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Probability Pattern and Effect of Extinction of Disease on Expectation of Life in Bangladesh

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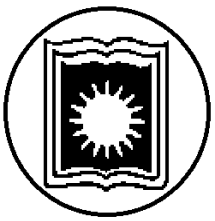
PROBABILITY PATTERN AND EFFECT OF EXTINCTION OF DISEASE ON EXPECTATION OF LIFE IN BANGLADESH

by

Aziza Sultana Rosy Sarkar

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Statistics to the Department of Statistics, University of Rajshahi, Bangladesh



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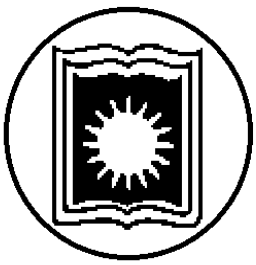

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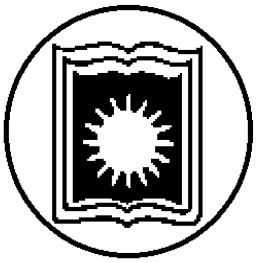

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CERTIFICATE

I have the pleasure to certify that the thesis entitled "PROBABILITY PATTERN AND EFFECT OF EXTINCTION OF DISEASE ON EXPECTATION OF LIFE IN BANGLADESH" is the original work of Aziza Sultana Rosy Sarkar. As far as I know, this is the candidate's own achievement and is not a conjoint work. She has completed this thesis under my direct guidance and supervision. I also certify that I have gone through the draft and final version of the thesis and found it satisfactory for submission to the Department of Statistics, University of Rajshahi in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Statistics.

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DECLARATION

I do hereby declare that the thesis entitled, "PROBABILITY PATTERN AND EFFECT OF EXTINCTION OF DISEASE ON EXPECTATION OF LIFE IN BANGLADESH", submitted to the Department of Statistics, Rajshahi University for the degree of Doctor of Philosophy in Statistics is exclusively my own and original work. This work is carried out by me under the supervision and guidance of Professor Dr. Md. Nurul Islam, Department of Statistics, University of Rajshshi, Rajshahi, Bangladesh. No part of it in any form, has been submitted to any other University or Institute for any degree, diploma or for other similar purposes.

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ABSTRACT

Mortality is one of the three components of population change. There are several causes of mortality which are different from country to country, age to age, sex to sex and present to past. A large number of people die every year by various causes of mortality in the world. Some causes of mortality mostly which are communicable are almost eradicated by following preemptive measures whereas some other causes of mortality i.e. non-communicable diseases exhibit challenging burden.

In this study an investigation has been made to get a clear conception regarding mortality, morbidity and relevant issues. So, the purpose of this study is to examine the trends and probability patterns of deaths by age due to a cause of deaths in presence of all causes and also to identify the main causes of deaths those influence the mortality rate. An attempt has also been made the eliminating effect of specific diseases on expectation of life.

Again, one of the components of population analysis is the study of differential of mortality classified by socioeconomic status and demographic characteristics. Thus this study attempts to identify important factors influencing non-communicable diseases related mortality.

Finally, we find out the expected non-communicable disease related deaths in Bangladesh and setting the targets to control non-communicable diseases as a future plan in health sectors.

Mortality trends and patterns in Bangladesh are primarily presented in the form of frequency distributions, prevalence rates, and mortality rates. This study uses Abridged Life table, Multiple Decrement Life table, Single Decrement Life table, Exponential Growth model, Polynomial Regression model, Logistic Regression model and ARIMA model for analyzing data to quantify the objectives of the study.

This study uses the vital registration and maternal and child health data gathered from Matlab, Bangladesh in 2000, 2004 and 2008 collected by the Health and Demographic Surveillance System of ICDDR,B (International Centre for Diarrhea Disease Research, Bangladesh). Also, this study based on primary data which have been collected from 30^{th} ward in Rajshahi City Corporation, Bangladesh.

The result of this study shows that a huge number of people died because of non-communicable diseases. This number rapidly increases year by year at a large scale. Among non-communicable diseases, circulatory system related diseases (stroke, ischemic heart disease and hypertensive disease) is significant in Bangladesh. The second major cause of death is neoplasm for the national population.

The analysis also warns that the burden of non-communicable diseases will significantly increase as the proportion of people aged over 40 rise.

The government of Bangladesh should take necessary action to handle all the non-communicable diseases for achieving desired life expectancies in order to become a healthy nation. Some efforts have been made by governmental and non-governmental organization to set a sustainable system including physician and non-physician workers, health workers. In addition adequate supply and access to the essential medications is keenly ensured especially for the poor. Counseling services about the guidelines, treatments of non-communicable diseases for the male and female need to be arranged. Health services according to age and sex should be fixed up as an immediate goal to control the mounting trends of non-communicable diseases.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

One of the most important demographic components of population growth is the mortality trends in population. Studying mortality trend is important for identifying the major causes of death and their impact on public health. It is also important to gain better knowledge about potential threats of the diseases that may cause burden in Bangladesh. Utilizing this knowledge will help taking preventive measures. Demographers have long been interested in examining patterns of mortality. The reason is that mortality patterns provide an effective way of studying mortality differentials and their underlying causes across populations. Every nation likes to increase the quality of health and life expectancy. For this reason, it is necessary to remove the avoidable causes of mortality to ensure healthy life of people.

Since independence in 1971, Bangladesh has made significant achievements in reducing poverty and improving health status. Infant mortality has declined from 72.6 deaths per 1000 live births in 1995-2000 to 57.2 deaths per 1000 live births in 2000-2005. It has further declined to 44.7 deaths per 1000 live births in 2005-2010. Under-five mortality rates were 101 per 1000 live births in 1995-2000, 77 in 2000-2005 and 57 in 2005-2010. During the first half of 1990s, life expectancy at birth was less than 60 years for both sexes. The pattern is also similar for both sexes. However, the last half of 1990s showed life expectancy of 60+ years with an increasing trend. It reached to 70 years in 2010. Life expectancy is higher for female than that of male (Farid et al., 2011).

It has been reported that overall mortality rate in Bangladesh has decreased significantly over the last couple of decades. However, deaths due to chronic diseases are increasing in an alarming rate (MOHFW, 2011).

There is a rapid increase observed in the burden of Non-Communicable Diseases (NCDs) worldwide. NCDs are a major health problem in industrialized countries. They are also increasing rapidly in the developing countries. Demographic transition and changing lifestyles among people are important factors for this kind of health problems (Nissenen et al., 2001). WHO (2002) has predicted that, by 2020, two-thirds of the world's global burden of disease will be caused by non-communicable conditions. It was

also reported (in 2005) that NCDs such as heart disease and stroke, diabetes mellitus, cancer, and chronic respiratory diseases caused approximately 60% of the total mortality in the world. Low and middle-income countries suffered a disproportionate 80% (approx.) of these deaths.

It was reported that the NCDs including cardiovascular diseases, diabetes, obesity, cancer and respiratory diseases account for 59% of the 57 million deaths annually and 46% of the global burden of diseases (WHO, 2008).

The burden of NCDs has been showing increasing trend in South Asia where almost half of all deaths in Asia and 47% of global burden of disease were attributable to these diseases (Ghaffar et al., 2004).

There are relatively few published studies about mortality, especially for NCDs, in developing countries like Bangladesh. It is a timely necessity to analyze mortality data by cause of deaths between the sexes and between various age groups from the perspective of Bangladesh. The aim of this study is to examine the mortality trends in Bangladesh and to project number of deaths due to major NCDs. These attainments will help to make strategies regarding the approach of the health sector to control these diseases.

1.2 Statement of the Problem

Mortality rates are still high among almost all ages of people in Bangladesh. A large number of people are dying painfully and prematurely which is avoidable.

A significant shifting in the causes of deaths from communicable to non-communicable diseases has been observed in Bangladesh. The top causes of deaths include cardiovascular system (40%), respiratory system (23%) and cerebrovascular system (10%). The rest of the causes of deaths each carry less than 10% of the total. It was observed that the male-female death ratio was 51:41. The percentage of cardiovascular diseases was found 1.5 times higher in males. Male death rates due to injury related cause were twice than female rates. The percentage of neoplasm related deaths is also higher in male than female. However, suicide mostly affected the female. Neonatal deaths carried 15% of all the deaths. It was 21% for infant. Most of the deaths (43%) were found at ages over 50 years. However, the age-group 15-24 years bore 23% deaths of the total percentages. (DGHS, 2012)

Probability pattern of deaths gives clear information about alarming diseases. In addition, the probability pattern of deaths by age and causes of death may vary from

population to population and from one time to another. Thus it is necessary to know the recent trend in mortality, the main causes of deaths, and how the higher mortality rate can be controlled.

The present study describes the probability pattern of deaths by age by different causes such as maternal and neonatal cause, communicable cause, non-communicable cause and miscellaneous cause.

The research is focused primarily on the cause specific comparative study of deaths in Bangladesh. It assists in finding the recent top causes of deaths. The causes of deaths are different from country to country, from continent to continent, and from present to past. It is necessary to find the recent mortality patterns in Bangladesh and to estimate the number of deaths by different diseases.

1.3 Significance of the Study

Health status reflects the development of a country. To explore the health behavior in Bangladesh, it is necessary to design the probability pattern of deaths for the following reasons:

1. Necessary modification

We live in a world of rapidly changing elements such as our environment, food supply, population, and scientific knowledge. These ever-changing elements of life should be in a positive balance to support healthy living. Our bodies, personalities, needs, and goals keep changing in different environments and times. As a result, we observe two key scenarios –

i. Causes of deaths are different from country to country and from continent to continent
ii. Causes of deaths are different from present to past

So it is necessary to find the recent mortality level, survivorship and life expectancy.

2. More attention to adult mortality

People who are attacked with chronic diseases at younger ages suffer longer. Sometimes these diseases make people burden to the nation and often cause early deaths. This can be prevented by systematically identifying and eradicating the major causes of deaths.

3. Finding and applying easier analytical tools to national data

Mortality data are analyzed by different differentials and models. Some techniques and models are applied here.

4. Obtaining better Knowledge in health sector

It is important to obtain better knowledge about diseases that attack the people of Bangladesh. This will help the country to prepare supplying necessary drugs to the diseased people accordingly.

5. Enhancing life expectancy and be a healthy nation.

Every nation wants to improve the health-level of its population. So, they take necessary plan to eradicate those diseases that attack people the most and ensure healthy life of the people.

6. Everlasting interest

The causes of death have great influence on duration of life. Thus demographers are always interested in examining the age pattern of mortality.

The findings from this study will support the health sector, the planning, and demography and other related fields. They will identify the causes of death that affect the people of Bangladesh so that the nation may join the group of countries of high life expectancy.

1.4 Study Area Setting

Mortality data of Bangladesh are hardly available. Information on deaths by cause was found in hospitals but it was not a representative sample of the deaths in the population. The Bangladesh Maternal Mortality (BMMS) and Health Care Survey provide some data on maternal and pregnancy related deaths. Bangladesh Demographic and Health Survey (BDHS) is a nationwide sample survey of men and women who deliver information on fertility and childhood mortality levels. Including these sources, there are some other sources too that could not fulfill the purpose of analyzing probability pattern of deaths because they were not cause-specific, age specific and gender based.

International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) is an international health research organization which provides cause-specific, age specific and gender related mortality data. The data used in this study is from ICDDR,B. For this study, the primary data were collected from 30^{th} ward in Rajshahi City Corporation, Bangladesh.

1.5 Objectives of the Study

In this study, it is intended to achieve the following five specific objectives, namely-

i. To observe the trend and pattern of deaths in Bangladesh
ii. To identify the main threatening causes of deaths; those that influence the mortality rate highly
iii. To find out the effect of elimination of causes of deaths on expectation of life
iv. To find out the projected number of deaths based on the most influential causes of deaths
v. To detect and find out the influence of risk factors

1.6 Limitations of the Study

The secondary data from ICDDR,B used in this analysis was not very large. The size of the primary sample was also small which may make it difficult to find significant relationships between dependent and independent variables. But there is no larger source to help this study directly. ICDDR,B presents the year-wise mortality data that might help to find the trend of mortality situation in Bangladesh.

In the case of the primary data collected from Mohonpur under 30^{th} ward of Rajshahi City Corporation, the types of risk factors considered were not the only influential risk factors. However, some other risk factors were not considered. Food habit, alcohol drinking, underweight, political and environmental determinants of health were not included in the analyses due to lack of data. Those are important factors in analyzing morbidity data. As in many other developing countries, there might have error in reporting the respondents' age in Bangladesh too.

1.7 Organization of the Study

This section provides us the organization of the study. The study is organized in nine chapters. A brief description of the chapters are given below-

Chapter one contains the background of the study, statement of the problem, objectives of the study, significance of the study, study area settings, limitations of the study and organization of the study.

Chapter two presents some literature reviews found in home and abroad on this topic.

Chapter three describes the data sources, sampling design, sample size determination, data processing and limitations of the study, methodology and related terminologies.

Chapter four dispatches the classification of diseases and distributions of death.

Chapter five reveals probability pattern of death with the help of Abridged Life Table and Multiple Decrement Life Table. It also provides a discussion about the results.

Chapter six works with the probability of deaths for a specific category of diseases in the presence of all categories of diseases. It also illustrates the resulting life expectancy after eliminating various causes of deaths by single decrement mortality table.

Chapter seven presents the trend of NCD-related mortality by different years and gender. It also shows the projected number of deaths based on non-communicable disease and major causes of deaths from the year 2012 to 2060.

Chapter eight tries to identify some determinants affecting non-communicable diseases. Finally, **chapter nine** summarizes the findings and draw conclusion. References and bibliography are attached at the end of the study.

CHAPTER TWO

LITERATURE REVIEW

A great number of literatures regarding this issue have been published personally and institutionally, which are available in journals, books and internet.

It was reported that non-communicable diseases were responsible for two-thirds of all deaths globally in 2011, up from 60% in 2000. The four main NCDs are cardiovascular diseases, cancers, diabetes and chronic lung diseases. These diseases caused an estimated 35 million deaths in 2005. In low and middle income countries, 80% of deaths are due to these diseases. It was also found that approximately 16 million deaths involved people who were below 70 years of age. The rapidly increasing burden of these diseases is affecting poor and disadvantaged populations excessively, contributing to widening health gaps between and within countries (WHO, 2013).

It was observed in much of sub-Saharan Africa that the leading risks were those associated with poverty. The risk factors mostly affect the children, but the contribution of different risk factors to disease burden has substantially shifted now from risks for communicable diseases in children towards those for non-communicable diseases in adults. It was found that the shift is related to the decreased mortality among children below 5 years, changes in cause-of-death composition, and changes in risk factor exposures. The risk factors included unimproved water and sanitation, vitamin A and zinc deficiencies, and ambient particulate matter pollution. (Lim et al., 2012).

The worldwide and regional cause-of-death pattern was estimated for 14 age-sex groups in eight regions for 107 causes for the year 1990. Lorenz-curve analysis was used to estimate cause-of-death pattern in areas. It was found that 98% of all deaths in children below 15 years, 83% of all deaths at 15-59 years, and 59% of all deaths at 70 years were occurring in the developing world. The probability of dying under 15 years of age ranges from 22.0% in sub-Saharan Africa to 1.1% in the established market economies. Probabilities of dying between 15 to 60 year of age range from 7.2% for women in established market economies to 39.1% for men in sub-Saharan Africa. The result demands public health facilities to be established according to regions. Communicable, maternal, perinatal, and nutritional disorders accounted for 17.2 million deaths. Non-communicable diseases accounted for 28.1 million deaths, and injuries accounted for 5.1 million deaths worldwide in 1990. (Murray & Lopez, 1997).

The disease mortality pattern in elderly patients of a Nigerian teaching hospital was studied from January 2007 to December 2011. A total of 3,002 elderly (>65 years) people were admitted of which 561 died. Among the population 317 were male and the rest were females. Cerebrovascular disease was the top cause of death (25.1%). The 2nd and 3rd majority of death cases were malignancies (15.2%) and diabetes mellitus (8%) (Uchendu & Forae, 2013).

Multiple decrement life table is widely used to extract statistical expressions for mortality. The use of multiple-decrement-life-table was mentioned in three different forms: (i) the life table from all causes-of-death combined; (ii) the life table disaggregated into selected cause-of-death categories; and (iii) the life table with particular causes and combinations of causes eliminated (James, 1989).

The post-1971 reduction in Australian mortality was examined with the help of multiple-decrement-life-table. The table was constructed for eleven leading causes of death by sex. The incidence of each cause of death was presented there. Significant changes in the contribution of the various causes to total mortality were found over 20 years (Jain, 1992).

Life table was also used to analyze the impact of major chronic diseases on a population. A life table model using the age at death due to elimination of specific cause (major chronic disease) was proposed. Even though many of the major causes of death related to intrinsic aging processes were impossible to eliminate, these causes might be significantly retarded. The results showed that even moderate delays in the progression of major chronic diseases will yield a sizable portion of total gain in life expectancy. More gain would be made if the diseases were totally eliminated (Manton et al., 1995).

The effect of eliminating a specific disease on mortality and morbidity was studied for Dutch population. Cause-elimination life table technique was employed to estimate cause-deleted probabilities of dying. Multiple logistic regression model was used to estimate cause-deleted disability prevalence. It was found that elimination of highly fatal diseases can lead not only to an increase in life expectancy but also to a relative expansion of morbidity. And eliminating nonfatal disabling diseases result in compression of morbidity (Nusselder et al., 1996).

Cause-elimination life tables were estimated from multiple causes of death data for four race/sex groups for the U.S. population in 1969. These "multiple causes" life tables were compared to cause elimination life tables (Manton et al., 1980).

With the help of life table, the years of life gained by elimination of the specific causes of death was calculated for the United States in 1939-1941. Potential years of life gained by simultaneous elimination of several causes of death were discussed in that report. The effect of elimination of a specific or a group of causes of death was examined by The US's National Center for Health Statistics. An abridged life table of the United States in 1959-1961 was also prepared on the basis of the assumption that malignant neoplasm is eliminated. It was showed that if cancer were eliminated, 2.27 years of life would be added to life expectancy (Dublin et al., 1949).

The mortality experience of the Australian population was analyzed by age, sex and selected causes of death during 1971 to 1992. A time trend analysis of age-standardized mortality rates were calculated by causes of death between 1971 and 1992. Regional mortality across Australia was also discussed considering that time period.

A comparison of the probabilities at birth of eventually dying from some specific causes was made in 1989-1991 in the US. It was found that heart disease and cancer were the two leading causes of death. A person had a 36 percent chance of dying from heart disease and a 22 percent chance of dying from malignant neoplasm. Eliminating heart disease would increase life expectancy at birth by nearly 13 years for those who would otherwise have died of heart disease. For those who would have died of cancer, the gain was approximately 15 years. However, for the other causes that excessively affect the younger population such as accidents, homicide, and HIV infection, the gains in life expectancy are larger, 28.67 years, 42.84 years, and 37.50 years respectively. In the case of those causes of death that affect primarily the beginning years of life, the gains in life expectancy are very large. If Sudden Infant Death Syndrome (SIDS) were eliminated, those who would have otherwise died from SIDS, would gain an additional 75.56 years on average. The gain for those who would have died of perinatal conditions was 75.57 years (Anderson, 1999).

Human Mortality Databases of 40 developed countries and regions were compared using national life table data for the period 1840 to 2009. It was found that although only 38% of deaths were premature, 84% of the increase in life expectancy resulted from avoiding premature deaths. A death was defined as premature if postponing it to a later age would decrease life disparity. Life disparity is a measure of how much lifespan differ among individuals. Another interesting observation from this

study is: the lower the life disparity is, the greater is the effort required to achieve an additional year of life expectancy (Vaupel et al., 2011).

