised regression analysis of parameter estimates, s-value, variance inflation function (VIF), Durbin-Watson statistic (DWS), AIC, BIC, MSE, $R^2(adj)$, R^2, standard error,t-test, p-values and F-values for the model. Note that all the models parameters estimates are significant at 5%, which seem unbiased.

- Population Forecast

Lag	Year	Forecast Value
1.	2020	173866782.9
2.	2021	175026009.3
3.	2022	176484716.3
4.	2023	180042267.9
5.	2024	182246286.3
6.	2025	294498511

Table 5: Forecast of the Population of Nigeria for a Period of 6 Years

Based on the created model, the findings in Table 5 present a summarized forecast of Nigeria's population for the following 6 years, from 2022 to 2027. The results showed that Nigeria's population will continue to grow for the next six years, despite the effects of infant and maternal mortality on the demographic.

V. CONCLUSION

Regression analysis was used to create a series plot for the individual variables that affected the population of Nigeria and their combined plot, which revealed a downward trend for the entire plot and suggested a linear but negative relationship between the mortality variables and the population of Nigeria. As a result, the significant parameters were determined using the Durbin method of estimating a multiple regression model. The regression model was then built using data values from 1980 to 2021. All of the model parameter estimates were significant at 5%, which appears to be fair.

Table 5 presents a summary of the population forecast for Nigeria for the following six years, from 2022 to 2027, based on the created model. The results showed that Nigeria's population will grow (slightly) over the next six years, notwithstanding the effects of newborn and maternal mortality on the population.

RECOMMENDATIONS

This paper recommend based on the findings that:

- All stakeholders, particularly males who are the major decision makers in culturally driven, male dominated society, should be included in developing innovative and effective solutions to reduce baby and maternal mortality rates.
- Husbands should let their wives go to antenatal clinics and give birth in hospitals.Women should seek medical help as soon as possible, visit antenatal clinics, and give birth in hospitals.
- The government can help by providing qualified health experts, enhancing healthcare facilities, and raising awareness about the need of antenatal care. Health workers should be taught and given the resources they need to do their jobs well.
- Advocates for reducing baby and maternal mortality will have to pay close attention to educational advancements, particularly the development of personnel in the medical and nursing professions.

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