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# Analyzing Infant and Child (Under-five) Mortality in Zaria: A Regression Analysis Approach

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**Abstract**

This study was carried out using secondary data from Ahmadu Bello University Teaching Hospital, Zaria, on infant and child (under-five) mortality and delivery rates. Descriptive statistics, Regression and Correlation analysis are the statistical techniques used for the study. From the regression analysis result obtained, it showed that both infant and child mortality rates has a direct relationship with delivery rates. The correlation analysis result showed that there is a very strong and positive relationship between mortality and delivery rates. The study revealed that infant and child mortality rates will continue to decrease if there can be improvement in the factors under study.

**Key Words:** Infant and Child Mortality, Death and Birth Rates, Regression and Correlation, Anova, Trend, Demography

## Introduction

Mortality (Death) according to World Health Organization (W.H.O) is the absence of all traces of life at any time after birth. These can also be referred to as non-functionality of all parts or the whole body after birth. Mortality is the risk of dying in a given year, measured by death rate. In the entire universe, lately, there are thousands of people that die due to one cause or the other. If these causes of death are not noticed, recognized and given proper attention, we may not know the exact causes of various deaths per hour. The best way to do this and make recommendation is to apply statistical techniques to extract the information as it relates to the population or sample of interest.

In fant death can simply be described as the death of a child before its first birthday while child mortality can be described as death of a child aged between one and five years. Demographers have for a long time been interested in the study of infant and child mortality, which can be classified as one of the components of population fluctuation. Child mortality is an important indicator of a country's overall health condition; these statistics the population and health programs and policies, as well as contributes to population projections of a country or a group of people. Childhood mortality statistics also help identify specific populations that are prone to health risk. Some measures of childhood mortality used by demographers in demographic health survey (DHS) are as follows:

**Neonatal Mortality:** the probability of dying within the first month of life.

**Post Natal Mortality:** The difference between infant and neonatal mortality.

**Infant mortality**: The probability of dying before the first birthday.

**Under-five Mortality**: The probability of dying before the fifth birthday.

In centuries past, quite a number of countries experienced downward trend in child mortality rates, but, the timing and space of the decline differs substantially. Absolute decline in child mortality began of recent in Europe, North America and Japan continued slowly throughout the twentieth century. Visible reductions in other parts of the world generally began only after the Second World. Mortality reductions in Asia, Latin America and Africa were usually faster than they had been in countries that began mortality decline earlier. By 1999 there were intense fluctuation in child mortality among countries for instance, although, less than 0.5 percent of children died before their fifth birthday in the more developed countries and more than 40 percent died by age 5 in less developed countries.

The downward trend in child mortality recently has appeared to have normalized. This can be associated with poverty and other crises experienced by developing countries. Also, during the 1990s, the HIV/AIDS pandemic paused or reversed decrease in child mortality in some Eastern and Southern African countries. For instance, in east Africa, in the period 1990-1994 there were 80 deaths of (under-5) years per 1000 live births by 1999 that rate rose to 118 deaths per 1000 live births.

Death in the pre-delivery stage is mostly caused by external conditions like: infectious diseases and accidents, while 2/3 of such deaths are preventable. Literatures have shown that quite a number of children that die annually could be rescued by technology, clinical effective interventions such as vaccines, antibiotics, micronutrients supplementation, insecticide bed treated nets, improved living condition. Also providing vaccine and antibiotics, education could be made available to nursing mothers about how they can make simple changes to living conditions such as improving hygiene in order to increase the health of their children (Curtis & Steele, 1996).

More so, the omission of any infant in the denominator or numerator in reported infant mortality rates can be misleading for comparisons. A great number of countries, including the Developed countries count as life birth infants which demonstrate any sign of movement of any part of body, irrespective of the month of ‘gestation” or the “size”, while the United States Centre for Disease Control (CDC), some countries differ in these practice. Quite a number of countries adopted W.H.O definition just recently which is used throughout the European Union. Therefore, this gives a clear view that there were differences within countries on what they describe as infant, child mortality and live births. These disparities made the UNICEF a more robust method to account for reporting differences among countries due to the unadherence to a given standard by regulatory bodies. Therefore, the reliability of a country's documentation depends on the accuracy of its infant mortality statistics.

Also, (Sabitu, 2001) in his forward to a book, "Cause of Death Statistics" said that acute death of unusable health data in the country (Nigeria) is a serious gap in the system, if medical records generated from hospitals, particularly teaching hospitals are amended, refined and processed to meet the needs of health care practitioners, teaching hospitals would constitute a very dependable source of local and national health information.

Gayus (2006) posits that decline tend to set if demographers extrapolate age-specific rates in mortality, that is, the speed of mortality decline will not slow down, relative to past performance (Lee and Carter, 1992, Wilmonth, 1998,). Demographers who tend to forecast linear increase in life expectancy tends to predict faster gains because they rely solely on international trends to determine forecast (Kaduulu, 1998). Demographers studying healthy sub-populations opined that fairly large advances in life expectancy are achievable through modifications in the forecast behavior (Manthon, Stallard and Tolley 1991).

In reasonable considerations, we can see that education and standard of living of a child bearing mother has great impact on the survival of a child and health status of children existing and those that are yet to come. So we shall see various opinions from different researchers on education and standard of living of a child bearing mother as a tool to increase or reduce the survival of children.