The association between individual income and remaining life years at the statutory retirement age (65) was studied in the Netherlands during 1996 to 2007. It was revealed that, conditional on marital status, individual income is about equally strong and negatively associated with mortality risk for both men and women. It was also found that the remaining life expectancy at age 65 was approximately 2.5 years less for low-income individuals than that for high-income individuals (Kalwij et al., 2013).

Cardiovascular disease is a major non-communicable disease taking almost 17 million lives each year. It is observed that decreasing primary risk factors such as unhealthy nutrition, physical inactivity, smoking etc. can decrease the body count significantly. Cost-effective healthy diet, physical activity, and avoiding smoking are able to decrease the organic changes that produce the lethal consequences of cardiovascular disease. Japanese diet got special importance because the longest life expectancy at birth and the smallest cardiovascular mortality can be found there (Fehér & Lengyel, 2006).

The effect of physical inactivity on major non-communicable diseases such as coronary heart disease, type-2 diabetes, and breast and colon cancers was examined for different countries. It was found that physical inactive persons are at greater risk of suffering from those diseases. Country-wise estimation was made for how much disease could be averted if physical inactivity were eliminated. Life-table analysis was used to estimate gains in life expectancy of the population. It was estimated that physical inactivity caused more than 5·3 million of the 57 million deaths that occurred worldwide in 2008. And elimination of physical inactivity would add 0.68 years to the life expectancy of the world's population. A 10% improvement in physically inactive population would have saved 533,000 lives (Lee et al., 2012).

To identify the main factors associated with neonatal mortality in Bangladesh a research was carried out. Sample of neonatal deaths was taken from 12 areas where mothers had received NGO health education and maternal health services. A case-control design was used for collection of data from mothers whose children, born alive in 2003, died within 28 days postpartum (cases), or did not die (controls). Crude and adjusted odds ratios (AOR) were calculated as estimates of relative risk for neonatal death, using 'neighborhood' controls and 'non-neighborhood' controls. For two sets of controls, the

results were complications-during-delivery [AOR, 2.6 (95% CI: 1.5-4.5) and 3.1 (95% CI: 1.8-5.3)], prematurity [AOR, 7.2 (95% CI: 3.6-14.4) and 8.3 (95% CI: 4.2-16.5)], care for a sick neonate from an unlicensed 'traditional healer' [AOR, 2.9 (95% CI 0.9-9.5 and 5.9 (95% CI: 1.3-26.3)], or care not sought at all [AOR, 23.3 (95% CI: 3.9-137.4)] (Mercer et al., 2006).

The prevalence and distribution pattern of multimorbidity among the persons of ages ≥60 was studied in rural Bangladesh. Data was collected from the Matlab Health and Demographic Surveillance System of the International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B). Multimorbidity is defined as suffering from two or more of nine chronic medical conditions, such as arthritis, stroke, obesity, signs of thyroid hypofunction, obstructive pulmonary symptoms, symptoms of heart failure, impaired vision, hearing impairment, and high blood pressure. Multivariate logistic regression analysis was used here. The result showed the overall prevalence of multimorbidity among the study population to be 53.8%. It was significantly higher among women, illiterates, singles, and persons in the non-poorest quintile (Khanam et al., 2011).

A study was conducted on causes of death of adults and elderly in Matlab, health and demographic surveillance area. Communicable diseases accounted for 18% and non-communicable diseases for 66% of all the deaths of adults and the elderly. It was revealed that the proportion of non-communicable diseases was increasing with age. The leading non-communicable diseases were circulatory system related diseases (35%), neoplasm (11%), respiratory system related diseases (10%), diseases of the digestive system (6%), endocrine and metabolic disorders (6%), injury and other external causes (5%). It emphasizes that the health system of this country needs to be improved according to pattern of morbidity and mortality to mitigate the income-erosion consequences of prolonged ill-health and premature death of adults (Alam et al., 2010).

From the survey data collected by ICDDR,B in 2008, it was reported that the overall death rates was 7.9 per thousand for male and 5.9 per thousand for females. Infant mortality rate was 33.6 and 22.3 per thousand live births respectively for males and females. It revealed that the expectation of life at birth had improved significantly in 2008 compared to 2007. In 2007, the life expectancy at birth was 68.1 years for males and 71.4 years for females whereas, in 2008, they were 68.7 years and 72.2 years respectively. The number of deaths in age-group 15-60 was 155.3 for males and 91 for

females per 1,000 people in 2008. In 2007 it was 173 and 91.6 respectively for males and females. Expectation of life was found higher in females in almost all the age groups. The report also assessed some causes of deaths. For neonates, prematurity and low birth weights were found vital irrespective of sex and area. Some major communicable and non-communicable diseases led to unexpected deaths too. The leading communicable diseases in the ICDDR,B service area were diarrhoea, respiratory infections, dysentery and septicaemia etc. On the other hand, in Government service area, the diseases were tuberculosis, respiratory infections, hepatitis and diarrhea. Circulatory system related diseases (stroke, ischaemic heart disease and hypertensive disease), neoplasms, asthma, diabetes, and digestive diseases were the major causes of deaths for both sexes. Accidents and drowning were the prominent causes of death in the injury category for both sexes (ICDDR,B, 2010).

The effect of obesity on life expectancy was examined and compared between the low and the high-income countries. To conduct the study, two data sets were used: Health and Retirement Study 2000 and 2004 for the United States and the Mexican Health and Aging Study 2001 and 2003 for Mexico. The result concluded that excessive mortality is associated with obesity. Relative risk was computed to make conclusion. The result established that for age group 60+, the mortality risk due to obesity and overweight were higher for Mexico than United States. In Latin American countries, the rapid growth of obesity and overweight occurred jointly with poor socioeconomic conditions. There was a gap in education level between these two countries (Monteverde, Noronha, Palloni & Novak, 2010).

Some interesting association was found on life expectancy in relation with hospital utilization. In some cases, if total days spent in hospital decline, then life expectancy would rise. For other cases, the gain in life expectancy increases with an increase in hospital days. It was showed that if mental health disorders were eliminated, life expectancy at age 45 would increase in little amount, from 34.9 to 35.3 years, but time spent in hospital would decline from 168 to 151 days. On the other hand, if diseases of the circulatory system were eliminated, life expectancy at age 45 would increase from 34.9 to 41.6 years, but time spent in hospital would shift from 168 to 209 days. Elimination of other diseases such as injuries, poisoning, and diseases of the nervous system had an inverse relationship, that is, reducing hospital use assured increasing life expectancy (Wayne & Gerry, 1995).

A sample of 5975 death certificates was examined in Netherlands in the year 1990. For the purpose of quantifying age and sex adjusted differences between four main underlying causes of death (neoplasms, cardiovascular diseases, respiratory diseases, all other diseases) logistic regression analysis was used. The prevalence differences were used to revise conventional methods of life expectancy. By conventional approach, the gain in life expectancy by elimination of cardiovascular diseases exceeded that for neoplasms by more than a year. In the revised method the number of years to be gained was found approximately equal (Mackenbach, 1999).

The mortality data of New South Wales of years 2000-2002 was studied. The study used abridged, multiple decrement and cause-elimination life tables to analyze mortality data. The effect of elimination of ischaemic heart disease (IHD) was also examined. The result showed that if diseases of cardiovascular system for people aged 65+ years, malignant neoplasm for people aged <65 years, and accidents, injury and poisoning, mainly for men aged 15-29 years were eliminated, then life expectancy would increase substantially. If IHD was eliminated, then 7.5 years for males and 6.7 years for females would add to the life expectancy at birth for them (Weerasinghe et al., 2009).

Cupola functions were used for potential dependence between heart disease or cancer and other causes of death. Another tool, correlation coefficient, was used to find the dependence structure. It was found that life expectancy at birth would increase by 3 months- to 6.5 years if cancer mortality was eliminated, and by 5 months- to 7.5 years for the elimination of heart disease (Somerville & Francombe, 2005).

A cross-sectional survey was conducted consisting of 7809 residents of south-western rural Uganda. The age of the population was 13+. Some risk factors were identified for non-communicable diseases. Mainly, socioeconomic status (SES) including household features, ownership, and occupation and education of the head of household was considered. Principal component analysis was used to find the risk factors. SES had strong relationship with NCD in rural population. Smoking, alcohol consumption (men only) and low high-density lipoprotein (HDL) cholesterol were more common among those of lower SES. However, low physical activity or consumption of fruits, vegetables or staples was not associated with SES (Murphy et al., 2012).

A cross sectional study was conducted involving 535 participants inhabitants of Sokoto in Nigeria to unravel the prevalence and pattern of Non-communicable diseases. The participants had overweight, obesity and morbid obesity containing 12.3%, 6.7%

and 0.9% of the population respectively. The prevalence of pre-hypertension and hypertension was 8.5% and 30.2% respectively (Makusidi et al., 2013).

The impact of malaria disease on overall mortality was examined for the Kassena-Nankana district of northern Ghana. Cause-of-death data was gathered from Navrongo Health Research Centre through the Navrongo Demographic Surveillance System (NDSS). To find the pattern of mortality for malaria disease, multiple-decrement life tables and associated multiple-decrement life-table techniques were employed. It was found that between about one-fourth and one- third of all deaths in this population were attributable to malaria. Almost 45 percent of the deaths due to malaria occur to children. If malaria were eliminated, life expectancy at birth would be expected to increase more than six years for the population (Bawah & Binka, 2005).

The effect of eliminating cerebrovascular death on the life expectancy was examined for Chinese population of recent years. Significant difference was found between rural and urban people. The data was collected from Death Surveillance data sets in 2005 and 2010 provided by the National Disease Surveillance System. Standard life table technique was used for finding cause elimination life expectancy. It was found that the loss of life expectancy was 2.26 years in 2010 and 0.04 years in 2005. The risk was highest for people of age 40+. The urban people showed decreasing trend and rural residents showed increasing trend for cerebrovascular deaths (Li et al., 2013).

It was stated that life expectancy at birth of Japanese people is now the longest in the world. To examine the effect of elimination of diseases and injuries, Japanese national health statistics data was chosen in 2007. The people were divided into two groups- with activity, and without activity limitation population. Six diseases were selected. These were injuries, malignant neoplasms, ischemic heart disease, cerebrovascular diseases, dementia, shoulder lesions/low back pain and fracture. Life tables that eliminate deaths and life tables without elimination of deaths were used for the analysis. It was found that life expectancy at birth was 79.2 years for males and 86.0 years for females. After eliminating malignant neoplasms, ischemic heart disease, and cerebrovascular diseases, people gains 0.6 to 4.0 years and for the other 3 diseases and injuries people gains only 0.0–0.1 years (Hashimoto et al., 2012).

CHAPTER THREE

DATA SOURCES AND METHODOLOGY

3.1 Introduction

Mortality data based on diseases is needed to analyze probability pattern of deaths for this study. It is not possible for an individual to collect the age-cause raw data from a large enough experimental area of population due to lack of time, resources, equipments and funds. International Centre for Diarrhoeal Diseases Research, Bangladesh (ICDDR, B) has created a great opportunity to overcome this situation by offering cause-specific age and sex data on mortality for Matlab population. It has created a great scope to investigate major causes of deaths and project the population that will die of different causes.

Matlab HDSS (Health and Demographic Surveillance System) started work in 1966 as a major part of the field research program of ICDDR,B. Matlab thana is in the district of Chandpur of Bangladesh. It is located about 55 kilometers southeast of the country's capital, Dhaka at 23.38° north latitude and 90.72° east longitude. It is treated as the largest and longest sustained Demographic Surveillance System. The total DSS (Demographic Surveillance System) area is 184 sq. km. It helps to develop better health management both in Bangladesh and the rest of the world.

ICDDR,B regularly publishes yearly reports. The reports are circulated among interested scientists, researchers, policy makers and program managers within and outside the country. HDSS data are extensively used for researchers which are published in scientific journals.

3.2 Data Sources

This study used the vital registration, maternal and child health data from the years 2000, 2004 and 2008 from Matlab, Bangladesh,. The data were collected and published by Health and Demographic Surveillance System of ICDDR,B.

The surveillance area is divided into two areas: an ICDDR,B service area, and a Government service area which receives usual government health and family planning services. The ICDDR,B service area is sub-divided into four blocks where family planning, immunization and limited curative services are provided to children of age under-five and women of reproductive age.

Primary data from 30th ward of Rajshahi City Corporation, Bangladesh was used in this study. An investigation has been made to obtain a clear concept regarding mortality, morbidity and relevant issues. The data included 278 households in Mohonpur Moholla of 30th ward of Rajshahi City Corporation.

3.2.1 Secondary Data: Matlab Population

The data used in this study were extracted from the Scientific Report No. 89, 93 and 109 published by ICDDR,B.

In 2000, 2004 and 2008, the surveys counted 218579, 224476 and 222218 individuals respectively. In 2000, the number of male was 106370 and female was 112209. In 2004, the number of male was 107439, and 117037 were female. In 2008, 103579 were male and 118639 were female.

In the year 2000, out of 1530 registered deaths, 19% were infants, 7% were children (1-4 years), and 52% were of age 60 and above. In 2004, 15.4% were infants, 4.2% were children of age 1-4 years, and 58.5% were aged 60 years and above out of 1,582 deaths. In 2008, out of 1,514 deaths, 9.4% were infants, 4% were of children aged 1-4 years, and 65% were aged 60 years and above in 2008. The data found 848, 858 and 815 deaths out of 106370, 107439 and 103579 midyear male population in those years respectively. For females, the number of deaths was 682, 724 and 699 out of 112209, 117037 and 118639 midyear female populations in years 2000, 2004 and 2008 respectively. The missing and unknown values were not accounted here because anonymous causes could not provide suitable information. So, 48 of the dead males and 49 of the dead females in 2000, 13 of the dead males and 16 of the dead females in 2004 and 39 of the dead males and 38 of the dead females in 2008 were decoded.

3.2.2 Primary Data: A Micro Survey from Mohonpur, Rajshahi

A survey was conducted in the area of Mohonpur. From this survey has helped to find out some socio-demographic risk factors of the causes of death were found. The choice of sample size for this analysis was made after balancing analytical requirements against cost, time and other logistic feasibility. The supporting information is summarized in the following table.

Table 3.1. Distribution of population of Mohonpur by indicated category

Indication category	Number
Total Household	278
Male person(Household head)	254
Female person (Respondent)	277
Number of Deaths	19
Total diseased person	106
Non-communicable disease person	93

3.2.2.1 Sampling Design

The research study on "Interrelationship between socio-demographic factors and diseases: Evidence from a micro survey" is based on the prospective pilot survey carried out on Mohonpur.

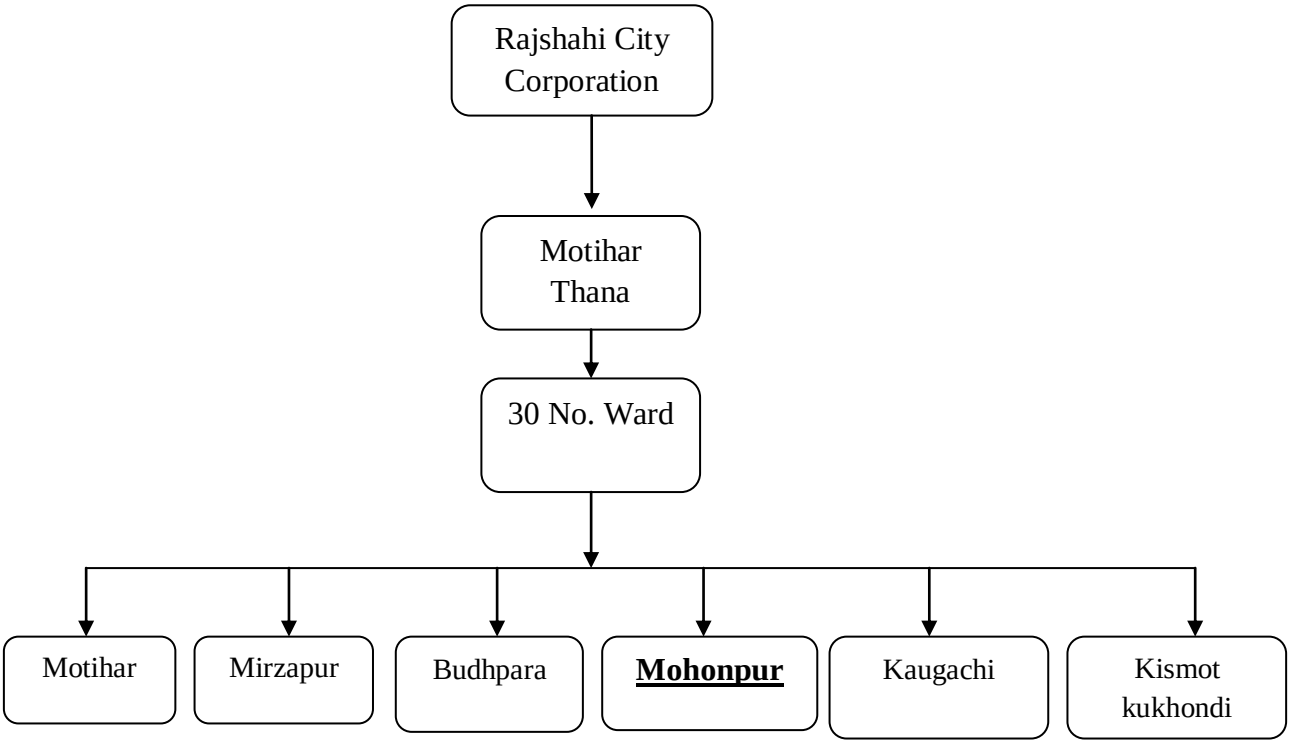


Figure 3.1. Position of the study area at a glance

3.2.2.2 Determination of Sample Size

Sample size estimation is an important factor to sampling design. There are many formulas to calculate sample size according to various aspects. For example, sample size estimation for single proportion or difference between two proportions.

The formula, $n= [Z_{\alpha/2}^2\{P_1 (1-P_1) +P_2 (1-P_2)\}]/d^{2*}$ was applied for the determination of sample size relevant to the study (Sultana, 2012).

where

n = required sample size,

$Z_{\alpha/2}$ = standard normal value at confidence level 100(1-α) % (ideal value is 1.96 at 95%),

P_1 = referred prevalence of group-1 = 0.0075 (No. of male death 776/ Midyear pop. 103579),

P_2 = referred prevalence of group-2 = 0.0056 (No. of female death 661/ Midyear pop. 118639), and

d = difference between the two groups = 2%.

Equal sample size is taken in both groups [total 2n]. For cluster sample, the sample size was multiplied by the design effect (d) whose value is usually 2.

So, n=124.97 and 2n=249.94~250

3.3 Data Processing

Data processing is a key factor to a research and to report-writing. Data processing procedure consists of three parts: editing, coding, and computing.

3.3.1 Editing

Responses to questionnaire were carefully checked each day following the completion of data collection of that day. The data were edited rigorously to correct any existing inconsistencies and to minimize the non-sampling error in the study. During the editing period the following considerations were taken into account:

- ✓ The data should be complete.
- ✓ The data should be consistent and
- ✓ The data should be accurate

3.3.2 Coding

All recorded data were coded in code sheets according to a comprehensive code plan. It makes the process easier and faster. Possible biases were minimized during the coding of open question.

3.3.3 Computing

Edited and coded data were next processed in a computer. Each data was entered in the SPSS software. The quantitative data were typed as it were, while the qualitative data were transferred by suitable numeric representations. The entire analysis of data was performed using SPSS (Statistical Package for Social Science) version 15.0, and Microsoft Office Excel 2007.

3.3.4 Presentation of Data and Results

Graphical representation of a frequency distribution is more effective than tabular representation and it is also easily comprehensible. Diagram is essential to convey the statistical information to the general public. It also facilitates the comparison of two or more frequency distributions. Some important types of graphical representation used in this study are given below:

1. **Bar diagram**: In bar diagram, multiple variables are compared easily. In this diagram different categories are represented along X-axis and their corresponding values are represented along Y-axis.

