ANALYSIS OF TRENDS AND DETERMINANTS OF MORTALITY IN THE KINDOM OF SAUDI ARABIA

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Abstract

Population plays an important role in the growth and development of the economy of the country. The purpose of this study is to find out the trends and determinants of mortality in Saudi Arabia such as crude death rates, child mortality rate under age 5, infant mortality, neonatal and maternal mortality have also been assessed. The factors that have been used in order to assess their influence on mortality rates are Gross Domestic Product (GDP) at market price, Health Expenditure Per Capita, Literacy Rate (data used on Gross Enrollment Ratio at Tertiary level), Urban Population Percentage, Life expectancy, and Population Total. The World Bank Database was the source of data used for the analysis. Various statistical methods have been used for analyzing the data in order to find out the strength of the variables in influencing mortality rate. These methods are Pearson correlation coefficient, scatter diagram, multiple linear regression, and polynomial models. Each of the components of mortality has shown a sharp decline during the last four decades. The results of bivariate analysis demonstrate a significant inverse relationship of crude death rate, child mortality rate and infant mortality with each of the factors included. In multiple regression analysis of crude death rate, each of the selected factors was found to have similar significant relation with crude death rate; however, only three factors GDP, education ratio and life expectancy have shown a significant relationship with child mortality and infant mortality.

Introduction

Birth, death and fertility rate are important elements in monitoring demographic changes. They are normally used to assess the health situation of a nation and to also plan for development as well as the allocation of resources to various groups of people. Since 1960 the population of Saudi Arabia has grown because of its largest oil reserves in the world which make the country able to support its population which is at approximately 33 million. There have been contradictions that the fertility rate of the people of Saudi Arabia has been decreasing considering the 2 million immigrants and the inhabitants of Saudi Arabia. As a result, it has been necessary to conduct a research to find out the rate of growth of population by finding out the rate of birth and death and the natural increase since there is no more immigration.

1.1 Background

This research focuses on finding out the factors that affect the population of Saudi Arabia in order to be able to understand the demographic characteristics of the country by statistical analysis. As a result, it will be necessary to find out the rate of births, deaths, the life expectancy, the economic aspect and their trend over years in order to ascertain the causes of various trends that will be found out and come up with recommendations to make improvements where necessary considering the resources of the country.

1.2 Objectives of the study

The following are the primary objectives of the study**:**

1) To determine the mortality changes over time in Saudi Arabia.
2) To identify the factors that relate to mortality changes in the country.
3) To assess suitable techniques of addressing improvement of mortality rate in Saudi Arabia.

The research questions related to objectives are:

1) How much mortality changes occurred over time in Saudi Arabia?
2) What are the factors that relate with mortality changes in Saudi Arabia?
3) What techniques or approaches would be effective in improvement of Mortality rate?

Literature Review

This chapter represents previous research done on diseases that cause childhood mortality in Saudi Arabia. Infant mortality can be described as the death of children who have not attained more than one year of age. According to the World Health Organization (WHO) fourth millennium development goals (MDG 4) objectives were to reduce the mortality rate of infants. These included improving maternal health. According to WHO finding, 41 % of under-five years die in the first 28 days of their neonatal periods. The statistics indicate that at least 75 % of the children die in the first week of life. The cause of the death is attributed to unskilled care for both the mother and newborn immediately after birth (Hay, 2017).

According to a research by the WHO in 2009, there are three major causes of infants' deaths worldwide. Infections account for more than 36 % of the accounted for childhood death. The most common infections just after birth include diarrhea, tetanus, and pneumonia. Preterm or premature birth accounts for more than 28 of the death while asphyxia accounts for 23 % of the deaths. Most of the infections are associated with unskilled and inadequate care of the mothers and their infants at birth. The first lack of the continuum of care occurs from maternal to child in which most mothers lack connection with child health programs leading the deaths of infants in the first month of their life. In some countries there has been no record of the neonatal death hence people could not be able to justify how much loss there occurs to newborns immediately after death. The emergence of efforts to tackle specific health problems in infants has resulted to the keeping of records in order to be able to determine the extent of the problem and therefore determine the resources required to solve the problem.

Other causes of infant mortality include; birth defects, low birth weight, sudden infant death syndrome (SIDS), pregnancy complications and injuries including suffocation. The sudden infant death syndrome is the unexplained death in the crib of an infant usually during sleep, of a baby who seems healthy, of less than a year old. The crib death is always associated with defects in the brains of the infants that control breathing and arousal from sleep. A combination of physical and environmental factors that make children susceptible to SIDS, low birth weight is associated with immature brains which makes an infant have less control over automatic processes such as breathing, arousal from sleep and heartbeat. In other cases, the occurrence of respiratory infections is associated with the SIDS death which results from difficulties in breathing (Al Matary et al., 2017).

The sleeping environment is a factor of child care. A child's death can be caused by sleeping position in combination with a physical problem. Children who sleep on their stomach or side are suspected to be more vulnerable to death due to breathing difficulties as compared to those who sleep on their backs. Sleeping on very soft surfaces with face down such as on a waterbed easily blocks an infant's airways and the breathing difficulties cause their death through suffocation and collapse of the respiratory system. During sleep, some children get too much warmth from clothing and covering by the mothers. This makes them vulnerable to SIDS. The risk factors for infants' death include sex. Male infants are more prone to SIDS as compared to the females. Infants at the age of four months are more susceptible to SIDS due to the exposed to various environments. Family history, race, second-hand smoke, and premature infants are all likely to have a high risk of SIDS. Maternal risks that make infants susceptible to SIDS include; use of drugs such as alcohol, cigarettes smoking, mother of age below 20 years and inadequate prenatal care due to levels of poverty and economic challenges. One or a combination of these factors or diseases contribute to infants' mortality, not only in Saudi Arabia but also in other parts of the world. The infants' bodies have low immunity at the tender age hence require absolute protection and care to reduce their susceptibility and mortality (Koblinsky, Campbell and Harlow, 2018). This chapter represents the various research works on mortality rate, its analysis, and trend as presented by other researchers. Mortality transition describes the passage from high mortality rate due to infectious and parasitic diseases to times of lower mortality rate usually associated with communicable diseases. The causes of death changes are as a result of natural causes, the life expectancy, age structure of a population, the measure of fertility of a population and quality of health care of a population of a country. The standard of living also forms an important part in the wellbeing of a population, mentally, physically and socially.

1.3 Mortality transition in Saudi Arabia

Health care is an increasing concern in many countries today due to increasing noncommunicable diseases which are a contributing factor to increasing deaths. (Saeedi, 2018) in his assessment report on cardiovascular diseases makes it clear that it is a major leading cause of increased mortality rate in Saudi Arabia every year accounting at least 20% of the total deaths. This disease is attributed to several other health problems such as diabetes, obesity, hypertension, smoking and sedentary lifestyle. This in turn has increased the cases of heart failure and heart disease. Cardiovascular disease is common in women since they adopt sedentary lifestyles because they are not allowed to drive or getting involved in physical activities. Studies show that cigarette smoking contributes about 9% of cardiovascular disease which is a killer disease. Hypertension and diabetes were common among women aged 40 years and above. These conditions lead to other severe problems, for example, obesity which causes hypertension. Obesity varied among different people depending on their level of education, marriage etc. with educated women registering fewer cases of obesity as compared to those with less education (Saeedi,2018).

1.4 Death rates

According to Gietel-Basten (2017), mortality rates in Saudi Arabia have decreased over years with the birth rate exceeding the death rates. This is because the government has involved itself in giving primary care services which ensure that those with health problems in remote areas can access health care easily and referral services to advanced specialists. Fertility rates have also increased with higher marriage age, female education, an increased value of raising children, increased life expectancy and reduced mortality and infant death rates. There is however a decline in fertility rate in Saudi Arabia which is believed to be attributed to delay in marriage, the spatial distribution of development and household characteristics (Gietel-Basten, 2017).

1.5 Health Services

Bamufleh (2017) notes that use of contraceptive enhances birth spacing although it has no significant effect on birth control. New strategies and policies have been advanced that are patient centered and focus on the social determinants of health, promotion and protection. More health centers have been accredited by the national agency so as to improve safety, and quality of services. Despite this improvement, the demand for human resources at the health centers is increasing rapidly which is a challenge. Some other challenges include lack of training programs, few trained health personnel. Some are below the standards required during treatment of patients and curative services. There is poor quality of health care offered and inconsistency in the health sector. Immunization provided to infants and variation in maternal care has led to a decline in infant mortality rate over time (Bamufleh, 2017).