**The Effect of Education on Mortality Rate**

Education as a tool for social enlightenment and positive change has a lot of good to offer in virtually all spheres of life and particularly in the area of this cliché called infant and child mortality. Educated mothers, will have better capacity to nurse their children via providing a symbiotic relationship between themselves and their host environment (Das, 1990).

Stephen S. (2008) in his project work, referenced by (Irewolede, 2010) stated that there are marginal deviations in the levels of infant and child mortality, comparing the child's age, gender, the mothers' educational attainment, age at birth, nature and duration of marriage, financial status. It has been discovered that a mother's education is one of the single most significant determinant of infant and child mortality (Desai, 2005).

**The Effect of Poverty on Mortality Rate**

The effect of poverty on mortality rate is not far-fetched due to direct or indirect experiences of people from various spheres of life. Particularly, on the topic of discussion, “infant and child mortality”, (Irewolede, 2010) in his project work titled “infant and child mortality”, reveal that child mortality are significantly associated with poverty rate. For instance, a child in Sierra Leone, which has one of the world’s highest child mortality rate (262 in 2007), is about 87 times at risk of death than a child born in places like Sweden (with rate of 3). With reference publication by “Save the Children”, there are wide variations in the under-five mortality rate between rich and poor households in developing countries (Esangbedo, 2010). For example, children from poor households in India have higher risk of death before their fifth birthday than those from the rich homes (Montgomery, 2005). As mortality rates reduces, both deaths within the first 28 days of delivery and mortality within one and five years of age nose-dives more rapidly than neonatal mortality. The reason for this is not far-fetched from improved living condition, better health care and public health programs have significant effects on external causes of death than on pregnancy complications (Peter, 2004). Proper orientation of girls of child bearing age is one of the most effective ways to combat mortality.

More so, according to a programme ‘World Malaria Day” on channels television on 30th April 2011 of 10:36am, Malaria is an agent or vector of mortality in children under – five years, because at this ages, children has not developed strong immunity to fight the parasite. Also it was recorded that during pregnancy immunity is low or reduces in pregnant mothers which can lead to still births. Malaria as one of the early killer of children records about 800 number of deaths yearly due to Malaria parasite. Condition such as miscarriages, anemia and complications during child birth also lead to low birth weight and genital infections in pregnant mothers. Malaria can be prevented through the use of insecticide, treated bed nets, prevention of mosquito bites and the use of drugs such as; Fansida, Malarex an all other antibiotics. Also Malaria can be treated by the use of drugs such as Coatem and Lonart etc. though there are cases of drug resistance, that is, some drugs work for some people and some drugs does not for others. So, therefore self-medication should be totally avoided because self-medication possess threat to human life.

Finally, after all consultations, it is clear that materials consulted have diverse but similar views about mortality. Thus, we can point out similarities between various contexts that mortality have been dependent on both internal and external health factor it also has relationship with living conditions of various populations or households and a country at large. Also haven observed that literacy and awareness are functions of mortality in comparisons between More Developed Countries (MDCs) and Less

Developed Countries (LDCs) Europe and Africa with some exceptions of more generality between the two continents in the area of living standard. That is standard of living is proportional to mortality and vice versa.

**Effect of Climate Change on Mortality Rate**

It has long been recognized that periods of extreme weather pose risks to human populations and in the history of human development much effort has been devoted to adapt to these risks. Currently, anticipated future climate change presents new potential threats across a variety of dimensions including physical health (US National Research Council 2010). Indeed, a recent review considers global climate change to be one of the greatest health threats currently facing the world's population (Oladimeji, 2010).

Climate change involves not only increased average temperatures, but also increased variability in weather, including the potential for mounting frequent and severe extreme weather events. These extreme weather conditions can have a substantial impact, both indirect and direct, on health, particularly for vulnerable populations. There are three main channels of transmission that are put forth in the literature as key drivers of the impact of weather on health (Boyo & Lindsay, 2003).

The first channel is the direct impact of weather. Clearly, tornados, hurricanes and heavy floods can have devastating health impacts, both on physical health and mental health (Green, 2006). Extreme heat and cold can also impact health, particularly among the elderly and children. Secondly, weather affects the infectious disease prevalence. For example, cholera and salmonella replicate more rapidly in warm temperature and malaria and dengue respond to temperature, wind, rainfall and humidity (Nerlander, 2009).

A warmer environment increases the pace of reproduction and the length of the active vector season. Climate change may open new geographic ranges for diseases to spread—the rise in temperature over the highlands of East Africa is a likely explanation for the appearance of malaria is this previously malaria-free area. Adverse weather or climatic conditions posses' threats to human life both directly and indirectly most importantly for infants and children under the age of five years (Aaby, 1992).

## Methodology

**Data Source, Collection and Type**: The data used in this research is a secondary one; the data was fetched from the medical records department of the ABUTH, Zaria. The data is based on infant and child mortality. The data covers the period from 2000-2010. The choice between primary and secondary data sometimes depends on the following considerations, due to falsifications of responses from respondents or errors during the process of data entry

i. Nature and scope of the research

ii. Financial constraint.

iii. Time constraint.

iv. Degree of accuracy desired.