2. **Pie chart**: Pie diagram represents the variables in a circle shape. Pie diagram is used for only single variable.

3. **Line chart**: Line charts are helpful to show trends over time or ordered categories, especially when there are many data points and the order in which they are presented is important.

3.4 Limitations

The study uses secondary data of HDSS that conducts to serve their own purpose.

The present study was carried out to collect information on various socioeconomic and demographic factors. However, there were certain limitations because of the illiteracy and ignorance of the rural people. It also contained missing values associated with many important variables. For e.g. many people did not know their exact age.

3.5 Methodology

To analyze mortality data, Abridged Life table, Multiple Decrement Life table, Single Decrement Life table, Exponential Growth model, Auto Regressive Integrated Moving Average (ARIMA) model, and Polynomial Regression model were used. These models are described briefly in the regarding sections.

This study considers bivariate analysis of diseased people for some selected independent variables. To investigate the effect of independent variables on the dependent variables and their statistical significances, contingency analysis of selected variables was carried out. The contingency analysis investigates the degree of association between selected variables. The correlation analysis examines the direction and magnitude of the interrelationship of the variables under study.

In a bivariate analysis, the use of percentages is an advantageous first step in studying the relationship between two variables. In view of performing differential analysis, it is required to categorize these variables by differentiating each quantitative variable into various categories on the basis of their respective standard ranges. Also, mortality rates from relevant chapters are used.

Probability pattern of deaths can be found by using Multiple Decrement Life table technique. It is easy to examine the probability pattern of deaths by age by a cause of death in presence of all causes using data from the years 2000, 2004 and 2008. The purpose is to identify the main causes of deaths that influence the mortality.

The elimination of major diseases can improve the health quality and increase life expectancy. The outcome of this analysis can help detecting the diseases which are to be controlled and utilizing the resources of health sector in a better efficient way. Single decrement life table is used in this case. The exponential growth model and ARIMA model are useful tools to project the future trend.

Cross tabulation displays the distribution of two variables. Cross table is a two-way table consisting of rows and columns. It is usually used to determine whether there is a relationship between row variable and column variable. If there are r rows and c columns in the table, then "theoretical frequency" for a cell is given in the table. The formula of expected frequency is:

$$E_{ij} = \frac{R_i \times C_j}{N} \text{ , where } R_i = \sum_i R_i \text{ and } C_j = \sum_j C_j$$

The chi-squire statistics:

$$\chi^2 = \sum_i \sum_j \frac{O^2_{ij}}{E_{ij}} - N \sim \chi^2_{(r-1)(c-1)}$$

Hypothesis testing

Null Hypothesis, H_o: There is no relation between Age of death and Disease of death

Alternative Hypothesis, H_1: There is relation

Test statistics: $$\chi^2 = \sum_i \sum_j \frac{O^2_{ij}}{E_{ij}} - N \sim \chi^2_{(r-1)(c-1)}$$

Prevalence rate: Prevalence rate is a good indicator of the disease occurring in a population. Prevalence rate refers to the proportion of cases of a disease existing in a population. It includes freshly diagnosed cases as well as those living with the disease, to the total population. Generally,

$$Prevalence\ rate = \frac{No.\ of\ cases\ in\ a\ disease}{Population\ size} \times 100$$

Thus, the following formulas can be used to obtain prevalence rate for this study.

$$Prevalence\ rate = \frac{No.\ of\ cases\ in\ a\ disease}{Respondent\ size(277)} \times 100$$

$$Prevalence\ rate = \frac{No.\ of\ cases\ in\ a\ disease}{The\ number\ of\ household\ head(254)} \times 100$$

To find the risk factors a commonly used logistic model is needed.

Logistic regression model is the most appropriate and commonly used.

Logistic regression: Logistic regression is applicable to that situation where the data of dependent variable are available in presence or absence manner of a characteristic. It measures the relationship between a dichotomous dependent variable and one or more independent variables. Logistic regression does not consider a linear relationship between the dependent and independent variables. The coefficients of logistic regression can be used to estimate odds ratios for each of the independent variables in the model.

There are two important uses of logistic regression:

i. It is used for prediction the dependent variable
ii. It also provides knowledge of the relationships and strengths among the variables

The logistic regression model is defined as follows:

$$\text{logit } (Y_i) = ln\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} \quad (1)$$

To predict the probability of the occurrence of the outcome of interest, antilog has been taken on both sides of (1) to obtain

$$\pi_i = \text{Probability}\left(\left(Y = \text{outcome of interest} \middle| \begin{matrix} X = x, \\ \text{a specific value of x} \end{matrix}\right)\right) = \frac{e^{\beta_0+\beta_1 X_{1i}+\beta_2 X_{2i}+\cdots+\beta_k X_{ki}}}{1 + e^{\beta_0+\beta_1 X_{1i}+\beta_2 X_{2i}+\cdots\beta_k X_{ki}}}$$

Where π is the probability of the outcome of interest

β_0 is the Y intercept

β's are the regression coefficients and

e = 2.71828 is the base of the system of natural logarithms.

3.6 Concept of Terminology

3.6.1 Classification of Stages of Life

" The global burden of disease (GBD) or Global Burden of Disease Study is a comprehensive regional and global assessment of mortality and disability from major diseases, injuries, and risk factors. The GBD project was commissioned in 1990 and is a collaborative effort between hundreds of experts worldwide, including researchers at the World Health Organization (WHO), Harvard School of Public Health, the Institute for Health Metrics and Evaluation (IHME), and the World Bank." ("Global burden of disease," 2013)

This study has used the same classification scheme as those used in the GBD (0-14, 15-59, 60+) or more detailed age groups such as those used in the GBD 2000 (0-4, 5-14, 15-29, 30-44, 45-59, 60-69, 70-79, 80+).

3.6.2 Classification of Diseases

The official international statistical classification defines cause of death as "the disease or injury that initiated the train of events leading directly to death, or the circumstances of accident or violence which produced the fetal injury."

The disease selection should be based on the list used for the GBD (Global Burden of Diseases) 2000 (Murray et al., 2001). Overall mortality is divided into three broad groups of causes: Group I- consisting of communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional deficiencies, Group II encompassing the non-communicable diseases; and Group III- comprising intentional and unintentional injuries.

Country perspective is the base of modifying the causes of deaths. We work with four broad groups. They are as follows:

1. Neonatal and maternal condition based (D1)--Maternal deaths, Premature and LBW, Birth asphyxia, Nutritional, Other neonatal.

2. Communicable diseases (D2) --Diarrhoeal, Dysentery, Tuberculosis, EPI related death, Meningitis, Hepatitis, Chicken pox, Rabies, Septicemia, Respiratory infections, Other communicable diseases.

3. Non-Communicable diseases(D3)--Malignant neoplasm, Neoplasm, Neoplasm in female organ, Congenital malformation, Endocrine disorder -Diabetes, Other endocrine, Neuro-psychiatric, Diseases of circulatory system-Rheumatic heart disease, Hypertensive disease, Ischemic heart disease, Stroke, Other cardiovascular, Respiratory disease-COPD, Asthma, Other respiratory, Digestive disease, Gentio-urinary disease - Renal failure, Nephritic syndrome, Other urinary and Other non-communicable.

4. Injuries and miscellaneous (D4)--Unintentional injuries-Accident, Drowning and intentional injuries– Suicide, Homicide. Also, miscellaneous-Senility, Fever of unknown origin, Edema of unspecified origin, Sudden infant death.

CHAPTER FOUR

CLASSIFICATION OF DISEASES AND DISTRIBUTION OF DEATH

4.1 Introduction

Methodology of the study and sources of data were discussed in the previous chapters. In this chapter, an overall idea of the mortality pattern of male and female population of the study area will be presented primarily by distribution of death. The different causes of deaths and their trends such as whether the deaths show increasing or decreasing pattern provide essential information. Age groupings of deaths are important to determine if deaths affect a particular age group more severely than the others. This chapter focuses on three major areas related to deaths. These are:

i. Percentage of deaths by diseases
ii. Percentage of deaths by ages
iii. Gender based death distribution

Percentage distribution of deaths, mortality rates, and cause specific mortality rates are helpful to investigate the patterns of deaths and diseases. Different kinds of percentage tables are constructed to acquire the following information:

i. Percentage distribution of causes of deaths within a stage of life
ii. Cause specific percentage distribution of deaths at different stages of life
iii. Percentage distribution due to causes of deaths and stages of life

In the case of (i), the total deaths occurred in a specific stage of life is distributed according to causes of deaths and by sex. In the case of (ii), the deaths by a specific cause are distributed according to the stages of life and sex. In the case of (iii), the total deaths of a sex were distributed according to stages of life and causes of deaths. The study of mortality provides the information of cause specific deaths by age and sex of the diseased person. The groups of diseases were discussed in detail in the previous chapter.

4.2 Distribution of Death

Table 4.1. Percent age distribution of deaths due to various causes within a stage of life (Matlab population, 2000)

Age Group		All causes	D1	D2	D3	D4
	Male	100.00	67.76	27.63	0.66	3.95
<1	Female	100.00	69.40	23.88	0.00	6.72
	Both	100.00	68.53	25.87	0.35	5.24
	Male	100.00	2.13	23.40	4.26	70.21
1--4	Female	100.00	25.45	20.00	0.00	54.55
	Both	100.00	14.71	21.57	1.96	61.76
	Male	100.00	2.38	21.43	9.52	66.67
5--19	Female	100.00	14.29	9.52	9.52	66.67
	Both	100.00	6.35	17.46	9.52	66.67
	Male	100.00	0.00	25.81	29.03	45.16
20--44	Female	100.00	35.42	14.58	16.67	33.33
	Both	100.00	15.45	20.91	23.64	40.00
	Male	100.00	1.31	30.72	47.71	20.26
45--64	Female	100.00	7.53	17.20	46.24	29.03
	Both	100.00	3.66	25.61	47.15	23.58
	Male	100.00	2.03	19.19	41.28	37.50
65+	Female	100.00	4.61	10.28	37.94	47.16
	Both	100.00	3.19	15.18	39.78	41.85
	Male	100.00	14.25	23.88	30.00	31.88
Total	Female	100.00	23.22	15.32	25.28	36.18
	Both	100.00	18.21	20.10	27.91	33.78

Table 4.1 shows the percentages of the four groups of diseases (i.e., the causes of deaths D1, D2, D3, and D4), for male, female, and the overall population irrespective of sex of the year 2000. It was observed that at the infant stage- D1 (Neonatal and maternal condition based diseases) contributed to the most of the deaths; 67.76%, 69.40%, and 68.53% for male, female, and both categories. Female infant died at a higher rate than male infant.

For age 1-4, D4 (Injury and Miscellaneous) took a major part in the death pattern where male children (70.21%) contributed significantly higher than female children (54.55%).

For age 5-19, D4 (Injury and Miscellaneous) continued to be the major cause of deaths. It was equal (66.67%) for male, female and both.

In case of the age group 20-44, D4 (Injury and Miscellaneous) was highest (45.16% for male and 33.33% for female). For female, D1 (Neonatal and maternal) caused more death than D2 and D3 together. For male, D2 (25.80%) and D3 (29.03%) shared more than half of the spectrum between them.

The other age class, 45-64 and 65+ were affected by D3 (Non-communicable) cause of deaths. For age class 46-64, D3 contained 47.71% and 46.24% for male and female categories respectively.

The older group (65+) had lost people mostly due to D3 (Non-communicable) and D4 (Injury and Miscellaneous) causes. D3 was the cause of death for 41.28% male, and 37.94% female.

It was clear that D4 (Injury and Miscellaneous) was an indispensable cause of death containing 33.78% of the total deaths. D3 (Non-communicable) covered 27.91% of the overall causes and was right next to D4 causing 30.00% of male to die.

Table 4.2. Cause specific percentage distribution of deaths by different stages of life (Matlab population, 2000)

Age Group		All causes	D1	D2	D3	D4
	Male	19.00	90.35	21.99	0.42	2.35
<1	Female	21.17	63.27	32.99	0.00	3.93
	Both	19.96	75.10	25.69	0.25	3.10
	Male	5.88	0.88	5.76	0.83	12.94
1—4	Female	8.69	9.52	11.34	0.00	13.10
	Both	7.12	5.75	7.64	0.50	13.02
	Male	5.25	0.88	4.71	1.67	10.98
5—19	Female	3.32	2.04	2.06	1.25	6.11
	Both	4.40	1.53	3.82	1.50	8.68
	Male	7.75	0.00	8.38	7.50	10.98
20--44	Female	7.58	11.56	7.22	5.00	6.99
	Both	7.68	6.51	7.99	6.50	9.09
	Male	19.13	1.75	24.61	30.42	12.16
45--64	Female	14.69	4.76	16.49	26.88	11.79
	Both	17.17	3.45	21.88	29.00	11.98
	Male	43.00	6.14	34.56	59.17	50.59
65+	Female	44.55	8.84	29.90	66.88	58.08
	Both	43.68	7.66	32.99	62.25	54.13
	Male	100.00	100.00	100.00	100.00	100.00
Total	Female	100.00	100.00	100.00	100.00	100.00
	Both	100.00	100.00	100.00	100.00	100.00

Table 4.2 provides information about the deaths caused by D1, D2, D3 and D4 by different stage of life in year 2000.

D1 (Neonatal and Maternal) was responsible for 18.21% (table 4.1) of the total deaths, 75.09% of which occurred at infancy. 90.35% of the male D1-victims were infant children. D1 affected at the infancy stage of life.

D2 (communicable diseases) mostly affected people aged 65+, 45-64, and less than 1 year with corresponding percentages of 32.99% , 21.88%, and 25.69% respectively.

D4 was the leading cause of death at the age of year 1-4, 5-19, and 20-44. 54.13% of the total D4 (Injury and Miscellaneous) victims were aged 65+. 13.02% of D4 deaths occurred at the age class 1-4, 8.68% of D4 deaths at the age class 5-19, and 9.09% at the age class 20-44.

The second major cause of deaths was D3 (Non-communicable). From Table 4.2, it was seen that the D3 mostly occurred at the later stages of life. 62.25% of D3 victims were aged 65+. Another 29.00% were of the age class 45-64. So, the non communicable disease was a dominant cause for these age groups.

Table 4.3. Percent age distribution of deaths among sexes due to various causes by different stages of life (Matlab population, 2000)

Age Group		All causes	D1	D2	D3	D4
	Male	10.61	7.19	2.93	0.07	0.42
<1	Female	9.35	6.49	2.23	0.00	0.63
	Both	19.90	13.64	5.15	0.07	1.04
	Male	3.28	0.07	0.77	0.14	2.30
1-4	Female	3.84	0.98	0.77	0.00	2.09
	Both	7.10	1.04	1.53	0.14	4.38
	Male	2.93	0.07	0.63	0.28	1.95
5-19	Female	1.47	0.21	0.14	0.14	0.98
	Both	4.38	0.28	0.77	0.42	2.92
	Male	4.33	0.00	1.12	1.26	1.95
20-44	Female	3.35	1.19	0.49	0.56	1.12
	Both	7.65	1.18	1.60	1.81	3.06
	Male	10.68	0.14	3.28	5.09	2.16
45-64	Female	6.49	0.49	1.12	3.00	1.88
	Both	17.12	0.63	4.38	8.07	4.04
	Male	24.01	0.49	4.61	9.91	9.00
65+	Female	19.68	0.91	2.02	7.47	9.28
	Both	43.56	1.39	6.61	17.33	18.23
	Male	55.83	7.93	13.29	16.70	17.75
Total	Female	44.17	10.23	6.75	11.13	15.94
	Both	100.00	18.21	20.10	27.91	33.78

Percentage distribution of deaths according to four causes and different stages of life of males and females for the year 2000 is presented in Table 4.3.

Table 4.3 shows that, in Bangladesh, D4 (Injury and Miscellaneous) was the leading cause of death (about 33.78% of deaths) closely followed by 27.91% of deaths of D3 (Non-communicable). D1 and D2 caused 18.21% and 20.10% of the total deaths respectively.

65+ deaths contributed a massive 43.56% to total deaths. The top two causes responsible for 65+deaths consisted of D3 and D4, contributing 17.33% and 18.23% to that number of 43.56%.

The second major percentage of deaths (19.90%) happened to children aged under 1 year. D1 (Neonatal and Maternal) played a vital role at this period contributing 13.64 to that of 19.90.

D3 (Non-communicable) showed notably high rates (8.07%) for the age group 45-64, 5.09% for male and 3.00% for female respectively.

Male mortality was higher than female mortality; 55.83% and 44.17 % for male and female respectively. This trend was followed by D3 (16.70% male and 11.13% female).

Table 4.4. Percent age distribution of deaths due to various causes within a stage of life (Matlab population, 2004)

Age Group		All causes	D1	D2	D3	D4
	Male	100.00	73.33	12.50	6.67	7.50
<1	Female	100.00	70.69	13.79	6.90	8.62
	Both	100.00	72.03	13.14	6.78	8.05
	Male	100.00	5.41	13.51	13.51	67.57
1--4	Female	100.00	3.57	7.14	7.14	82.14
	Both	100.00	4.62	10.77	10.77	73.85
	Male	100.00	0.00	7.69	46.15	46.15
5--19	Female	100.00	10.53	7.89	60.53	21.05
	Both	100.00	6.25	7.81	54.69	31.25
	Male	100.00	0.00	7.14	70.00	22.86
20--44	Female	100.00	17.86	1.79	66.07	14.29
	Both	100.00	7.94	4.76	68.25	19.05
	Male	100.00	0.00	8.00	86.29	5.71
45--64	Female	100.00	0.97	2.91	87.38	8.74
	Both	100.00	0.36	6.12	86.69	6.83
	Male	100.00	0.48	11.03	75.54	12.95
65+	Female	100.00	2.72	6.27	75.20	15.80
	Both	100.00	1.53	8.80	75.38	14.29
	Male	100.00	10.89	10.30	63.91	14.91
Total	Female	100.00	15.25	6.78	61.58	16.38
	Both	100.00	12.88	8.69	62.85	15.58

Table 4.4 shows the percentage distribution of different causes of deaths within the stages of life for male, female, and both categories. It was found that, at the infant stage, D1 (Neonatal and Maternal) contributed most of the shares which were 73.33% for male, 70.69% for female, and 72.03% irrespective of sex.

For the age 1-4, D4 (Injury and Miscellaneous) was the dominant cause of death. Female children contributed significantly higher deaths (82.14%) than male children (67.57%).

It was observe that D3 (Non-communicable) was the dominant cause of death for age group 5-19 years. It was 46.15% for male, 60.53% for female, and 54.69% irrespective of sex.

For ages 20-44, D3 (Non-communicable) continued to be the dominant cause of deaths. 70.00% of the male deaths and 66.07% of the female deaths were because of D3.

For age groups 45-64 years, almost the whole spectrum of deaths was captured by D3 (86.69% of all deaths in this age group). For the age group of 65+ years, 75.38% died due to D3 (Non-communicable) cause of deaths.

It was indicated that age groups of 5-19, 20-44, 45-64, and 65+ years, the majority of deaths were due to D3.