1.6 Maternal Mortality

Maternal mortality rate is annual rate per 100,000 of the death of females who are either pregnant, during birth or 42 days within termination of pregnancy (Wayne, 2013). Braham (2017) states that a low level of education and low economic status are a contributing factor for increasing maternal deaths which are mainly caused by hemorrhage, uterine rupture among other causes. This was as a result of increasing the availability of banked blood and adoption of life saving surgery to the expectant women. Braham (2017) further states that women getting pregnant beyond the age of 35 years are not after pursuing a career since there are higher rates of illiteracy among women aged 35 years and above and the adolescents. Age affects the reproductive systems of the body among other body systems and this exposes women to problems at birth or during pregnancy. The adolescents are believed to havea short cervix, physical immaturity and small uterine volume resulting in preterm delivery but also are likely to deliver normally unlike women with advanced maternal age. Braham (2017),therefore, comes to a conclusion that fertility of women in Saudi Arabia has fallen which could be as a result of late marriages, low economic status and studies. Also, cases of abortions have risen among women over the age of 40 years with increased rates of infertility attributed to unhealthy foods, obesity, hypertension, smoking, and unsuitable living environment. However, the population of Saudi Arabia has increased over the years as compared to mortality rates (Braham, 2017.)

Methodology

This section presents variables used for the research topic, the source of data and statistical methods used for analyzing the data.

1.7 Data Source

The data used for the study obtained from World Bank Data Base on Saudi Arabia. The source does not provide the data based on the individual level, but it provides aggregate level of data (http://data.worldbank.org/).

1.8 Variables

To address the objectives of the study, the variables which are available in the data source are used.

Dependent Variables

Given the limitation of the availability of the data, the following variables are analyzed to assess the trend and changes in mortality through regression analysis:

- Crude Death Rate
- Child mortality under age 5
- Infant mortality rate

In addition, maternal mortality and neonatal mortality are used for assessing the existing level and trends but not for statistical linear models because these variables have a very limited number of observations.

Independent Variables

The following variables are used to assess their strength of the relationship with dependent variables.

- Gross Domestic Product (GDP) at market price
- Health Expenditure, Per Capita
- Literacy Rate (data used on Gross Enrollment Ratio at Tertiary level)
- Urban Population Percentage
- Life expectancy
- Population Total

1.9 Statistical Method

The section of the paper presents various statistical methods used in the analyzing the data collected for the study. Statistical methods are used for collecting, summarizing, analyzing and interpreting variables numerical data. These involve mathematical formulae and techniques used in analyzing raw research data in order to extract important information and to provide ways of assessing the robustness of research inputs. The various techniques adopted in this research paper in analysis of raw data include; simple linear regression, Pearson correlation coefficient, and multiple regression analysis (Gregory, 2014).

1.10 Terminologies

Crude Death rate-- describes the number of people who die in a population of a place over a given period of time by a number of people (per 1000 people). Crude death gives the number of deaths that occur throughout a year, per 1000 population of a country.

$$\text{Crude death rate (CDR)} = \frac{\text{Total resident deaths}}{\text{Total population}} * K, \qquad \text{where K} = 1000$$

Child mortality rate under age 5-- refers to the ratio deaths of children under age 5 over live births in a year. The functional definition of the term is:

$$\text{Child mortality rate under age 5} = \frac{\text{Number of death under age 5, in a year}}{\text{Total number of live birth in a year}} * K$$

Infant mortality rate (IMR) -- describes the number of newborn babies who die before attaining the age of one year. The functional definition of it is;

$$\text{Infant mortality rate} = \frac{\text{Number of death under 1 year of age during a year}}{\text{Total number of live births during the year}} * K$$

Where $K = 1000$

Neonatal mortality rate (NMR) is defined as the number of deaths of infants under 4 weeks of age (28 days) or under 1 month of age during a year per 1,000 live births during the year. The functional definition of it is:

$$\text{Neonatal mortality rate} = \frac{\text{Number of deaths under 28 days of age during a year}}{\text{Total number of live births during the year}} * K$$

Where $K = 1000$

Maternal mortality rate--- refers to the death of a woman while pregnant or in 42 days of termination of pregnancy regardless of the duration and other factors except for accidental or incidental causes. Maternal mortality is usually measured by means of maternal mortality rate defined as the number of deaths of women during a given period due to childbirth and complications of pregnancy for every 100,000 births during the period. The functional definition of the term is:

$$\text{Maternal mortality rate (MMR)} = \frac{\text{Deaths from all puerperal causes during a year}}{\text{Total live births during the year}} * K$$

Where $K = 100000$ (Wayne, 2013)

Life expectancy – refers to the number of years an individual is expected to live under the prevailing conditions in the country and society. The knowledge of rate of mortality in a population is significant in ascertaining the distribution and number of people. It also gives the changes in numbers of a population over time, sex composition and birthrates. These studies are mainly used in finding out the causes and consequences of changes in population. There are three major things that are known to be the sole cause of population change, birth rates, death rates and migration normally referred to components of population change.

1.11 Data transformations

In most cases, biological data does not meet the assumptions of parametric statistical tests and therefore it is likely to lack homogeneity and is not normally distributed for analysis. Data has to be normally distributed in order to use statistical tests such as linear analysis regression so as to give accurate results son analysis. Transformation of data makes it fit the assumptions of a normally distributed data. Transformation can be done by the use of square root or logarithmic transformation (Little and Rubin, 2014).

1.11.1 Log transformation

In this study, the log transformation is used for analysis of the data and it involves taking the logarithm of each of the available observations. This is done by taking base10 logs also known as natural logarithms and it helps to normalize the distribution of a variable. In the case of the population;
Log Gross Domestic Product (GDP) at market price = log (Gross Domestic Product (GDP) at market price). In the use of linear regression transformation of data to logarithmic form helps in plotting line of best fit. When logarithm of a variable is taken they change the mathematical function.

1.12 Person correlation coefficient

The Person correlation coefficient is used to test the strength of the relationship between variables and it is used mostly in linear regression. The coefficients usually range for -1 to +1 where; a correlation coefficient represented by R shows a positive correlation if when values are plotted gives a positive slope through the origin. If the slope is negative, the correlation is considered to be negative and when the slope is 0, there is no correlation (Little and Rubin, 2014).

Formula

The Pearson correlation coefficient measures a linear relationship between two random variables, Y and X. The formula for this is:

$$r = \frac{\sum(XY) - \sum\frac{\sum(X)\sum(Y)}{n}}{\sqrt{(\sum(X^2 - \frac{\sum(X)^2}{n})(\sum(Y^2 - \frac{\sum(Y)^2}{n})}}, -1 \leq r \leq +1$$

where: X and Y represent the pair of the variable under consideration and n the number of the pair of variables.

1.13 Regression Model

1) Simple linear regression model

Simple linear regression is used in statistical analysis tool used to study the relationship between two quantitative variables. This model indicates the relationship between the variables and how they are associated to one another. The simple linear relationship explores the relations between variables for example, x to represent an independent variable and y a dependent variable. The two variables when plotted on a graph their relationship is given by:

$$Y = \beta_0 + \beta_1 X + \varepsilon.$$

Where, Y is the dependent variable, X is an independent variable; β_0 is an intercept, β_1 is the slope of the variable X; and ε is residual or error term.

2) Multiple regression model

The multiple regression model is

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_i + \varepsilon_i.$$

where β_s are unknown and coefficient of Xs. β_0 is an intercept and ε is residual or error term. Y is a dependent variable and Xs are independent variables.

Backward Elimination Procedure

The backward elimination procedure is a method of variable selection. The backward elimination procedure starts with the full model and successively drops one variable at a time the variables are dropped based on the basis of their contribution to the reduction of error sum of squares. The variables which have the smaller contribution to the reduction of sum of square are deleted or removed from the model (Chatterjee and Hadi, 2012).

3) Polynomial models

Polynomial models are used when the relationship between variables under study show a curvilinear relationship. There are various polynomials model and a model is said to be linear of its parameters are linear; The generalized form of polynomial model is:

$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \ldots + \beta_k X^k + \varepsilon.$$

Where Y is a dependent variable, and X, X^2 , …, X^k are the predictors of the polynomial model. β_s are the co-efficients of the predictors.
The third degree polynomial model, which is also known as cubic model or equation is:

$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 + \varepsilon.$$

A polynomial can be more than one order, such as first or third order but it is required that the order of a polynomial is kept as low as possible.

4) Scatter diagrams

The scatter plot is used to visualize the relationship that exists between two variables measured on the same set of individuals. It is used to find the trends and relationship between variables. Once a relationship is found between variables linear model is used to plot the curve of best fit (Gregory, 2014).

a. Test of Significance

The researchers are interested to see how strong the association between two variables are. The correlation coefficient is estimated only with quantitative variables. There is a testing procedure to assess that. As we have a sample data size not large, we use the test statistic t for assessing the significance of the correlation between two variables. The computed test statistic t is compared with critical value of t at n-2 degrees of freedom and level of significance. If the computed t is greater than critical t, we reject the null hypothesis H0, which implies the correlation between two variables is significant; otherwise, the relationship is weak. not significant.

The test of significance of regression coefficient demonstrate how strongly the corresponding variable relates with the dependent variable. The test statistic t represents the method of testing procedure. The same test statistic is used for both simple linear regression and multiple linear regression coefficients but the estimation of standard error differs due to difference in number of variables. The computed value of test statistic t is compared with critical value of t which is obtained from t-table using degrees of freedom and level of significance. If the computed value is greater than the critical value, then reject the null hypothesis of $\beta = 0$ which means that the variable has strong (significant) relationship with dependent variable. The p value refers to the probability of computed t statistic. Two-tail test, as opposed to one tail test, which refers to dividing level of significance by two, and then use the corresponding critical value for decision making.