**Method of Analysis:** The statistical methods or approach to be used for analysis in this project work are as follows:

i. Regression Analysis

ii. Correlation Analysis

iii. Other diagrammatical representations such as; pie charts, bar charts and pictogram

## Regression Analysis

Regression analysis is a statistical technique used in examining the average relationship between two or more study variables. When a dependent variable, say, Y, depends on the effect or changes in other predictor variables say $X_1, X_2, \ldots, X_n$, we say the variables Y and $X_1, X_2, \ldots, X_n$, are related or there exists a functional relationship between them.

$$Y = \text{intercept} + \text{slope} + \text{error} \quad 1$$

$$Y = \text{constant} + \text{coefficient}\, X + \text{error} \quad 2$$

$$Y = \beta_0 + \beta_1 X + e \quad 3$$

This is called a simple linear regression model of Y on X. The values for $\beta_0$ and $\beta_1$ are fixed. The parameters, $\beta_0$, $\beta_1$ and $\bar{y}$ and $\bar{x}$ can be computed as shown in equations 2.4 to 2.7.

$$\hat{\beta}_1 = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \quad 4$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1\bar{x} \qquad 5$$

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i \qquad 6$$

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad 7$$

where n = number of unit selected

Steps in Regression Analysis:

i. Problem Statement
ii. Selection of potentially relevant variables.
iii. Data Collection
iv. Model Specification
v. Choice of fitting method
vi. Model fitting
vii. Model criticism and validation
viii. Using the chosen model for the solution of the posed problem.

Coefficient of Determination ($R^2$)

$$R^2 = \frac{SS_R}{SS_T} = 1 - \frac{SS_R}{SS_T} = 1 - \frac{\sum_{i=1}^{n} e_i{}^2}{\sum_{i=1}^{n} y_i^2} \qquad 8$$

where:

$$SS_T = \sum_{i=1}^{n}(y_i - \bar{y})^2$$

$$SS_R = \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$$

$$SS_E = \sum_{i=1}^{n} e_i{}^2 = \sum_{i=1}^{n}(y_i - \hat{y})^2 = SS_T - SS_R$$

**Adjusted $R^2$**

This is preferred to the R-square because of preciseness

$$R^2{}_{adj} = 1 - \frac{SSe/_{(n-p)}}{SS_t/_{(n-1)}} \qquad 9$$

where:

$SS_e$ = sum of squared residuals (errors)

n = number of observations

p = number of parameters

$SS_t$ = total sum of squares

**Coefficient of Correlation**

Correlation analysis is a statistical technique used to estimate the strength and direction of association between two variables say X and Y. The basic concept of correlation is to find out how strong the relationship between the two variables X and Y is.

$$r = \frac{\sum_{i=1}^{n}(y_i - \bar{y})(x_i - \bar{x})}{\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2 \sum_{i=1}^{n}(x_i - \bar{\bar{x}})^2}} \qquad 10$$

**Analysis Results and Discussion**

This table (1 to 4) gives a summary of statistics for each of the selected variables. The statistics of interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant deviation from normality, which would tend to invalidate many of the statistical procedures normally applied to this data. In this case, the following variables show standardized skewness values outside the expected range.

This table 5 shows the correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the linear relationship between the variables. The second entry is the associated P-value which tests the statistical significance of the estimated correlations. P-values below 0.05 indicate statistically significant non-zero correlations at the 95.0% confidence level. However, the following pairs of variables have P-values below 0.05:

Deliveries and Infant Mortality

Deliveries and Child Under Five Mortality

Infant Mortality and Child Under Five Mortality

**Simple Regression - Infant Mortality vs. Deliveries**

Dependent variable: Infant Mortality

Independent variable: Deliveries

Linear model: Y = a + b*X

The output is the results of fitting a linear model to describe the relationship between Infant Mortalities and Deliveries. The equation of the fitted model is:

Infant Mortalities = 27.4484 + 0.0760058*Deliveries

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between Infant Mortalities and Deliveries at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 73.5146% of the variability in Infant Mortalities. The correlation coefficient equals 0.857406, indicating a moderately strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 51.4707. The mean absolute error (MAE) of 33.8304 is the average value of the residuals.

Table 8 shows the predicted values for Infant Mortalities using the fitted model. In addition to the best predictions, the table shows:

(1) 95.0% prediction intervals for new observations

(2) 95.0% confidence intervals for the mean of many observations

The prediction and confidence intervals correspond to the inner and outer bounds on the graph of the fitted model.

Table 9 shows the results of fitting several curvilinear models to the data. Of the models fitted, the Reciprocal-Y Logarithmic-X model yields the highest R-Squared value with 79.3449%. This is 5.83035% higher than the currently selected linear model.

The output shows the results of fitting a linear model to describe the relationship between Child Under Five Mortality and Deliveries (Fig.1). The equation of the fitted model is

Child Under Five Mortality = -2.64136 + 0.0423646*Deliveries

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between Child Under Five Mortality and Deliveries at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 81.3814% of the variability in Child Under Five Mortality. The correlation coefficient equals 0.902117, indicating a relatively strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 22.8618. The mean absolute error (MAE) of 14.3155 is the average value of the residuals.

The lack of fit test is designed to determine whether the selected model is adequate to describe the observed data, or whether a more complicated model should be used. The test is performed by comparing the variability of the current model residuals to the variability between observations at replicate values of the independent variable X.

Table 13 shows the predicted values for Child Under Five Mortality using the fitted model. In addition to the best predictions, the table shows:

(1) 95.0% prediction intervals for new observations

(2) 95.0% confidence intervals for the mean of many observations

The prediction and confidence intervals correspond to the inner and outer bounds on the graph of the fitted model.

Table 14 shows the results of fitting several curvilinear models to the data. Of the models fitted, the multiplicative model yields the highest R-Squared value with 85.8495%. This is 4.46803% higher than the currently selected linear model.