Table 4.5. Cause-specific percentage distribution of deaths by different stages of life (Matlab population, 2004)

Age Group		All causes	D1	D2	D3	D4
	Male	14.20	95.65	17.24	1.48	7.14
<1	Female	16.38	75.93	33.33	1.83	8.62
	Both	15.20	85.00	22.96	1.64	7.85
	Male	4.38	2.17	5.75	0.93	19.84
1 – 4	Female	3.95	0.93	4.17	0.46	19.83
	Both	4.19	1.50	5.19	0.72	19.83
	Male	3.08	0.00	2.30	2.22	9.52
5-19	Female	5.37	3.70	6.25	5.28	6.90
	Both	4.12	2.00	3.70	3.59	8.26
	Male	8.28	0.00	5.75	9.07	12.70
20- 44	Female	7.91	9.26	2.08	8.49	6.90
	Both	8.11	5.00	4.44	8.81	9.92
	Male	20.71	0.00	16.09	27.96	7.94
45- 64	Female	14.55	0.93	6.25	20.64	7.76
	Both	17.90	0.50	12.59	24.69	7.85
	Male	49.35	2.17	52.87	58.33	42.86
65+	Female	51.84	9.26	47.92	63.30	50.00
	Both	50.48	6.00	51.11	60.55	46.28
	Male	100.00	100.00	100.00	100.00	100.00
Total	Female	100.00	100.00	100.00	100.00	100.00
	Both	100.00	100.00	100.00	100.00	100.00

As seen on Table 4.5, 85.00% of all D1-deaths in 2004 occurred at the infancy stage. 95.65% of all D1 induced male deaths and 75.93% of all D1 induced female deaths were to infantsD2 was spread across different age groups unlike D1. 22.96% deaths induced by D2 were to infants, 12.59% belonged to age group 45-64, and 51.11% to people of age 65+. Again D2 was responsible for 8.69% of all deaths in 2004.

Among all D3 induced deaths, 8.81% occurred to people aged 20-44, 24.69% to people aged between 45-64, and 60.55% to people aged 65+. For the age group 45-64, male population was at more risk of facing D3 induced death than female population. But for people of 65+ years, females faced relatively high risk than the males.

For D4 19.83% deaths occurred at the age 1-4 and 46.28% occurred at ages 65+. Other age groups showed lower and almost equal percentages- such as 7.85%, 8.26%, 9.92%, and 7.85% to age groups <1, 5-19, 20-44, and 45-64 respectively.

So, except D1, the other three causes of death i.e. D2, D3, and D4 had their percentages high on age group 65+ with 51.11%, 60.55%, and 46.28% respectively.

Table 4.6. Percent age distribution of deaths due to various causes by stages of life (Matlab population 2004)

Age Group		All causes	D1	D2	D3	D4
	Male	7.73	5.67	0.97	0.52	0.58
<1	Female	7.47	5.28	1.03	0.52	0.64
	Both	15.20	10.95	2.00	1.03	1.22
	Male	2.38	0.13	0.32	0.32	1.61
1-4	Female	1.80	0.06	0.13	0.13	1.48
	Both	4.19	0.19	0.45	0.45	3.09
	Male	1.67	0.00	0.13	0.77	0.77
5-19	Female	2.45	0.26	0.19	1.48	0.52
	Both	4.12	0.26	0.32	2.25	1.29
	Male	4.51	0.00	0.32	3.16	1.03
20-44	Female	3.61	0.64	0.06	2.38	0.52
	Both	8.11	0.64	0.39	5.54	1.55
	Male	11.27	0.00	0.90	9.72	0.64
45-64	Female	6.63	0.06	0.19	5.80	0.58
	Both	17.90	0.06	1.09	15.52	1.22
	Male	26.85	0.13	2.96	20.28	3.48
65+	Female	23.63	0.64	1.48	17.77	3.73
	Both	50.48	0.77	4.44	38.06	7.21
	Male	54.41	5.92	5.60	34.77	8.11
Total	Female	45.59	6.95	3.09	28.07	7.47
	Both	100.00	12.88	8.69	62.85	15.58

Table 4.6 shows that, for both sexes, the leading cause was D3 (Non-communicable) responsible for about 62.85% of deaths. D4 (Injury and Miscellaneous) was responsible for about 15.58% of the deaths, D1 (Neonatal and Maternal) about 12.88% and D2 (communicable) about 8.69%.

The highest percentage of deaths at older category (65+) was 38.06% due to Non-communicable causes. It was 20.28% for male and 17.77% for female.

The second major occurrence of diseases was also D3 (Non-communicable). It played a vital role at the age 45-64. The percentage for male was 9.72%, 5.80% for female and for both sexes it was 15.52%.

D4 (Injury and Miscellaneous) cause gave a notably high rate which were 1.61% for male. But it was only about 1.48% for female. Total percentage was 3.09% for the age group 1-4.

The other age classes say 5-19 and 20-44 ages were affected by D3 (Non-communicable) cause. D3 (Non-communicable) cause of deaths contributed 2.25% and 5.54% for those of the age group which had the highest percentage of the stages of life.

In summary, the overall percentage of death for male was 54.41% and for female it was 45.59%. It implied that male mortality was higher than female mortality.

Table 4.7. Percent age distribution of deaths by various causes of deaths within a stage of life (Matlab population 2008)

Age Group		All causes	D1	D2	D3	D4
	Male	100.00	78.31	12.05	6.02	3.61
<1	Female	100.00	62.22	26.67	6.67	4.44
	Both	100.00	72.66	17.19	6.25	3.91
	Male	100.00	3.57	17.86	28.57	50.00
1--4	Female	100.00	0.00	21.43	14.29	64.29
	Both	100.00	1.79	19.64	21.43	57.14
	Male	100.00	3.70	14.81	37.04	44.44
5--19	Female	100.00	3.85	26.92	23.08	46.15
	Both	100.00	3.77	20.75	30.19	45.28
	Male	100.00	1.89	5.66	71.70	20.75
20--44	Female	100.00	28.57	2.38	52.38	16.67
	Both	100.00	13.68	4.21	63.16	18.95
	Male	100.00	0.59	9.41	84.71	5.29
45--64	Female	100.00	0.85	4.24	89.83	5.08
	Both	100.00	0.69	7.29	86.81	5.21
	Male	100.00	1.45	7.71	82.89	7.95
65+	Female	100.00	3.98	4.98	80.60	10.45
	Both	100.00	2.69	6.36	81.76	9.18
	Male	100.00	9.66	9.02	70.75	10.57
Total	Female	100.00	8.77	7.72	70.35	13.16
	Both	100.00	9.26	8.42	70.56	11.76

Table 4.7 shows the percent distribution of deaths by causes of deaths for male, female, and both sex of the year 2008. It was found that, at the infant stage, D1 (Neonatal and Maternal) contributed most of the percentage which were 78.31%, 62.22% and 72.66% for male, female and both. Female infant died at a higher rate than male infant.

For the age 1-4, it was found that D4 (Injury and Miscellaneous) took an important part to explain the death pattern where female child (64.29%) contributed higher than male child (50.00%). D4 (Injury and Miscellaneous) was also responsible for death of the 5-19 years aged children. It was almost equal for male children (44.44%) and female children (46.15%).

In the case of age 20-44 years, most of the male person died by D3 (Non-communicable) which covered 71.70% deaths. At this age, females also died mostly by D3 (52.38%).

In the age groups of 20-44 and 45-64 years, the majority of deaths were due to D3 (Non-communicable), 63.16% and 86.81% for both sexes. Moreover for the age group of 65+ years, 81.76% died of D3 (Non-communicable).

In summary, most of the deaths in age under 1 year accounted for D1 cause. For age groups of 20-44, 45-64, 65+ years, the majority of deaths were due to D3 (Non-communicable) cause.

Only for the age group of 1-4, 5-19 years, 57.14% and 45.28% died of D4 (Injury and Miscellaneous).

Table 4.8. Cause specific percent distribution of deaths by different stages of life (Matlab population 2008)

Age Group		All causes	D1	D2	D3	D4
	Male	10.70	86.67	14.29	0.91	3.66
<1	Female	6.81	48.28	23.53	0.65	2.30
	Both	8.91	69.92	18.18	0.79	2.96
	Male	3.61	1.33	7.14	1.46	17.07
1-4	Female	4.24	0.00	11.76	0.86	20.69
	Both	3.90	0.75	9.09	1.18	18.93
	Male	3.48	1.33	5.71	1.82	14.63
5-19	Female	3.93	1.72	13.73	1.29	13.79
	Both	3.69	1.50	9.09	1.58	14.20
	Male	6.83	1.33	4.29	6.92	13.41
20-44	Female	6.35	20.69	1.96	4.73	8.05
	Both	6.61	9.77	3.31	5.92	10.65
	Male	21.91	1.33	22.86	26.23	10.98
45-64	Female	17.85	1.72	9.80	22.80	6.90
	Both	20.04	1.50	17.36	24.65	8.88
	Male	53.48	8.00	45.71	62.66	40.24
65+	Female	60.82	27.59	39.22	69.68	48.28
	Both	56.85	16.54	42.98	65.88	44.38
	Male	100.00	100.00	100.00	100.00	100.00
Total	Female	100.00	100.00	100.00	100.00	100.00
	Both	100.00	100.00	100.00	100.00	100.00

The Table 4.8 gives information about causes of deaths by different stage of life for male, female and both population of the year 2008. D1 (Neonatal and Maternal) was the leading cause (responsible for about 69.92% of deaths) occurred at the infancy stage. It was 86.67% for male infant and 48.28 % for female infant. It was a decreased percentage compared to the corresponding percentages of 2004.

The second major cause of deaths was D3 (Non-communicable) which was responsible for about 26.23% of deaths for male, 22.80% deaths for female and 24.65% deaths for both sexes at the age 45-64 years. At the age 65+, the percentages for D3 were 62.66% of deaths for male, 69.68% deaths for female and 65.88% deaths for both sexes. But it exhibited somewhat increasing trend compared to 2004.

D4 (Injury and Miscellaneous) was also the leading cause at the age 1-4, responsible for about 17.07% of deaths for male, 20.69% deaths for female and 18.93% deaths for both sexes. At the age group 5-19, D4 (Injury and Miscellaneous) accounted for 14.63% deaths for male, 13.79% deaths for female and 14.20% deaths for both sexes. These patterns showed an increasing trend compared to 2004.

It was observed that, out of the total adult deaths (age 20-44), most of them occurred due to D4 (Injury and Miscellaneous). The Table showed 13.41% deaths occurred for males, 8.05% deaths occurred for females, and 10.65% deaths occurred for both sexes. This trend was slightly higher than 2004.

Finally, the majority of people aged 45-64 and 65+ died with non-communicable disease. So, the non communicable disease was a dominant cause for these age groups.

Table 4.9. Percent age distribution of deaths due to various causes by stages of life (Matlab population 2008)

Age Group		All causes	D1	D2	D3	D4
	Male	5.78	4.52	0.70	0.35	0.21
<1	Female	3.13	1.95	0.84	0.21	0.14
	Both	8.91	6.47	1.53	0.56	0.35
	Male	1.95	0.07	0.35	0.56	0.97
1--4	Female	1.95	0.00	0.42	0.28	1.25
	Both	3.90	0.07	0.77	0.84	2.23
	Male	1.88	0.07	0.28	0.70	0.84
5-19	Female	1.81	0.07	0.49	0.42	0.84
	Both	3.69	0.14	0.77	1.11	1.67
	Male	3.69	0.07	0.21	2.64	0.77
20-44	Female	2.92	0.84	0.07	1.53	0.49
	Both	6.61	0.90	0.28	4.18	1.25
	Male	11.83	0.07	1.11	10.02	0.63
45-64	Female	8.21	0.07	0.35	7.38	0.42
	Both	20.04	0.14	1.46	17.40	1.04
	Male	28.88	0.42	2.23	23.94	2.30
65+	Female	27.97	1.11	1.39	22.55	2.92
	Both	56.85	1.53	3.62	46.49	5.22
	Male	54.00	5.22	4.87	38.20	5.71
Total	Female	46.00	4.04	3.55	32.36	6.05
	Both	100.00	9.26	8.42	70.56	11.76

Percentage distribution of deaths according to four causes of deaths by stages of life of males and females for the years 2008 is presented in Table 4.9. It was gained mortality information considering the total deaths.

The Table 4.9 shows that for both sexes, the leading cause was D3 (Non-communicable, responsible for about 70.56% of deaths) followed by D4 (Injury and Miscellaneous, responsible for about 11.76% of deaths), D1 (Neonatal and Maternal, about 9.26%) and D2 (communicable, about 8.42%). The ranking were same to 2004. But the percentages were very high in 2008 compared to 2004.

The highest percentage of older category (65+) was 46.49% by Non-communicable cause. It obtained 22.55% for male and 23.94% for female.

D3 (Non-communicable) again played a vital role at the stage of 45-64. This Table indicates that the percentage for male was 10.02%, 7.38% for female. For both sexes it was 17.40%.

The age category 20-44 was also affected by D3 (Non-communicable). D3 (Non-communicable) contributed 2.64% for male and 1.53% for female for that age group which were the highest percentage for this stage of life.

D4 (Injury and Miscellaneous) was also the leading cause at the age groups 1-4 which was responsible for about 0.97% of deaths for male, 1.25% deaths for female and 2.23% deaths for both sexes at the age 1-4 year and . This cause also contributed most at the age group 5-19.

At the infant stage, D1 (Neonatal and Maternal) contributed most of the percentage which were 4.52%, 1.95% and 6.47% for male, female and both.

In summary, the overall death percentage for male was 54.00% and for female it was 46.00%. Male mortality was higher than female mortality.

4.3 Mortality Rates

Mortality rate is a measure of the number of deaths for a specific cause in a population, scaled to the size of that population, per unit of time. Mortality rate is expressed in units of deaths per 1000 individuals per year.

Cause-Specific Mortality Rate is the mortality rate from a specified cause for a population during a specified time period.

$$Cause\text{-}specific\ mortality\ rate = \frac{Number\ of\ deaths\ from\ a\ specific\ cause}{Total\ \ population} \times 100$$

Table 4.10. Mortality rates by different years for Matlab male and female

Year	Sex	Midyear population	Total deaths	D1	Rate	D2	Rate	D3	Rate	D4	Rate	Overall rate per thousand
2000	Male	106370	800	114	1.07	191	1.80	240	2.26	255	2.40	7.52
	Female	112209	633	147	1.31	97	0.86	160	1.43	229	2.04	5.64
2004	Male	107439	845	92	0.86	87	0.81	540	5.03	126	1.17	7.86
	Female	117037	708	108	0.92	48	0.41	436	3.73	116	0.99	6.05
2008	Male	103579	776	75	0.72	70	0.68	549	5.30	82	0.79	7.49
	Female	118639	661	58	0.49	51	0.43	465	3.92	87	0.73	5.57

Table 4.10 shows the rates and frequencies of deaths for male. For male and female, the first cause, neonatal and maternal diseases (D1), showed decreasing trend. The second cause, communicable diseases (D2), also showed decreasing trend. But the third cause, non-communicable diseases (D3), showed increasing trend and it almost doubled its victim-count from 2000 to 2004. The fourth cause, injuries and miscellaneous (D4), showed significant declining trend. The overall death rate from year 2000 to year 2004

represented growing trend and reached to 7.86 from 7.52, then falling back to 7.49 in year 2008.

It reveals similar characteristics for female. The first cause, neonatal and maternal cause, showed strictly declining trend. The second cause, communicable diseases, also showed decreasing trend. The third cause, non-communicable diseases, showed increasing trend as was in the case of males. And the fourth cause, injuries and miscellaneous, showed diminishing trend. The pattern for females changes similarly to the pattern for males.

In summary, the data showed that the neonatal and maternal cause (D1), communicable cause (D2), and injuries and miscellaneous causes (D4) displayed downward trend and only non-communicable disease (D3) showed uprising trend for both male and female. Also the overall death rates were higher to male population. The following diagram depicts this fact.

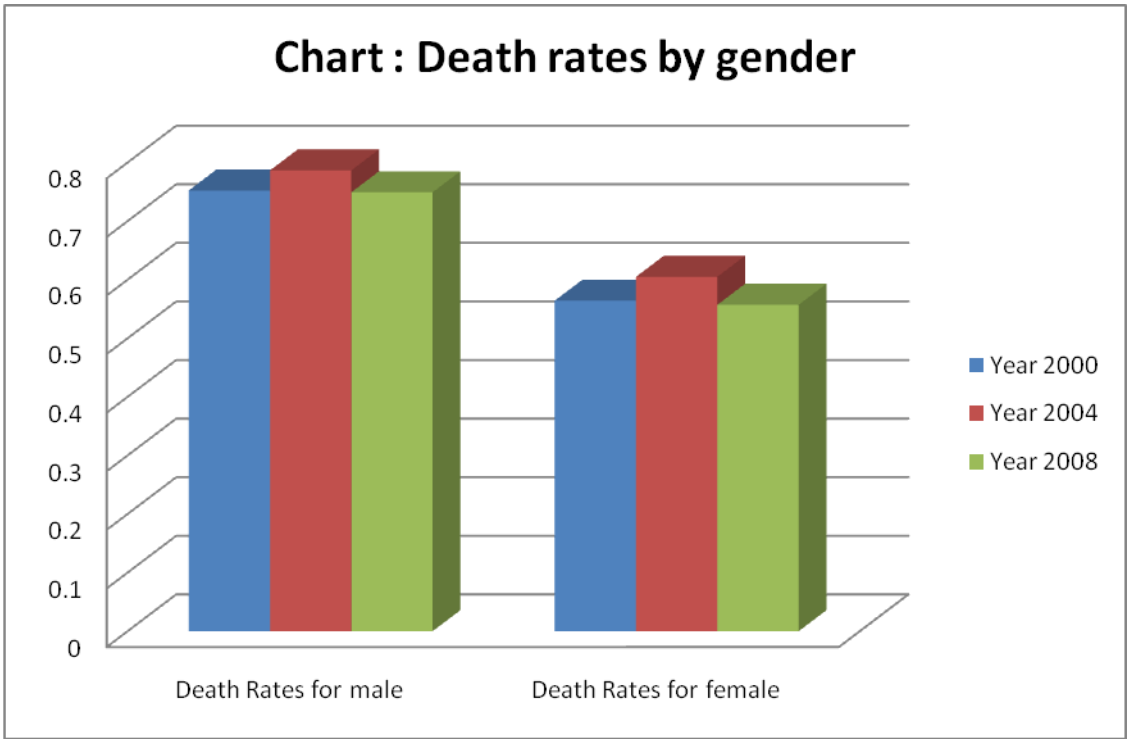


Figure 4.1. Death rates by gender in different year

From the Figure 4.1, it is observed that the frequency rose from 800 (7.52 per thousand) to 845 (7.86 per thousand) as the point shifted from 2000 to 2004. It then decreased to 776 (7.49 per thousand) in the year 2008. Similarly for female, there was an upward trend from year 2000 to 2004, followed by a downward trend from 2004 to 2008.