The test of regression model refers to whether the included independent variables have some relationship with the dependent variable. The F-statistic is used to test joint hypothesis about regression coefficient. If F-statistics is significant, that indicates some of the independent variables have strong relationship or association with the dependent variable. If not significant, the regression model is insignificant. To assess the effective regression model, we utilize this testing procedure. Although F becomes equal to t^2, we use F test for testing regression model

The coefficient of determination, R^2, is the square of multiple correlation coefficient. The R^2 value is expressed as percentage by multiplying it by 100, which explained as the percentage of variation in dependent variable is associated with independent variables.

i. Test for Pearson Correlation Co-efficient

Hypothesis:

Null hypothesis, H_o: $\rho = 0$; Alternative hypothesis, H_a: $\rho \neq 0$

Test statistic:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

where, n -2 is the degrees of freedom to get the critical value of t at α level of significance. (Wayne, 2013)

ii. Test for β co-efficient (regression co-efficient)

Hypothesis: Null hypothesis, H_o: $\beta_i = 0$; Alternative hypothesis, H_a: $\beta_i \neq 0$

Test statistic:

$$t = \frac{\widehat{\beta_i}}{se(\widehat{\beta_i})}$$

Where, $\widehat{\beta_i}$ is the estimated value of the ith regression co-efficient, and the standard

error of β_i co-efficient, $se(\widehat{\beta_i}) = \frac{S_{y/x}}{\sqrt{\sum(x_i - \overline{x})^2}}$

Where, $S_{y/x} = \sqrt{\frac{\sum(Y_i - \widehat{Y_i})^2}{(n-k-1)}}$

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n = number of observations, and k = number of variables The critical value of t is $t_{n-k-1,1-\alpha/2}$ where α is a level of significance (Wayne, 2013)

iii. Test for the regression model

The independent variables as a whole need to have some power to explain the variation of the dependent variable. The F-test provides such test.

Hypothesis:

Null hypothesis, H_o: $\beta_1 = \beta_2 = \ldots = \beta_k = 0$
Alternative hypothesis, H_a: At least one of $\beta_i \neq 0$

Test statistic

$$F = \frac{\sum(\widehat{Y}_i - \overline{Y})^2/k}{\sum(Y_i - \widehat{Y}_i)^2/(n-k-1)}, 0 < F < \infty$$

Where, n = number of observation k= number of independent variables in the model $\widehat{Y}_i$ is the estimated value of the dependent variable. The critical value of F is $F_{k,(n-k-1)}, \alpha$ where degrees of freedom = $(k, n-k-1)$ and α is level of significance. The attained significance level is given by $p - value = P_r\ (F > F_{(computed)})$

iv. The co-efficient of Determination, R^2

In multiple linear regression, R^2 explains the total variation in Y, dependent variable by all the independent variables jointly.

The formula for R^2 is:

$$R^2 = \frac{\sum(\widehat{Y}_i - \overline{Y})^2}{\sum(Y_i - \overline{Y})^2}, 0 \leq R^2 \leq 1$$

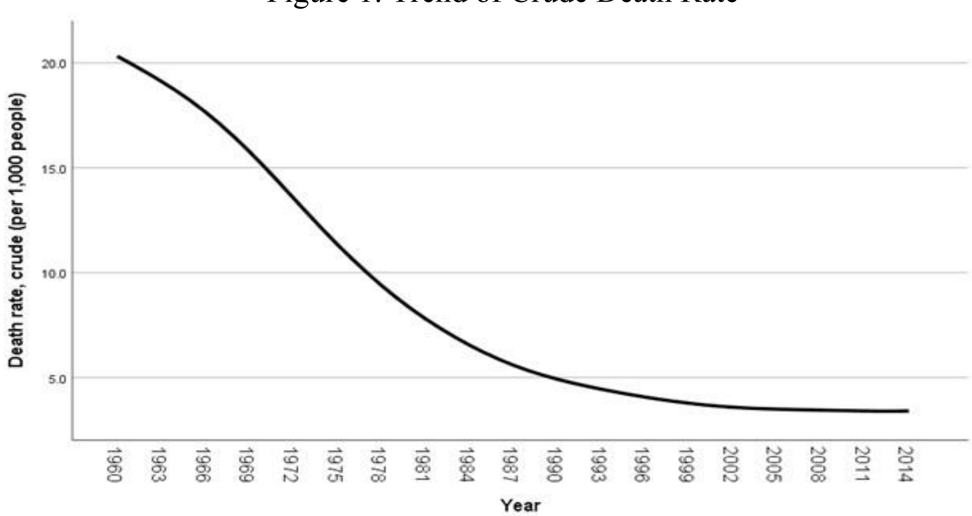
Where, $\widehat{Y}_i$ is the estimated value of the dependent variable.

RESULTS AND ANALYSIS

a. Trends of Mortality

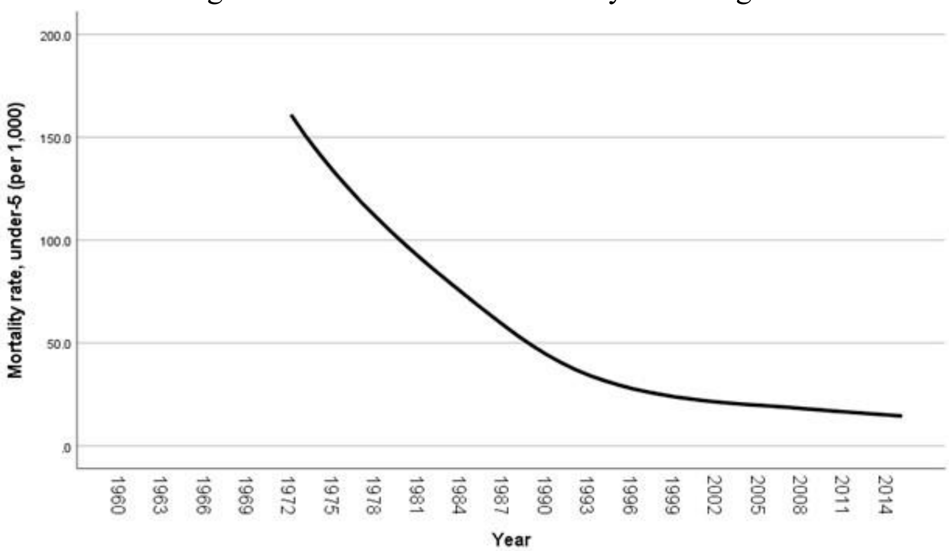
v. Crude Death Rate

Figure 1: Trend of Crude Death Rate



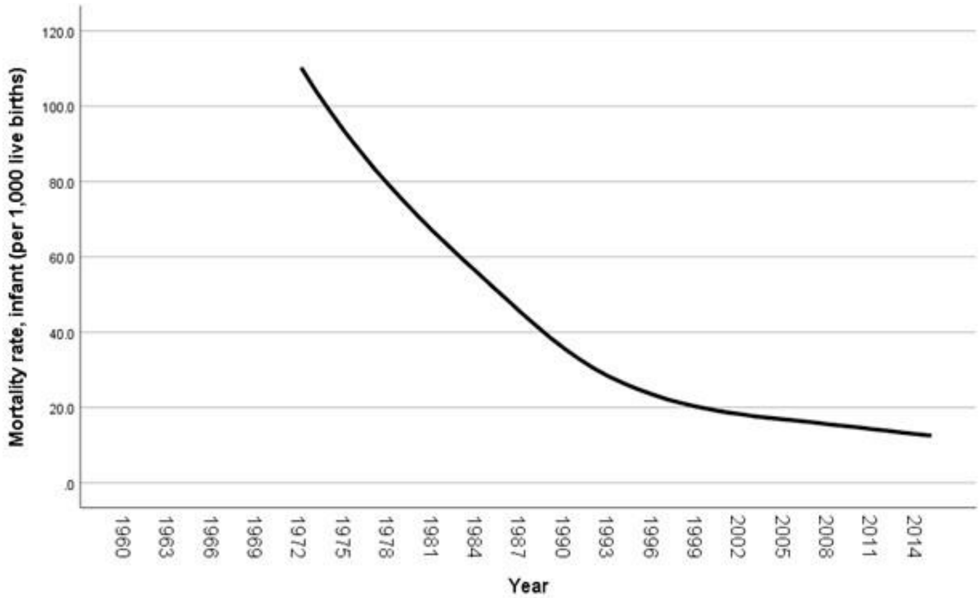
Mortality rate is the measure of deaths in a certain population as scaled to the size of the given population. The crude death rate on the other hand, is the measure of deaths per 1000 people in a given geographic area within a certain period per the total number of people in the given area. The above figure 1 shows the crude death rate (Per 1000 people) between the year 1960 and 2014. From the graph, it is evident that the death rate declined to less than 5 per1000 people by the year 2014. The largest decline in crude death rate occurred between the year 1960 and 1988 with the highest recorded crude death rate as 20 per 1000 people in the year 1960. According to the graph, there was an almost 0 change in death rate between the year 2000 and 2014.

