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STATISTICAL ANALYSIS OF INFANT MORTALITY RATE: A CASE STUDY OF TARABA STATE

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ABSTRACT: *Reduction of infant mortality has been one of the key issues for both government and individuals. The purpose of this study is to predict and determine the infant mortality rate in the future. To achieve our aim, we used Linear Regression model and student t-test to analyze our data. Data were collected from Specialist Hospital, Jalingo, Taraba State and the analysis was done based on the stated methods in the stated models. The results showed that in 2019, the mortality will be 45 per 1000 and birth will be 124 per 1000; in 2025, the mortality will be 65 per 1000 and birth will be 191 per 1000; in 2030, the mortality will be 90 per 1000 and birth will be 272 per 1000; in 2035, the mortality will be 110 per 1000 and birth will be 340 per 1000. This shows that as the birth is increasing, death is also increasing. From Figure 2, we discovered that mortality is on the increase from year to year. The t-test indicated that there is a linear relationship between infant mortality and birth from 2018–2037, which shows us that t calculated (0.143) < t tabulated (2.021), thereby giving us room not to reject our* H_0.

KEYWORDS: Infant Mortality, Linear Regression, Fertility, Birth Rate.

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INTRODUCTION

Since Nigeria was given her independence in the year 1960, the federal government has been doing a lot in the following areas: agriculture, education, industries, health services, and banking, amongst others.

In the area of health services, the government's efforts have been to ensure that she achieves good health for all, especially women and children. The proof of her effort is seen in the creation of many public health establishments throughout the states. These include the hospitals, maternities and clinics.

Despite the efforts of the government on the improvement of health, they appear insignificant when compared to the magnitude of the problem still to be solved especially as it concerns infant diseases and infant mortality.

Every day, Nigeria loses about 2,300 children that are beneath-five months old and 145 women of childbearing age. This makes the country to be the second biggest contributor to under-5 and maternal mortality rates in the whole world. Many lives can be saved if global inequalities are reduced (UNICEF, 2017). Today, 89,700 day-old infants die in Nigeria every year (UNICEF, 2016).

According to the Oxford Advanced Learners Dictionary, mortal means to die; that cannot live forever. Encyclopedia Britannica expresses it as the state of temperedness of living or not living forever.

Neelam et al. (2017) carried out research work to find out the contextual factors leading to infant mortality in a rural block of Haryana. They observed that the majority of the families of the deceased infants belonged to lower middle socioeconomic status.

Major causes of loss of life among youngsters vary by using age. Children under 5 are vulnerable to infectious illnesses like malaria, pneumonia, diarrhea, HIV, and tuberculosis. For older youngsters, non-communicable illnesses, injuries, and struggles pose sizable threats to them.

Despite being totally preventable and treatable, common infectious diseases are still killing younger children in large numbers, according to the Centre for Disease Control and Prevention (CDC, 2020).

In West African countries, there was a high incidence of killer diseases which affected maternal and infant health leading to high mortality of infants. This can be attributed to the type of vegetation in West Africa and other factors which include: the sanitary condition of our local populace, mode of feeding, and also lack of health infrastructures. All these created problems that led to high infant mortality (CDC, 2020).

Again, other causes of infant mortality are recognized killer childhood diseases, such as measles, malaria, smallpox, tetanus, whooping cough, hepatitis, poliomyelitis, diphtheria, and jaundice. In the late 80s, the government of Nigeria, through the National Program on Immunization and Expanded Program on Immunization, achieved a lot regarding the improvement of infant health (CDC, 2020).

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Now, in the account of the current health journal "health care," the liming legs are first disappearing; the plague of onchocerciasis as a result of the black fly is long past. Our kids and toddlers are dwelling nowadays without it. Poliomyelitis was also kicked out from the shorelines of our country, courtesy of the three-month immunization programme of the year 2000. Although a few toddler-killer illnesses are eradicated or almost eliminated, there is still an excessive stage of infant mortality in Nigeria.

Mother's education, place of residence, birth interval, weight at birth, skill of birth attendants, unimproved water, and unimproved toilet significantly influenced neonatal, infant, and under-five mortalities. Though these factors have been pointed out in literature, not much progress has been recorded in the reduction of the burden of childhood deaths (Morakinyo, 2017).

Baraki et al. (2020) stated that, at the same time, as you consider that infant mortality remains an excessive public health trouble, intervention shall be done giving more attention to infants who were delivered multiple and who are preterm.

Finnerty, Provost, O'Donnell, Selk, Stephens, and Kim et al. (2019) stated that studying infant mortality is helpful for improving child health and maternal health as well.

Teshia et al. (2017), in their work titled, What's Killing Our Children: Child and Infant Mortality among American Indians and Alaska Natives, stated that multiple factors underlie the negative health outcomes in infant and child mortality rates among AIAN. These factors include social, behavioral, and environmental ones that affect the mother and the child, such as domestic violence and stress, nutrition, tobacco and alcohol use, pollution, and environmental degradation.