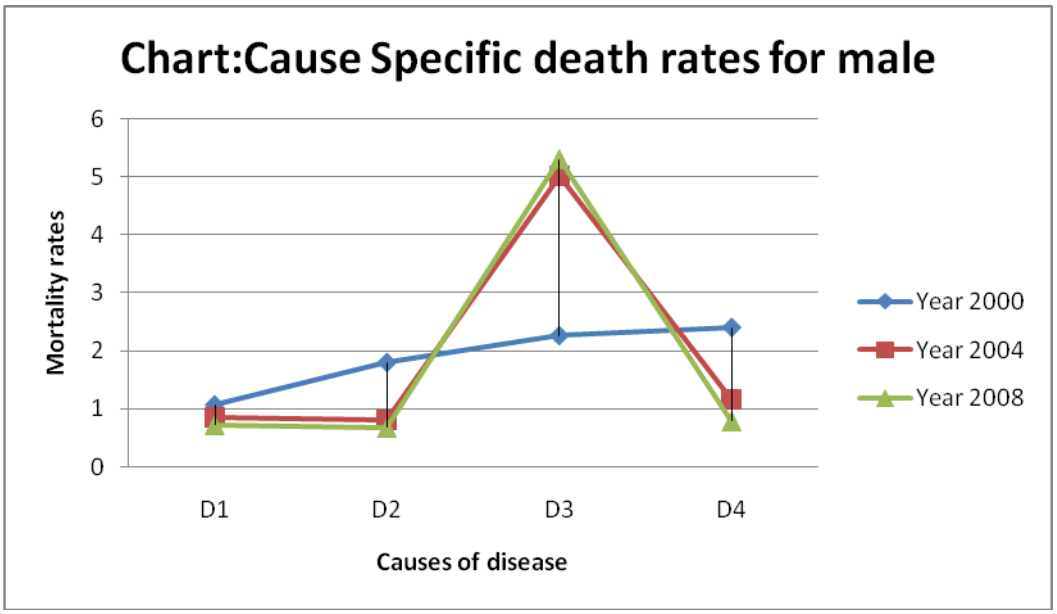


Figure 4.2. Cause specific death rates for Matlab male by different years

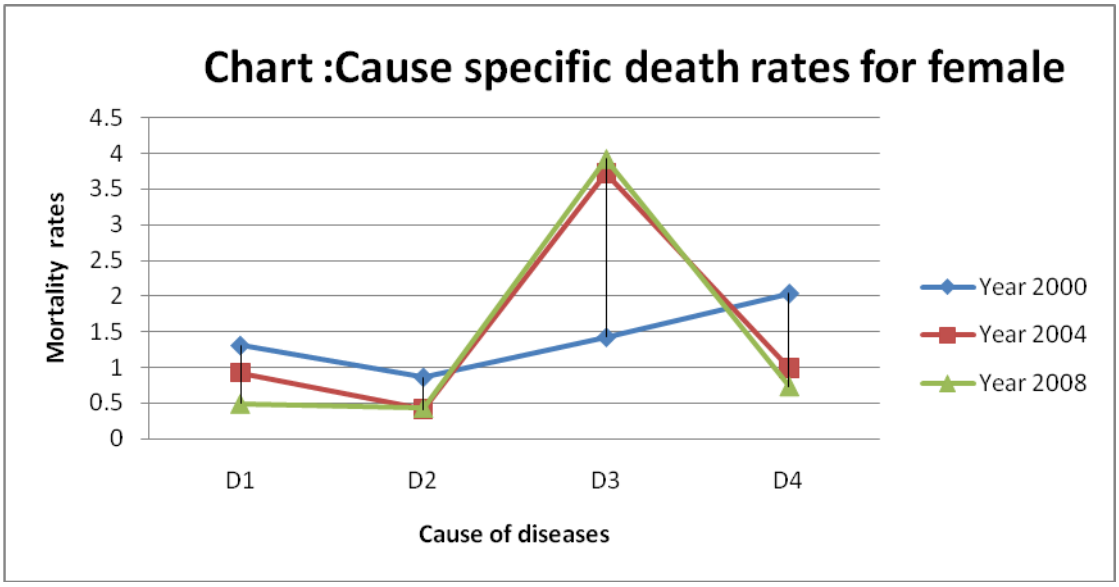


Figure 4.3. Cause specific death rates for Matlab female by different years

From the above tables and figures, it is observed that the causes of mortality, D1, D2, and D4 showed significant declining pattern from year 2000 to 2004 to 2008, for both male and female population. But the death rate for non-communicable disease (D3) of the male population increased from 2.3 per 1,000 people in 2000 to 5.0 and 5.3 per 1,000 people in 2004 and 2008 respectively. For female population, the death rate for non-communicable disease (D3) increased from 1.4 per 1,000 people in 2000 to a rate of 3.7 and 3.9 per 1,000 people in 2004 and 2008.

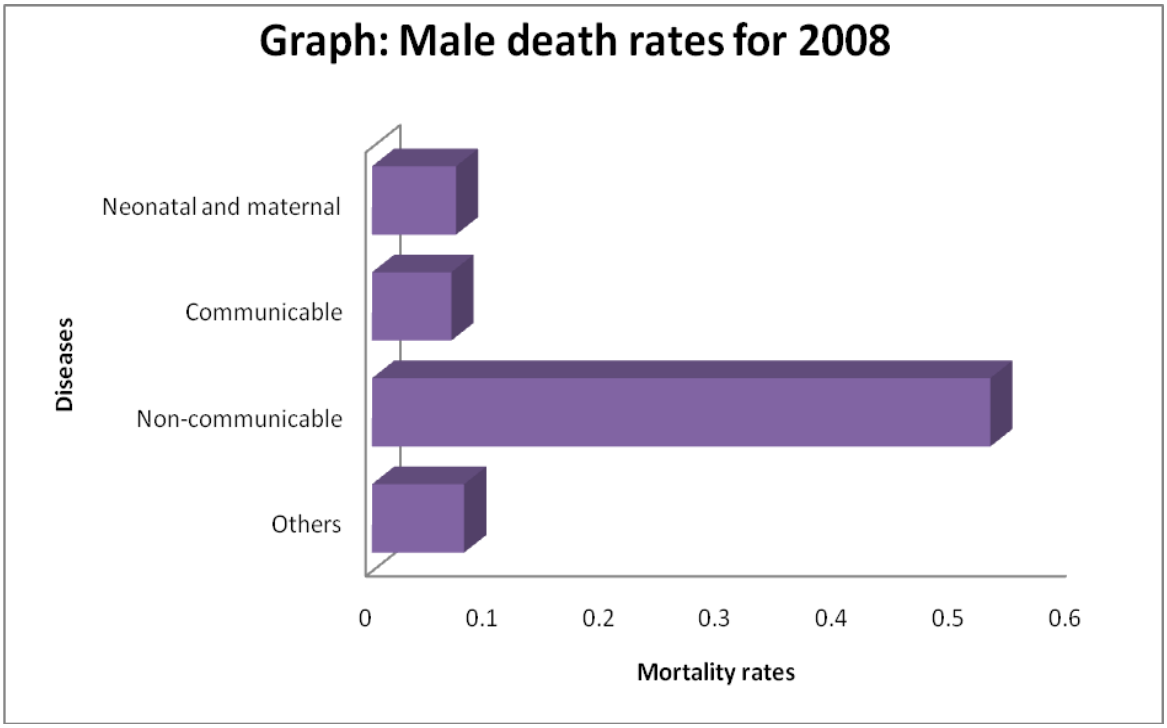


Figure 4.4. Cause-specific mortality rates for male for the year 2008

Figure 4.4 shows the deaths by disease of the year 2008. Non-communicable diseases showed highest indication of the occurring mortality.

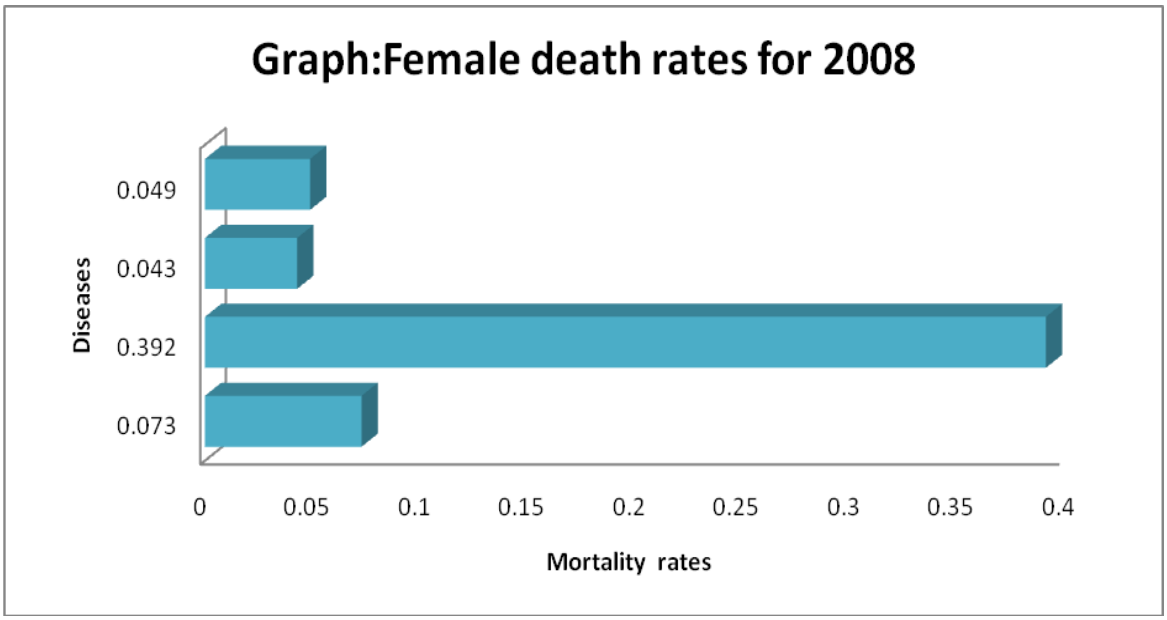


Figure 4.5. Cause-specific mortality rates by female for the year 2008

Figure 4.5 represents the death rates by diseases for female in the year 2008. Similar to the male case, non-communicable diseases provided highest indication of mortality.

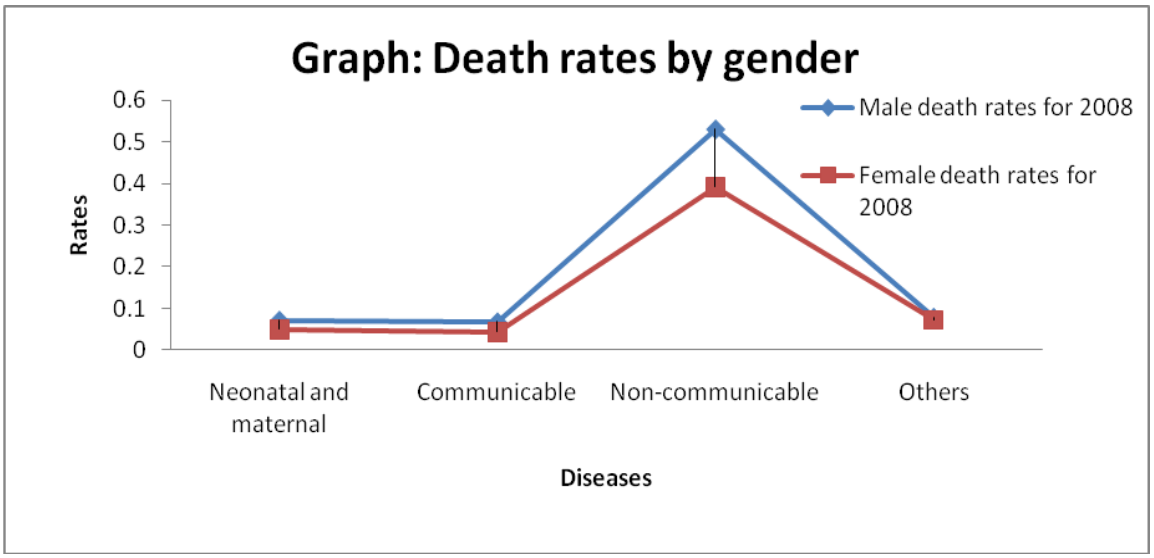


Figure 4.6. Cause-specific mortality rates by gender for the year 2008

It is observed from Figure 4.6 that the mortality rate of male was higher than the mortality of female in the year 2008. Also, non-communicable deaths were significantly higher than rest of the categories of diseases for both sexes.

Table 4.11. Percentage distribution of deaths by gender

	Matlab population 2000	Matlab population 2004	Matlab population 2008
Percent of male	55.83	54.41	54.00
Percent of female	44.17	45.59	46.00
Total deaths	1433.00	1553.00	1437.00

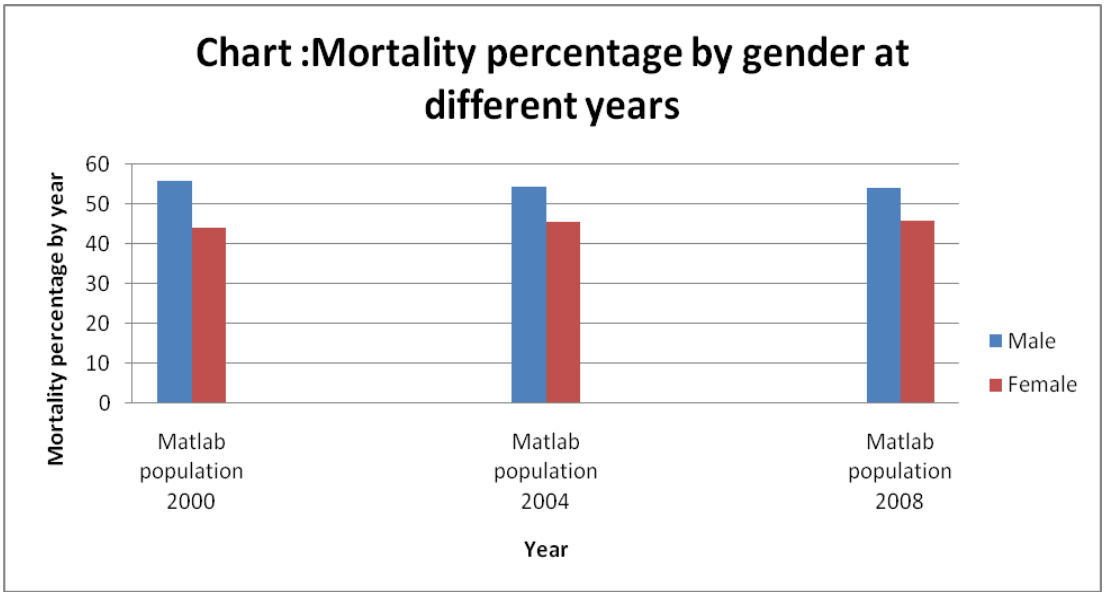


Figure 4.7. Percentage of deaths by gender at different years

After analyzing the data and figure of percentage of deaths by gender at different years it had come to know that male deaths was higher than that of female deaths throughout the year 2000, 2004 and 2008.

Table 4.12. Age specific death rates for male person

Age group	Midyear population for 2000	Total deaths for 2000	Rates per thousand	Midyear population for 2004	Total deaths for 2004	Rates per thousand	Midyear population for 2008	Total deaths for 2008	Rates per thousand
0-1	13039	199	15.26	13794	157	11.38	12919	111	8.59
0-14	40470	229	5.66	39400	175	4.44	38030	129	3.39
15-59	57397	161	2.81	58927	176	2.99	55866	170	3.04
60+	8503	410	48.23	9112	494	54.21	9683	477	49.26
Total	106370	800	7.52	107439	845	7.86	103579	776	7.49

Table 4.12 provides the age specific death information for male person. Infant mortality was highest in 2000 among the years; which was 15 per 1,000 children. The Table exhibites gradual declining rate of infant mortality over the year from 2000 to 2008. It was 11 per 1000 children in the year 2004 and 9 per 1000 children in the year 2008.

The death rate was also declining for the age 0-14 from year 2000 to year 2008. On the contrary, age group 15-59 showed increasing death rates from the year 2000 to 2008. The death rate was 2.81 per thousand in the year 2000, 2.99 per thousand in the year 2004 and 3.04 per thousand in the year 2008. Finally, natural trends were observed in the age group 60+. Most of the people died in that age.

Table 4.13. Age specific death rates for female person

Age group	Midyear population for 2000	Total deaths for 2000	Rates per thousand	Midyear population for 2004	Total deaths for 2004	Rates per thousand	Midyear population for 2008	Total deaths for 2008	Rates per thousand
0-1	12505	189	15.11	13305	144	10.82	12523	73	5.83
0-14	39520	203	5.14	38288	167	4.36	37198	86	2.31
15-59	64204	99	1.54	68851	129	1.87	70328	120	1.71
60+	8485	331	39.01	9898	412	41.62	11113	455	40.94
Total	112209	633	5.64	117037	708	6.05	118639	661	5.57

For ages over 60 years, mortality of females was lower than mortality of males in Bangladesh. Female's death rates over age 60 were 39 per thousand in 2000 and 42 per thousand in 2004. Among males, the death rates over age 60 were 48 per thousand males in 2000 and 54 per thousand males in 2004. The pattern remained same for the year 2008. This was also true for the age group 15-59. The age-specific death rate between male and female of the age group 0-14 did not show significant difference.

Infant mortality was highest in 2000 among the years that were 15 per thousand for both male and female infant. It exhibited gradual declining over the year from 2000 to 2008 similar to male infant mortality. Infant mortality rate was 11 per thousand in the year 2004 and 6 per thousand in the year 2008.

4.4 Conclusion

It was observed that a large portion of the dead population died because of non-communicable diseases. The rate was rapidly increasing each year at an alarming scale. It was also observed that the neonatal and maternal cause (D1), communicable cause (D2), and injuries and miscellaneous cause (D4) displayed downward trend and only non-communicable cause (D3) showed uprising trend for both male and female. Also D3 related deaths were significantly higher than the rest of the categories of diseases for both sexes. Overall death rates were higher for male person than females.

CHAPTER FIVE

PROBABILITY PATTERN OF DEATHS: APPLICATION OF LIFE TABLE ANALYSIS

5.1 Introduction

In the previous chapter, the mortality situation of male and female was highlighted by different causes of deaths. Percentage distribution of deaths, mortality rates and cause specific mortality rates were primarily discussed there.

Mortality rate and expectation of life are interrelated. So, the effect of mortality on expectation of life is now focused on. In this chapter, the effect of mortality on probability pattern of deaths, expectation of life is discussed. Expectation of life, conditional probability of deaths and cumulative distribution of age of deaths are estimated using life table analysis. These are the tools and techniques used to find out the probability pattern of deaths. Each cause of death presents different pattern of probability.

Life table provides summary index of population health status. It summarizes the mortality experience that includes the probability of a person dying at a certain age.

Life expectancy is an important tool to measure health condition of a country. Shryock, et al. (1971) defines life expectancy as the expected number of years to be lived. So, in this chapter, life tables are used to portray the impact of deaths on the length of life and the effect of multiple causes of deaths on expectation of life.

One of the objectives of this chapter is to investigate the probability pattern of deaths. To do this, expectation of life, conditional probability of deaths, and cumulative distribution of deaths by age are compared between different years. The data used in this analysis were collected from the vital registration, maternal and child health data from Matlab, Bangladesh under Health and Demographic Surveillance System of ICDDR,B.

5.2 Abridged Life Table

There are two types of life table: complete life table and abridged life table. A complete life table is constructed using data on deaths at each single year of age 0, 1, 2, 3… 99, 100+. An abridged life table considers the death rate as the same for all ages in an age group; and therefore uses death rates calculated from groups of ages. The age groups are such as 0, 1-4, 5-9… 95-99, 100+.

5.2.1 Construction Procedure of Abridged Life Table

In an abridged life table, some columns are computed based on duration of life. ${}_nm_x$, ${}_nq_x$, l_x, ${}_nd_x$, ${}_nL_x$, T_x, e^0_x were calculated for the life expectancy. A brief description of them (Shryock et al., 1975) are given below.

1. ${}_nq_x$,represents the probability of dying between ages x and $x + n$, and is given by

$$ {}_nq_x = \frac{{}_nm_x}{1/n + {}_nm_x[1/2 + n/12 + ({}_nm_x - \ln C)]} $$

${}_nq_x$: = 1, for x=80 years and over (say)

Note: ln C is assumed to be 0.095.

${}_nm_x$ is age specific death rate. It is defined as follows:

$$ {}_nm_x = \frac{\text{Deaths during the year to persons of age x } (D_x)}{\text{Population aged x at mid - year } (P_x)} $$

2. The converse of ${}_nq_x$ is ${}_np_x$. This is defined as the probability of surviving between exact age x and x+n:

$$ {}_np_x = 1 - {}_nq_x $$
$$ \therefore {}_np_x + {}_nq_x = 1 $$

3. l_x is the number of people alive at exact age x out of some arbitrarily defined number (l_o) at birth. The first value, l_0, is an arbitrary number called the radix. It is usually a round number such as 100,000. By definition, the following relationships hold:

$$l_{x+n} = l_x * {}_n p_x = l_x * (1 - {}_n q_x)$$
$${}_n d_x = l_x - l_{x+n}$$
$$= l_x \cdot {}_n q_x$$

Where, ${}_nd_x$ is the number of deaths in the life table population between exact ages x and x + n. We start with l_o=100,000.