The output in tables 15 and 16 shows the results of fitting a linear model to describe the relationship between Infant and Child Mortalities and Deliveries. The equation of the fitted model is

Infant and Child Mortalities = 24.8071 + 0.11837*Deliveries

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between Infant and Child Mortalities and Deliveries at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 80.2818% of the variability in Infant and Child Mortalities. The correlation coefficient equals 0.896001, indicating a moderately strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 66.1859. The mean absolute error (MAE) of 42.1118 is the average value of the residuals.

The lack of fit test is designed to determine whether the selected model is adequate to describe the observed data, or whether a more complicated model should be used. The test is performed by comparing the variability of the current model residuals to the variability between observations at replicate values of the independent variable X.

Table 18 shows the predicted values for Infant and Child Mortalities using the fitted model. In addition to the best predictions, the table shows:

(1) 95.0% prediction intervals for new observations

(2) 95.0% confidence intervals for the mean of many observations

The prediction and confidence intervals correspond to the inner and outer bounds on the graph of the fitted model.

Table 19 shows the results of fitting several curvilinear models to the data. Of the models fitted, the multiplicative model yields the highest R-Squared value with 84.2275%. This is 3.94572% higher than the currently selected linear model.

**Conclusion**

Finally, based on the data collected on infant and under-five mortality and delivery rates and from the analysis carried out so far we have been able to see that death is a phenomenon that is consistent with human nature. It only requires some safety caution to avoid the unnatural aspect of it. But for the natural, it is inevitable because it is due to human nature and creation.

We have observed that, in recent years the rate of mortality is on the decline compared to earlier years with the exception of some years with a peculiar outbreak of certain sicknesses or diseases. We might incline this decline due to the availability of information and technological knowhow, that is, as mothers get informed on methods of taking good care of their children, the rate of infant and child mortality will continue to decrease.

This is clear that literacy has a significant role to play when it comes to the issue of child mortality in general. Also a good and conducive living environment cannot be over emphasized. Taking a careful look at the data obtained, male deaths are considerably higher than female death indicating sex differential. These might be as a result of the fact that in this region or part of the country, there exists, some sort of cultural restriction against the utilization of hospital services by the females resulting in less female admission. Therefore, this reason might be responsible for the higher rate of infant and child mortality in male compared to that of the female. However, the evidence of higher male deaths might be a strong case of epidemiological investigation.

Finally, from the regression analysis, correlation analysis and analysis of variance carried out, we observed a strong positive relationship between both variables under study, that is; delivery and mortality rates. That is to say as the number of deliveries increases the probability of mortality also increases.

Also, from the correlation coefficients obtained, we see a very strong positive relationship between infant, children (under-five), mortality rates and delivery rate. That is to say mortality is inevitable among children but can be controlled or prevented, as in the case of more developed countries *(M.D. Cs).*

**Summary**

Based on the mortality data collected from Ahmadu Bello University ABUTH, it shows that infants and child mortality has claimed a considerable percentage of life of children born that is, percentage of death, and it is simply because of some reasons like mother's educational attainment, poverty and other environmental factors.

From the analysis carried out and the results obtained, we observed that both mortalities will continue to decrease if there can be improvement in the factors stated above.

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**Table 1: Descriptive Statistics for Deliveries (2000-2010)**

| **Statistics** | **Male** | **Female** | **Total Deliveries** |
|---|---|---|---|
| Mean | 1138.545 | 1051.455 | 2188.909 |
| Standard Error | 172.8205 | 150.0212 | 322.7171 |
| Median | 1092 | 985 | 2077 |
| Standard Deviation | 573.1808 | 497.5639 | 1070.332 |
| Sample Variance | 328536.3 | 247569.9 | 1145610 |
| Kurtosis | -1.27822 | -1.4246 | -1.3543 |
| Skewness | 0.362691 | 0.339476 | 0.344762 |
| Range | 1659 | 1391 | 3050 |
| Minimum | 470 | 486 | 956 |
| Maximum | 2129 | 1877 | 4006 |
| Sum | 12524 | 11566 | 24078 |

**Table 2: Descriptive Statistics for Infant Mortality (2000-2010)**

| Statistics | Male | Female | Total Infant Mortality |
|---|---|---|---|
| Mean | 112.8182 | 81 | 193.8182 |
| Standard Error | 16.01353 | 12.94253 | 28.60763 |
| Median | 109 | 84 | 200 |
| Standard Deviation | 53.11086 | 42.92552 | 94.88079 |
| Sample Variance | 2820.764 | 1842.6 | 9002.364 |
| Kurtosis | -1.88889 | -1.38069 | -1.74405 |
| Skewness | 0.250496 | 0.319138 | 0.263243 |
| Range | 129 | 123 | 246 |
| Minimum | 58 | 29 | 93 |
| Maximum | 187 | 152 | 339 |
| Sum | 1241 | 891 | 2132 |

**Table 3: Descriptive Statistics for Child (Under-Five) Mortality (2000-2010)**

| Statistics | Male | Female | Total Child (Under-Five) Mortality |
|---|---|---|---|
| Mean | 50.54545 | 39.54545 | 90.09091 |
| Standard Error | 8.611159 | 6.861439 | 15.15523 |
| Median | 47 | 49 | 96 |
| Standard Deviation | 28.55998 | 22.75682 | 50.26421 |
| Sample Variance | 815.6727 | 517.8727 | 2526.491 |
| Kurtosis | -1.00383 | -1.40271 | -1.15969 |
| Skewness | 0.636519 | 0.041649 | 0.371984 |
| Range | 81 | 69 | 150 |
| Minimum | 21 | 8 | 29 |
| Maximum | 102 | 77 | 179 |
| Sum | 556 | 435 | 991 |