Okwuwa, Charles Onuora, Adejo, and Simon M. (2020) stated that the immoderate rate of toddler mortality and incapability of pregnant ladies to get admission to healthcare implicate children's life chances, maternal psychosocial and economic well-being, future family welfare, and community and national development potentialities.

Majumder et al. (2014) and Kulkarni et al. (2007) observed a higher mortality rate among mothers in the age group of 21–25 years. In the study, mortality among females was higher (54.5%) compared to male children (45.5%). These findings were in correlation with the findings of Dalal et al. (2016) who found a greater number of female deaths (53.8%) compared to males (46.2%), and Muzammil et al. (2014) who also reported 58.3% female infant deaths. These findings reflect the differential care and attention given to the female child. It can be addressed by counseling the families regarding the importance of the girl child and improving the literacy status of women.

The World Health Organization (WHO), in collaboration with UNICEF, implemented the Integrated Management of Childhood Illnesses (IMCI) strategy in the mid-1990s. The proposal is to reduce child mortality. For this, the IMCI has set in motion preventive and curative interventions at the family, community, and institutional levels. A number of studies have demonstrated that this strategy is not only effective but also efficient (Adam, Manzi, Armstrong, et al., 2005).

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Statement of Problem

The incidence of infant mortality rate has been of great concern to both the government and individuals in Nigeria.

Aim

To consider and predict the trend of infant mortality in the future.

objectives

1. To determine the trend line and forecast of infant mortality in the future.
2. To evaluate the rate of infant mortality in Nigeria.

Significance of Study

The research work will be of great importance to researchers carrying out their research work on related topics.

This research work will be useful for the management of infant mortality rate. It will also create awareness to the local government health personnel to find an everlasting solution to what is causing infant mortality.

It will also enlighten women on the need to take their antenatal check-up seriously in order to avoid complications during delivery.

Hypothesis for the Research Work

H_0: There is a linear relationship between infant mortality and live birth.

H_1: There is no linear relationship between infant mortality and live birth.

Decision Rule

Reject H_0 if T (calculated) > T (tabulated)—otherwise, do not reject—and conclude.

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RESEARCH METHODS

The methods used are linear regression analysis and independent t-test. In using the linear regression analysis, the independent variable will be fitted against the dependent variable.

Regression Analysis

Regression analysis refers to the technique for modeling and analyzing several variables. Regression analysis is widely used for prediction (including forecast of time series data). It is also used to understand which among the independent variables are related to the dependent variable and to explore the forms of this relationship. The variable to be forecasted is called the DEPENDENT VARIABLE and it is often denoted by Y, while the related variables are called INDEPENDENT VARIABLES and also denoted by $X_1 + X_2 + \cdots + X_k$, where k is the number of independent variables.

The standard equation for this is

$$Y = \beta_0 + \beta_1 X_1 + e \quad (1)$$

Y = Infant mortality (dependent variable), β_0 = intercept, β_1 = slope, X = infant fertility (independent variables), *e* = error term, where Y is the dependent variable, X is the independent variable, β_o and β_1 are the parameters of the model representing the intercept and the slope respectively, and e ~ NID ($0\sigma^2$) is the error term which is normally and independently distributed with mean zero and constant variable σ^2. If β_0 and β_1 are known, the value of Y can be computed from any given value of X. However, when we remove the restriction and allow for any number of independent variables, then we have multiple regression (Montgomery, 2005).

Let us assume a linear relationship exists between a variable Y and k-independent or predictor variable $X_1 + X_2 + \ldots + X_k$ and an error e. If there is a sample of n observations on Y and X_i′s, we can write:

$$Y_i = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + e^i \; i, k = 1,2, \cdots n \quad (2)$$

The β_k are the estimated coefficients for the parameters X_k with the error. $e_i \sim NID(0\ \sigma^2)$ are unknown and our problem is to obtain estimates of these unknowns. The *n* equations in (2) above can be set out compactly in matrix form as:

$$Y = \beta X + e_i \quad (3)$$

where

$$Y = [Y_1\ Y_2\ \vdots\ Y_n\ ]\beta = [\beta_1\ \beta_2\ \vdots\ \beta_n\ ]X$$
$$= [1\ X_{11}\ X_{12}\ \cdots\ X_{1k}\ \ 1\ X_{21}\ X_{22}\ \cdots\ X_{2k}\ \ \vdots\ 1\ \vdots\ X_n\ \vdots\ X_{n2}\ \ddots\ \cdots\ \vdots\ X_{nk}\ ]$$

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The Least Square Method

This method is used in estimating the parameters $\beta_o and\ \beta_1$, and this is done by differentiating the sum of squares errors to obtain a minimum error.