Figure 2: Trend of Child Mortality under Age 5



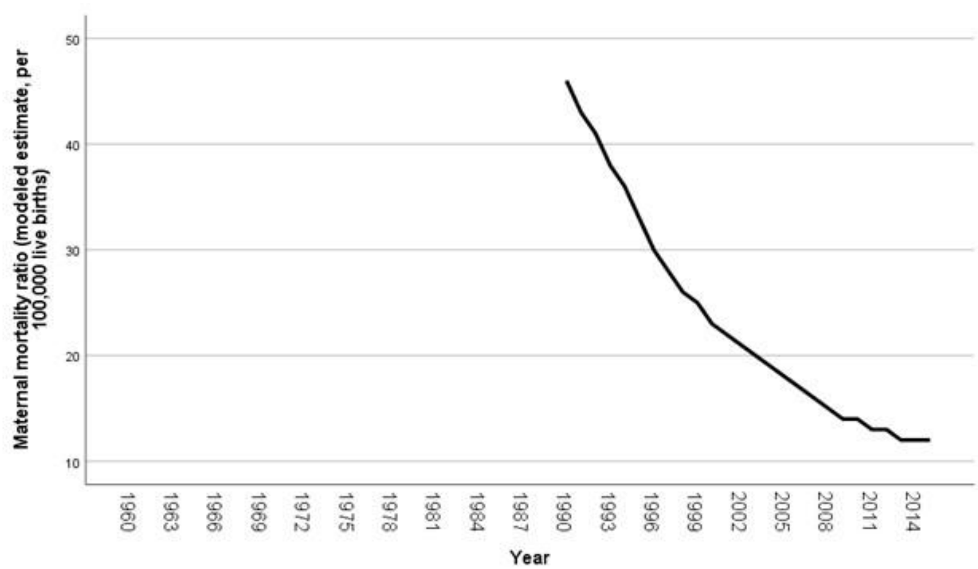
The best way to present the probability of 1000 live births dying between birth and exactly 5 years after birth is by putting the records on an under- five mortality rate graph. The figure 2 above is a representation of under-five mortality rate in Kingdom of Saudi Arabia (KSA) between the year 1960 and 2014. From the graph, under-five mortality rate(per 1000 live births) was recorded as from the year 1972. According to the graph, there was a gradual decrease in under-five mortality (per 1000) between 1996 and 2014.A steady decline was also recorded between the years 1972 and 1992. The year 1972 had the highest record of over 150 deaths (per 1000) compared to a lower value of less than 25 (per 1000) by 2014.

Figure 3: Trend of Infant Mortality Rate



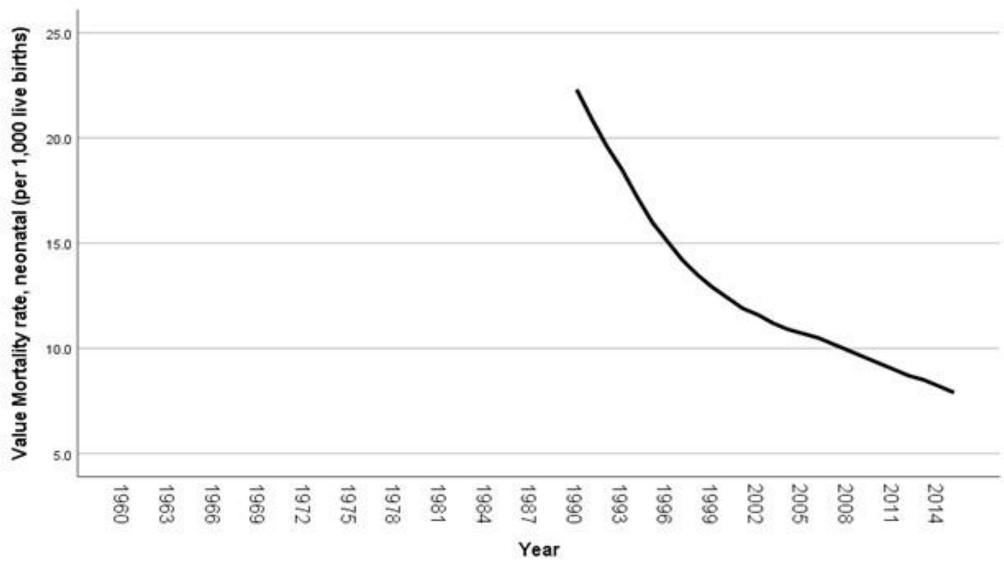
Infant mortality rate is a count of children deaths aged between 0 and 1year per 1000 live births. The figure above is a graph showing the infant mortality rate in KSA between the year1960 and 2014. From the data represented in graph form, there are no records of infant death rates between 1960 and 1972. The highest recorded infant mortality rate was in the year 1972 but decreased greatly between the year 1972 and 1993. Infant mortality rate declined to less than 20 (per 1000 live births) by 2014.This might have been brought about by advancement in health and medical services as well as the increase in health centers. According to the graph, there were very slow changes in infant mortality rate between the year 2003 and 2014.

Figure 4: Trend of Maternal Mortality



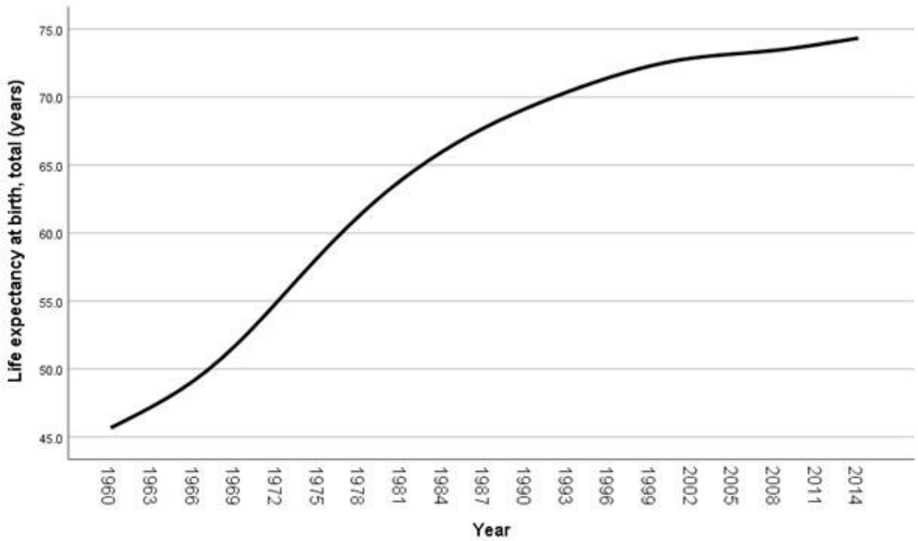
The simplest and best way to measure the number of female deaths related to pregnancy not including incidental and accidental is by analyzing them in a Maternal Mortality Ratio (MMR) graph. The figure above shows MMR (per 100000 live births) in KSA. The graph shows a great decrease in the maternal mortality ratio between 1990 and 2014. MMR reduced to 12 (per 100000 live births) in the year 2014. According to the presented data, there were no records of maternal mortality ratio from 1960 to 1990. There was a sharp decrease in MMR between the year 1990 and 2001. The years 2009 and 2014 recorded a gradual change in maternal mortality ratio with the years 2009,2011 and 2014 recording almost zero changes.

Figure 5: Neonatal Mortality Rate



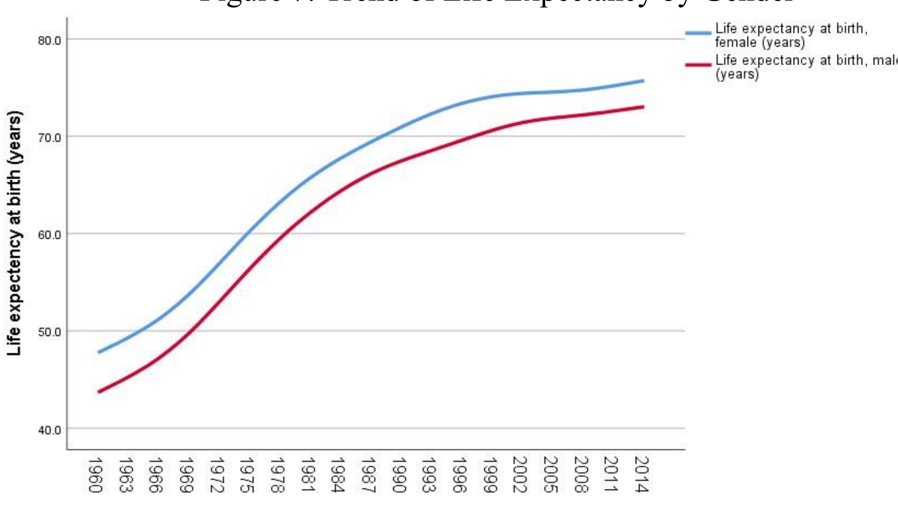
The above graph represents data on the rate of deaths on live births in the first 28 days of their life (per 1000 live births) from the year 1960 to 2014. From the graph, no records were kept for neonatal value mortality rate from the year 1960 till 1990. As per the graph, 1990 had the highest number of neonatal deaths of more than 20 deaths per 1000 live births. The year 2014 recorded the lowest number below 10(per 1000 live births). According to the graph, the neonatal mortality rate declined dramatically from 22 deaths (per 1000 live births) to 8 deaths (per 1000 live births) .