**Table 4: Descriptive Statistics for the Entire Data**

| Statistics | Deliveries | Infant Mortality | Child Under Five Mortality |
|---|---|---|---|
| Average | 2188.91 | 193.818 | 90.0909 |
| Standard deviation | 1070.33 | 94.8808 | 50.2642 |
| Coeff. of variation | 48.898% | 48.9535% | 55.7928% |
| Minimum | 956.0 | 93.0 | 29.0 |
| Maximum | 4006.0 | 339.0 | 179.0 |

| | | | |
|---|---|---|---|
| Range | 3050.0 | 246.0 | 150.0 |
| Stnd. Skewness | 0.46681 | 0.356433 | 0.503668 |
| Stnd. Kurtosis | -0.916864 | -1.18073 | -0.785116 |

**Table 5: Correlations**

| | Deliveries | Infant Mortality | Child Under Five Mortality |
|---|---|---|---|
| Deliveries | | 0.8574 | 0.9021 |
| | | 0.0007 (p-value) | 0.0001 (p-value) |
| Infant Mortality | 0.8574 | | 0.8875 |
| | 0.0007 (p-value) | | 0.0003 (p-value) |
| Child Under Five Mortality | 0.9021 | 0.8875 | |
| | 0.0001 (p-value) | 0.0003 (p-value) | |

**Table 6: Coefficients**

| Parameter | Least Squares Estimate | Standard Error | T-Statistic | P-Value |
|---|---|---|---|---|
| Intercept | 27.4484 | 36.7265 | 0.747373 | 0.4739 |
| Slope | 0.0760058 | 0.0152069 | 4.9981 | 0.0007 |

**Table 7: Analysis of Variance**

| Source | Sum of Squares | Df | Mean Square | F-Ratio | P-Value |
|---|---|---|---|---|---|
| Model | 66180.5 | 1 | 66180.5 | 24.98 | 0.0007 |
| Residual | 23843.1 | 9 | 2649.24 | | |
| Total | 90023.6 | 10 | | | |

Correlation Coefficient = 0.857406
R-squared = 73.5146 percent
R-squared (adjusted) = 70.5718 percent
Standard Error of Est. = 51.4707
Mean absolute error = 33.8304

**Table 8: Predicted Values**

| | Predicted | 99% Prediction | Limits | 95% Confidence | Limits |
|---|---|---|---|---|---|
| *X* | *Y* | *Lower* | *Upper* | *Lower* | *Upper* |
| 956.0 | 100.11 | -28.6862 | 228.906 | 45.0526 | 155.167 |
| 4006.0 | 331.928 | 195.191 | 468.665 | 260.235 | 403.62 |

**Table 9: Comparison of Alternative Models**

| *Model* | *Correlation* | *R-Squared* |
|---|---|---|
| Reciprocal-Y logarithmic-X | -0.8908 | 79.34% |
| Multiplicative | 0.8900 | 79.22% |
| Logarithmic-Y square root-X | 0.8863 | 78.55% |
| Reciprocal-Y square root-X | -0.8855 | 78.41% |
| Square root-Y logarithmic-X | 0.8819 | 77.77% |
| Double square root | 0.8792 | 77.30% |
| Double reciprocal | 0.8745 | 76.48% |
| Exponential | 0.8739 | 76.38% |
| S-curve model | -0.8722 | 76.07% |
| Reciprocal-Y | -0.8713 | 75.91% |
| Square root-Y | 0.8683 | 75.39% |
| Logarithmic-X | 0.8682 | 75.37% |
| Square root-X | 0.8668 | 75.13% |
| Square root-Y reciprocal-X | -0.8628 | 74.44% |
| Linear | 0.8574 | 73.51% |
| Reciprocal-X | -0.8477 | 71.85% |
| Logarithmic-Y squared-X | 0.8281 | 68.57% |
| Squared-Y square root-X | 0.8275 | 68.48% |
| Squared-Y logarithmic-X | 0.8262 | 68.26% |

**Table 10: Summary of Coefficients**

| Parameter | Least Square Estimate | Standard Error | T-Statistic | P-Value |
|---|---|---|---|---|
| Intercept | -2.64136 | 16.3129 | -0.161919 | 0.8749 |
| Slope | 0.0423646 | 0.00675449 | 6.27207 | 0.0001 |

**Table 11: Analysis of Variance**

| Source | Sum of Squares | Df | Mean Square | F-Ratio | P-Value |
|---|---|---|---|---|---|
| Model | 20560.9 | 1 | 20560.9 | 39.34 | 0.0001 |
| Residual | 4703.97 | 9 | 522.663 | | |
| Total | 25264.9 | 10 | | | |

Correlation Coefficient = 0.902117
R-squared = 81.3814 percent
R-squared (adjusted) = 79.3127 percent

Standard Error of Est. = 22.8618
Mean absolute error = 14.3155

**Table 12: Analysis of Variance with Lack-of-Fit**

| *Source* | *Sum of Squares* | *Df* | *Mean Square* | *F-Ratio* | *P-Value* |
|---|---|---|---|---|---|
| Model | 20560.9 | 1 | 20560.9 | 39.34 | 0.0001 |
| Residual | 4703.97 | 9 | 522.663 | | |
| Lack-of-Fit | 4703.97 | 9 | 522.663 | | |
| Pure Error | 0.0 | 0 | | | |
| Total | 25264.9 | 10 | | | |