Also l_x is a decreasing function of x, i.e. as age increases, l_x decreases. For the last interval, the number of people dying is the same as the number of people alive at its start:

$$d_{x+} = l_x$$

For example, $d_{85+} = l_{85.}$

4. ${}_nL_x$ function is defined as the number of person-years lived (contributed by those alive and those who died) between exact ages x and $x+n$. It is defined as follows:

$$L_0 = 0.20 l_0 + 0.80 l_1$$
$${}_n L_x = n(l_x - 1/2 {}_n d_x), \text{ for other age groups}$$
$$\text{and } L_{85+} = \frac{d_{85+}}{m_{85+}} = \frac{l_{85}}{m_{85+}}$$
$$\text{note that., } d_{85+} = l_{85} \text{ since everyoneeventually dies.}$$

5. T_x represents the total number of person-years lived after age x. It is obtained by cumulating the ${}_nL_x$ function from the bottom (highest age interval) up. Symbolically

$$T_x = T_{x+n} + {}_n L_x$$

6. e^0_x indicates the expected (average) number of years of life left for a person aged x. Thus, for the l_x people alive at age x, the total number of years left for them to live is given by T_x. Therefore, on average, each of these l_x individuals has, approximately T_x/l_x years to live. Hence,

$$e_x^0 = \frac{T_x}{l_x}$$

The life table analysis makes the following assumptions:

i. A cohort, often called a radix, takes 100000 births.

ii. Pattern of death of the population in this study has similar characteristic in the usual life table.

iii. The deaths are equally distributed throughout the year.

5.3 Multiple Decrement Life Table

Several life-table approaches have the inability to account for the individuals subject to mutually exclusive causes of death. In the single decrement life table, an individual exits the table in only one way: through death by undifferentiated cause. In the multiple decrement life table (MDLT), an individual can exit the table through differentiated causes. At the beginning, MDLT was used for human demography and now it is also used for situations that might lead to exiting the table in addition to death, such as marriage, divorce, contraception etc. In this sense, any life table that differentiates and quantifies more than one cause is a MDLT.

Preston et al. (1972) described MDLT as a life table in which the numbers of deaths in each age interval are distributed according to the cause of death. Conventionally multiple decrement life table presents the data in the form of two tables. The first one is the ordinary life table for all causes of death combined. The second one may give either the distribution by cause of deaths occurring in each age interval, or the distribution by cause of deaths occurring above specified age.

5. 3. 1 Construction Procedure of Multiple Decrement Life Table

The following rules and formulas are necessary to compute the probability pattern of deaths by age due to a cause of death in presence of all causes of deaths in years 2000, 2004, and 2008. They are useful to identify the main causes of deaths-those that influence mortality the most. To construct Multiple Decrement Life Table the following three assumptions (Carey, 1993) are considered:

i. The death of each individual can be attributed to a single cause
ii. Each individual has equal probability of dying from any cause
iii. Causes are independent

In the analysis, the following notions are adopted from Johnson et al. (1980) in this analysis.

i. ${}_al_x$ denotes the expected number of survivors at exact age x out of ${}_al_0$ starters. Usually take ${}_al_0$ =100000
ii. ${}_naq_x$ is the conditional death probability in [x,x+n) given alive at age x;
iii. ${}_nad_x$ is the total expected number of deaths in age interval [x,x+n);
iv. ${}_naL_x$ is the amount of person-years in [x,x+n)
v. $al_{\alpha x}$ is the number living at exact age x who ultimately were expressed to die from cause D_α
vi. ${}_nad_{\alpha x}$ is the expected number of deaths between age x and x+n from cause D_α, among al_x living at age x
vii. ${}_naq_{\alpha x}$ is the crude conditional probability of death from cause ${}_nD_{\alpha x}$ between age x and x+n, in presence of all other causes, given alive at exact age x
viii. The effective number of lives at exact age x is given by

$$N_x^{/} = \frac{1}{n}[\,{}_np_x + n(1-{}_nf_x)\,{}_nD_x\,]$$

ix. The probability of dying between ages x to x+n due to all categories of causes is denoted by ${}_naq_x = \frac{{}_nD_x}{N_x^{/}}$

x. The probability of dying between ages x to x+n due to the α-th category of causes is denoted by

$$ {}_n aq_{\alpha x} = \frac{nD\alpha x}{{}_n D_x} {}_n aq_x, \text{ for } \alpha = 1, 2, ..., k $$

xi. Since deaths due to various causes are additive in nature, therefore

$$ {}_n aq_x = \sum {}_n aq_{\alpha x} $$

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

$$ {}_n ad_x = al_x * {}_n aq_x $$

$$ {}_n ad_{\alpha x} = al_x * {}_n aq_{\alpha x} $$

xii. The ${}_a l_{\alpha x}$ functions are obtained by adding together all deaths from cause D_α which occur after age x, that is

$$ {}_a l_{\alpha x} = {}_n ad_{\alpha x} + {}_n ad_{\alpha, x+n} + \ldots + {}_\infty ad_{\alpha w} $$, where w is the last recorded age.

xiii. The conditional probabilities of death from α-th cause D_α after an exact age x given alive at age x is

$$ \pi_{\alpha x} = \frac{al_{\alpha x}}{al_x} $$

xiv. The death distributions by age is also obtained which is the analogues of

$$ F_{\alpha x} = 1 - \frac{al_{\alpha x}}{al_{\alpha 0}} $$

where $\frac{al_{\alpha x}}{al_{\alpha 0}}$ denotes the probability of surviving from age 0 to age x due to cause α denoted by D_α

xv. The approximate density functions evaluated at midpoint are

$$ f_\alpha(x^*) = \frac{al_{\alpha x} - al_{\alpha, x+n}}{n \times al_{\alpha 0}} \text{ where } x^* = x + \frac{n}{2} $$

5.4 Results and Discussion

Table 5.1. Abridged life table for males, 2000

Age group	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	152	2750	0.06	0.05	100000	5370	95704	6395382	63.95
1—4	47	10289	0.00	0.02	94630	1703	93778	6299678	66.57
5—9	21	13056	0.00	0.01	92927	743	462775	6205899	66.78
10—14	9	14375	0.00	0.00	92183	286	460202	5743124	62.30
15—19	12	11900	0.00	0.01	91897	459	458339	5282923	57.49
20—24	13	8739	0.00	0.01	91438	677	455498	4824584	52.76
25—29	8	6638	0.00	0.01	90761	545	452445	4369086	48.14
30—34	4	6192	0.00	0.00	90217	289	450362	3916640	43.41
35—39	15	6886	0.00	0.01	89928	971	447212	3466278	38.54
40—44	22	6168	0.00	0.02	88957	1566	440870	3019066	33.94
45—49	19	4214	0.00	0.02	87391	1931	432128	2578196	29.50
50—54	27	3429	0.01	0.04	85460	3256	419159	2146068	25.11
55—59	41	3231	0.01	0.06	82204	4957	398627	1726908	21.01
60—64	66	2876	0.02	0.10	77247	8080	366035	1328281	17.20
65—69	93	2377	0.04	0.17	69167	11579	316888	962247	13.91
70—74	81	1571	0.05	0.21	57588	12117	257650	645358	11.21
75—79	66	958	0.07	0.26	45472	11986	197393	387708	8.53
80—84	48	437	0.11	0.36	33485	12165	137014	190315	5.68
85+	56	284	0.20	1.00	21320	21320	53301	53301	2.50
Total	800	106370				100000	6395382		

Where, P_x is Midyear population by age group
${}_nD_x$ is No. of death by age group
${}_nm_x$ is No. of death rate by age group
${}_nq_x$ is Probability of death between age x to x+n
${}_np_x$ is Survival rate between age x to x+n
${}_nd_x$ is Population death between age x to x+n
l_x is Population live at age x
${}_nL_x$ is Person-years lived between age x to x+n
T_x is Total population live after age x
e^0x is Life expectancy at age x

Table 5.2. Abridged life table for female, 2000

Age group x to x+n	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	134	2526	0.05	0.05	100000	5160	95872	6700105	67.00
1--4	55	9979	0.01	0.02	94840	2058	93811	6604233	69.64
5--9	7	12717	0.00	0.00	92782	260	463260	6510422	70.17
10--14	7	14298	0.00	0.00	92522	222	462056	6047161	65.36
15--19	7	11196	0.00	0.00	92300	286	460785	5585105	60.51
20--24	10	9683	0.00	0.01	92014	469	458897	5124320	55.69
25--29	15	8273	0.00	0.01	91545	824	455664	4665423	50.96
30--34	8	8606	0.00	0.00	90721	417	452561	4209759	46.40
35--39	9	8007	0.00	0.01	90304	506	450253	3757199	41.61
40--44	6	5900	0.00	0.01	89798	458	447844	3306945	36.83
45--49	16	4375	0.00	0.02	89340	1608	442679	2859101	32.00
50--54	9	4000	0.00	0.01	87732	983	436202	2416422	27.54
55--59	19	4164	0.00	0.02	86749	1943	428888	1980220	22.83
60--64	49	3155	0.02	0.07	84806	6182	408574	1551332	18.29
65--69	65	2437	0.03	0.12	78624	9419	369570	1142759	14.53
70--74	77	1461	0.05	0.21	69204	14824	308963	773188	11.17
75--79	55	849	0.06	0.25	54381	13688	237685	464225	8.54
80--84	46	378	0.12	0.39	40693	15732	164136	226540	5.57
85+	39	205	0.19	1.00	24961	24961	62404	62404	2.50
Total	633	112209				100000	6700105		

*The notations are the same as in Table 5.1.

Table 5.3. Abridged life table for males, 2004

Age group x to x+n	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	120	2808	0.04	0.04	100000	4180	96656	6470804	64.71
1—4	37	10986	0.00	0.01	95820	1274	95183	6374148	66.52
5—9	11	12820	0.00	0.00	94546	407	471712	6278965	66.41
10—14	7	12786	0.00	0.00	94139	254	470060	5807254	61.69
15—19	8	11514	0.00	0.00	93885	329	468603	5337194	56.85
20—24	9	8264	0.00	0.01	93556	505	466518	4868591	52.04
25—29	5	6194	0.00	0.00	93051	372	464325	4402072	47.31
30—34	10	6510	0.00	0.01	92679	704	461633	3937748	42.49
35—39	16	6392	0.00	0.01	91975	1140	457021	3476114	37.79
40—44	30	7005	0.00	0.02	90834	1908	449401	3019093	33.24
45—49	28	5728	0.00	0.02	88927	2134	439297	2569692	28.90
50—54	34	4041	0.01	0.04	86792	3524	425152	2130395	24.55
55—59	36	3279	0.01	0.05	83269	4372	405414	1705243	20.48
60—64	77	2910	0.03	0.12	78897	9389	371013	1299829	16.48
65—69	98	2586	0.04	0.16	69508	11323	319234	928816	13.36
70—74	102	1794	0.06	0.23	58185	13237	257834	609583	10.48
75—79	104	1026	0.10	0.35	44948	15521	185939	351749	7.83
80—84	57	497	0.11	0.37	29428	10979	119689	165810	5.63
85+	56	299	0.19	1.00	18448	18448	46121	46121	2.50
Total	845	107439				100000	6470804		

*The notations are the same as in Table 5.1.

Table 5.4. Abridged life table for female, 2004

Age group x to x+n	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	116	2689	0.04	0.04	100000	4220	96624	6749157	67.49
1--4	28	10616	0.00	0.01	95780	1006	95277	6652533	69.46
5--9	12	12308	0.00	0.00	94774	464	472711	6557256	69.19
10--14	11	12675	0.00	0.00	94310	406	470536	6084546	64.52
15--19	15	12497	0.00	0.01	93904	563	468113	5614010	59.78
20--24	11	10320	0.00	0.01	93341	495	465468	5145896	55.13
25--29	6	8438	0.00	0.00	92846	325	463419	4680428	50.41
30--34	9	8133	0.00	0.01	92521	509	461334	4217010	45.58
35--39	16	8295	0.00	0.01	92012	883	457854	3755675	40.82
40--44	14	7540	0.00	0.01	91129	838	453550	3297822	36.19
45--49	20	5554	0.00	0.02	90291	1598	447458	2844272	31.50
50--54	12	4092	0.00	0.01	88693	1286	440248	2396814	27.02
55--59	26	3982	0.01	0.03	87407	2780	430084	1956566	22.38
60--64	45	3713	0.01	0.06	84627	4883	410928	1526482	18.04
65--69	90	2760	0.03	0.14	79744	11411	370192	1115555	13.99
70--74	81	1790	0.05	0.19	68333	12929	309342	745363	10.91
75--79	88	983	0.09	0.32	55404	17613	232988	436021	7.87
80--84	63	436	0.14	0.43	37791	16080	148755	203033	5.37
85+	45	216	0.21	1.00	21711	21711	54278	54278	2.50
Total	708	117037				100000	6749157		

*The notations are the same as in Table 5.1.

Table 5.5. Abridged life table for males, 2008

Age group x to x+n	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	83	2634	0.03	0.03	100000	3100	97520	6657154	66.57
1—4	28	10285	0.00	0.01	96900	1047	96377	6559634	67.69
5—9	11	13257	0.00	0.00	95853	393	478285	6463257	67.43
10—14	7	11854	0.00	0.00	95460	277	476610	5984972	62.70
15—19	9	10267	0.00	0.00	95184	419	474871	5508362	57.87
20—24	10	7158	0.00	0.01	94765	654	472190	5033490	53.12
25—29	5	5756	0.00	0.00	94111	405	469543	4561301	48.47
30—34	7	5684	0.00	0.01	93706	572	467102	4091758	43.67
35—39	13	5737	0.00	0.01	93135	1043	463066	3624655	38.92
40—44	18	5912	0.00	0.02	92092	1381	457004	3161590	34.33
45—49	30	6691	0.00	0.02	90710	1996	448562	2704585	29.82
50—54	37	4998	0.01	0.04	88715	3185	435611	2256024	25.43
55—59	41	3663	0.01	0.05	85530	4576	416209	1820413	21.28
60—64	62	3033	0.02	0.09	80954	7618	385725	1404204	17.35
65—69	97	2529	0.04	0.16	73336	12071	336503	1018479	13.89
70—74	110	1974	0.06	0.22	61265	13717	272032	681976	11.13
75—79	81	1236	0.07	0.25	47548	12072	207558	409944	8.62
80—84	61	566	0.11	0.36	35475	12736	145538	202386	5.70
85+	66	345	0.19	1.00	22740	22740	56849	56849	2.50
Total	776	103579				100000	6657154		

*The notations are the same as in Table 5.1.

Table 5.6. Abridged life table for female, 2008

Age group x to x+n	${}_nD_x$	${}_nP_x$	${}_nm_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e^0x
<1	45	2571	0.02	0.02	100000	1740	98608	7018518	70.19
1--4	28	9952	0.00	0.01	98260	1101	97710	6919910	70.42
5--9	11	12732	0.00	0.00	97159	418	484753	6822200	70.22
10--14	2	11943	0.00	0.00	96742	77	483515	6337447	65.51
15--19	13	11195	0.00	0.01	96664	561	481920	5853932	60.56
20--24	9	10662	0.00	0.00	96104	404	479509	5372012	55.90
25--29	8	8904	0.00	0.00	95700	431	477424	4892503	51.12
30--34	5	7963	0.00	0.00	95269	295	475609	4415080	46.34
35--39	11	7817	0.00	0.01	94974	665	473208	3939471	41.48
40--44	9	7977	0.00	0.01	94309	528	470226	3466263	36.75
45--49	24	6895	0.00	0.02	93781	1613	464873	2996037	31.95
50--54	21	5045	0.00	0.02	92168	1889	456117	2531164	27.46
55--59	20	3870	0.01	0.03	90279	2284	445683	2075048	22.98
60--64	53	3760	0.01	0.07	87995	5860	425322	1629365	18.52
65--69	91	3157	0.03	0.13	82134	10546	384306	1204043	14.66
70--74	102	2137	0.05	0.20	71588	14146	322576	819738	11.45
75--79	73	1228	0.06	0.24	57442	13528	253392	497162	8.65
80--84	68	551	0.12	0.39	43915	17118	176778	243769	5.55
85+	68	280	0.24	1.00	26797	26797	66991	66991	2.50
Total	661	118639				100000	7018518		

*The notations are the same as in Table 5.1.

The abridged life tables provide information about the death rates and probability of deaths. The life expectancies for male and female person were obtained separately.

Column 1 indicates age interval x to x+n. Column 2 and column 3 indicate the total deaths in the Matlab DSS data and midyear population of that territory respectively. Column 4 presents the death rates of each age interval. Column 5 indicates the probability that a person at his x^{th} birthday will die before his $(x+n)^{th}$ birthday. Column 6 is the number of person living at the beginning of the indicated age interval out of the total number of births assumed as the radix of the life table. Column 7 represents the number of persons who will die within the indicated age interval out of the total number of births assumed in the life table.

Column 8 is the number of person-years that would be lived within the indicated age interval by the cohort of the total birth assumed. Column 9 is the total number of person-years that will be lived after beginning of the indicated age interval by the cohort of the total birth assumed. The last one, column 10 shows the average remaining lifetime for a person who survives to the beginning of the indicated age interval which function is called the complete expectation of life.

Table 5.7 is a summary of the information about life expectancy of male and female which show the trend in year 2000, 2004 and 2008.

Table 5.7. Life expectancy for male and female

Expectation of life	Year 2000	Year 2004	Year 2008	Absolute difference from 2000 to 2004	Absolute difference from 2004 to 2008	Absolute difference from 2000 to 2008	Relative difference from 2000 to 2004	Relative difference from 2004 to 2008	Relative difference from 2000 to 2008
For male	63.95	64.71	66.57	0.76	1.86	2.62	1.19	2.87	4.10
For female	67.00	67.49	70.19	0.49	2.70	3.19	0.73	4.00	4.76

From the summary Table, it is observed that life expectancy in Bangladesh has been increasing. The increasing trends are both for male and female.

In the year 2000 to 2004, 0.49 year was added to the life expectancy at birth for female whereas, for male person, 0.76 year was added. Life expectancy increased a further 1.86 years for male from 2004 to 2008; which was approximately twice the previous increment. For females, it increased by 2.70 years from 2004 to 2008, which was approximately six times greater than the previous year. So, life expectancy of females grew faster than that of males.

The life expectancy at birth in the year 2000, 2004, and 2008 were 63.95 and 67.00 years, 64.71 and 67.49 years, and 66.57 and 70.19 years, for males and females respectively. It indicated that life expectancy was higher for females.

The next table describes the probability pattern of deaths by age by different causes such as maternal and neonatal cause (D1), communicable cause (D2), non-communicable cause (D3) and miscellaneous cause (D4). Conditional probability of deaths and approximate density function from various causes were calculated for males and females separately for the years 2000, 2004, and 2008. At first, ${}_naq_{\alpha x}$, the crude conditional probability of death from cause D_α between age x and x+n in presence of all other causes given alive at exact age x was derived.

