UNIVERSITY OF NAIROBI

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ANALYSIS OF INFANT AND CHILD MORTALITY RATES IN KENYA MULTIPLE DECREMENT THEORY MODEL

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DECLARATION

This is my own work and has not been presented for a degree in any other university

Signed Dated

16th NOV 2012

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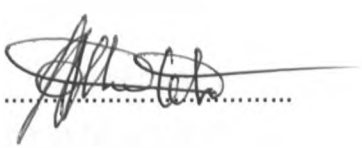
This project has been submitted for examination with my approval as a University supervisor

Signed Dated



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MBIRA ANTHONEY

AUGUST, 2012

TO

MY MUM Mrs. MBIRAH AGNES,

DAD Dr. PETER MBIRAH

AND MY LOVING SON ALVIN MBIRAH.

Contents

Lists of Tables

Lists of Figures

Lists of Abbreviations

AIDS: Acquired Immune Deficiency Syndrome.

ANC: Antenatal Care.

AOP: Annual Operational Plan.

CBS: Central Bureau of Statistic.

DOMC: Division of Malaria Control.

HIV: Human Immune deficiency Virus.

IMR: Infant Mortality Rate.

ITN: Insecticide Treated Nets.

KDHS: Kenya Demographic and Health Survey.

KEPI: Kenya Expanded Programme on Immunization.

KIHBS: Kenya Integrated Household Budget Survey

KNBS: Kenya National Bureau of Statistics

KNMS: Kenyan National Malaria Strategy.

MDG's: Millennium Development Goals.

MMR: Maternal Mortality Rate.

MOH: Ministry Of Health.

NFP: Natural Family Planning.

NHSSP: National Health Sector Strategic Plan.

OM: Ovulation Method.

U-5MR: Under-five Mortality Rate.

WHO: World Health Organization.

DEFINITIONS

Attrition Factor / Decrement: Are events experienced by individuals of the cohort that make them no longer eligible to be members of the cohort.

Child mortality: Death at age one year to four years or under five mortality.

Cohort / Radix: A group of individuals to whom a certain event occurred at the same period of time.

Entomology: study of insects

Gynecologist: A surgical-medical specialist dealing with female reproductive organs in their non-pregnant state

Infant mortality: Death at age zero to eleven months, also include deaths at age zero.

Live birth: When the newborn after expulsion / extraction from the mother shows evidence of life whether or not the umbilical cord has been cut.

Neonatal mortality: Death at the age 0-30 days, also include death at the age zero.

Obstetrician: A surgical-medical specialist dealing with female reproductive organs in their pregnant state.

Post neonatal mortality: Death at age 1 month to 11 months, also include deaths at 31 to 59 days.

Chapter 1

GENERAL INTRODUCTION

Multiple decrement theory has been employed by a broad range of users for diverse purposes. Insurance companies, actuaries, demographers, obstetricians and gynecologists, entomologists, nutritionists and others have used multiple decrement theory for their particular purpose. These include evaluation of several causes of decrement in the cohort, probabilities of the decrements and the force of individual and combined decrement in the cohorts.

In infant and child mortality, the model has been widely used to evaluate the probability of individual and combined decrement factors. Also they are used to determine the force of individual decrement in the infant and child cohort. They are widely used in the prediction of the life expectancy of a country, effectiveness of government policies regarding mortality rates and efficiency and effectiveness of the medical services. They are also used as an indicator of a country's wellbeing, as it reflect social, economic and environmental condition in which children and other in the society live. Multiple decrement theory has been proposed as the method to be used to compare and evaluate infant and child mortality for the duration of interest, 2000 to 2011. It is therefore important to understand the nature of mortality rate and some of the issues that impact on it.

1.1 Definition of multiple decrement theory

The multiple decrement theory summarizes the life experience of a cohort in which membership can be terminated by two or more attrition factors. Multiple decrement theory is an extension of standard mortality models whereby there is simultaneously operation of several causes of decrement. The summary is in tables called multiple decrement life tables.

Multiple decrement life tables are widely used in human actuarial literature and provide statistical expression for mortality in three different forms:

- ✓ The life table from all causes of death combined.
- ✓ The life table disaggregated into selected causes of death categories.
- ✓ The life table with particular causes and combinations of causes eliminated.

The conventional life table shows the probability of survivorship of an individual subject to one undifferentiated hazard of death. It considers a radix subject to several independent causes of decrement over time. The assumptions of multiple decrement life table is that multiple causes of death act independently and is concerned with the probability that an individual will die of a certain cause in the presence of other causes. In general, multiple decrement theory is concerned with three basic questions (Elandt-Johnson and Johnson, 1980):

- ❖ What is the age distribution of deaths from different causes acting simultaneously in a given population?
- ❖ What is the probability that a newborn individual dies after a given age or stage from a specified cause?
- ❖ How might the mortality pattern or life expectation change if certain causes were eliminated?

The first two questions are concerned with evaluating patterns and rates of mortality while the last is concerned with what is termed as competing risk analysis. The analysis of the two cases are based on three assumptions (Vaupel and Yashin, 1985),

- Each death is due to a single decrement cause.
- Each individual in a population has exactly the same probability of dying from any of the causes operating on the population.
- Probability of dying from any given cause is independent from the probability of dying from any other source.

1.2 Users and fields of application for Multiple decrement theory

Multiple decrement theory has various users from diverse application fields. Some of the users include; Insurance companies, actuaries, demographers, obstetricians and gynecologists, entomologists, nutritionists.

Insurance companies use multiple decrement theory to price insurance products, and ensure the solvency of insurance companies through adequate reserves. Projections are developed of future insured events using decrement model of rates and timing of the event. They are also used in in life insurance since financial calculations are combined with mathematical modeling of mortality.

Actuaries use multiple decrement tables for computation of rates and force of mortality in a given population. The computation facilitates extraction and generation of underlying trends of the rates and force of mortality for the period of interest.

Demographers have applied multiple decrement theory technique in the analysis of cohorts in which there are two or more forms of exit from the initial cohort; one of which is mortality and the other is change in social or economic status. Complex tables allowing successive transition among living states, and hence increments into subsequently occupied states or re-entries into a previously occupied states have been developed.

Obstetricians and gynecologists have used the model for clinical trials of the ovulation methods (OM) of natural family planning (NFP) delineated failure rates for both perfect and imperfect use during teaching phase, the effectiveness phase, and the actual 1st year of use, and offered computed failure rates for various types of use errors.

In entomology research, understanding how and why insects' numbers fluctuate through time and space has been a central theme for more than a century. Multiple decrement theory has been used to understand temporal and spatial patterns in insects' numbers.

Water is a macro nutrient that is under appreciated. It has been extremely difficult to establish a specific level of water intake that ensures adequate hydration and promotes optimal healthy under all potential conditions and population. Multiple decrement theory has been used by nutritionists to examine the

relationship between hydration state and optimal wellness along with diseases relationship. This has led to the belief that there is a relationship between hydration and diseases.

1.3 Actuarial consideration

Multiple decrement theory embraces most of the major concept and techniques currently used in mortality analysis. These include convectional life table, Abbott's Correction and Key Factor Analysis. Independent variable for each is time, age, stage or dose. All techniques either explicitly or implicitly rely on the assumption of competing risks. Also the techniques are based on the actuarial assumption of independence among the competing risks.

1.4 Background information

In 2000, 193 United Nations member states and 23 international organizations agreed to achieve the Millennium Development Goals (MDGs) by the year 2015. The MDGs originated from the Millennium Declaration produced by the United Nations. The Declaration asserts that every individual has the right to dignity, freedom, equality, a basic standard of living that includes freedom from hunger and violence, and encourages tolerance and solidarity. The MDGs were made to operationalize these ideas by setting targets and indicators for poverty reduction in order to achieve the rights set forth in the Declaration on a set fifteen-year timeline.

The MDGs were developed out of the eight chapters of the Millennium Declaration, signed in September 2000. There are eight goals with 21 targets, and a series of measurable indicators for each target. The eight goals are

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health

- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

The Millennium Development Goal on child mortality aims at reduction of under-five mortality rate by two thirds between 1990 and 2015. The indicators outlined for monitoring progress in MDG 4 are: Under five mortality rate, Infant mortality rate and Proportion of 1 year-old children immunized against measles

To accelerate the achievement of MDG 4, the Government launched a Child Survival and development Strategy that is hosted in 2009 as an effort to accelerate child survival and provide a framework to improve indicators for children. The strategy is guided by the National Health Sector Strategic Plan II (NHSSP II) and the Vision 2030 Medium Term Plan that aim to reduce inequalities in the health care services and improve on the child health indicators.

In addition, the Ministry of Public and Sanitation has prioritized malaria control through the National Health Sector Strategic Plan (NHSSPII) and mandated the Division of Malaria Control (DOMC) to coordinate the implementation of the National Malaria Strategy. In collaboration with partners, the government has also developed the 8-year Kenyan National Malaria Strategy (KNMS) 2009-2017 which was launched on 4th November 2009.

The Malezi Bora Strategy initiated in 2007 has provided a comprehensive package of services that includes child immunization, Vitamin A supplementation, deworming of under-fives and pregnant women, treatment of childhood illnesses, HIV Counseling & Testing, ITNs use in Malaria prevention and improved ANC Services. Malezi Bora provides an opportunity to provide children with a comprehensive and integrated package of services.

Other Government efforts towards reduction in child mortality and in line with attainment of the MDG target are Integrated Management of Childhood Illnesses which includes immunization, one of the most effective primary health interventions in reducing child mortality. Under this, the Ministry of Health continues to strengthen immunization

activities throughout the country under the Kenya Expanded Programme on Immunization (KEPI) as well as management of childhood illnesses.

The under-five mortality rate has shown impressive decline over the period under review. The KDHS 2008/2009 shows a remarkable decline in levels of childhood mortality compared to the rates observed in the 2003 KDHS. For example, the infant mortality rate decreased to 52 deaths per 1,000 live births in 2008-09 from 77 in 2003. Similarly, the under-five mortality rate decreased to 74 deaths per 1,000 live births in 2008-09 from 115 in 2003. The decrease in infant mortality between 2003 and 2008 can be associated with increased campaigns against five diseases, namely, acute respiratory infections, diarrhea, measles, malaria and malnutrition.

In Kenya, like other sub-saharan countries, infant and child mortality rates remain high despite action plans and interventions made to reduce the rates. Kenya lags behind other developing countries such as South Africa, Malaysia and Indonesia in basic health indicators, which includes infant mortality, under-five mortality and maternal mortality. Although accurate information on causes of death is lacking, leading causes of under-five mortality in Kenya is pneumonia, malaria, measles and diarrhea diseases, which are estimated to have been responsible for 60% of disease burden in the region (Murray and Lopez, 1996). The major causes of IMR and U5MR may be classified into three categories, infectious diseases, malnutrition and dietary related illness and birth trauma related effects.