For simple linear regression, from the equation:

$$Y = \beta_0 + \beta_1 X_1 + e$$

$$e = Y - \beta_0 - \beta_1 X_1 \quad (4)$$

Squaring both sides and summing over i, we have:

$$S = e^2 = \sum \quad (Y - \beta_0 - \beta_1 X_1)^2 \quad (5)$$

Differentiating partially with respect to $\beta_0\ and\ \beta_1$ and equating to zero,

$$\frac{\partial S}{\partial \beta_0} = -2 \sum \quad (Y - \beta_0 - \beta_1 X_1) = 0$$

Therefore,

$$\sum_{i=1}^{n} \quad Y_I - n\beta_0 - \beta_1 \sum_{i=1}^{n} \quad X_i = 0$$

$$n\beta_0 = \sum_{i=1}^{n} \quad Y_i - \beta_1 \sum_{i=1}^{n} \quad X_i$$

$$\beta_0 = \frac{\sum_{i=1}^{n} \quad Y_i}{n} - \frac{\beta_1 \sum_{i=1}^{n} \quad X_i}{n}$$

$$\beta_0 = \underline{Y} - \beta_1 \underline{X} \quad (6)$$

Differentiating partially with respect to β_1, we have:

$$\frac{\partial S}{\partial \beta_1} = -2 \sum_{i=1}^{n} \quad (Y_I - \beta_0 - \beta_1 X_1) X_i = 0$$

$$\sum_{i=1}^{n} \quad X_i Y_i - \beta_0 \sum_{i=1}^{n} \quad X_i - \beta_1 \sum_{i=1}^{n} \quad X_i^2 = 0$$

$$\beta_1 \sum_{i=1}^{n} \quad X_i^2 = \sum_{i=0}^{n} \quad X_i Y_i - \beta_0 \sum_{i=0}^{n} \quad X_i$$

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But

$$\beta_0 = \underline{Y} - \beta_1 \underline{X} \tag{7}$$

Therefore,

$$\beta_i = \frac{n\sum_{i=1}^{n} X_i Y_i}{n\sum_{i=1}^{n} X_i^2} - \frac{\sum_{i=1}^{n} (X_i Y_i)}{\left(\sum_{i=1}^{n} X_i\right)^2} \tag{8}$$

For the matrix form,

$$Y = X\beta + e$$

$$e = Y - X\beta$$

$$SSE = S = \sum e_i^2 = e'e = (Y - X\beta)'(Y - X\beta)$$

$$S = Y'Y - Y'X\beta - X'\beta'Y + X'\beta X\beta$$

$$S = Y'Y - 2\beta'X'Y + \beta'X'X\beta \tag{9}$$

This follows due to the fact that $\beta X'Y \; is \; a \; 1 \times 1$ matrix or a scalar whose transpose $(\beta'X'Y) = Y'X\beta$ must have the same value.

$$\frac{\partial S}{\partial \beta} = -2X'Y + 2\beta X'X \tag{10}$$

At the turning point, we equate $\frac{\partial S}{\partial \beta}$ to zero; thus, we have:

$$2(X'X)\beta = 2X'Y$$

where $X'X$ is non-singular.

Then,

$$\beta = (X'X)^{-'}X'Y.$$

t-TESTS: A t-test is an analysis of two samples means through the use of statistical examination; a t-test with two samples is commonly used with small sample sizes, testing the difference between the samples when the variances of two normal distributions are not known. Also, t-test looks at the t-statistic, the t-distribution and degrees of freedom to determine the probability of difference between samples; the test statistic in the test is known as the t-statistic. As a two location and is used to test the hypothesis that two samples have equal or unequal means. It can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistics are known. When the scaling term is unknown and replaced by an estimate based on the data, the test statistics (under student's t-distribution)

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The t-statistics was introduced in 1980 by William Sealy Gussets, a chemist working for the Guinness brewery in Dubbin, Ireland ("student" was his pen name). Gusset graduated from Oxford and Cambridge to apply biochemistry and statistics to Guinness industrial processes.

The independent t-test—also called the two sample t-test, independent-samples t-test or student's t-test—is an inferential statistical test that determines whether there is a statistically significant difference between the means in two unrelated groups.