Figure 6: Trend of Life Expectancy



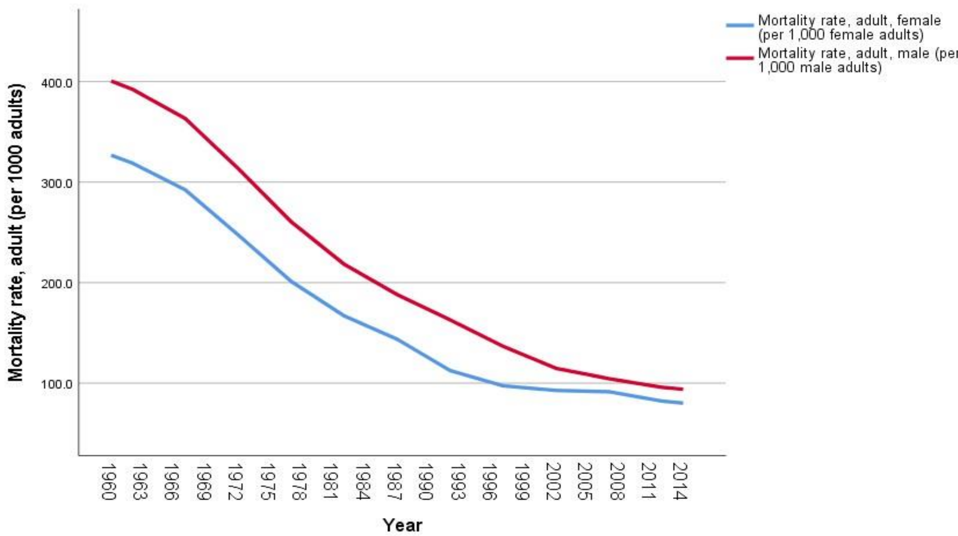
Life expectancy at birth is a statistical term referring to the average number of years a newborn is expected to live after birth if there are constant mortality patterns for the newborn from birth and in future. The above figure shows a data represented In graph form for the life expectancy at birth in KSA between the year 1960 and 2014. With the data recorded at the rate of 3years, there was a steady increase in life expectancy between the recorded years 1960 and 2014. The highest life expectancy recorded (in years) was 2014 at 74 years and the lowest recorded in the year 1960 at 46 years. From the graph, there was a gradual change in life expectancy at birth between 1992 and 2014. The largest increase in life expectancy occurred between 1967 and 1976.

Figure 7: Trend of Life Expectancy by Gender



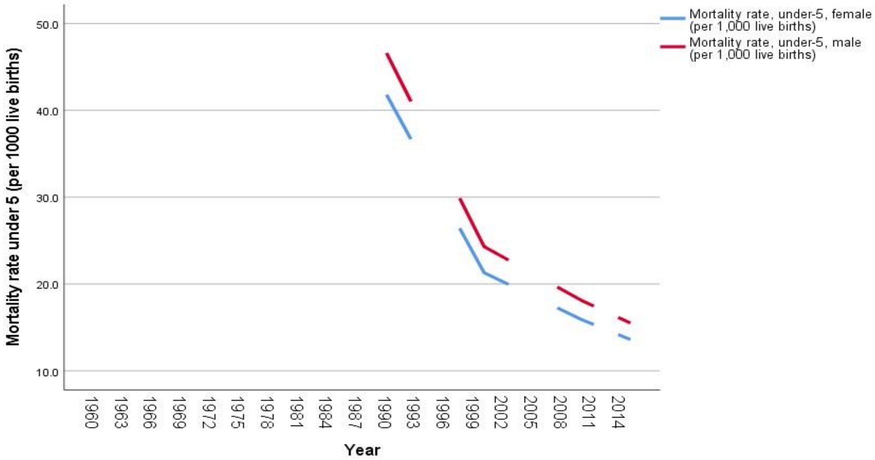
The above figure is a graph representing the average number of years a newborn is expected to live till death if neonatal mortality rate and under-five mortality rate remain constant for both male and female. From the graph, the female had a higher life expectancy compared to men. The lowest life expectancy for the female was 48(in years) while for the male is 43 years. Female also recorded the highest life expectancy of 76 years with men living slightly lower than the female in 3 years. Both male and female experienced a steady increase in life expectancy from 1960 t0 2014. From the year 1987 to 2014, female live births lived between 70 and 75 years while male live births lived between 67 and 73 years. This is compared to a life expectancy of less than 70 years but above 42 years for both male and female between the year 1960 and 1987

Figure 8: Trends of Adult Mortality by Gender



The above data is mortality rate (per 1000 adults) for both male and female adults between the year 1960 and 2014. The graph depicts a steady and gradual decrease in mortality rate from 1960 to 2014 for both male and female adults. According to the data presented in graph form, male adults had the highest mortality rate compared to female adults. In the year 1960, an approximated 400 male (per 1000 adults) died compared to 320 (per 1000 adults) death rate in females. Female adults experienced a more gradual decrease in mortality rate than male adults between the year 1996 and 2014.

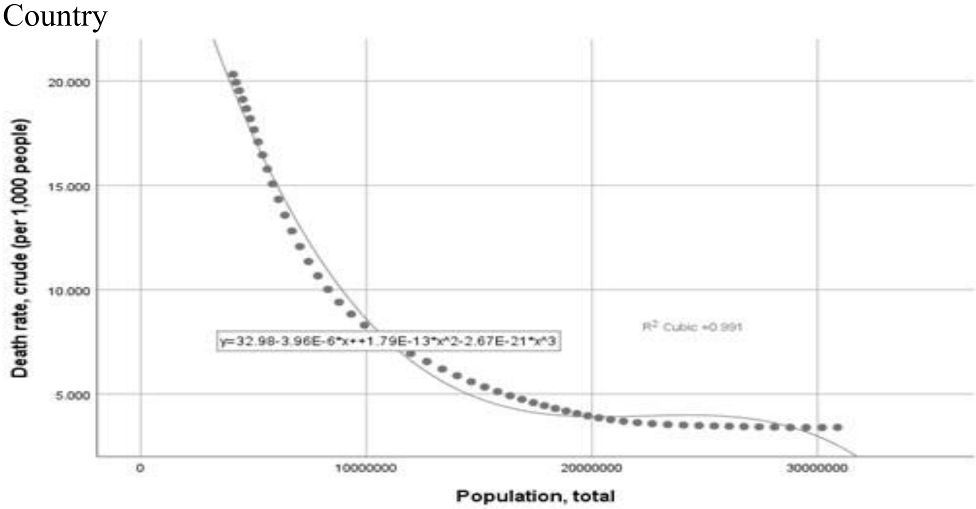
Figure 9: Trends of Child Mortality Rate under Age 5 by Gender



The above under-five mortality rate graph represents the probability of live births dying between birth and exactly five years per 1000 live births in KSA between 1960 and 2014. According to the graph, under-five mortality rate records began to be kept from the year 1990 up to 2014 and from the presented data, male children had a higher probability of dying below five years compared to female live births(per 1000 live births). The highest records for the male were 46 (per 1000 live births) while for the female were 42 (per 1000 live births) There was an even but sharp decrease in under-five mortality rate between 1990 and 2000 compared to an even but steady decline from the year 2000 to 2014. The year 2014 recorded the lowest rates with male recording 15 (per 1000 live births) under-5 mortality rates slightly higher than 13(per 1000 live births) for female.