YEAR	IMR per 1000 live births	U5MR per 1000 live births
1948	184	N/A
1962	126	219
1969	119	190
1979	104	157
1989	59	113
1993	62	93
1998	71	105
2000	73	116
2003	77	115
2006*	60	92
.CBS, KHDS		
*KNBS: KIHBS-2005/2006		

Table 1.1 Trends in Infant and Child mortality

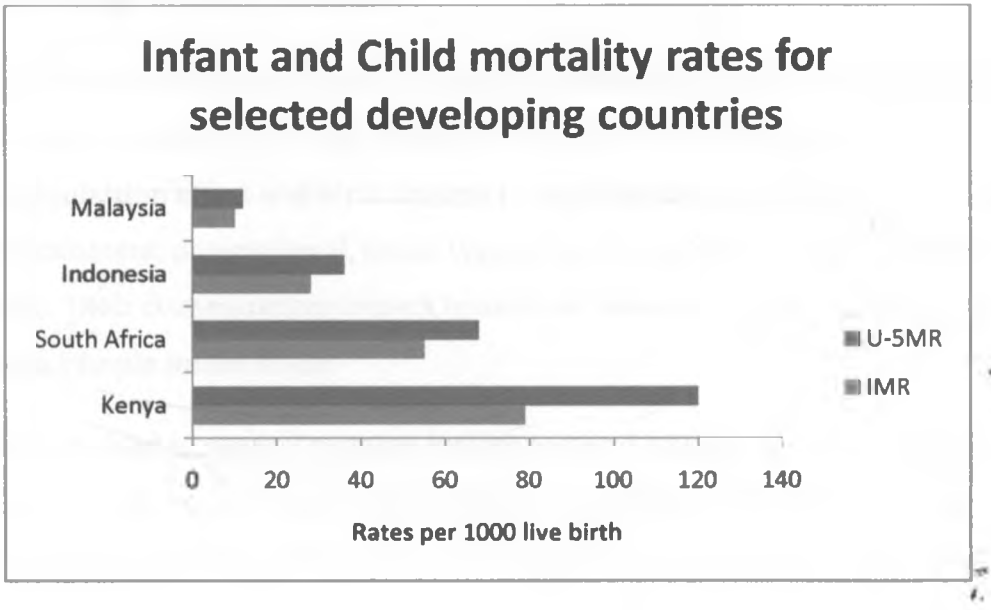

Figure 1.2 Infant and Child mortality rates for selected developing countries.

The Kenyan government plan to have reduced maternal mortality to 147 per 1000 live births, infant mortality to 25 per 1000 live births and under-5 mortality to 33 per 1000 live births by the year 2012.

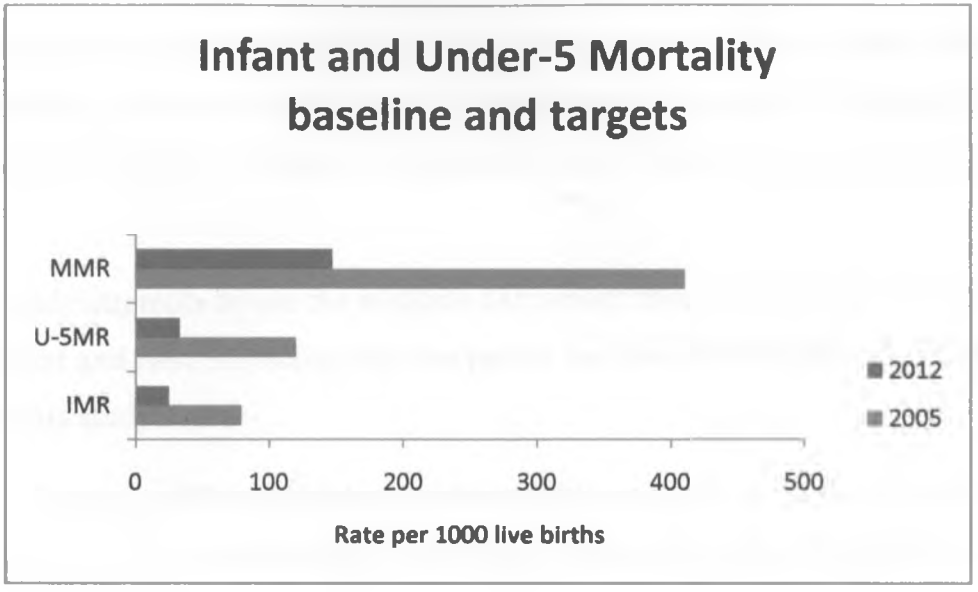

Figure 1.3 Infant and Child Mortality baseline rates and target rates.

1.5 Statement of the problem

The multiple decrement theory is used to evaluate forces and rates of several decrement factors on the subject population or sample. The prevalence of infectious diseases, malnutrition effect and birth trauma is significantly influenced by the mothers education attainment, occupational, union type, area of residence, religion, age and sex of the new born. Their consequences impact heavily on infant and child mortality rates of the population or sample under study.

The study lead to several testable hypothesis and emphasize that it is not possible to estimate the effect of any mortality factor without considering its interaction with competing mortality factors, which has far reaching consequences for the population under study.

1.6 Objectives of the study

There are many users of multiple decrement theory with different purpose for their use. Majority of the users, use the multiple decrement theory as a part of some overall larger objectives. Multiple decrement theory has been proposed as the method to compare and evaluate rates of infant and child mortality for the period between 2000 and 2011. When used and interpreted correctly, it represents a valid method to evaluate the rate of mortality.

This study attempts to use the multiple decrement theory to evaluate the changes in the rate of infant and child mortality over the period between 2000 and 2011. The specific objectives of this study are to:-

1. Come up with a multiple decrement table on the mode of decrement.
2. Find out the independent decrement rates associated with each mode of decrement.
3. Evaluate the strides gained by the government in realization of millennium development goal on child mortality reduction.
4. Evaluate the government gains on realization of vision 2030 goal of social pillar.

1.7 Significance of the study

Since multiple decrement theory is broadly used by various players in their different fields, it is important that the data used satisfy the requirement for the theory. Irrespective of the diverse uses of the theory, the focal point of all users is identical. The principle use is to evaluate the effect of individual decrement factor on the population or the sample under study. This study will evaluate the rates of infant and child mortality with an aim to establish whether the government is on the right track to achieve the target rates at the end of year 2012.

Chapter 2

LITERATURE REVIEW

Infant mortality refers to the death of a child born alive before its first birthday. Child mortality is the death of a child aged between one and five years. Mortality is a major component of the population changer. Infant and child mortality are the best indicators of social economics development because a society's life expectancy at birth is determined by the survival chances of infants and children. Even though infant mortality and child mortality have declined in the region since 1960's they are still unquestionably high and have for various reasons stagnated in their decline. In the Kenya vision 2030, the issue is addressed under the social pillar one of the three major pillars in it. The aim is to restructure the health delivery system and also shift the emphasis to "promotive" care in order to lower the nationals' disease burden.

Kenya high infant and under five mortality rates could be attributed to, HIV/AIDS pandemic, poverty and decline in economic well-being. The main causes can be classified into three major categories, infections, protein-calorie malnutrition and birth trauma (Page and Coale, 1972; Newman, 1979; Newland,1982). Most causes are preventable.

- ✓ Infections include neonatal tetanus, diarrhea, respiratory infections, measles, malaria and HIV/AIDS (Page and Coale, 1972).
- ✓ Protein calorie malnutrition is a major secondary and underlying cause of death, it comes into play when the child are weaned and given solid foods (Newman, 1979).
- ✓ Birth trauma are dominated by the factors related to the birth process, they include low birth weight, poor sanitation and water supply, poverty, lack of education and information and inadequate health care (Mott,1982).

In developing countries children suffers from more than one disease at a time. There appear to be a synergism of infection whereby children tend to suffer several diseases at the same time on top of protein calorie malnutrition.

In Kenya it has been found that respiratory infections, especially pneumonia, are the main cause of death among infants and children (Ewbank et. al., 1986). Rotavirus has been isolated in at least 30% of young children admitted to the pediatric ward of Kenyatta National Hospital for acute diarrhea (Leeuwenburg et al., 1984). In the Machakos longitudinal study in Kenya, it has been found that diarrhea plays a role in the measles syndrome. Diarrhea has been found to be a concomitant symptom in 50% of the measles cases (Leeuwenburg et al., 1984).

This is supported by the fact that in Kenya, respiratory death among children is frequently associated with malnutrition and with other infectious diseases (Newland, 1982) (Ewbank et al, 1986). Mondot-Bernard (1977) found that in this part of the world, children suffer from kwashiorkor between 18 months and 3 years, the time which they are weaned and given more solid food.

Neonatal deaths tend to be dominated by factors related to the birth process or congenital phenomena, but as the child grows older, exogenous factors take over and play a bigger role. Conditions which exacerbate the above causes of death include low birth weight, poor sanitation and water supply, poverty, inadequate food supplies, lack of education and information and inadequate health care (Newland, 1982).

Children in developing countries, usually suffer from more than one disease at a time. There appears to be a synergism of infection whereby children tend to suffer from several diseases at the same time on top of protein-calorie malnutrition.

There are considerable variations in the levels of infant and child mortality according to mothers education attainment, religion, union type, age and sex, mothers parity, rural urban factor and occupational.

a) Mother's education background

It has been found that maternal education is the single most significant determinant of infant and child differential. Increasing educational attainment of the mother has been associated with declines in the infant and child mortality (Mott, 1982).

Reason for this inverse association includes breaks with traditional methods of, and attitudes to, child care and the resort to medical alternatives, better nutritional use of available foods, intensive care and a greater share of the family resources spent on the child (Mott, 1982). Mwaniki (1983) citied in Ewbank et al (1986; 49) found that according to the Kenya Fertility Survey data for both parents, one to three years of education is not significant to affect infant and child mortality significantly.

Maina-Ahlberg (1979) citied in Ewbank et al, (1986;49) has found that in Kenya, education has little effect on the likelihood that a child with measles or acute diarrhea will be treated using modern medicine. In other words, education does not rule out the fact that parents may resort to traditional medicine to cure the child's measles or diarrhea. The finding pointed to the factor that little education viz, three years or less is not enough to positively affect infant and child mortality.

b) Religion

Muslim women usually experience higher infant and child mortality than Christian women. However, religion per se does not greatly affect infant and child mortality but lower levels of infant and child mortality maybe a reflection of the fact that Christian group may contain more educated mothers than the group consisting of traditional or other worshippers (Gaisie, 1979; 457).

c) Union type

Polygamy in some instances has been found to be associated with above average levels of infant and child mortality. Mott (1982) doubts the strength of this association and says his issue should be looked at in a multivariate context. Argues that infant and children in polygamous union may receive less attention than those in monogamous. He adds that polygamous marriage are associated with more traditional child bearing practices because the woman may, on the average have less education than their counterpart in monogamous marriage. In the final analysis, he concedes that it's clear for uncertain reasons that there are significant differentials in infant and child mortality between women in different type of marriage, even after controlling for educational differences.

d) Age & sex

It has been found that child mortality is higher than child mortality (Adegbola, 1985). This is clearly a pointer to the environmental hazards to the accompanying diseases. It has also cost some doubt on the efficiency of infant mortality as an indicator of community health standards since child mortality tend to be higher. This seems to suggest that mortality maybe a better indicator of the level of wellbeing of a society.