**Table 13: Predicted Values**

| | *Predicted* | *95% Prediction* | *Limits* | *95% Confidence* | *Limits* |
|---|---|---|---|---|---|
| *X* | *Y* | *Lower* | *Upper* | *Lower* | *Upper* |
| 956.0 | 37.8592 | -19.3484 | 95.0668 | 13.4043 | 62.3141 |
| 4006.0 | 167.071 | 106.337 | 227.806 | 135.227 | 198.915 |

## Table 14: Comparison of Alternative Models

| *Model* | *Correlation* | *R-Squared* |
|---|---|---|
| Multiplicative | 0.9265 | 85.85% |
| S-curve model | -0.9232 | 85.23% |
| Double reciprocal | 0.9224 | 85.07% |
| Square root-Y logarithmic-X | 0.9187 | 84.40% |
| Logarithmic-Y square root-X | 0.9183 | 84.33% |
| Double square root | 0.9166 | 84.02% |
| Square root-Y | 0.9084 | 82.52% |
| Square root-Y reciprocal-X | -0.9044 | 81.80% |
| Exponential | 0.9037 | 81.67% |
| Reciprocal-Y logarithmic-X | -0.9036 | 81.64% |
| Square root-X | 0.9035 | 81.64% |
| Linear | 0.9021 | 81.38% |
| Logarithmic-X | 0.8994 | 80.89% |
| Squared-X | 0.8848 | 78.29% |
| Reciprocal-Y square root-X | -0.8843 | 78.20% |
| Square root-Y squared-X | 0.8770 | 76.91% |
| Reciprocal-X | -0.8749 | 76.54% |

| | | |
|---|---|---|
| Double squared | 0.8749 | 76.54% |
| Squared-Y | 0.8630 | 74.47% |
| Logarithmic-Y squared-X | 0.8596 | 73.88% |
| Reciprocal-Y | -0.8591 | 73.81% |
| Squared-Y square root-X | 0.8511 | 72.44% |
| Squared-Y logarithmic-X | 0.8352 | 69.76% |
| Reciprocal-Y squared-X | -0.7962 | 63.39% |
| Squared-Y reciprocal-X | -0.7933 | 62.93% |

Table 15: Coefficients

| *Parameter* | *Least Squares Estimate* | *Standard Error* | *T Statistic* | *P-Value* |
|---|---|---|---|---|
| Intercept | 24.8071 | 47.2265 | 0.525279 | 0.6121 |
| Slope | 0.11837 | 0.0195545 | 6.05335 | 0.0002 |

**Table 16: Analysis of Variance**

| *Source* | *Sum of Squares* | *Df* | *Mean Square* | *F-Ratio* | *P-Value* |
|---|---|---|---|---|---|
| Model | 160518. | 1 | 160518. | 36.64 | 0.0002 |
| Residual | 39425.2 | 9 | 4380.58 | | |
| Total | 199943. | 10 | | | |

Correlation Coefficient = 0.896001
R-squared = 80.2818 percent
R-squared (adjusted for d.f.) = 78.0909 percent
Standard Error of Est. = 66.1859
Mean absolute error = 42.1118

**Table 17: Analysis of Variance with Lack-of-Fit**

| *Source* | *Sum of Squares* | *Df* | *Mean Square* | *F-Ratio* | *P-Value* |
|---|---|---|---|---|---|
| Model | 160518. | 1 | 160518. | 36.64 | 0.0002 |
| Residual | 39425.2 | 9 | 4380.58 | | |
| Lack-of-Fit | 39425.2 | 9 | 4380.58 | | |
| Pure Error | 0.0 | 0 | | | |
| Total (Corr.) | 199943. | 10 | | | |

**Table 18: Predicted Values**

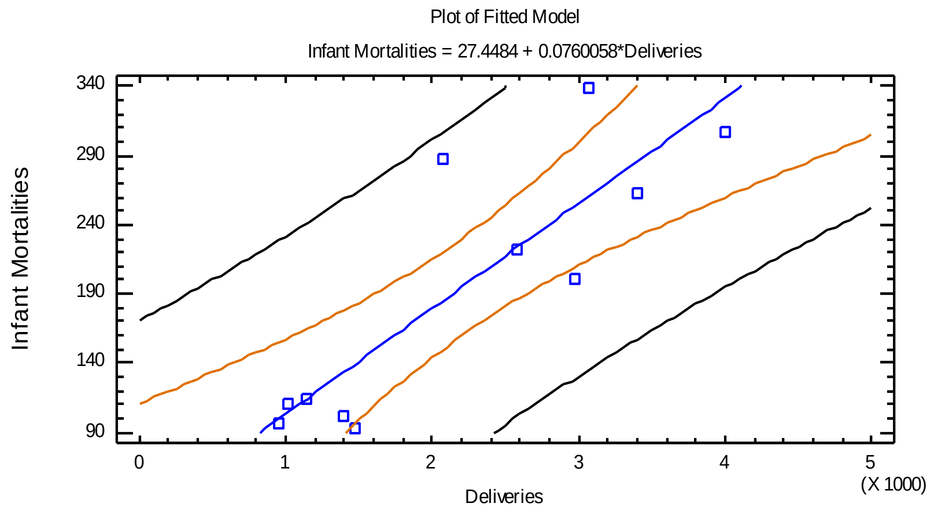
| | *Predicted* | *95.00% Prediction* | *Limits* | *95.00% Confidence* | *Limits* |
|---|---|---|---|---|---|
| *X* | *Y* | *Lower* | *Upper* | *Lower* | *Upper* |
| 956.0 | 137.969 | -27.6492 | 303.588 | 67.1712 | 208.767 |
| 4006.0 | 498.999 | 323.17 | 674.828 | 406.81 | 591.188 |