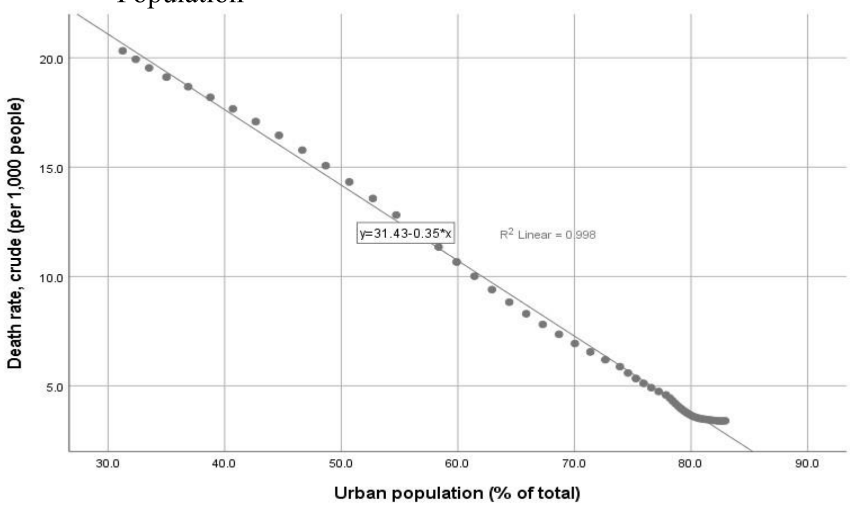
b. Bivariate Analysis: Scatter Diagram and Fitted lines

Figure 10: Scatter Diagram between Crude Death Rate and Population of the Country



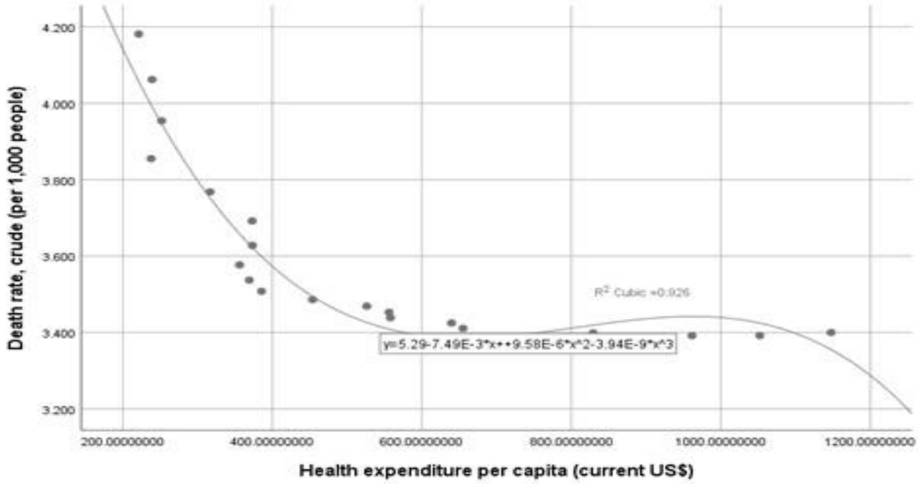
The graph above shows the crude death rate (Per 1000 people) of the population in KSA. From the graph, the highest recorded crude death rate was 21 (per 1000 people) in a total population of 5,000,000 people. On the other hand, the lowest recorded was 3(per 1000 people) in a total population of over 30,000,000. According to the data presented above, it's in contrast that crude rate reduced with the increase in population. As recorded from the graph, there was a drastic decrease in crude death rate (per 1000 people) in the total population of 5,000,000 and 10,000,000. However, a gradual steady decrease in crude death rate occurred between total population of 20,000,000 and 30,000,000 on (3 per 1000 people) of the total population died.

Figure 11: Scatter Diagram between Crude Death Rate and Percent of Urban Population



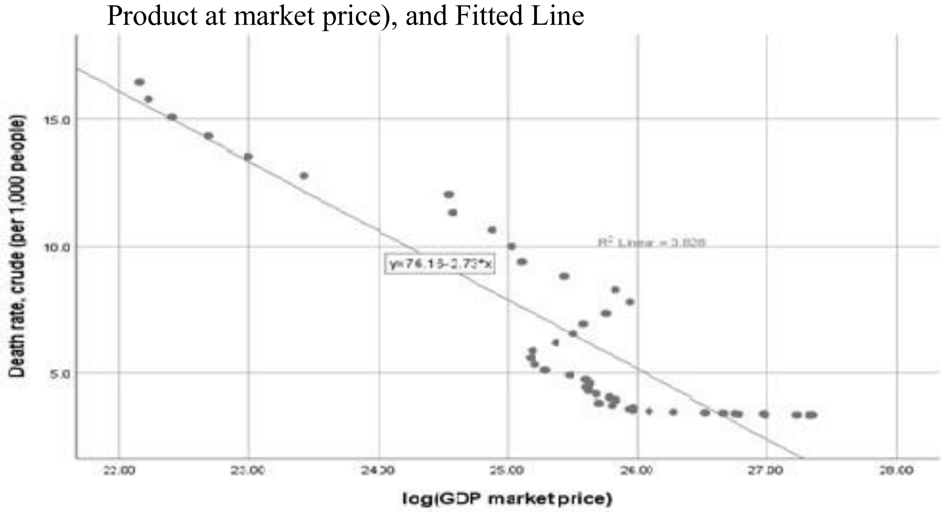
The above graph represents the crude death rate (per 1000 people) versus the urban population of the total population in KSA. From the graph, the degree of certainty of the data provided was 0.998. The graph depicts a steady but even decline in the crude death rate for the urban population (per 1000 people). The highest recorded crude death rate was 21(per 1000 people) of 31% urban population of the percentage total in KSA. The lowest was 3 (per 1000 people) of 80% of the total urban population. Crude death rate remained constant at 2.5 (per 1000 people) in an urban population of over 80% of the total population in KSA

Figure 12: Scatter Diagram between Crude Death Rate and Per Capita Health Expenditure, and Fitted line



The above is a representation data of crude death rate (per 1000 people) versus Health expenditure per capita in USD. The degree of certainty of the above data was 0.540. From the graph, crude death rate decreased unevenly with increase in health expenditure per capita. The highest recorded crude death rate was 4.2 (per 1000 people) when KSA spend over 200 USD per capita. Crude death rate (per 1000 people) reduced drastically to (3.5 per 1000 people) when health expenditure per capita was increased to 400 USD. The crude death rate was realized to 3.4 (per 1000 people) and remained constant when health expenditure per capita was increased to between 600 and 1200 USD.

Figure 13: Scatter Diagram between Crude Death Rate and log (Gross Domestic Product at market price), and Fitted Line

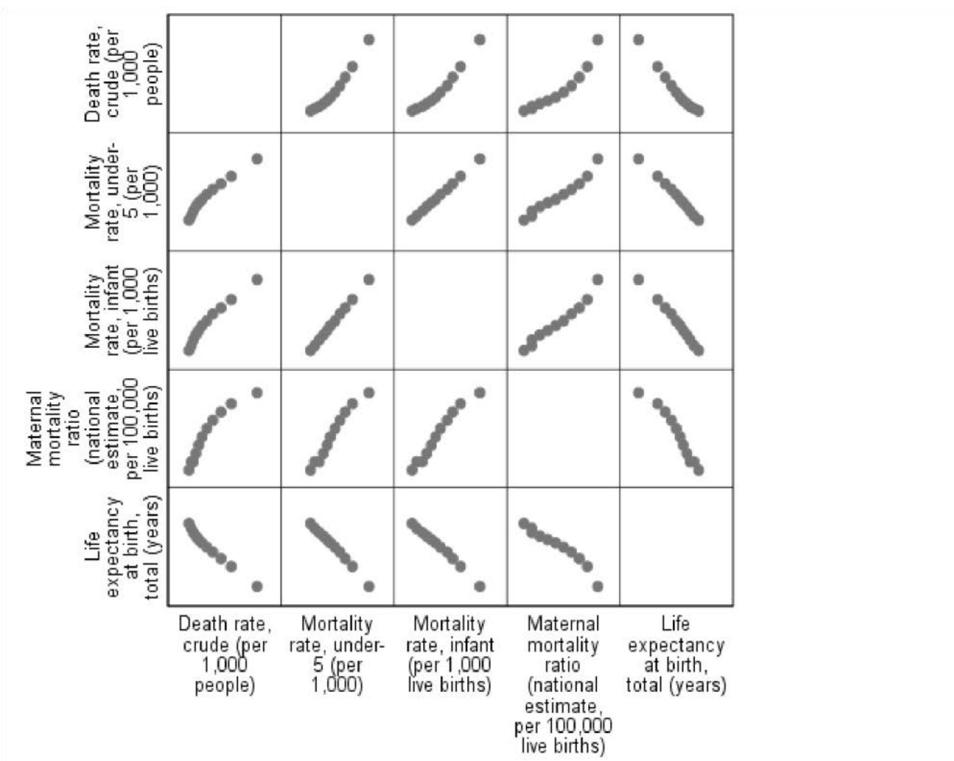


From the above graph of crude death rate (per 1000 people) versus logGDP at market price in KSA, according to the regression line, the degree of certainty of this data was

0.828. Although the trend is not even, it's evident that KSA experienced a dramatic reduction in crude death rate (per 1000 people) as the logGDP at market price increased. However, according to the data provided, although the logGDP at market price reduced from 26 to 25.2, the crude death rate also recorded a decline from 7 to 5 (per1000 people). Crude death rate also remained constant at 2.5 (per 1000 people) even as logGDP at market price increased from 26 to 27.4.

c. Pairwise patterns of relations

Figure 14: Plot Matrix of Pairwise Scatter Diagram of Selected Variables



The figure 14 represents the pairwise scatter of the selected variables and it shows an association between the variables. From the scatter diagram it can be seen that death rate crude (per 1000 people) increases with increase in mortality rate under5 (per 1000 people) this relationship shows a normal trend whereby the increase in one variable results in an increase in another variable. The data has no outliers and therefore has the great correlation. A similar trend is seen with the maternal mortality rate(per 100000) and mortality rate under-5(per 1000) people, and mortality infant rate(per 1000 live births). The infant mortality rate (per 1000) shows a linear relationship with mortality rate under -5. As the more infants die at birth, there are low chances of infants surviving to age of 5. These are associated with premature birth and labor complication at birth. Other factors that contribute to infants' death include lack of quality health care and suffering malnutrition in the case of poor communities. From this analysis it clear that the rate of death increases at infants and under -5. This trend has a direct impact on life expectancy in the sense that due to many factors contributing to the increase in deaths, the life expectancy is significantly reduced with time. Life expectancy shows a negative association with the other variables since it largely depends on the mortality rate. When the rate of mortality decrease, the life expectancy increases.