It has also been found that there are significantly higher numbers of infant death among male than female (Anker & Knowles, 1977; Page, 1971). Among the reason given are those by Mott (1982: 15) who explain that ".....physiological differences in the capability of male and female infants to survive early infancy largely account for this pattern. Boys have higher risk of birth injury, breathing difficulties and jaundice." He however, explains further that for cultural reasons, female neonatal deaths are likely to be underreported than male deaths.

On the other hand, male child mortality appears to be lower than female child mortality. Seetharam and Mekki (1970) explain that excess female child mortality may be a reflection of the preference of male children over female children.

e) Mother's parity / Child spacing & mother's age at birth

High infant and child mortality is usually accompanied by a high birth rate (Monsted and Walji, 1978). This is because when an infant dies, there is a discontinuation of breastfeeding (leading to the early return to ovulation) and the parents would like to replace the deceased child by another – 'replacement effect' (Lucas and Macdonald, 1980: 141; Mondot-Bernald, 1977). Alternatively, some parents gives birth to as many children as they can so that in case some dies, a sizeable number remains – 'insurance effect' (Lucas and McDonald, 1980: 141-2). A high birth rate results in closely spaced birth which seems to lead to higher levels of infant and child mortality.

The occurrence of second birth which the first child is still being breastfeed may lead to abrupt weaning and higher child mortality and that is why mortality tends to rise at age of six months and remain high throughout most of the second and third years of life

(Gaisie, 1979). Frequent births create a strain on the woman's health and this, coupled with poor nutritional conditions, is bound to have an impact on the child's health too (Monsted and Walji, 1978).

High parity is also exacerbated if the births are spaced close together. Births of parity one and high parity births are associated with above average deaths (Cadwell, 1979). The mother's age at birth also impinges on her health and that of her child. According to Chen (1983: 208), evidence shows that child bearing at very young (under 17) and very old (over 35) ages jeopardizes the infant's and the mother's survival chances.

f) Rural urban & region factor

Mortality differential exist between regions such as drought stricken areas, monoculture crop areas, rich and poor region and rural and urban areas. High mortality is estimated for high density population near the lake and at the coast, while districts north of Nairobi have very low levels (Ewbank, 1986).

Cities and town tend to have low mortality than rural areas (Gaisie, 1979). Although there is enough evidence to support this inverse association, the rural-urban differential does not reflect rural to urban residence per se but other factors like education, marital status and family size which is associated with it (Mott, 1982). Olusola (1985) the reason that Africans living in rural areas are less educated than their counterparts and that the distribution of amenities is lopsided in favor of the urban areas.

g) Occupation

Farmer's children have been found to have higher incidence of diarrhea and thus high mortality than children of people in other occupations.

Infectious diseases, malnutrition and trauma seem to be the major causes of death for infant and children under five years. The study adopts the multiple decrement models considering the whole population in Kenya in the study.

The next chapter outlines the model used in the study, introducing the multiple decrement theory and study the theory in details giving the parameter and the processes

involved. Chapter 4 gives the data analysis and results generated from the study. Chapter 5 gives a summary of what has been done and concluded based on the results of this study.

Chapter 3

METHODOLOGY

3.1 Introduction

In this chapter we look at the model used in the study in details. Multiple decrement theory model is primarily used to study the rates and forces of independent decrement modes and combined effect of several decrement modes. The decrement modes act on the model population as it advances from age to age. The effect on the model population involves both individual modes effect and combined modes effect. The multiple decrement theory model is introduced in the next section.

3.2General Multiple Decrement Theory Model Notation

The multiple decrement theory model, at times referred to as multiple decrement life table, is widely used in scientific research to understand or derive the time trend in the model population. It allow analyst to investigate time, as well as spatial and temporal patterns. Compared to the single decrement life tables, the multiple decrement theory model offer researchers several benefits:-

1) by following individual decrement factor, researcher can study the dynamics relations of individual decrement mode.
2) the model allow complex tables involving successive transition among living state and hence increment into subsequently occupied states or re-entry into previously occupied states.

Conventional notation functions used in the multiple decrement theory model table correspond to the single decrement case except:

a) The prefix "a" is added to denote 'in presence of all causes'.
b) The symbol "x" is used to denote the stage index rather than the age interval.

al_xrepresent the surviving population present at exact age x.

al_x^krepresent the dependent decrement rate due to mode k.

ad_x^krepresent lives exiting between age x and x+1 due to mode k.

am_x^krepresent the dependent central rate of decrement due to mode k at age x.

$a\mu_x^k$represent force of decrement by mode k in the tables at age x.

The total number of exits by all modes between ages x and x+1 is

$ad_x = \sum_{k=1}^{m} ad_x^k = al_x - al_{x+1}$ ..... (a)

Consider a life table, showing decrement of the population due to various decrement factors over the course of their lifetime or period of interest. The population is subject to several decrement factors

The probability of survival of a life aged x years will survive the next one year is

$$ap_x = \frac{al_{x+1}}{al_x} \text{ ..... (b)}$$

The probability that a life aged x years will withdraw due to the decrement factor ad_x^{d1} in the next one year is

$$aq_x^{d1} = \frac{ad_x^{d1}}{al_x} \text{ ..... (c)}$$

The probabilities of decrement involve an interval of time during which all the causes of decrement are operative, so that the number of decrement due to any cause will not be independent of the size of the other decrement.

The force of decrement in a multiple decrement table is defined as

$a\mu_x = -\frac{1}{al_x}\frac{d_{al_x}}{dx} = {}^{d}/_{dx}\text{-log}_e\, al_x$..... (d)

Using uniform distribution of death, the force of mortality can be approximated if the number of exits by mode d_1 is uniform over (x-1, x+1).

$al_{x+t}a\mu_{x+t}^{d1}$ = constant $\forall -1 \leq t \leq 1$

$$= al_x a\mu_x^{d1} \text{ ..... (e)}$$

Therefore,

$ad_{x-1}^{d1}+ad_x^{d1}= 2*al_x a\mu_x^{d1}$

Giving the force of mortality as

$$a\mu_x^{d1} = \frac{ad_{x-1}^{d1}+ad_x^{d1}}{2al_x} \quad \text{..... (f)}$$

In order to evaluate am_x^{d1} from the multiple decrement tables (MDT), it is often assumed that the total decrement is uniformly distributed over the year i.e.

$al_{x+1} = al_x - t * ad_x \quad 0 \leq t \leq 1.$

$$al_x = \int_0^1 \{al_x - t * ad_x\}dt$$

$$= al_x - {}^1/_2\, al_x \quad \text{..... (g)}$$

Thus,

$$am_x^{d1} = \frac{ad_x^{d1}}{al_x} = \frac{ad_x^{d1}}{al_x - 0.5al_x} = \frac{aq_x^{d1}}{1-0.5aq} \quad \text{..... (h)}$$

Determining aq_x^{d1} using the values of am_x^{d1} using the same assumptions on distribution of decrements gives

$$aq_x^{d1} = \frac{ad_x^{d1}}{al_x} \cong \frac{am_x^{d1} * aL_x}{aL_x + {}^1/_2 ad_x} \cong \frac{am_x^{d1}}{1+{}^1/_2 am_x} \quad \text{..... (i)}$$

The various formulae are combined to produce the multiple decrement theory model table. The table includes the forces for the various decrement mode and their probabilities, which are in turn used to generate the trend for the modes.

3.3 The Study Model General Framework

In the analysis of causes of death, the force of the mortality function from different causes is additive because disentangling precisely the effects of other causes of death is difficult, particularly in settings where precise measurement is not possible. Thus, the sum of the different causes is equal to all causes combined as represented in equation (1) thus:

$$\mu(x) = \sum_{i=1}^{I} \mu_i (x) \quad \text{..... (1)}$$

Where $\mu(x)$ is the force of mortality from all causes combined and parameters $\mu_i(x)$ refer to the death rate for the i^{th} cause of death. This implies that the rates of decrements are also additive:

$$_n m_x = \sum_{i=1}^{i} {}_n m_{xi} \quad \text{..... (2)}$$

Where $_n m_x$ is the rate of decrement from all causes and $_n m_{xi}$ in this case is the rate of decrement from the i^{th} decrement mode. In light of the basic relationship between mortality rates ($_n m_x$) and the probability of dying ($_n q_x$) as shown in the conventional life table, the transformation of the rates to probabilities of dying is shown in the following equation as:

$$_n q_x = \frac{n \cdot {}_n m_x}{1+(n - {}_n a_x)\, {}_n m_x} \quad \text{..... (3)}$$

Where $_n a_x$ is defined as the average number of person-years lived in the interval x to $x+n$ by those who died in the interval. This relationship extends to multiple-decrement processes as follows:

$$_n q_{xi} = \frac{n \cdot {}_n m_{xi}}{1+(n - {}_n a_x)(m_{xi} + {}_n m_{x,-i})} \quad \text{..... (4)}$$

Where $_n m_{xi}$ and $_n m_{x,-i}$ represent decrement rates from i^{th} decrement factor and all other causes other than i^{th} decrement factor combined, respectively. Data concerning the causes of death by age and the corresponding number of person-years by the same subcategories define the probabilities of dying at each age ($_n q_x$), by cause of death. Unfortunately, obtaining the $_n a_x$ values is often difficult. We employed different techniques to estimate the $_n a_x$ values. We assumed, first, that those who died in the interval on average lived halfway through the interval. On the basis of this assumption, we adopted an initial value of 2.5 for all age groups with an interval of five years. For the younger than one-year and one-to-four-year age groups, we adopted the procedure suggested by Coale and Demeny (1983).

Using the $_n a_x$ values of 2.5 in the $_n m_x$ to $_n q_x$ conversion formula, we first estimate $_n q_x$ values and use these to obtain $_n d_x$ (the number of deaths between age x and $x+n$) in a life table. These $_n d_x$ estimates are plugged into the iteration formula below to obtain new sets of

${}_na_x$ values. These values are subsequently reintroduced into the ${}_nm_x$_${}_nq_x$ conversion formula to re-estimate new ${}_nd_x$ values, which are reintroduced in the iteration formula to obtain a new set of ${}_na_x$ values. This process is repeated until stable estimates of ${}_na_x$ are achieved (Preston et al. 2001). The iteration equation used is specified as follows:

$${}_na_x = \frac{-\frac{n}{24}\,{}_nd_{x-n} + \frac{n}{2}\,{}_nd_x + \frac{n}{24}d_{x+n}}{{}_nd_x} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

The stable ${}_na_x$ values then are used to generate a life table through the basic ${}_nm_x$_${}_nq_x$ conversion formula. With the overall life table generated, we can estimate the probability of dying from i^{th} decrement mode (${}_nq_x^i$), by applying the proportion of deaths that are due to i^{th}decrement mode to the overall probabilities of dying for each age, ${}_nq_x$, as follows:

$${}_nq_{xi} = {}_nq_x \cdot \frac{{}_nD_{xi}}{{}_nD_x} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where ${}_nq_{xi}$ and ${}_nD_{xi}$ represent the probability of dying from i^{th} decrement mode and the observed number of deaths from i^{th}decrement mode, respectively. The above relationship is based on the assumption that the observed death rates for i^{th} decrement mode (${}_nM_{xi}$) are equal to the life-table death rates for i^{th} decrement mode (${}_nm_{xi}$), that is, ${}_nM_{xi}$ = ${}_nm_{xi}$.