Test Statistics:

Let x_{1i} and x_{2i} be two of the observations from different populations of individual I; then we obtained:

$$t = \frac{\overline{x_1} - \overline{x_2}}{sp\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} = \cong t_{\frac{\alpha}{2}}, n_1 + n_2 - 2 \quad (11)$$

where $\underline{x}=\sum \frac{x}{n1}$, $\underline{y}= \sum \frac{y}{n2}$ and $sp= \frac{1}{n1+n2-2}[\sum (x-\underline{x})^2 + \sum (y-\underline{y})^2]$

The Model Equations

$$\left.\begin{aligned} Mortality &= 37.267 + 4.024year \\ Birth &= 96.933 + 13.485year \end{aligned}\right\} \quad (12)$$

RESULT ANALYSIS

The model equation (12) gives the results in Table 1 as shown below:

Table 1: Birth and Mortality per 1000

YEAR	BIRTH	MORTALITY
1	110	41
2	124	45
3	137	49
4	151	53
5	164	57
6	178	61
7	191	65
8	205	70
9	218	74
10	232	78
11	245	82
12	259	86
13	272	90
14	286	94
15	299	98

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16	313	102
17	326	106
18	340	110
19	353	114
20	367	118

Source: Specialist Hospital, Jalingo.

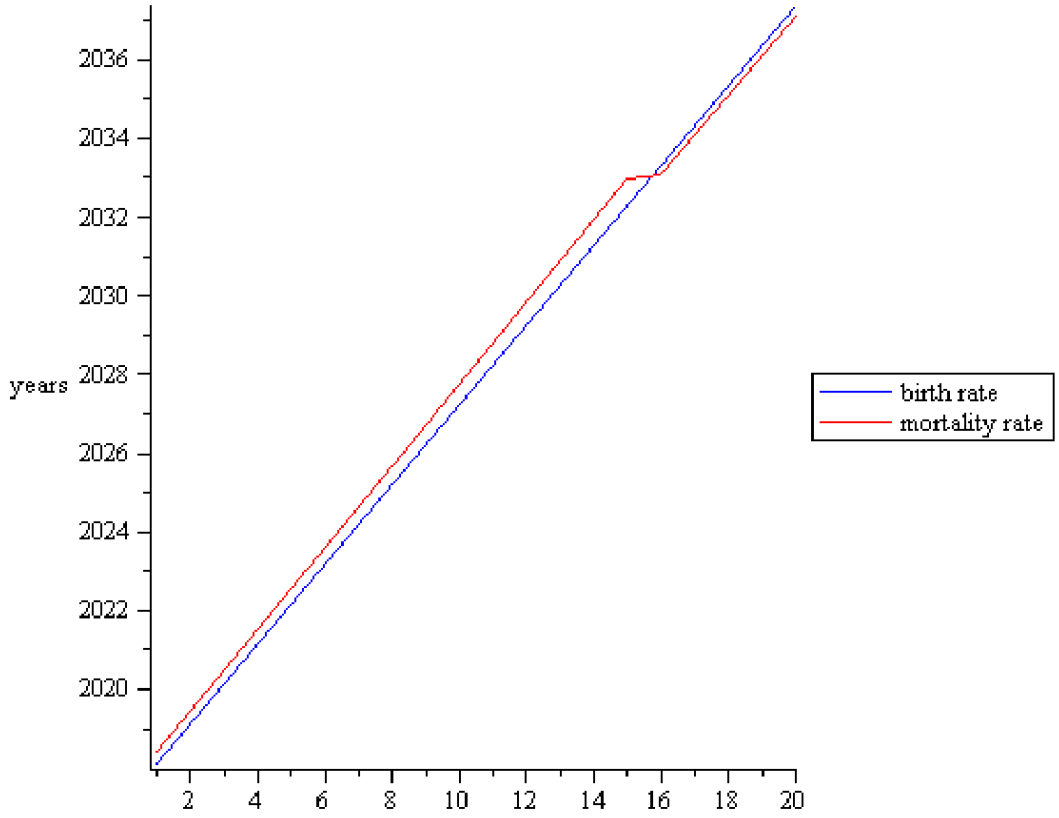

Figure 1: Presenting the trend of the mortality and birth rate

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t-TEST

$$t = \frac{238.5 - 79.65}{3480.88\sqrt{\frac{1}{20} + \frac{1}{20}}} = \frac{158.85}{3480.88\sqrt{0.1}} = \frac{158.85}{1113.88} = 0.143$$

$$t_{0.025,38} = 2.021$$

Decision

Since t_{cal} (0.143) < t_{ble} (2.021) we do not reject H_0 and conclude that there is a linear relationship between mortality and live birth.

CONCLUSION

Any country or state where infants are not considered is bound to go extinct. This is because infants are the future leaders and the determinant factor for the existence of any country or state. An infant mortality rate (IMR) is considered a primary and important indicator of a geographic area's overall health status of life. Reduction of infant mortality has been one of the key issues for both the government and individuals. The reduction or complete elimination of infant mortality needs to be a paramount agenda of any country or any state. In our finding, it shows that there is going to be a high infant mortality rate from 2019–2037. This means that there is a need for the government and non-governmental organizations to pay attention to infant mortality so as to reduce infant mortality rate.

Declaration of Competing Interests

The authors declare that there is no conflict of interest.

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