**Table 19: Comparison of Alternative Models**

| *Model* | *Correlation* | *R-Squared* |
|---|---|---|
| Multiplicative | 0.9178 | 84.23% |
| Reciprocal-Y logarithmic-X | -0.9170 | 84.09% |
| Logarithmic-Y square root-X | 0.9127 | 83.30% |
| Square root-Y logarithmic-X | 0.9121 | 83.20% |
| Double reciprocal | 0.9114 | 83.06% |
| Double square root | 0.9098 | 82.77% |
| Reciprocal-Y square root-X | -0.9073 | 82.32% |
| S-curve model | -0.9039 | 81.70% |
| Square root-X | 0.9028 | 81.50% |
| Logarithmic-X | 0.9023 | 81.41% |
| Square root-Y | 0.8997 | 80.95% |
| Exponential | 0.8996 | 80.94% |
| Linear | 0.8960 | 80.28% |
| Square root-Y reciprocal-X | -0.8940 | 79.92% |
| Reciprocal-Y | -0.8893 | 79.09% |
| Reciprocal-X | -0.8798 | 77.40% |
| Squared-Y | 0.8779 | 77.07% |
| Squared-Y square root-X | 0.8777 | 77.03% |
| Squared-Y logarithmic-X | 0.8711 | 75.88% |

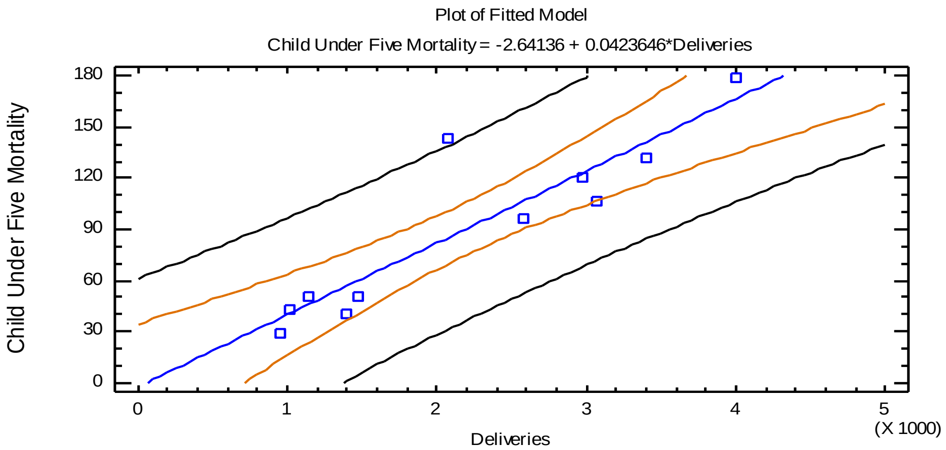
| | | |
|---|---|---|
| Squared-X | 0.8640 | 74.65% |
| Double squared | 0.8617 | 74.25% |
| Square root-Y squared-X | 0.8605 | 74.05% |
| Logarithmic-Y squared-X | 0.8541 | 72.94% |
| Squared-Y reciprocal-X | -0.8402 | 70.59% |
| Reciprocal-Y squared-X | -0.8338 | 69.53% |

**Figure 1: Simple Regression - Child Under Five Mortality vs. Deliveries**




Dependent variable: Child Under Five Mortality
Independent variable: Deliveries
Linear model: Y = a + b*X

**Figure 2: Simple Regression - Infant and Child Mortalities vs. Deliveries**




Dependent variable: Infant and Child Mortalities
Independent variable: Deliveries
Linear model: Y = a + b*X