Estimating the contribution of mortality from i^{th} decrement mode to overall mortality also permits us to estimate the effect of completely eliminating i^{th} decrement mode through "causedeleted" life-table analysis (Chiang 1968). If i^{th} decrement mode were eliminated as a cause of death, survival at age interval x to $x+n$, will be represented as

$${}_np_{x,-i} = {}_np_x^{\left\{\frac{{}_nD_{xi}}{{}_nD_x}\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

The approach described above assumes that the force of mortality function from each cause is proportional to all causes combined in the interval x to $x+n$ and constant throughout the interval (Keyfitz 1985; Preston et al. 2001). The ${}_na_x$ values for the associated single -decrement life table were obtained using the following formula for all age groups except the first two and the last:

$${}_na_{x,-i} = n + R^i \frac{{}_nq_x}{{}_nq_{x,-i}}({}_na_x - n) \quad \ldots\ldots\ldots\ldots \quad (8)$$

where ${}_na_{x,-i}$ refers to the average number of person-years lived by those dying in the interval from all causes other than i^{th} decrement mode, and R^i represents the proportion of

deaths due to i^{th} decrement mode. For the other age groups, the iteration procedure used for estimating the ${}_na_x$ values in the parent life table is used.

3.4 The Model Target Rates Computation

The target rates are infant mortality to 25 per 1000 live births and child mortality to 33 per 1000 live births by the year 2012. The fraction dying in the interval, designated (aq_x), $(k_x - D_X)/k_x$ is the fraction of a cohort that survives from x to $x + 1$.

aq_x=1.0 - $[(k_x - D_x)/k_x]$

For infant mortality,

aq_x=1.0 - $[(k_x - D_x)/k_x]$

$$aq_1 = 1\text{-}[(1000 - 25)]/1000$$

$$=0.025$$

For child mortality

$$aq_2 = 1 - [(975 - 33)/975]$$

$$=0.0338$$

The main multiple decrement table uses the aq_{ix} values to determine schedules for the fraction of the starting cohort dying in stage x due to cause $i(\mathrm{ad}_{i,x})$, the total fraction dying in stage x due to all causes (ad_x) and the fraction of newborn surviving to stage x (al_x). They are computed as follows

*Step 1.*Compute survival to stage x subject to all causes. I set al_1=1.0 and compute progressively

$$al_{x+1} = al_x(1 - aq_x)$$

For child mortality,

$$al_2 = al_1(1 - aq_1)$$

$$= 1.0\ (1 - 0.025)$$

$$=0.975$$

$$al_3 = 0.975(1 - 0.0338)$$

$$=0.942$$

*Step 2.*Compute the fraction of newborn dying in stage x due to all causes. This is computed as

$$ad_x = al_x - al_{x+1}$$

For child mortality,

$$ad_2 = al_1 - al_2$$
$$=0.975 - 0.942$$
$$= 0.033$$

Step 3. Compute the fraction of newborn dying in stage x due to cause i. This is computed using

$$ad_{i,x} = al_x(aq_{i,x})$$

Values for the various relationships are given in Tables 8.1.1 to 8.2.3 this table reveals relations that were not evident from tables 7.1.1 to 7.2.3. The probabilities involve an interval of time during which all the causes of decrement due to any cause will be independent of the size of the other decrement. On the other hand, force of each decrement is not based on a time interval and is not affected by any variation in the other decrement.

Chapter 4

DATA ANALYSIS

In Kenya, the population is divided into nine major cohorts;

- Under 1 year
- 1 – 4 years
- 5 – 14 years
- 15 – 24 years
- 25 – 34 years
- 35 – 44 years
- 45 – 54 years
- 55 – 74 years
- 75 + years

This study is concerned with the first and second cohort, referred to as infant and child stage respectively. The entire Kenyan population in all the eight administrative provinces was taken into consideration when calculating the infant and child mortality rates. The data in this study has been limited to the year 2000 to 2011 for infant mortality and 2006 to 2011 for child mortality, provided by the department of civil registration. The study categorized the causes of death into four groups; infectious causes, dietary related causes, trauma related causes and other causes. Infectious causes include; diarrhea, tuberculosis, malaria, meningitis, tetanus, measles, pneumonia, HIV/AIDS, sepsis and typhoid. Dietary causes include; malnutrition, anemia and dehydration. Trauma related causes; prematurity, headache, hypertension abortion and stroke while other causes are composed of all the other causes not mentioned. The actual deaths, probabilities of deaths and mortality rates are given in tables (6.1.1-6.2.3), (7.1.1-7.2.3) and (8.1.1-8.2.3) respectively. The data has been analyzed using PASW and Excel packages.

4.1 Computed parameters and results

The government target rates for the infant and child mortality by the year 2012 are

Infant mortality rate ⇒ 0.025 or 2.5%.

Child mortality rate ⇒ 0.0338 or 3.38%.

The study result for the period between 2000 and 2011 are as follows

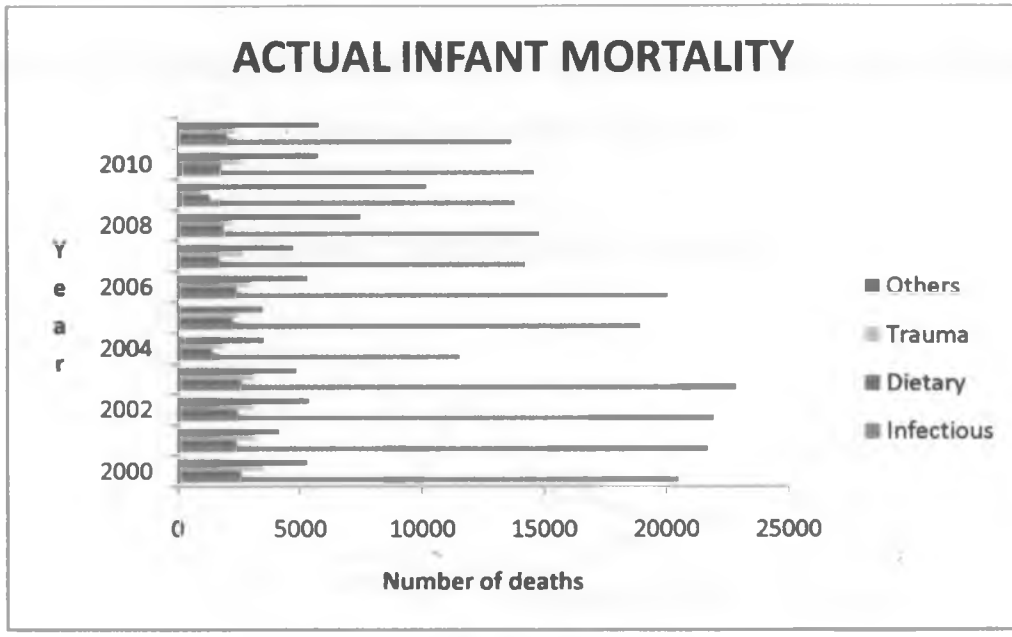

Figure 4.1.1 Actual infant mortality bar graph for infectious, dietary, trauma and other causes.

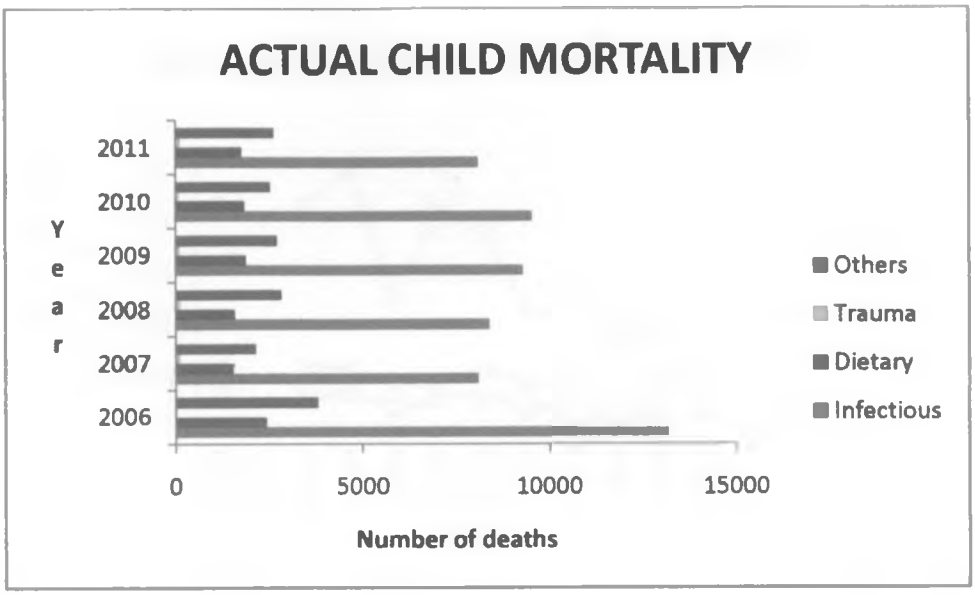

Figure 4.1.2 Actual child mortality bar graph for infectious, dietary, trauma and other causes.

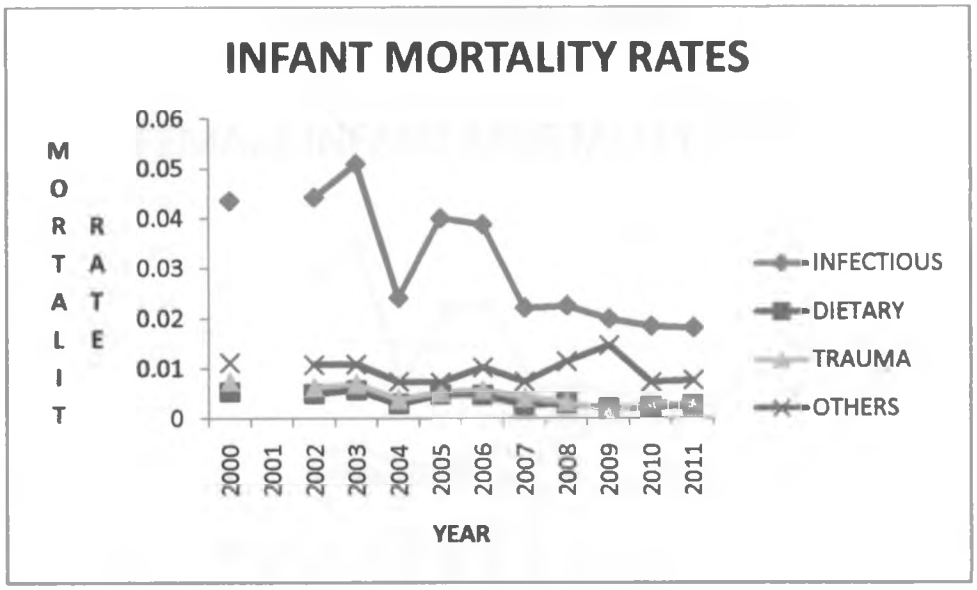

Figure 4.2.1 Infant mortality rate trend for infectious, dietary, trauma and other causes.