The decrease in death rates is also associated with health conditions of the population of a country. Better health services improve the quality of life and reduce the deaths thus increasing the life expectancy of a population under study. There are other elements such as fertility trend that affect the difference between the rate of birth and the rate of death. The difference gives the rate of natural increase is also affected by the age composition of the population of the country. These two variables give the rate of growth of a population. These rates are forms of summary which do not indicate the various factors which have a distorting effect on the purpose of a more detailed comparison.

Figure 15: Plot Matrix of Pairwise Scatter Diagram of Selected Variables

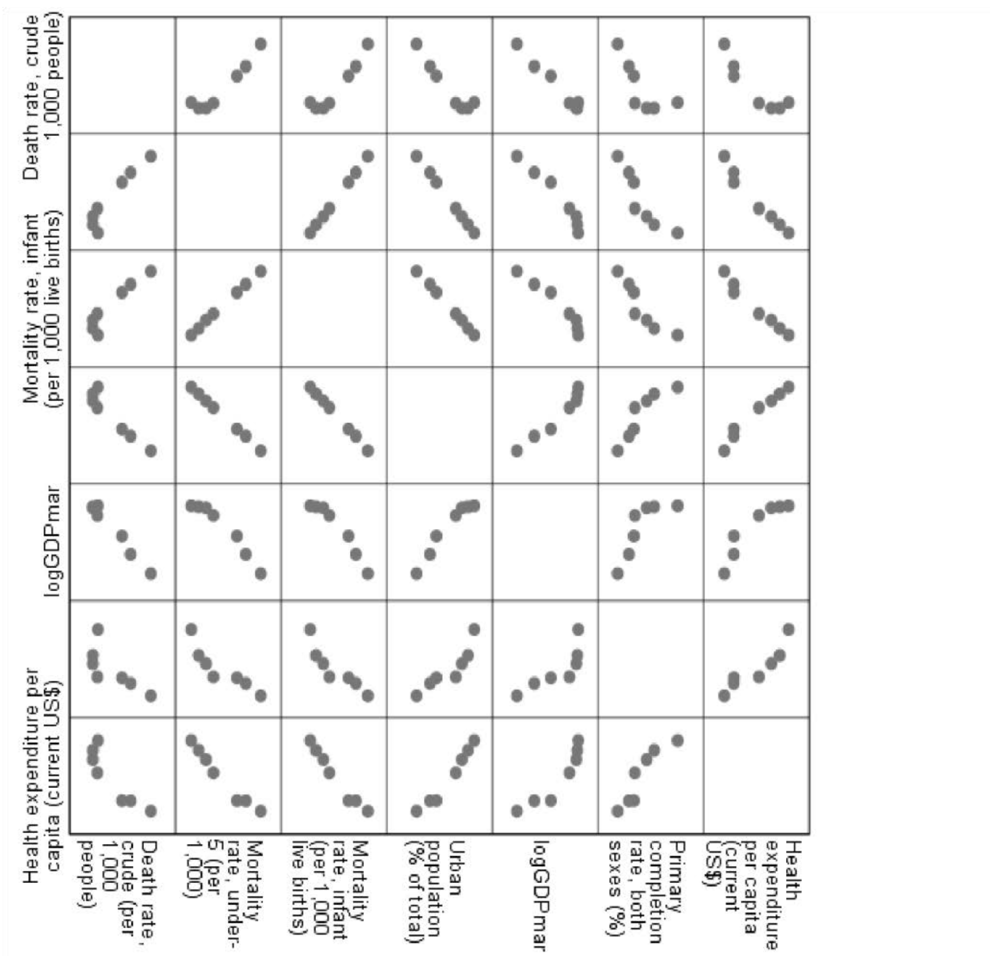


Figure 15 shows a pairwise scatter diagram of selected variables, the crude death rate (per 1000) increases with the increase in mortality rate of under 5(per 1000) and mortality rate under 5(per 1000) has linear relationship with the mortality infant rate (per 1000 live births). The crude death rate shows a negative association with the urban population. As the population in urban increases, the total crude death rate (per 1000) reduces. This is due to ease of access of health facilities and clinics in urban centers as compared to remote rural areas which are challenged by transportation facilities in order to access quality care.

The primary completion rate, both sexes show little correlation with logGDP at market price, while the logGDP at market price shows a positive association with the urban population, that is, the GDP is expected to increase with the increase in the urban population. The primary completion rate, both sexes increases with the increase in health expenditure per capita (US$). As a result, greater investment in healthcare significantly contributes to completion rate. Generally, the crude death rate is affected by a number of issues such as income, affordability of quality health care and accessibility to health care facilities. When the GDP increases, people have more incomes and therefore can afford to have quality health care hence, the crude death rate in this case has a negative association with other variables such as health expenditure.

Table 1: Pearson correlations coefficient

		Death rate, crude (per 1,000 people)	Mortality rate, infant (per 1,000 live births)	Mortality rate, under-5 (per 1,000)	Life expectancy at birth, total (years)	Urban population (% of total)	Gross enrolment ratio, tertiary, both sexes (%)	Health expenditure per capita (current US$)	logGDPmar
Death rate, crude (per 1,000 people)	Corr (r)	1	.991**	.995**	-.995**	-.999**	-.702**	-.735**	-.910**
Mortality rate, infant (per 1,000 live births)	Corr (r)	.991**	1	.999**	-.999**	-.996**	-.756**	-.872**	-.826**
Mortality rate, under-5 (per 1,000)	Corr. (r)	.995**	.999**	1	-.998**	-.998**	-.738**	-.866**	-.819**
Life expectancy at birth, total (years)	Corr. (r)	-.995**	-.999**	-.998**	1	.996**	.772**	.885**	.913**
Urban population (% of total)	Corr (r)	-.999**	-.996**	-.998**	.996**	1	.744**	.930**	.911**
Gross enrolment ratio, tertiary, both sexes (%)	Corr. (r)	-.702**	-.756**	-.738**	.772**	.744**	1	.984**	.831**
Health expenditure per capita (current US$)	Corr (r)	-.735**	-.872**	-.866**	.885**	.930**	.984**	1	.937**
logGDPmar	Corr (r).	-.910**	-.826**	-.819**	.913**	.911**	.831**	.937**	1

*. Correlation is significant at the 0.05 level (2-tailed).; **. Correlation is significant at the 0.01 level (2-tailed).; and ***. Correlation is significant at the 0.001 level (2-tailed).

The table1 represents the Pearson correlation coefficient matrix for various variables used in multiple regression analysis of the mortality transition in Saudi Arabia. Most of the independent variables in table 1 show collinearity. In the analysis mortality rate transition, several variables have been taken into consideration to determine their contribution to death rate and life expectancy; crude death rate, mortality rate for infants and under 5 year, life expectancy, urban population, gross enrollment ratio, health expenditure and Log GDP in market price. These are all economic and demographic factors that determine the quality of life and their variation and relationship with each other has effect on mortality transition. There is a significant positive correlation at 0.01 level (2-tailed) between infant mortality rate (per 1,000 live births) and crude death rate (per 1,000 people) (0.991**) since the increase in deaths at the young age contributes significantly to total deaths observed in a country. The mortality rate under 5 (per 1000 people) shows a linear relation with the mortality infant rate(per 1000 live birth) but a negative association with life expectancy (0.998**). Increase in deaths has a negative impact on the life expectancy. Death rate shows a negative correlation with other variables such as life expectancy (-0.995**), urban population (-0.999**) gross enrollment (-0.702**). Most of the other variables have an effect on each other either directly or indirectly therefore, they have a correlation. Table 1 shows the correlations between the various variable under study. Crude rate increases with increase in both mortality rates of infants and under age of 5. The relationship is 99% positive as opposed to the negative relationship between the death rate and life expectancy which is at -99.8%. This relationship shows that as one variable goes up so does the other and this happens when one variable goes down. These relationships when plotted in a graph in most cases gives a straight line of positive slope for the variables going up and a negative slope for the values going down. The negative sign indicates a negative slope which means as one variable goes up the other one goes down. For instance, the life expectancy of a population increases with the decrease in mortality rate. On the other hand log GDP at market price and Health expenditure per capita (current US$) shows a similar positive trend (0.937) and relationship as Gross enrolment ratio, tertiary, both sexes (%) and Health expenditure per capita (current US$) at 98.4%. this is similar for most of the other variable under consideration.

d. Descriptive Statistics of the Selected Variables

In order to carry out a successful multiple regression analysis, it is important to understand the number of cases to be taken into consideration. In this case, table 2: analysis will be based on 20 cases in which the various independent variables have been statistically analyzed and organized in such a way that the maximum and minimum expected values of each variable are determined. The average and standard deviation have a significant importance in decision making regarding the mortality rate in Saudi Arabia. The maximum and minimum give the range over which variable that can be analyzed while the mean average is important for general decision. The table below shows the statistical properties of the various variables.