Figure: 3

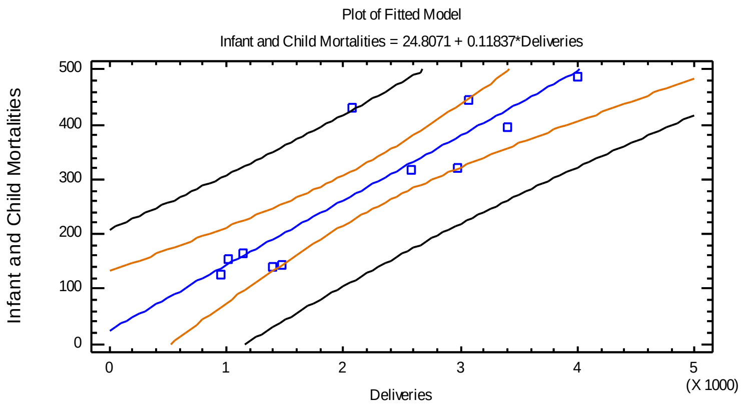



Figure: 4

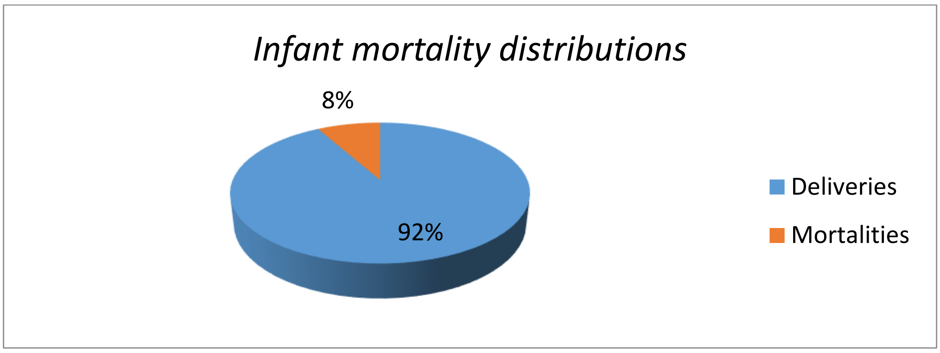



*Figure 5*

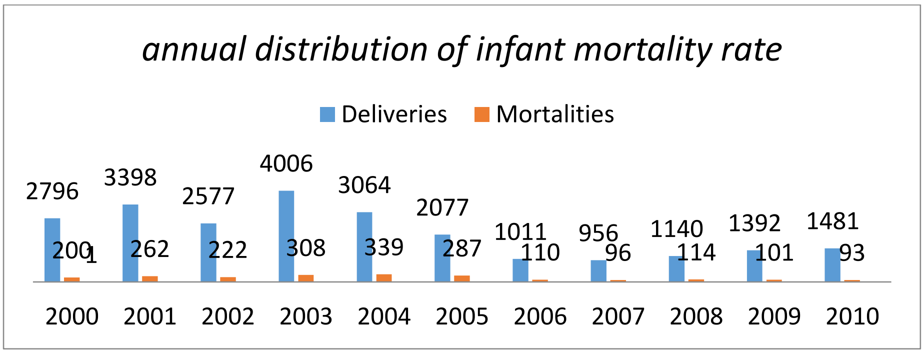



*Figure 6*

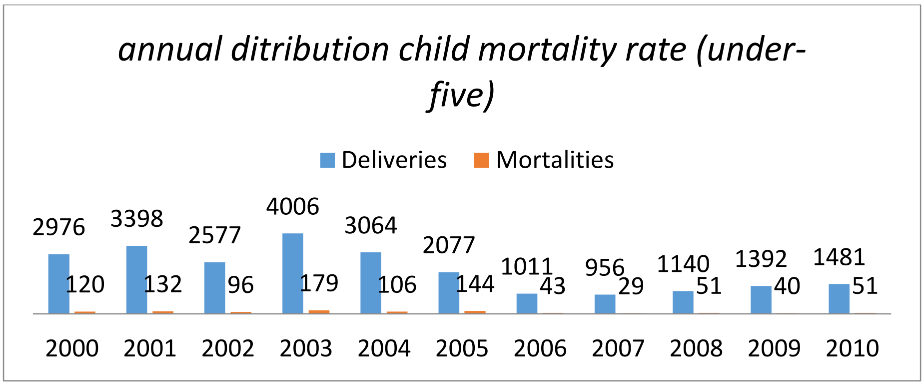



*Figure 7*

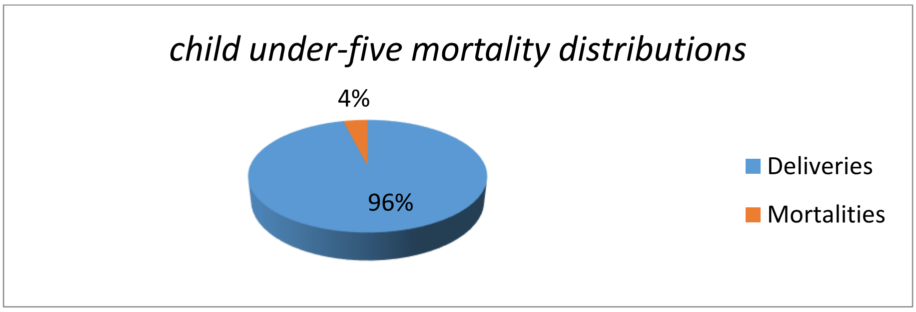



*Figure 8*

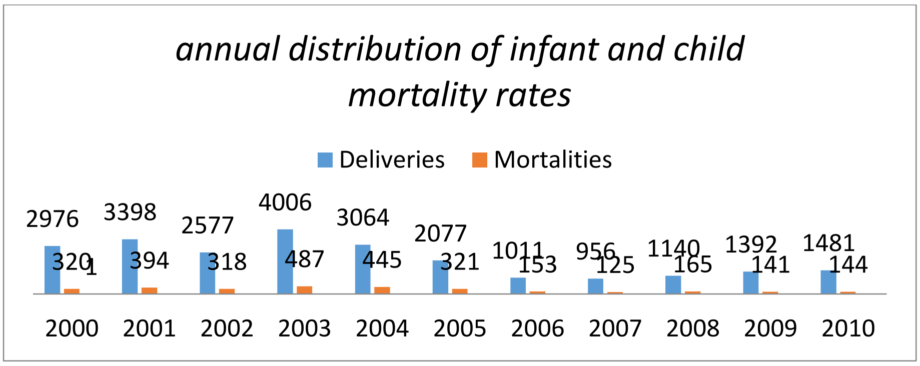



*Figure 9*