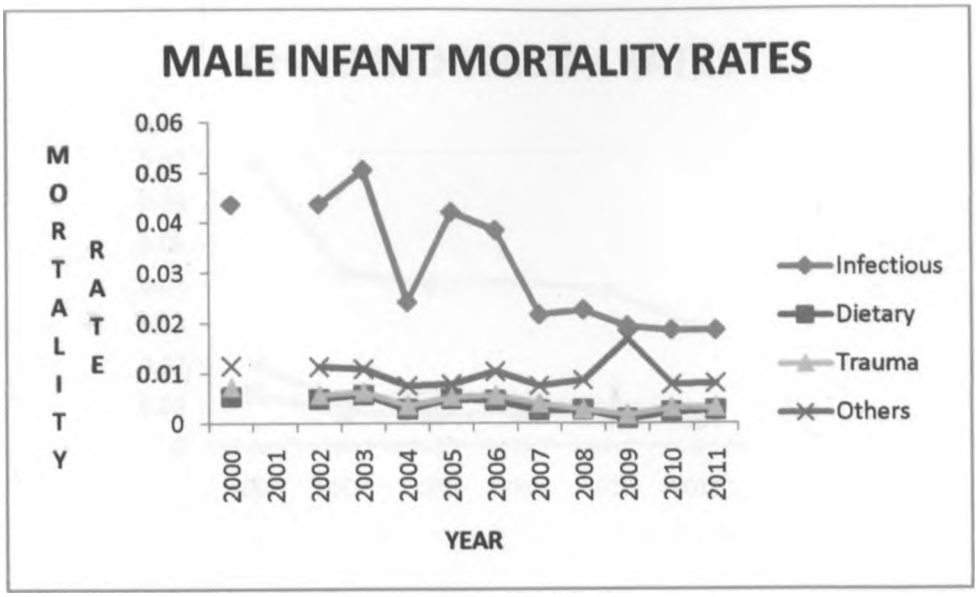

Figure 4.2.2Male infant mortality rates trend for infectious, dietary, trauma and other causes.

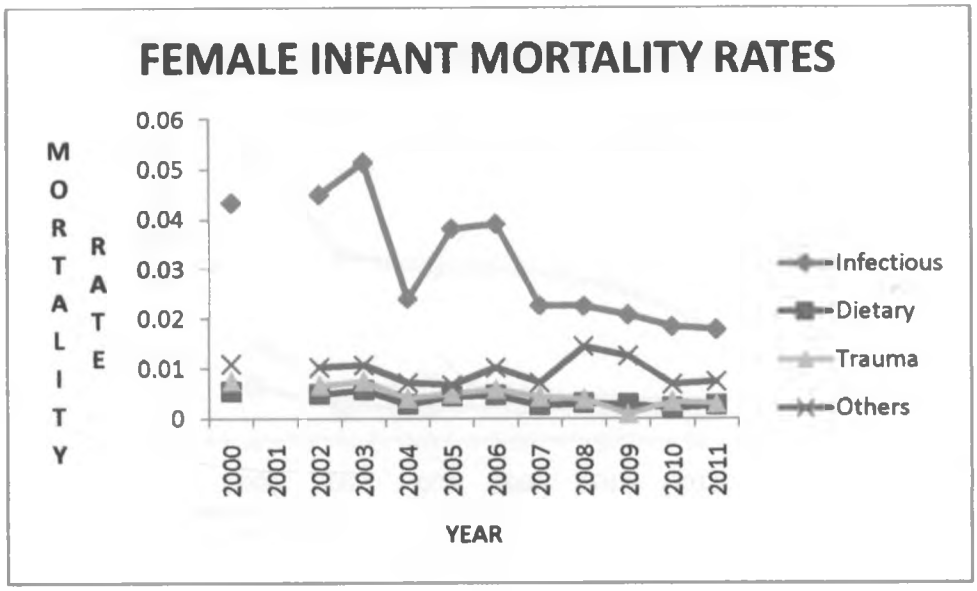

Figure 4.2.3 Female infant mortality trend for infectious, dietary, trauma and other causes.

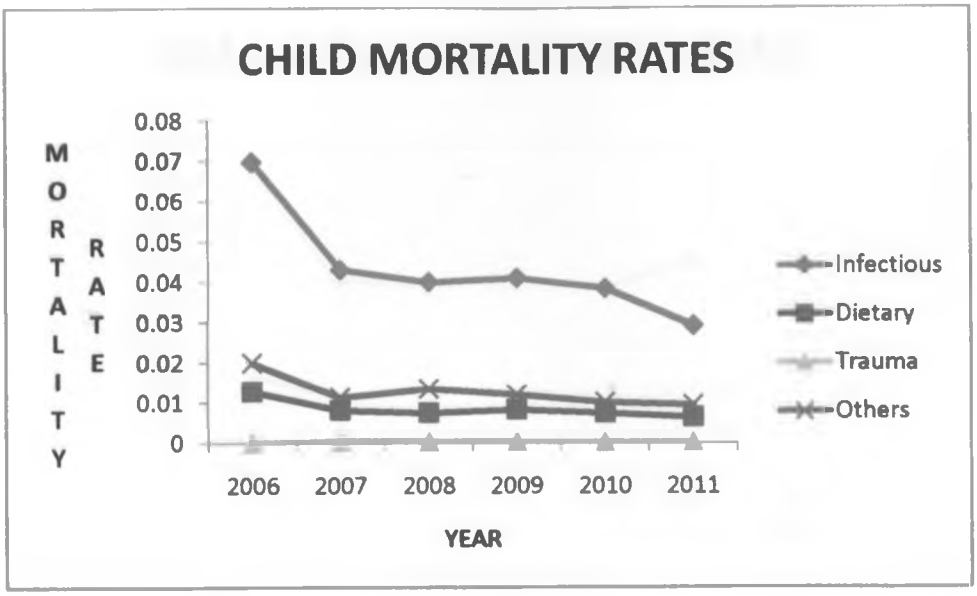

Figure 4.3.1 Child mortality rate trend for infectious, dietary, trauma and other causes.

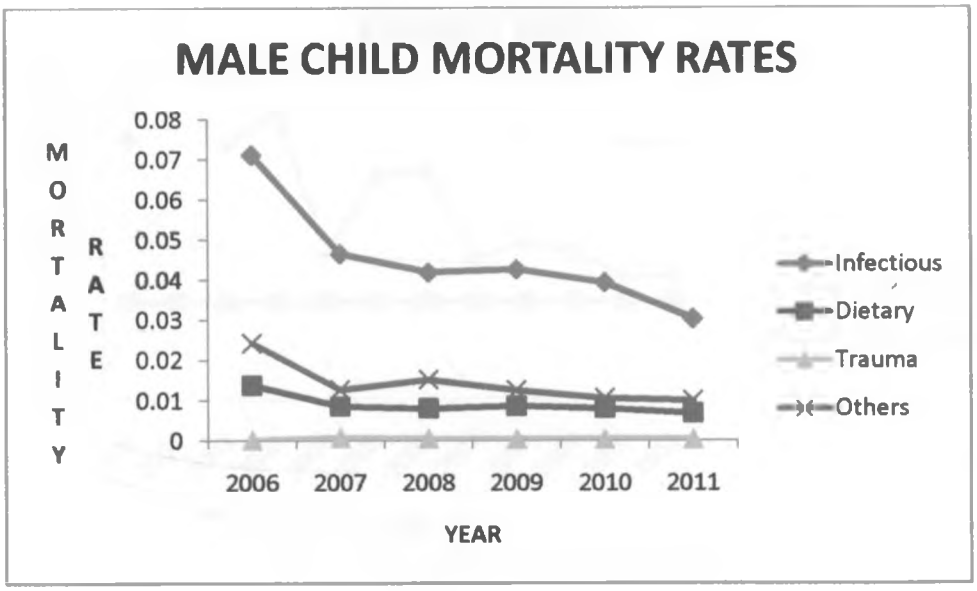

Figure 4.3.2Male child mortality rate trend for infectious, dietary, trauma and other cause.

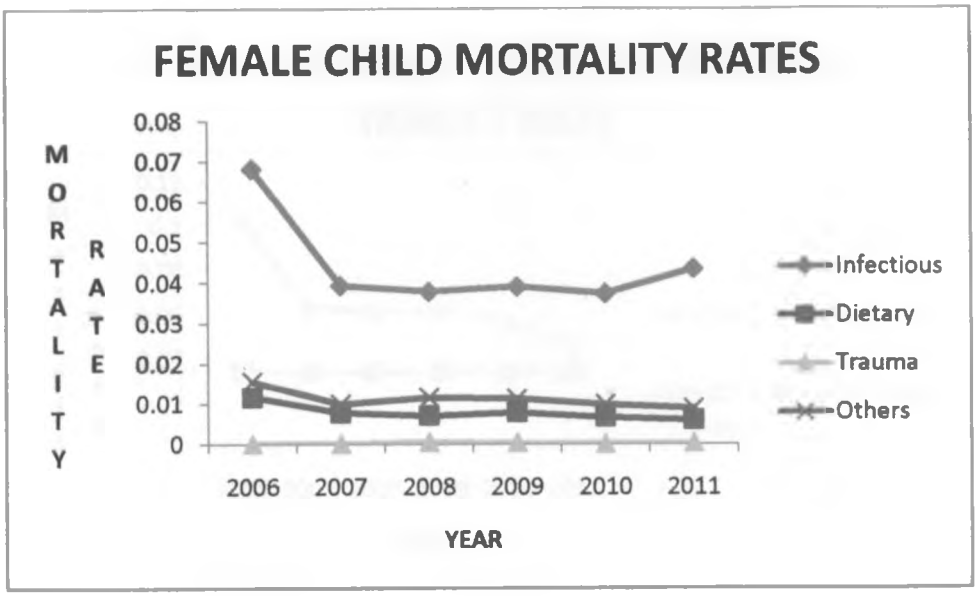

Figure 4.3.3 Female child mortality rate trend for infectious, dietary, trauma and other causes.