Table 2: Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Death rate, crude (per 1,000 people)	55	3.392	20.319	8.38062	5.665619
Mortality rate, infant (per 1,000 live births)	44	12.5	110.3	40.705	29.2635
Mortality rate, under-5 (per 1,000)	44	14.5	161.0	54.218	43.5011
Life expectancy at birth, total (years)	55	45.66	74.33	64.19	9.50
Urban population (% of total)	55	31.25	82.93	66.79	16.39
Health expenditure per capita (current US$)	20	221.28	1147.44	525.16	278.92
Log (GDP at market price)	47	22.16	27.35	25.4723	1.30440
Gross enrolment ratio, tertiary, both sexes (%)	43	1.61	61.11	17.94	14.69
Valid N (listwise)	20				

e. Multiple Regression Analysis

i. Multiple Regression Analysis of Crude Death Rate

Table 3: Multiple Regression Analysis of Crude Death Rate

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	32.227	.518		62.161	.000
Life expectancy at birth, total (years)	-.457	.030	-1.709	-15.231	.000
Urban population (% of total)	.084	.035	.462	2.390	.031
Gross enrolment ratio, tertiary, both sexes (%)	.004	.001	.188	2.479	.027
Health expenditure per capita (current US$)	.000	.000	.376	4.222	.001
Log (GDP at market price)	-.089	.037	-.226	-2.391	.031

a. Dependent Variable: Death rate, crude (per 1,000 people)

b. $R^2 = .998$ Adjusted $R^2 = .997$ F=1365.81 ; df =(5,14) ; $p \leq .001$

Table 3 compares the relative importance of each of the standardized variables. The larger the value of beta, the stronger the effect of the independent variable to the dependent variable in a regression model. In this case, the life expectancy does not have any effect on the rate of death (beta =-1.709). The log GDP at market price has the weak relationship with the mortality rate. Other constants such as urban population, gross enrollment ratio, and health expenditure show some strong relationship under standardized conditions as compared to life expectancy and log GDP at market price.

ii. Multiple Regression Analysis of Child Mortality under Age 5

Table 4: Multiple Regression Analysis of Child Mortality under Age 5

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
(Constant)	389.840	3.493		111.593	.000
Life expectancy at birth, total (years)	-4.658	.202	-1.001	-23.057	.000
Urban population (% of total)	-.236	.237	-.075	-.998	.335
Gross enrolment ratio, tertiary, both sexes (%)	.046	.010	.139	4.744	.000
Health expenditure per capita (current US$)	.000	.001	.013	.369	.718
Log (GDP at market price)	-.440	.252	-.064	-1.748	.102

a. Dependent Variable: Mortality rate, under-5 (per 1,000)
R^2 = 1.00 Adjusted R^2 =1.000 F= 9144.33; df = (5,14); p ≤.001

Table 5: Multiple regression of child mortality under the age of 5 on selected variables, in Backwards Elimination

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	390.413	3.259		119.788	.000
Life expectancy at birth, total (years)	-4.854	.057	-1.043	-85.078	.000
Gross enrolment ratio, tertiary, both sexes (%)	.049	.004	.147	12.958	.000
Log (GDP at market price)	-.641	.092	-.093	-6.946	.000

a. Dependent Variable: Mortality rate, under-5 (per 1,000)
b. R^2 = 1.000 Adjusted R^2 = 1.000 F=16208.50; df = (3,16); p ≤ .001

In the analysis of the mortality rate under the age of 5, only three factors were considered as shown in table 5. Of the three variables only the gross enrollment ratio at tertiary, both sexes shows a strong effect on the mortality rate. The other two factors have no influence or significant contribution to the mortality rate at birth. The value of life expectancy (-3.043) shows that it depends on the values of child mortality.

iii. Multiple Regression of Infant Mortality

Table 6: Multiple regression of infant mortality on selected variables

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	310.983	2.530		122.930	.000
Life expectancy at birth, total (years)	-3.689	.146	-.978	-25.219	.000
Urban population (% of total)	-.176	.171	-.069	-1.029	.321
Gross enrolment ratio, tertiary, both sexes (%)	.035	.007	.128	4.889	.000
Health expenditure per capita (current US$)	1.564E-5	.000	.001	.042	.967
Log (GDP at market price)	-.414	.182	-.074	-2.271	.039

a. Dependent Variable: Mortality rate, infant (per 1,000 live births)

b. R^2=1.000 Adjusted R^2=1.000 F=11464.19; df = (5,14); $p \leq .001$

When more variable are considered in Table 6, only health expenditure (0.001) and gross enrollment (0.128) shows some relation with the variable under study. The economic status does not have great effect on the child mortality. All other factors show a negative relationship and effect ,therefore, do not provide the sufficient basis of comparison since at tender age, computation of the variable ignores the number of children and also it is not possible to continually update the values since births occur continually every minute. Therefore, log GDP at market price does not take into consideration of new birth and so does to death of the infants. Its relationship therefore with the mortality rate has no effect.

Table 7: Multiple regression of infants mortality on selected variables, in the backward elimination approach

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	311.567	2.362		131.892	.000
Life expectancy at birth, total (years)	-3.831	.041	-1.015	-92.634	.000
Gross enrolment ratio, tertiary, both sexes (%)	.034	.003	.128	12.536	.000
Log (GDP at market price)	-.584	.067	-.105	-8.724	.000

a. Dependent Variable: Mortality rate, infant (per 1,000 live births)

b. R^2=1.000 Adjusted R^2= 1.000 F=20283.80; df = (5,14); $p \leq .0001$

In table 7, life expectancy at birth, (total years) has a negative value (1.015) and life expectancy calculation are based on the values of birth obtained within a specified period. Therefore, according to the backward elimination approach, it does not meet the criteria to prove it effect on the life expectancy at birth. Secondly, the log GDP at market price cannot be able to account for every child born every minute and to keep the record up to date in a country with a large productive population is not possible. Generally, the gross enrollment (0.128) ratio stands out to be one of the important factors that has effect on the child mortality since it shows a positive relation in relation to the variables under consideration.

CONCLUSION

In conclusion, the death rate in Saudi Arabia has shown a rapid decline. The factors contributed to the decline appears to be due to increase education, economic development, and health services as observed. Over years, Saudi Arabia population has been increasing and lifestyles have been changing through improved education. Therefore, things have been changing over time and impacting a number of factors that have significantly contributed to demographic transition. People through interaction, improvement all with help of technology people are able to access quality healthcare abroad while conducting researches on how to solve most of the problems that have been contributing negatively to a child survival.

Population plays an important role in the growth and development of the economy of the country. The purpose of this study is to find out the trends and determinants of mortality in Saudi Arabia such as crude death rates, child mortality rate under age 5, infant mortality, neonatal and maternal mortality. The factors that have been used in order to assess their influence on mortality rates are Gross Domestic Product (GDP) at market price, Health Expenditure, Per Capita, Literacy Rate (data used on Gross Enrollment Ratio at Tertiary level), Urban Population Percentage, Life expectancy, and Population Total.

The World Bank Database was the source of data used for the analysis. Various statistical methods have been used for analyzing the data in order to find out the strength of the variables in influencing mortality rate. These methods are: Pearson correlation coefficient, scatter diagram, multiple linear regression, and polynomial models. Each of the components of mortality has shown a sharp decline during the last four decades. The rates of these in most the recent year 2015 are: CDR was 3.4 per 1000, CMR under age 5 was 14.5 per 1000, IMR was 12.5 per 1000, NMR was 7.9 per 1000 and MMR was 12 per 100,000. Although the rates have shown a sharp decline, there is a notable gender difference in each of the rates. The male rates are higher than the rates of the female. The results of bivariate analysis demonstrate a significant inverse relationship of crude death rate, child mortality rate and infant mortality with each of the factors included. In multiple regression analysis of crude death rate, each of the selected factors was found to have similar significant relation with crude death rate; however, only three factors (GDP), education ratio and life expectancy have shown a significant relationship with child mortality and infant mortality.

Future Research

This study was based on the rates of aggregate data. It does not have any information on cause-specific mortality, and the causes that have the significant impact on deaths. In order to provide or adopt effective service program to reduce unusual deaths, it is important to carry out a study based on individual level data which provides causes of deaths and factors contributing to that.

Policy Recommendation

Based on the study and existing literature, the government may consider adoption or implementation of the following proposed issue.

1) Primary Health Care services should be made available in the rural areas and the areas where it is not available so that people can have access to primary health services.

2) In order to adopt a service program to reduce deaths by certain causes, it is important to have a program which will maintain information of cause specific deaths based on which preventive curative program should be introduced

3) More programs to encourage healthy life style could be imported and encouraged by the government of Saudi Arabia.

4) Since women's health and well-being affect child care, child mortality, infant mortality, and neonatal mortality, it will be helpful if women especially of child bearing age, encouraged to have more education and to have less sedentary life style.

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