Table 5.8. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_naq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab males, 2000

Age group x to x+n	${}_naq_x$	${}_naq_{1x}$	${}_naq_{2x}$	${}_naq_{3x}$	${}_naq_{4x}$
<1	0.053786	0.036447	0.014862	0.000354	0.002123
1--4	0.018107	0.000385	0.004238	0.000770	0.012713
5--9	0.008010	0.000000	0.000763	0.000763	0.006484
10--14	0.003126	0.000000	0.001389	0.000347	0.001389
15--19	0.005029	0.000419	0.001257	0.000419	0.002934
20--24	0.007410	0.000000	0.002280	0.000000	0.005130
25--29	0.006008	0.000000	0.001502	0.003004	0.001502
30--34	0.003225	0.000000	0.000000	0.000806	0.002419
35--39	0.010833	0.000000	0.002889	0.001444	0.006500
40--44	0.017676	0.000000	0.004821	0.008838	0.004017
45--49	0.022293	0.000000	0.005866	0.012906	0.003520
50--54	0.038610	0.000000	0.005720	0.021450	0.011440
55--59	0.061497	0.000000	0.023999	0.022499	0.014999
60--64	0.108517	0.003288	0.036172	0.052614	0.016442
65--69	0.178195	0.000000	0.044070	0.099636	0.034489
70--74	0.228362	0.005639	0.028193	0.118410	0.076121
75--79	0.293856	0.004452	0.066785	0.093500	0.129118
80--84	0.430880	0.017953	0.080790	0.116697	0.215440
85+	1.000000	0.035714	0.160714	0.250000	0.553571
Total	0.036242	0.005164	0.008653	0.010873	0.011552

Table 5.9. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_naq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab females, 2000

Age group x to x+n	${}_naq_x$	${}_naq_{1x}$	${}_naq_{2x}$	${}_naq_{3x}$	${}_naq_{4x}$
<1	0.051678	0.035866	0.012341	0.000000	0.003471
1--4	0.021806	0.005551	0.004361	0.000000	0.011894
5--9	0.002748	0.000000	0.000000	0.000393	0.002356
10--14	0.002445	0.000349	0.000699	0.000349	0.001048
15--19	0.003121	0.000892	0.000000	0.000000	0.002229
20--24	0.005150	0.002060	0.001030	0.000515	0.001545
25--29	0.009025	0.001805	0.001805	0.001203	0.004212
30--34	0.004637	0.002898	0.000580	0.000000	0.001159
35--39	0.005604	0.001868	0.000623	0.001868	0.001245
40--44	0.005072	0.001691	0.000000	0.001691	0.001691
45--49	0.018120	0.001133	0.003398	0.006795	0.006795
50--54	0.011187	0.002486	0.001243	0.004972	0.002486
55--59	0.022557	0.003562	0.002374	0.010685	0.005936
60--64	0.074752	0.001526	0.015256	0.036613	0.021358
65--69	0.125024	0.001923	0.011541	0.067321	0.044239
70--74	0.232839	0.015119	0.021167	0.099788	0.096764
75--79	0.278763	0.020274	0.030411	0.116574	0.111505
80--84	0.466531	0.020284	0.030426	0.101420	0.314402
85+	1.000000	0.025641	0.179487	0.153846	0.641026
Total	0.027814	0.006459	0.004262	0.007030	0.010062

Table 5.10. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_nq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab males, 2004

Age group x to x+n	${}_nq_x$	${}_nq_{1x}$	${}_nq_{2x}$	${}_nq_{3x}$	${}_nq_{4x}$
<1	0.041841	0.030683	0.005230	0.002789	0.003138
1--4	0.013382	0.000723	0.001808	0.001808	0.009042
5--9	0.004281	0.000000	0.000778	0.001168	0.002335
10--14	0.002734	0.000000	0.000000	0.001562	0.001172
15--19	0.003468	0.000000	0.000000	0.002168	0.001301
20--24	0.005431	0.000000	0.000603	0.001810	0.003017
25--29	0.004028	0.000000	0.000000	0.001611	0.002417
30--34	0.007651	0.000000	0.001530	0.005356	0.000765
35--39	0.012438	0.000000	0.000777	0.008551	0.003109
40--44	0.021186	0.000000	0.000706	0.018362	0.002119
45--49	0.024146	0.000000	0.000000	0.022422	0.001725
50--54	0.041202	0.000000	0.004847	0.031508	0.004847
55--59	0.053428	0.000000	0.002968	0.047492	0.002968
60--64	0.124093	0.000000	0.012893	0.107977	0.003223
65--69	0.173084	0.000000	0.026492	0.132462	0.014129
70--74	0.248902	0.004880	0.029283	0.207418	0.007321
75--79	0.404355	0.000000	0.034992	0.318818	0.050544
80--84	0.445661	0.000000	0.031274	0.304926	0.109461
85+	1.000000	0.000000	0.107143	0.607143	0.285714
Total	0.038566	0.004199	0.003971	0.024646	0.005751

Table 5.11. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_nq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab females, 2004

Age group x to x+n	${}_nq_x$	${}_nq_{1x}$	${}_nq_{2x}$	${}_nq_{3x}$	${}_nq_{4x}$
<1	0.042228	0.029851	0.005825	0.002912	0.003640
1--4	0.010495	0.000375	0.000750	0.000750	0.008621
5--9	0.004863	0.000000	0.000405	0.002837	0.001621
10--14	0.004330	0.000394	0.000787	0.002755	0.000394
15--19	0.005983	0.001197	0.000000	0.003590	0.001197
20--24	0.005315	0.001450	0.000000	0.002899	0.000966
25--29	0.003549	0.001183	0.000000	0.001775	0.000592
30--34	0.005518	0.000613	0.000000	0.002452	0.002452
35--39	0.009598	0.001200	0.000000	0.008398	0.000000
40--44	0.009241	0.001320	0.000660	0.006601	0.000660
45--49	0.017844	0.000892	0.000000	0.014276	0.002677
50--54	0.014556	0.000000	0.000000	0.014556	0.000000
55--59	0.032123	0.000000	0.001235	0.029652	0.001235
60--64	0.058816	0.000000	0.002614	0.049667	0.006535
65--69	0.150754	0.001675	0.013400	0.122278	0.013400
70--74	0.203262	0.012547	0.015056	0.160602	0.015056
75--79	0.365752	0.008313	0.016625	0.266002	0.074813
80--84	0.530750	0.000000	0.025274	0.379107	0.126369
85+	1.000000	0.044444	0.044444	0.666667	0.244444
Total	0.029796	0.004545	0.002020	0.018349	0.004882

Table 5.12. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_nq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab males, 2008

Age group x to x+n	${}_nq_x$	${}_nq_{1x}$	${}_nq_{2x}$	${}_nq_{3x}$	${}_nq_{4x}$
<1	0.031022	0.024295	0.003738	0.001869	0.001121
1--4	0.010831	0.000387	0.001934	0.003094	0.005415
5--9	0.004140	0.000376	0.000753	0.001129	0.001882
10--14	0.002948	0.000000	0.000000	0.001685	0.001264
15--19	0.004373	0.000000	0.000972	0.001458	0.001944
20--24	0.006961	0.000000	0.000000	0.001392	0.005569
25--29	0.004334	0.000867	0.000000	0.003467	0.000000
30--34	0.006139	0.000000	0.000000	0.005262	0.000877
35--39	0.011266	0.000000	0.001733	0.007800	0.001733
40--44	0.015108	0.000000	0.000839	0.014269	0.000000
45--49	0.022170	0.000739	0.004434	0.015519	0.001478
50--54	0.036342	0.000000	0.001964	0.033396	0.000982
55--59	0.054442	0.000000	0.007967	0.039835	0.006639
60--64	0.097240	0.000000	0.003137	0.092535	0.001568
65--69	0.174995	0.003608	0.012629	0.147934	0.010824
70--74	0.244553	0.000000	0.024455	0.200089	0.020009
75--79	0.281543	0.000000	0.020855	0.250261	0.010428
80--84	0.424495	0.013918	0.027836	0.361865	0.020877
85+	1.000000	0.030303	0.060606	0.727273	0.181818
Total	0.036771	0.003554	0.003317	0.026014	0.003886

Table 5.13. Conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_naq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab females, 2008

Age group x to x+n	${}_naq_x$	${}_naq_{1x}$	${}_naq_{2x}$	${}_naq_{3x}$	${}_naq_{4x}$
<1	0.017351	0.010796	0.004627	0.001157	0.000771
1--4	0.011191	0.000000	0.002398	0.001599	0.007194
5--9	0.004311	0.000000	0.001567	0.000784	0.001959
10--14	0.000837	0.000000	0.000000	0.000000	0.000837
15--19	0.005789	0.000445	0.001336	0.001781	0.002227
20--24	0.004212	0.002340	0.000000	0.001404	0.000468
25--29	0.004482	0.002241	0.000000	0.001121	0.001121
30--34	0.003135	0.000627	0.000000	0.001881	0.000627
35--39	0.007011	0.001275	0.000637	0.003824	0.001275
40--44	0.005625	0.000000	0.000000	0.005000	0.000625
45--49	0.017254	0.000000	0.000000	0.015816	0.001438
50--54	0.020598	0.000000	0.001962	0.016675	0.001962
55--59	0.025510	0.001276	0.002551	0.021684	0.000000
60--64	0.068080	0.000000	0.001285	0.064226	0.002569
65--69	0.134436	0.001477	0.005909	0.118186	0.008864
70--74	0.213211	0.008361	0.010452	0.188127	0.006271
75--79	0.258773	0.003545	0.014179	0.219780	0.021269
80--84	0.471567	0.034674	0.013870	0.353675	0.069348
85+	1.000000	0.073529	0.073529	0.602941	0.250000
Total	0.027475	0.002411	0.002120	0.019328	0.003616

Tables 5.8 to 5.13 provide information about the crude conditional probabilities of death from various causes of death, for male and female person of the years 2000, 2004 and 2008. Table 5.14 summarizes the key results of all the above tables.

Table 5.14. Highest conditional probabilities of deaths of Matlab males by age for different years

Age group x to x+n	Highest Prob. of Dying, ${}_nAq_{\alpha x}$ for year 2000	Highest Prob. of Dying, ${}_nAq_{\alpha x}$ for year 2004	Highest Prob. of Dying, ${}_nAq_{\alpha x}$ for year 2008
<1	${}_nq_{1x}$=0.036447	${}_nq_{1x}$=0.030683	${}_nq_{1x}$=0.024295
1--4	${}_nq_{4x}$=0.012713	${}_nq_{4x}$=0.009042	${}_nq_{4x}$=0.005415
5--9	${}_nq_{4x}$=0.006484	${}_nq_{4x}$=0.002335	${}_nq_{4x}$=0.001882
10--14	${}_nq_{4x}$=0.001389	${}_nq_{3x}$=0.001562	${}_nq_{3x}$=0.001685
15--19	${}_nq_{4x}$=0.002934	${}_nq_{3x}$=0.002168	${}_nq_{4x}$=0.001944
20--24	${}_nq_{4x}$=0.005130	${}_nq_{4x}$=0.003017	${}_nq_{4x}$=0.005569
25--29	${}_nq_{3x}$=0.003004	${}_nq_{4x}$=0.002417	${}_nq_{3x}$=0.003467
30--34	${}_nq_{4x}$=0.002419	${}_nq_{3x}$=0.005356	${}_nq_{3x}$=0.005262
35--39	${}_nq_{4x}$=0.006500	${}_nq_{3x}$=0.008551	${}_nq_{3x}$=0.007800
40--44	${}_nq_{3x}$=0.008838	${}_nq_{3x}$=0.018362	${}_nq_{3x}$=0.014269
45--49	${}_nq_{3x}$=0.012906	${}_nq_{3x}$=0.022422	${}_nq_{3x}$=0.015519
50--54	${}_nq_{4x}$=0.021450	${}_nq_{3x}$=0.031508	${}_nq_{3x}$=0.033396
55--59	${}_nq_{2x}$=0.023999	${}_nq_{3x}$=0.047492	${}_nq_{3x}$=0.039835
60--64	${}_nq_{3x}$=0.052614	${}_nq_{3x}$=0.107977	${}_nq_{3x}$=0.092535
65--69	${}_nq_{3x}$=0.099636	${}_nq_{3x}$=0.132462	${}_nq_{3x}$=0.147934
70--74	${}_nq_{3x}$=0.118410	${}_nq_{3x}$=0.207418	${}_nq_{3x}$=0.200089
75--79	${}_nq_{4x}$=0.129118	${}_nq_{3x}$=0.318818	${}_nq_{3x}$=0.250261
80--84	${}_nq_{4x}$=0.215440	${}_nq_{3x}$=0.304926	${}_nq_{3x}$=0.361865
85+	${}_nq_{4x}$=0.553571	${}_nq_{3x}$=0.607143	${}_nq_{3x}$=0.727273

Table 5.14 allows us to find the age groups of males that showed highest probability of dying in 2000, 2004 and 2008. The trends of probability of dying were almost similar between 2004 and 2008.

It was evident that the risks of death by neonatal complications among the infants were relatively higher than all other causes and all other ages from 1 year to 49 year except the last age groups. It was the same through all the years- 2000, 2004 and 2008.

Valuable information available from different years confirmed a slowly downward trend in infant mortality for males. The probability of death in males at the infancy period was 0.036 in 2000, but dropped to 0.024 in 2008. For the age 1-9, the risk of miscellaneous and injury related deaths was higher in the years 2000, 2004 and 2008.

It is evident that the risks of death by different causes of deaths among the middle age groups were relatively low than all other age groups. The infant and child mortality occurred with greater intensity due to maternal and neonatal complications, and injuries respectively. Furthermore, the persons of ages over 45 were sharply fallen at the category of high risk of death.

In the year 2000, the major part of male population of age 30+ did not die particularly heavily of a single cause of death. However, in both of the year 2004 and 2008, the major part of male population of age 30 and above died of non-communicable diseases. The highest probabilities of death of aged 10-29 were injuries and non-communicable diseases.

It is clear that the probability of dying at middle-ages had slightly declined compared to that of early ages and elderly age. For age < 1 year, cause-D1 influenced most; for ages 1-29, cause-D4 (injury related) and D3 (non-communicable) had greater impact to the number of deaths. The death pattern of other age groups was affected mainly by cause D3 (non-communicable).

Table 5.15. Total conditional probabilities of deaths of Matlab males for different years

Year	${}_nq_{1x}$	${}_nq_{2x}$	${}_nq_{3x}$	${}_nq_{4x}$
2000	0.005164	0.008653	0.010873	0.011552
2004	0.004199	0.003971	0.024646	0.005751
2008	0.003554	0.003317	0.026014	0.003886

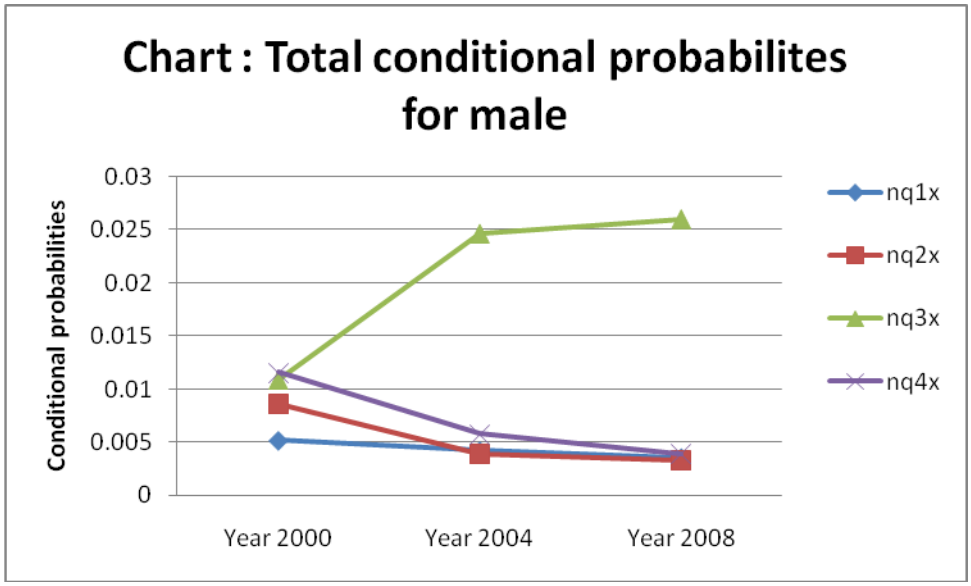


Figure 5.1. Total conditional probabilities of deaths of Matlab males for different years

Table 5.15 and Figure 5.1 represent the trend of total conditional probabilities of deaths for male. The first cause, neonatal and maternal complications, showed almost decreasing trend; the second cause, communicable diseases, showed decreasing trends too; whereas the third cause, non-communicable diseases, showed the only rising trend among the categories; and the forth cause, injuries and miscellaneous, showed declining trend.

Table 5.16. Highest total conditional probabilities of deaths of Matlab males for different years

Highest risk of death for male	Year 2000	Year 2004	Year 2008
1st	${}_nq_{4x}$ =0.011552	${}_nq_{3x}$ =0.024646	${}_nq_{3x}$ =0.026014
2nd	${}_nq_{3x}$=0.010873	${}_nq_{4x}$ =0.005751	${}_nq_{4x}$ =0.003886

Total probabilities of dying of the two leading causes i.e. (non-communicable and injury related causes) arranging in ascending order of magnitude by different years for male population are shown in Table 5.16. The probabilities of death in males due to non communicable diseases was 0.010 in 2000, but rapidly climbed to 0.025 in 2004 and rose to 0.026 in 2008 where the second highest probabilities of death due to injury related causes showed slightly decreasing pattern. It was 0.011 in 2000 but declined to 0.006 in 2004 and further to 0.004 in 2008.

Table 5.17. Ranking by total conditional probabilities of deaths of Matlab males for different years

Age group x to x+n	The $_naq_x$ in year 2000	Highest ranking	The $_naq_x$ in year 2004	Highest ranking	The $_naq_x$ in year 2008	Highest ranking
<1	0.053786	2nd	0.041841	2nd	0.031022	3rd
1--4	0.018107	5th	0.013382		0.010831	
5--9	0.008010		0.004281		0.004140	
10--14	0.003126		0.002734		0.002948	
15--19	0.005029		0.003468		0.004373	
20--24	0.007410		0.005431		0.006961	
25--29	0.006008		0.004028		0.004334	
30--34	0.003225		0.007651		0.006139	
35--39	0.010833		0.012438		0.011266	
40--44	0.017676		0.021186	5th	0.015108	5th
45--49	0.022293	4th	0.024146	4th	0.022170	4th
50--54	0.038610	3rd	0.041202	3rd	0.036342	2nd
55--59	0.061497	1st	0.053428	1st	0.054442	1st
60--64	0.108517	*	0.124093	*	0.097240	*
65--69	0.178195		0.173084		0.174995	
70--74	0.228362		0.248902		0.244553	
75--79	0.293856		0.404355		0.281543	
80--84	0.430880		0.445661		0.424495	
85+	1.000000		1.000000		1.000000	

The total conditional probabilities of dying are presented in the Table 5.17. This table provides information about the highest cause of deaths in different years. It is observed from the Table that non-communicable diseases were highest ranked. The second highest cause of deaths was neonatal complications for the years 2000 and 2004. However, in the year 2008 non-communicable diseases were second ranking and neonatal complications have third ranking among the cause of deaths.