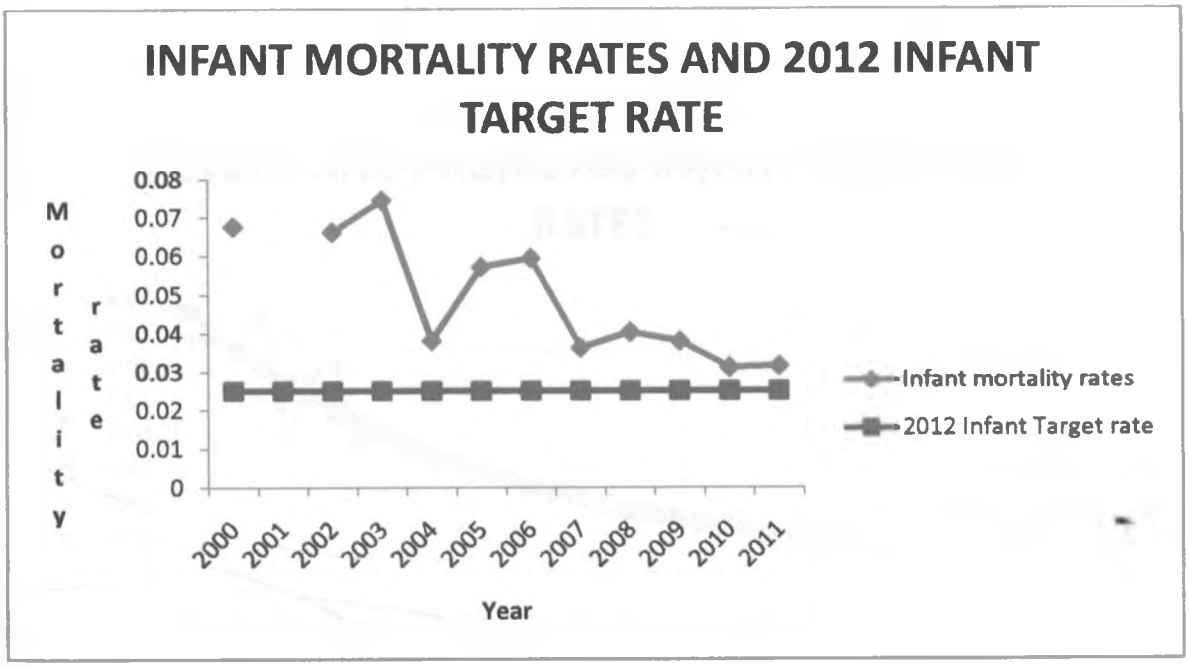

Figure 4.4.1 Infant mortality rates and 2012 target rate trend for infectious, dietary, trauma and other causes

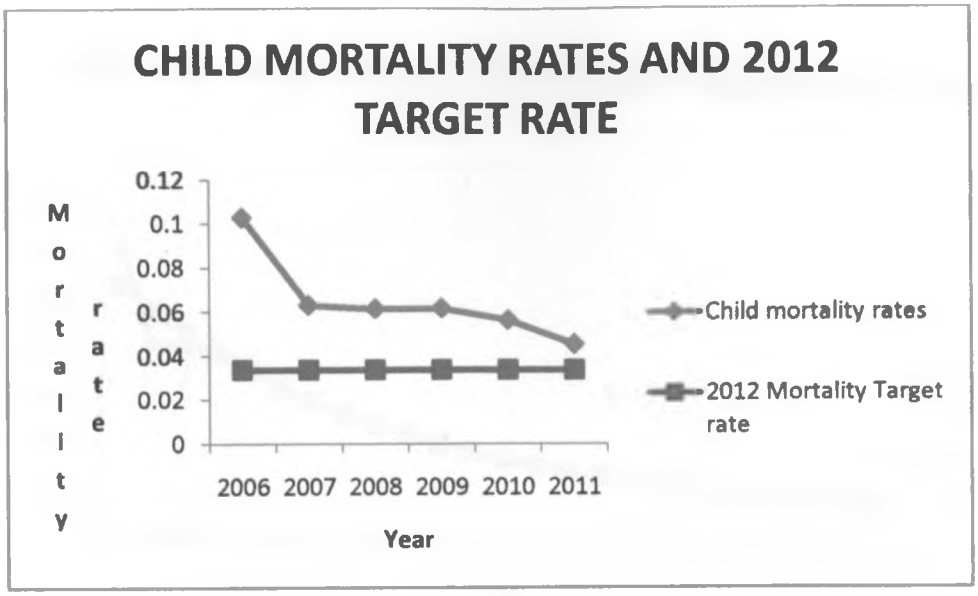

Figure 4.4.2 Child mortality rates and 2012 target rate trend for infectious, dietary, trauma and other causes

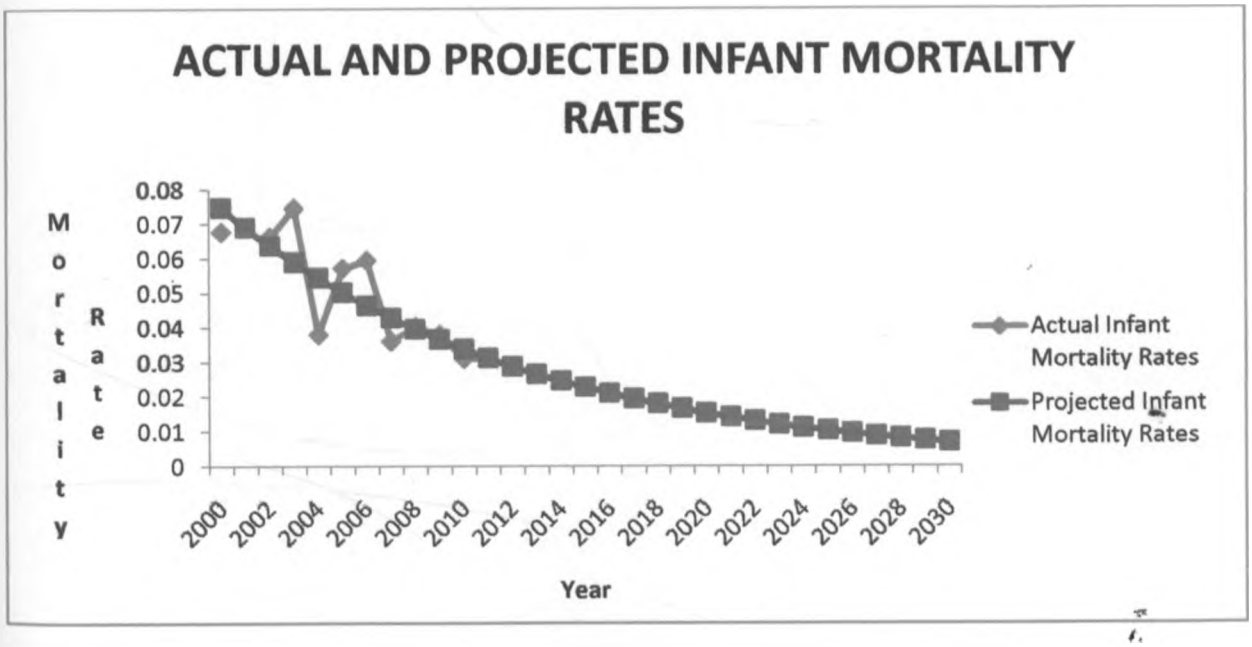

Figure 5.5.1 Actual and projected infant mortality rates

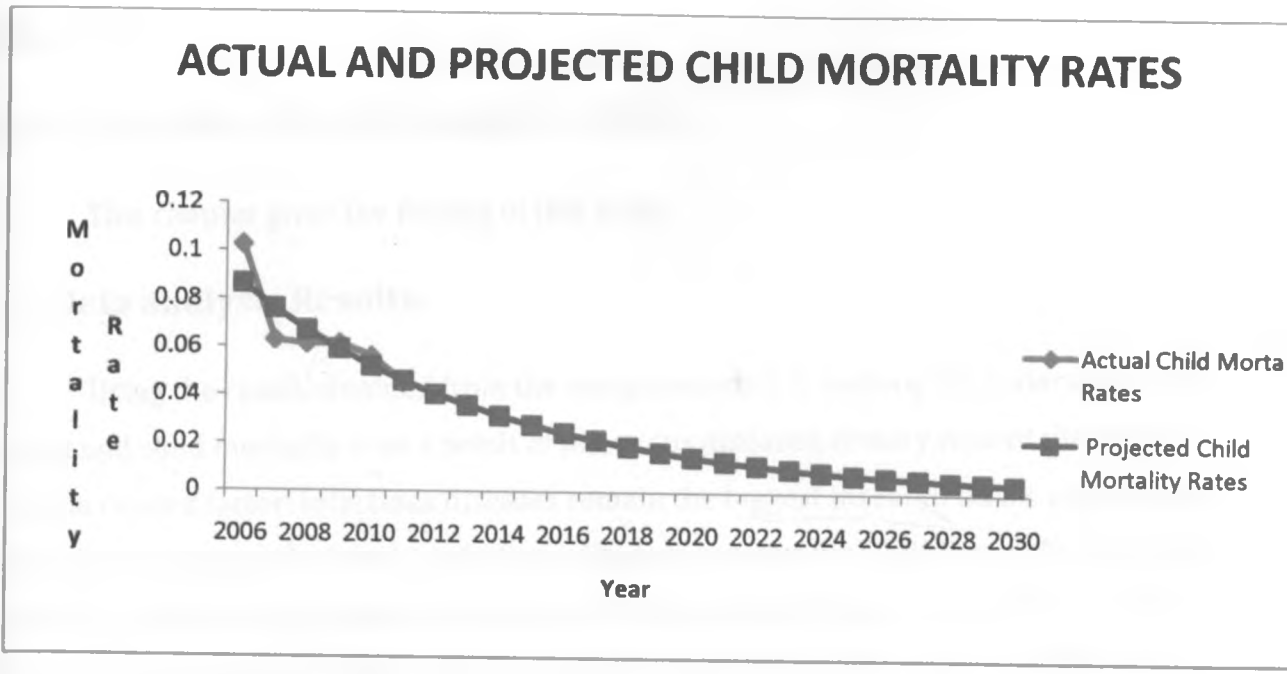

Figure 5.5.2 Actual and projected child mortality rates

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter gives the finding of this study.

5.1 Data analysis Results.

Using the result obtained from the computations it is evident the major causes of infant and child mortality is as a result of infectious diseases, dietary related illness and trauma related factor. Infectious diseases remain the biggest threat to infant and children throughout the period of study. Infectious diseases account for 62.85% and 70.12% of the deaths in infant and child stage respectively, dietary related illness account for 7.39% and 12.40% of the deaths in infant and child stages respectively while trauma related causes account for 9.29% and 0.48% of the deaths in infant and child stages respectively. It is evident infectious poses the biggest threat in infancy and child stages of life. Dietary related illness effect is higher in child stage than infancy stage; this can be attributed to the bridge between breastfeeding and weaning of the young ones. Trauma related causes decreases significantly in the child stage but remain significantly high in infancy stage. This can be attributed to a significant number of mothers give births through informal methods, i.e. giving births through midwives and others by themselves.

The trend rates for the major causes of infant and child mortality declined significantly during the period of study. For the infant mortality during the period between 2000 and 2011, the rates were computed as follows 6.76%, 6.62%, 7.45%, 3.82%, 5.72%, 5.95%, 3.63%, 4.03%, 3.80%, 3.12% and 3.16% for the years respectively excluding year 2001 whose data was not available for the study. The trend depicts a general decline in infant mortality rates during the period of the study. For child mortality during the period between 2006 and 2011, the rates were computed as follows 10.27%, 6.31%, 6.15%, 6.17%, 5.64% and 4.55% for the various years respectively. The trend for individual gender depicts similar trends as the one for the entire infancy and child stages.

5.2 Target Mortality Rates.

The government and health sector planning processes main objective in infant and child health is to reduce the mortality rates to 2.5% and 3.38% for the infant and children respectively by 2012. This is a mid-term strategy which forms a part of the bigger plan of government development goals in the Vision 2030 and MDGs.

5.3 Comparison of Infant & Child Mortality Rates.

From the result, it is evident that the estimate computed compare favorably with the expected values of the infant and child mortality over the period of study. The trend rates as at the end of 2011 are, 3.16% and 4.55% for infant and child mortality respectively. The targets for the year 2012 are, 2.5% and 3.38% for infant and child mortality respectively. This clearly shows the government is on course to achieve the objective set to reduce infant and child mortality in the blueprint of both the MDGs and Vision 2030. In general, the rates depicts decline in the rates of mortality but a lot need to be done on the infectious diseases, as they remain the major causes of infant and children deaths, especially malaria, pneumonia and measles.

5.4 Projected Mortality Rates.

From the result, infant and child mortality rates are expected to continue declining in the projection period up to 2030. Infant rates declines to 2.89%, 2.47%, 1.66%, 1.04% and 0.76% for year 2012, 2015, 2020, 2025 and 2030 respectively. This translates to29, 25, 17, 10 and 8 deaths per 1000 live births for the respective years. Child mortality rates declines to 4.06%, 2.78%, 1.48%, 0.79% and 0.42% for year 2012, 2015, 2020, 2025 and 2030 respectively. This translates to 41, 28, 15, 8 and 4 deaths per 1000 live births for the respective years. It is clear from the projection; child mortality rates will be lower than infant mortality rates from year 2025 onwards.

5.5 Conclusion.

From the results, infant and child mortality has shown impressive decline over the period under review. The 2012 mortality rate target will not be achieved but will be

realized on year 2015.The decrease in infant and child mortality rates can be associated with increased campaigns against infectious diseases, namely, diarrhea, measles, malaria, HIV/AIDs, respiratory infections and dietary related disease, namely, malnutrition which are the major causes of infant and child mortality.

Limitations.

Lack of quantitative and qualitative data makes the task of analyzing demographic trends an arduous one. This is due to the absence of accurate vital registration system and other high quality sources of data. The quality of mortality estimates calculated from retrospective birth histories depends upon the completeness with which births and deaths are reported and recorded. Potentially the most serious data quality problem is the selective omission from the births histories of births who did not survive, which can lead to underestimation of mortality rates. Other potential problems include displacement of births dates, which may cause a distortion of mortality trends, and misreporting of the age at death, which may distort the age pattern of mortality. Some of the specific compounded challenges leading to ineffectiveness of the policy and structure put in place to achieve the fourth MDG goal include,

1. Health sector coordination weaknesses resulting to competing interests among state actors.
2. Poor monitoring and evaluation.
3. Lack of availability, poor accessibility and low utilization of skilled attendance during pregnancy and child birth.
4. Inadequate access to reproductive health information.
5. Fragmentation of priority intervention among different programs.
6. Limited resources in maternal and newborn health.

RECOMMENDATIONS.

Infant and child mortality rates remain high irrespective of the various government initiative put in place to curb the trend. Further analysis should be carried out; to determine the number of life's that could be saved if infectious diseases were to be

completely eliminated in Kenya. For monitoring and evaluation purposes, proper and accurate data should be maintained to keep track of progress and make necessary adjustments towards achieving the MDG goal. The government should waive the birth and death certificate fee to allow for more registration. Some of specific interventions to reduce infant and child mortality include,

1. Increased access to health services for treatment and management of childhood diseases.
2. Increased immunization coverage for immunizable diseases.
3. Reinforcement of structures and programmes that addresses main causes of infant and child mortality.
4. Increased political commitment.
5. Increased reproductive health information dissemination at all levels.
6. Implementation of the community health strategy.

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APPENDIX

1.Infectious diseases.

Measles

Measles is a highly contagious viral disease that can be fatal. In most people, the disease produces fever (temperature > 101 F [38.3 C]), a generalized rash that last greater than three days, cough, runny nose (coryza), and red eyes (conjunctivitis). The complications of measles that result in most deaths include pneumonia and inflammation of the brain (encephalitis).

Pneumonia

Pneumonia is an infection of one or both lungs which is usually caused by bacteria, viruses, or fungi.

Diarrhea

Diarrhea is an increase in the frequency of bowel movements or a decrease in the form of stool (greater looseness of stool) than it is normal for a person. Although changes in frequency of bowel movements and looseness of stools can vary independently of each other, it can be distinguished by incontinence of stool, rectal urgency, incomplete evacuation and bowel movement immediately after eating a meal. It is caused by viruses, bacteria and parasites.

Tuberculosis

Tuberculosis (TB) is an infectious disease caused by bacteria whose scientific name is Mycobacterium tuberculosis. Commonly it affects the lungs but also can involve almost any organ of the body.

Malaria

Malaria is an infectious disease caused by a parasite, Plasmodium, which infects red blood cells.

Meningitis

Meningitis is an inflammation of the membranes (called meninges) that surround the brain and spinal cord. It is caused by a variety of bacteria and viruses.

Tetanus

Tetanus is an acute, often-fatal disease of the nervous system that is caused by nerve toxins produced by the bacterium Clostridium tetani.

HIV / AIDS

AIDS (Acquired immune deficiency syndrome or acquired immunodeficiency syndrome) is a disease caused by a virus called **HIV** (Human Immunodeficiency Virus). The illness alters the immune system, making people much more vulnerable to infections and diseases.

Typhoid

Typhoid fever is an acute illness associated with fever that is most often caused by the Salmonella typhi bacteria. It can also be caused by Salmonella paratyphi, a related bacterium that usually leads to a less severe illness.

Sepsis

is a potentially dangerous or life-threatening medical condition, found in association with a known or suspected infection (usually caused by but not limited to bacteria) whose signs and symptoms fulfill at least two of the following criteria of a systemic inflammatory response syndrome (SIRS): elevated heart rate (tachycardia) >90 beats per minute at rest

2. Dietary related causes.

Malnutrition

is the condition that results from taking an unbalanced diet in which certain nutrients are lacking, in excess (too high an intake), or in the wrong proportions.

Anemia

Anemia is a medical condition in which the red blood cell count or hemoglobin is less than normal. The normal level of hemoglobin is generally different in males and females.

Dehydration

Occurs when the amount of water leaving the body is greater than the amount being taken in.

3. Trauma related causes

Hypertension

High blood pressure (HBP) or hypertension means high pressure (tension) in the arteries. Normal blood pressure is below 120/80; blood pressure between 120/80 and 139/89 is called "pre-hypertension", and a blood pressure of 140/90 or above is considered high.

Headache

is defined as a pain in the head or upper neck.

Prematurity

refers to the birth of a baby of less than 37 weeks gestational age. The cause for preterm birth is in many situations elusive and unknown; many factors appear to be associated with the development of preterm birth, making the reduction of preterm birth a challenging proposition.

Stroke

Brain cell function requires a constant delivery of oxygen and glucose from the bloodstream. A stroke, or cerebrovascular accident (CVA), occurs when blood supply to part of the brain is disrupted, causing brain cells to die.

Spontaneous Abortion / Miscarriage

A miscarriage is any pregnancy that ends spontaneously before the fetus can survive.

STUDY DATA

Year	Total Births	Total Deaths	Number of Infant deaths due to			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2000	470928	31858	20516	2557	3481	5304
2001	[redacted]	31351	21710	2370	3128	4143
2002	494941	32763	21932	2419	3044	5368
2003	448412	33399	22862	2575	3091	4871
2004	478221	18262	11557	1365	1822	3518
2005	472914	27063	18956	2217	2438	3452
2006	517352	30760	20088	2378	2971	5320
2007	642359	23309	14253	1679	2651	4726
2008	655569	26442	14839	1872	2193	7538
2009	691312	26273	13844	1303	934	10192
2010	790937	24696	14614	1746	2565	5771
2011	754052	23826	13699	1983	2329	5815

Table 6.1.1 Annual Infant number of births and deaths.

Year	Male Births	Total Male Deaths	Number of Male Infant deaths			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2000	241381	16399	10540	1304	1759	2796
2001	[redacted]	16017	11071	1210	1508	2228
2002	255185	16727	11169	1227	1443	2888
2003	231237	17038	11718	1317	1464	2539
2004	246284	9390	5974	686	870	1860
2005	230482	13880	9730	1116	1222	1812
2006	267162	15776	10318	1193	1497	2768
2007	338540	12112	7367	874	1327	2544
2008	337349	12435	7663	893	943	2936
2009	354154	13719	6856	308	597	5958
2010	406260	12839	7524	918	1257	3140
2011	387377	12477	7164	997	1225	3091

Table 6.1.2 Annual Male Infant number of births and deaths

Year	Female Births	Female Deaths	Causes of Female Infant deaths			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2000	229547	15459	9976	1253	1722	2508
2001	[redacted]	15334	10639	1160	1620	1915
2002	239756	16036	10763	1192	1601	2480
2003	217175	16361	11144	1258	1627	2332
2004	231937	8872	5583	679	952	1658
2005	242432	13183	9226	1101	1216	1640
2006	250190	14984	9770	1185	1474	2552
2007	303819	11197	6886	805	1324	2182
2008	318220	14007	7176	979	1250	4602
2009	337158	12554	6988	995	337	4234
2010	384677	11857	7090	828	1308	2631
2011	366675	11349	6535	986	1104	2724

Table 6.1.3 Annual Female Infant number of births and deaths.

Year	Total Children	Total Deaths	Number of Child deaths due to			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2006	1783001	194610	132130	24230	330	37920
2007	1807415	118450	80820	15260	1030	21340
2008	2011452	128980	83880	15770	1100	28230
2009	2180620	139600	92850	18730	940	27080
2010	2399808	139460	95260	18280	700	25220
2011	2679457	125700	80780	17660	1090	26170

Table 6.2.1 Annual Child number of births and deaths

Year	Total Male	Male Deaths	Number of Male Child deaths due to			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2006	906153	105370	68520	13290	160	23400
2007	919081	65450	44460	8070	800	12120
2008	1031310	70350	45020	8530	490	16310
2009	1119330	74710	49750	10020	410	14530
2010	1243163	74760	50590	10280	480	13410
2011	1385198	67780	43300	9670	520	14290

Table 6.2.2 Annual Male number of births and deaths

Year	Total Female	Female Deaths	Number of Female Child deaths due to			
			Infectious	Dietary	Trauma	Others
x	K_x	D_x	D_{1x}	D_{2x}	D_{3x}	D_{4x}
2006	876848	89240	63610	10940	170	14520
2007	888334	53000	36360	7190	230	9220
2008	980142	58630	38860	7240	610	11920
2009	1061290	64890	43100	8710	530	12550
2010	1156645	64700	44670	8000	220	11810
2011	1294259	57920	37480	7990	570	11880

Table 6.2.3 Annual Female Child number of births and deaths

Year	Total Deaths	Causes of Infant deaths probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2000	0.067649	0.043565	0.00543	0.007392	0.011263
2001					
2002	0.066196	0.044312	0.004887	0.00615	0.010846
2003	0.074483	0.050984	0.005742	0.006893	0.010863
2004	0.038187	0.024167	0.002854	0.00381	0.007356
2005	0.057226	0.040083	0.004688	0.005155	0.007299
2006	0.059457	0.038828	0.004596	0.005743	0.010283
2007	0.036287	0.022189	0.002614	0.004127	0.007357
2008	0.040334	0.022635	0.002856	0.003345	0.011498
2009	0.038005	0.020026	0.001885	0.001351	0.014743
2010	0.031224	0.018477	0.002208	0.003243	0.007296
2011	0.031597	0.018167	0.00263	0.003089	0.007712

Table 7.1.1 Probabilities for Annual decrement modes in infants.

Year	Total Prob	Causes of Male Infant deaths Probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2000	0.067938	0.043665	0.005402	0.007287	0.011583
2001					
2002	0.065549	0.043768	0.004808	0.005655	0.011317
2003	0.073682	0.050675	0.005695	0.006331	0.01098
2004	0.038127	0.024257	0.002785	0.003533	0.007552
2005	0.060222	0.042216	0.004842	0.005302	0.007862
2006	0.05905	0.038621	0.004465	0.005603	0.010361
2007	0.035777	0.021761	0.002582	0.00392	0.007515
2008	0.036861	0.022715	0.002647	0.002795	0.008703
2009	0.038737	0.019359	0.00087	0.001686	0.016823
2010	0.031603	0.01852	0.00226	0.003094	0.007729
2011	0.032209	0.018494	0.002574	0.003162	0.007979

Table 7.1.2 Probabilities for male annual decrement modes in infants.

Year	Total Prob	Causes of Female Infant death Probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2000	0.067346	0.04346	0.005459	0.007502	0.010926
2001					
2002	0.066885	0.044891	0.004972	0.006678	0.010344
2003	0.075336	0.051313	0.005793	0.007492	0.010738
2004	0.038252	0.024071	0.002928	0.004105	0.007148
2005	0.054378	0.038056	0.004541	0.005016	0.006765
2006	0.05989	0.03905	0.004736	0.005892	0.0102
2007	0.036854	0.022665	0.00265	0.004358	0.007182
2008	0.044017	0.02255	0.003076	0.003928	0.014462
2009	0.037235	0.020726	0.002951	0.001	0.012558
2010	0.030823	0.018431	0.002152	0.0034	0.00684
2011	0.030951	0.017822	0.002689	0.003011	0.007429

Table 7.1.3 Probabilities for female annual decrement modes in infants.

Year	Total Prob	Causes of children death Probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2006	0.10915	0.07411	0.01359	0.000185	0.02127
2007	0.06554	0.04472	0.00844	0.00057	0.01181
2008	0.06412	0.0417	0.00784	0.000547	0.01403
2009	0.06402	0.04258	0.00859	0.000431	0.01242
2010	0.05811	0.03969	0.00762	0.000292	0.01051
2011	0.04691	0.03015	0.00659	0.000407	0.00977

Table 7.2.1 Probabilities for annual decrement modes in child stage.

Year	Total Prob	Causes of male child death Probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2006	0.11628	0.07562	0.01467	0.000177	0.02582
2007	0.07121	0.04837	0.00878	0.00087	0.01319
2008	0.06821	0.04365	0.00827	0.000475	0.01581
2009	0.06614	0.04445	0.00895	0.000366	0.01298
2010	0.06014	0.04069	0.00827	0.000386	0.01079
2011	0.04893	0.03126	0.00698	0.000375	0.01032

Table 7.2.2 Probabilities for male annual decrement modes in child stage.

Year	Total Prob	Causes of female child death Probability			
		Infectious	Dietary	Trauma	Others
x	aq_x	aq_{1x}	aq_{2x}	aq_{3x}	aq_{4x}
2006	0.10177	0.07254	0.01248	0.000194	0.01656
2007	0.05966	0.04093	0.00809	0.000259	0.01038
2008	0.05982	0.03965	0.00739	0.000622	0.01216
2009	0.06114	0.04061	0.00821	0.000499	0.01183
2010	0.05594	0.03862	0.00692	0.00019	0.01021
2011	0.04475	0.02896	0.00617	0.00044	0.00918

Table 7.2.3 Probabilities for female annual decrement modes in child stage.

TOTAL INFANT MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	ad_x	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2000	0.067649	1	0.067649	0.0436	0.0054	0.0074	0.0113
2001							
2002	0.066196	1	0.066196	0.0049	0.0049	0.0062	0.0108
2003	0.074483	1	0.074483	0.0510	0.0057	0.0069	0.0109
2004	0.038187	1	0.038187	0.0242	0.0029	0.0038	0.0074
2005	0.057226	1	0.057226	0.0401	0.0047	0.0052	0.0073
2006	0.059457	1	0.059457	0.0388	0.0046	0.0057	0.0103
2007	0.036287	1	0.036287	0.0222	0.0026	0.0041	0.0074
2008	0.040334	1	0.040334	0.0226	0.0029	0.0033	0.0115
2009	0.038005	1	0.038005	0.0200	0.0019	0.0014	0.0147
2010	0.031224	1	0.031224	0.0185	0.0022	0.0032	0.0073
2011	0.031597	1	0.031597	0.0182	0.0026	0.0031	0.0077

Table 8.1.1 Infant mortality rates multiple decrement table.

MALE INFANT MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	ad_x	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2000	0.067938	1	0.067938	0.043665	0.005402	0.007287	0.011583
2001							
2002	0.065549	1	0.065549	0.043768	0.004808	0.005655	0.011317
2003	0.073682	1	0.073682	0.050675	0.005695	0.006331	0.01098
2004	0.038127	1	0.038127	0.024257	0.002785	0.003533	0.007552
2005	0.060222	1	0.060222	0.042216	0.004842	0.005302	0.007862
2006	0.05905	1	0.05905	0.038621	0.004465	0.005603	0.010361
2007	0.035777	1	0.035777	0.021761	0.002582	0.00392	0.007515
2008	0.036861	1	0.036861	0.022715	0.002647	0.002795	0.008703
2009	0.038737	1	0.038737	0.019359	0.00087	0.001686	0.016823
2010	0.031603	1	0.031603	0.01852	0.00226	0.003094	0.007729
2011	0.032209	1	0.032209	0.018494	0.002574	0.003162	0.007979

Table 8.1.2 Male infant mortality rates multiple decrement table.

FEMALE INFANT MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	ad_x	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2000	0.067346	1	0.067346	0.04346	0.00549	0.007502	0.010926
2001							
2002	0.066885	1	0.066885	0.044891	0.004972	0.006678	0.010344
2003	0.075336	1	0.075336	0.051313	0.005793	0.007492	0.010738
2004	0.038252	1	0.038252	0.024071	0.002928	0.004105	0.007148
2005	0.054378	1	0.054378	0.038056	0.004541	0.005016	0.006765
2006	0.05989	1	0.05989	0.03905	0.004736	0.005892	0.0102
2007	0.036854	1	0.036854	0.022665	0.00265	0.004358	0.007182
2008	0.044017	1	0.044017	0.02255	0.003076	0.003928	0.014462
2009	0.037235	1	0.037235	0.020726	0.002951	0.001	0.012558
2010	0.030823	1	0.030823	0.018431	0.002152	0.0034	0.00684
2011	0.030951	1	0.030951	0.017822	0.002689	0.003011	0.007429

Table 8.1.3 Female infant mortality rates multiple decrement table.

TOTAL CHILD MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	ad_x	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2006	0.10915	0.940543	0.1027	0.0697	0.0128	0.0002	0.02
2007	0.06554	0.963713	0.0631	0.0431	0.0081	0.0005	0.0114
2008	0.06412	0.959666	0.0615	0.04	0.0075	0.0005	0.0135
2009	0.06402	0.961995	0.0617	0.041	0.0083	0.0004	0.012
2010	0.05811	0.968776	0.0564	0.0385	0.0074	0.0003	0.0102
2011	0.04691	0.968403	0.0455	0.0292	0.0064	0.0004	0.0095

Table 8.2.1 Child mortality rates multiple decrement table.

MALE CHILD MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	a_{dx}	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2006	0.11628	0.94095	0.1095	0.0712	0.0138	0.0002	0.0243
2007	0.07121	0.964223	0.0686	0.0466	0.0085	0.0008	0.0127
2008	0.06821	0.963139	0.0657	0.042	0.008	0.0005	0.0152
2009	0.06675	0.961263	0.0642	0.0427	0.0086	0.0004	0.0125
2010	0.06014	0.968397	0.0583	0.0394	0.008	0.0004	0.0105
2011	0.04893	0.967791	0.0475	0.0303	0.0068	0.0004	0.01

Table 8.2.2 Male child mortality rates decrement table.

FEMALE CHILD MORTALITY MULTIPLE DECREMENT TABLE							
Year	Probability of death	Fraction Living at the beginning of interval	Fraction of all deaths	Fraction death due to			
				Infectious	Dietary	Trauma	Others
x	aq_x	al_x	ad_x	ad_{1x}	ad_{2x}	ad_{3x}	ad_{4x}
2006	0.10177	0.94011	0.0957	0.0682	0.0117	0.0002	0.0156
2007	0.05966	0.963146	0.0574	0.0394	0.0078	0.0002	0.01
2008	0.05982	0.955983	0.0572	0.0379	0.0071	0.0006	0.0116
2009	0.06114	0.962765	0.0587	0.0391	0.0079	0.0004	0.0113
2010	0.05594	0.969177	0.0542	0.0374	0.0067	0.0002	0.0099
2011	0.04475	0.969049	0.0587	0.0434	0.006	0.0004	0.0089

Table 8.2.3 Female child mortality rates decrement tables.