Table 5.18. Highest conditional probabilities of deaths of Matlab females by age for different years

Age group x to x+n	Highest Prob. of Dying, ${}_naq_{\alpha x}$ for year 2000	Highest Prob. of Dying, ${}_naq_{\alpha x}$ for year 2004	Highest Prob. of Dying, ${}_naq_{\alpha x}$ for year 2008
<1	${}_nq_{1x}$=0.003471	${}_nq_{1x}$=0.029851	${}_nq_{1x}$=0.010796
1--4	${}_nq_{4x}$=0.011894	${}_nq_{4x}$=0.008621	${}_nq_{4x}$=0.007194
5--9	${}_nq_{4x}$=0.002356	${}_nq_{3x}$=0.002837	${}_nq_{4x}$=0.001959
10--14	${}_nq_{4x}$=0.001048	${}_nq_{3x}$=0.002755	${}_nq_{4x}$=0.000837
15--19	${}_nq_{4x}$=0.002229	${}_nq_{3x}$=0.003590	${}_nq_{4x}$=0.002227
20--24	${}_nq_{1x}$=0.001545	${}_nq_{3x}$=0.002899	${}_nq_{1x}$=0.002340
25--29	${}_nq_{4x}$=0.004212	${}_nq_{3x}$=0.001775	${}_nq_{1x}$=0.002241
30--34	${}_nq_{1x}$=0.001159	${}_nq_{3x}$=0.002452	${}_nq_{3x}$=0.001881
35--39	${}_nq_{1x}$=0.001245	${}_nq_{3x}$=0.008398	${}_nq_{3x}$=0.003824
40--44	${}_nq_{4x}$=0.001691	${}_nq_{3x}$=0.006601	${}_nq_{3x}$=0.005000
45--49	${}_nq_{4x}$=0.006795	${}_nq_{3x}$=0.014276	${}_nq_{3x}$=0.015816
50--54	${}_nq_{3x}$=0.002486	${}_nq_{3x}$=0.014556	${}_nq_{3x}$=0.016675
55--59	${}_nq_{3x}$=0.005936	${}_nq_{3x}$=0.029652	${}_nq_{3x}$=0.021684
60--64	${}_nq_{3x}$=0.021358	${}_nq_{3x}$=0.049667	${}_nq_{3x}$=0.064226
65--69	${}_nq_{3x}$=0.044239	${}_nq_{3x}$=0.122278	${}_nq_{3x}$=0.118186
70--74	${}_nq_{3x}$=0.096764	${}_nq_{3x}$=0.160602	${}_nq_{3x}$=0.188127
75--79	${}_nq_{3x}$=0.111505	${}_nq_{3x}$=0.266002	${}_nq_{3x}$=0.219780
80--84	${}_nq_{4x}$=0.314402	${}_nq_{3x}$=0.379107	${}_nq_{3x}$=0.353675
85+	${}_nq_{4x}$=0.641026	${}_nq_{3x}$=0.666667	${}_nq_{3x}$=0.602941

The highest probabilities of dying among females in 2000, 2004 and 2008 year are presented in Table 5.18. The trend of probabilities of dying were almost similar between the year 2004 and 2008 for the age interval 0-4 and 30-85+.

It was evident that the risks of death by neonatal and maternal complications among the infants were relatively higher than all other causes and all other ages from 1 year to 44 year except the last age groups. It was true for all the years 2000, 2004 and 2008. The probability of dying for infancy period of male was higher than that of female infants.

Valuable information from different years showed a rise and then a drop in infant mortality for males. The probabilities of death of females at the infancy period was 0.003 in 2000, but gradually increased to .029 in 2004 and dropped to 0.011 in 2008.

For the age 1-4, the risk of deaths was higher for miscellaneous and injury related diseases for the year 2000, 2004 and 2008.

The probabilities available in the above Table show increasing trend from the lower ages (starting at five) to higher ages.

The risks of death by different causes among the middle-age groups were relatively low than other age groups. The infant and child mortality occurred with greater intensity due to maternal and neonatal complications, and injuries respectively. Furthermore, those with ages over 45 were sharply fallen at the category of high risk of death.

The major part of female population of the age 30 and above in year 2000 died with different causes. However, in both the year 2004 and 2008, the major part of female population of the age 30 and above died due to non- communicable diseases. The highest probabilities of death of aged 10-29 were maternal causes and injuries. Despite some disparities compared to males in value level, the trend for females showed the same pattern like male except maternal complications. The probabilities of dying of middle years of age had slightly declined comparing to that of early age and elderly age. For age <1, D1 cause influenced most deaths, for age 1—29, D4 (injury related) cause had greater influence on death and for other age groups, the death pattern was greatly affected by D3 (non-communicable cause) largely.

Table 5.19. Total conditional probabilities of deaths of Matlab females for different years

For female	${}_nq_{1x}$	${}_nq_{2x}$	${}_nq_{3x}$	${}_nq_{4x}$
For 2000	0.006459	0.004262	0.007030	0.010062
For 2004	0.004545	0.002020	0.018349	0.004882
For 2008	0.002411	0.002120	0.019328	0.003616

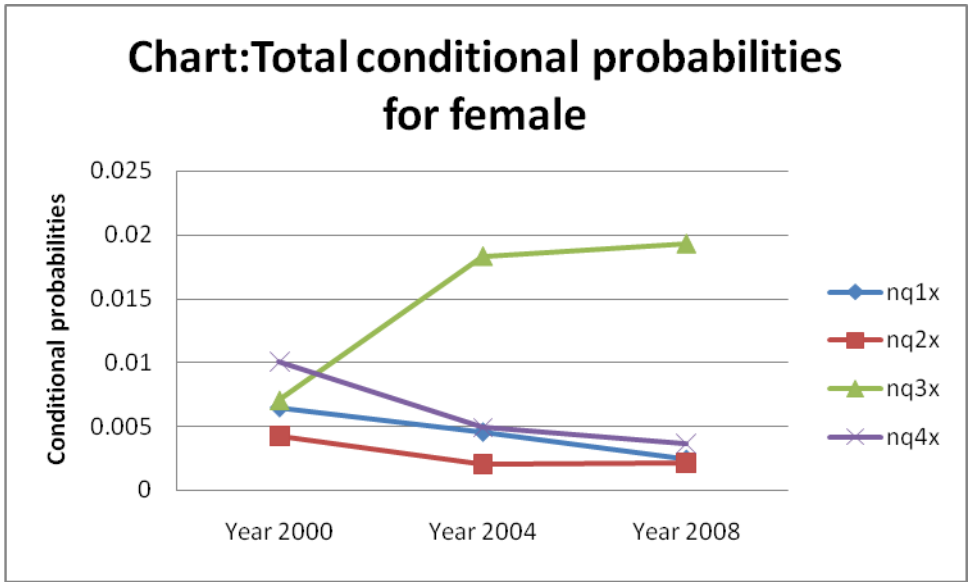


Figure 5.2. Total conditional probabilities of deaths of Matlab females for different years

Table 5.19 and Figure 5.2 show the trend of total conditional probabilities of deaths for females. The first cause, neonatal and maternal complications, showed declining trend in 2000 to 2008, communicable diseases also provided decreasing trend whereas non-communicable diseases, the third cause, presented rising trend and the forth cause, injuries and miscellaneous cause showed diminishing trend.

Table 5.20. Highest total conditional probabilities of deaths of Matlab females for different years

Highest risk of death	Year 2000	Year 2004	Year 2008
1st	${}_nq_{4x}$ =0.010062	${}_nq_{3x=}$0.018349	${}_nq_{3x=}$0.019328
2nd	${}_nq_{3x=}$0.007030	${}_nq_{4x=}$ 0.004882	${}_nq_{4x}$ =0.003616

Total probabilities of dying from a specific cause (non-communicable and injury related) are arranged in descending order of magnitude by different years for female population in Table 5.20. The probabilities of death of females due to non communicable diseases was 0.007 in 2000, but went up to 0.018 in 2004, and to 0.019 in 2008 which was slightly different from male population. The second highest probabilities of deaths, deaths due to injury related causes, showed slow decreasing pattern similar to the male population. It was 0.010 in 2000 but declined to 0.005 in 2004 and to 0.004 in 2008.

Table 5.21. Ranking by total conditional probabilities of deaths of Matlab females for different years

Age group x to x+n	The ${}_nq_x$ in year 2000	Rank	The ${}_nq_x$ in year 2004	Rank	The ${}_nq_x$ in year 2008	Rank
<1	0.051678	1st	0.042228	1st	0.017351	3rd
1--4	0.021806	3rd	0.010495	5th	0.011191	5th
5--9	0.002748		0.004863		0.004311	
10--14	0.002445		0.004330		0.000837	
15--19	0.003121		0.005983		0.005789	
20--24	0.005150		0.005315		0.004212	
25--29	0.009025		0.003549		0.004482	
30--34	0.004637		0.005518		0.003135	
35--39	0.005604		0.009598		0.007011	
40--44	0.005072		0.009241		0.005625	
45--49	0.018120	4th	0.017844	3rd	0.017254	4th
50--54	0.011187	5th	0.014556	4th	0.020598	2nd
55--59	0.022557	2nd	0.032123	2nd	0.025510	1st
60--64	0.074752	*	0.058816	*	0.068080	*
65--69	0.125024		0.150754		0.134436	
70--74	0.232839		0.203262		0.213211	
75--79	0.278763		0.365752		0.258773	
80--84	0.466531		0.530750		0.471567	
85+	1.000000		1.000000		1.000000	

The total conditional probabilities of dying are presented in the Table 5.21. This Table provides information about the top causes of deaths of females. Non-communicable diseases were highest ranked. However, its magnitude was low comparing to male population. The second highest cause was neonatal and maternal complications which had high intensity of probability of deaths comparing to male population. Male death rates were generally higher than female death rates from major causes of death such as non-communicable diseases.

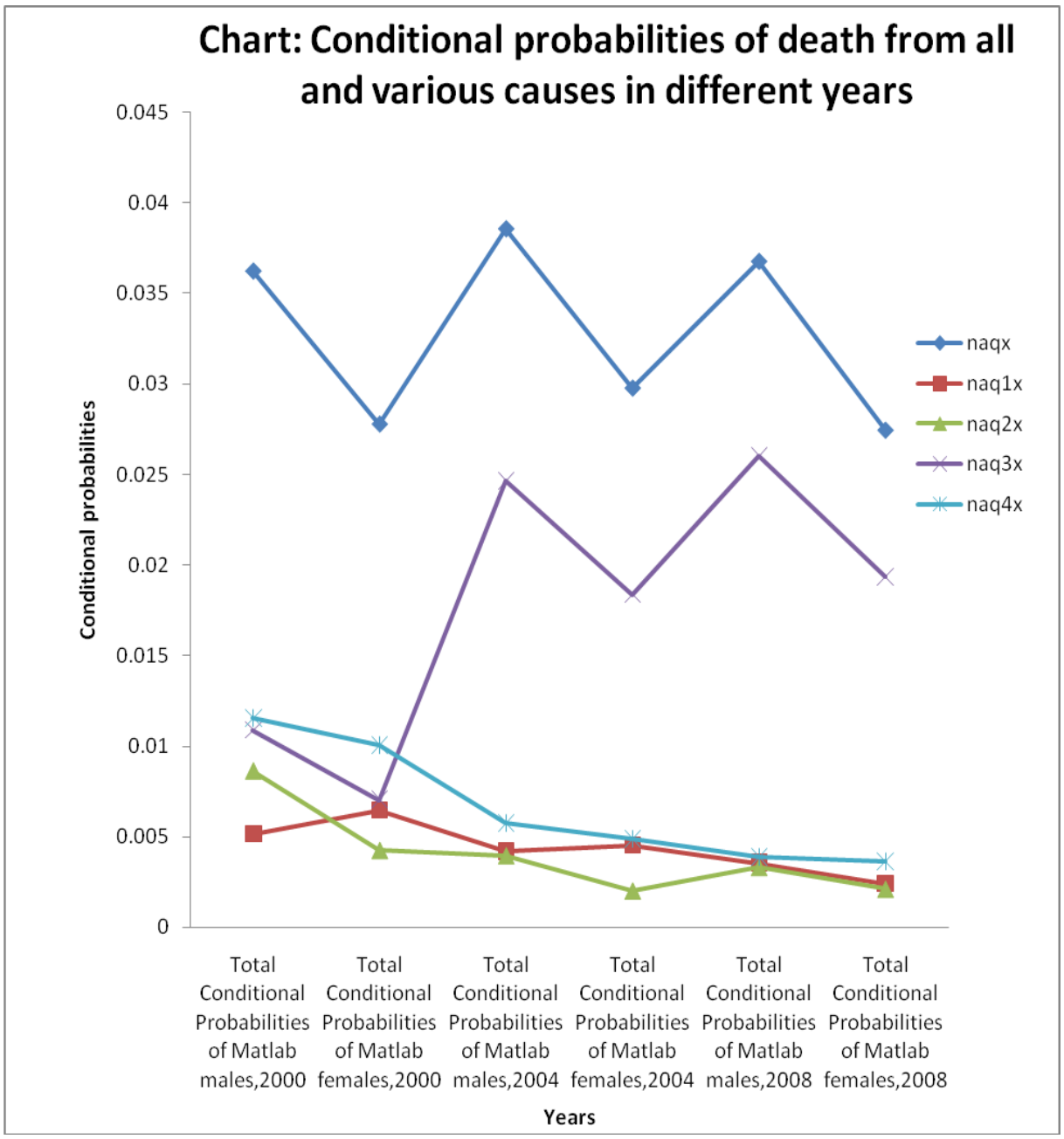


Figure 5.3. Total conditional probabilities of deaths from specific cause D_α (α=1, 2, 3, 4), ${}_naq_{\alpha x}$ (α=1, 2, 3, 4) of Matlab population by different years

It is found from the graph that the total conditional probabilities of deaths ($_nq_x$) of Matlab population, in all causes, were relatively higher for male population than female population.

For females, the neonatal and maternal condition played a significant role in the year 2000 and 2004. But in 2008, the conditional probability for females was less than males'.

The conditional probabilities of deaths due to communicable diseases were always low for females compared to males in all years. The conditional probabilities of non-communicable deaths were high for male population. The conditional probability of non-communicable deaths, for females, was only 0.007 in 2000; but it reached 0.018 in 2004 and 0.019 in 2008. Also the conditional probabilities of injury related deaths were greater for male than that of female.

Table 5.22. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab males, 2000

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.056629	0.218213	0.359417	0.365741
1--4	0.021329	0.214910	0.379473	0.384288
5--9	0.021330	0.214557	0.385686	0.378427
10--14	0.021503	0.215520	0.388032	0.374946
15--19	0.021570	0.214803	0.388900	0.374728
20--24	0.021258	0.214625	0.390444	0.373673
25--29	0.021416	0.213930	0.393359	0.371294
30--34	0.021546	0.213712	0.392715	0.372027
35--39	0.021616	0.214403	0.393176	0.370805
40--44	0.021852	0.213831	0.396022	0.368295
45--49	0.022246	0.212771	0.394151	0.370832
50--54	0.022753	0.211622	0.389938	0.375687
55--59	0.023667	0.214171	0.383286	0.378876
60--64	0.025217	0.202634	0.384429	0.387720
65--69	0.024598	0.186724	0.372205	0.416473
70--74	0.029932	0.173587	0.331671	0.464810
75--79	0.031483	0.188423	0.276374	0.503720
80--84	0.038279	0.172256	0.258977	0.530489
85+	0.035714	0.160714	0.250000	0.553571
Average	0.026523	0.203758	0.363592	0.406126

This Table covers the pattern of deaths by specific causes. If $\pi_{\alpha x}$ remained stable, the distribution of deaths from cause D_α (α= 1, 2, 3, 4) in presence of all causes showed the same pattern as overall distribution. Except the age group <1, the first cause (D1) showed almost stable state in other age groups. This was same for the rest of the causes too. The pattern represented stable state to same cause of deaths revealed in columns, but showed heterogeneity among the causes of deaths explored by rows.

Table 5.23. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab females, 2000

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.094678	0.127412	0.308491	0.469418
1--4	0.062017	0.121342	0.325302	0.491339
5--9	0.057725	0.119588	0.332554	0.490132
10--14	0.057885	0.119918	0.333076	0.489121
15--19	0.057676	0.119512	0.333543	0.489269
20--24	0.056962	0.119886	0.334587	0.488565
25--29	0.055186	0.119471	0.335801	0.489541
30--34	0.053868	0.118738	0.337645	0.489749
35--39	0.051207	0.118709	0.339218	0.490866
40--44	0.049617	0.118751	0.339251	0.492380
45--49	0.048170	0.119357	0.339282	0.493191
50--54	0.047906	0.118099	0.338622	0.495372
55--59	0.045934	0.118178	0.337425	0.498463
60--64	0.043350	0.118476	0.334281	0.503893
65--69	0.045204	0.111560	0.321716	0.521520
70--74	0.049464	0.114311	0.290746	0.545479
75--79	0.044769	0.121414	0.248915	0.584902
80--84	0.033963	0.126177	0.183492	0.656369
85+	0.025641	0.179487	0.153846	0.641026
Average	0.051643	0.122652	0.308831	0.516873

The conditional probabilities of death of female person from various causes of death, such as neonatal complications, communicable diseases, non-communicable diseases, and miscellaneous after age x, given alive at age x, represented by $\pi_{\alpha x}$, are given in the Table 5.23. This pattern was similar to the males but vary in value level. The neonatal and maternal cause of deaths showed high intensity compared to the males.

Table 5.24. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab males, 2004

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.034159	0.100940	0.723372	0.141529
1--4	0.003628	0.099889	0.752050	0.144434
5--9	0.002944	0.099411	0.760417	0.137229
10--14	0.002956	0.099057	0.762514	0.135474
15--19	0.002964	0.099328	0.763037	0.134670
20--24	0.002975	0.099674	0.763518	0.133834
25--29	0.002991	0.099611	0.765867	0.131531
30--34	0.003003	0.100014	0.767346	0.129636
35--39	0.003026	0.099243	0.767866	0.129865
40--44	0.003064	0.099706	0.768878	0.128352
45--49	0.003131	0.101143	0.766761	0.128966
50--54	0.003208	0.103645	0.762757	0.130389
55--59	0.003346	0.103044	0.762674	0.130937
60--64	0.003535	0.105724	0.755549	0.135192
65--69	0.004036	0.105983	0.739316	0.150665
70--74	0.004880	0.096129	0.733876	0.165114
75--79	0.000000	0.088998	0.700918	0.210084
80--84	0.000000	0.090668	0.641489	0.267843
85+	0.000000	0.107143	0.607143	0.285714
Average	0.004413	0.099966	0.740281	0.155340

This Table covers the pattern of death by specific causes of deaths for males. Except the group of age below one, the first cause showed almost stable state in all others age groups. The other causes of deaths also showed similar stable pattern. The pattern represented stable according to same cause of deaths revealed in column but showed heterogeneity among the causes of deaths explored by rows. The distinction between year 2000 and 2004 was that the neonatal cause of death in year 2004 showed more decreasing pattern than 2000 whereas the non-communicable pattern showed increasing level.

Table 5.25. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab females, 2004

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.059251	0.057116	0.711875	0.171758
1--4	0.030697	0.053553	0.740220	0.175530
5--9	0.030644	0.053363	0.747314	0.168679
10--14	0.030793	0.053217	0.748115	0.167875
15--19	0.030532	0.052658	0.748601	0.168209
20--24	0.029512	0.052975	0.749496	0.168018
25--29	0.028212	0.053258	0.750586	0.167944
30--34	0.027125	0.053447	0.751478	0.167949
35--39	0.026660	0.053744	0.753182	0.166415
40--44	0.025706	0.054265	0.752001	0.168027
45--49	0.024614	0.054105	0.752353	0.168928
50--54	0.024153	0.055088	0.751487	0.169272
55--59	0.024509	0.055901	0.747817	0.171773
60--64	0.025323	0.056480	0.742000	0.176197
65--69	0.026905	0.057232	0.735598	0.180264
70--74	0.029709	0.051613	0.722193	0.196485
75--79	0.021540	0.045883	0.704863	0.227714
80--84	0.020856	0.046129	0.691940	0.241075
85+	0.044444	0.044444	0.666667	0.244444
Average	0.029536	0.052867	0.735147	0.182450

This pattern of conditional probabilities of deaths was similar to the females in year 2000. The neonatal and maternal cause offered slightly decreasing pattern and non-communicable cause of deaths showed rapidly increasing pattern compared to females in 2000.

Table 5.26. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab males, 2008

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.039388	0.078633	0.788226	0.093754
1--4	0.015576	0.077293	0.811532	0.095598
5--9	0.015356	0.076184	0.817290	0.091170
10--14	0.015042	0.075745	0.819554	0.089659
15--19	0.015086	0.075969	0.820287	0.088657
20--24	0.015153	0.075327	0.822426	0.087094
25--29	0.015259	0.075855	0.826789	0.082097
30--34	0.014455	0.076185	0.826906	0.082455
35--39	0.014544	0.076656	0.826719	0.082081
40--44	0.014710	0.075776	0.828251	0.081264
45--49	0.014935	0.076086	0.826468	0.082510
50--54	0.014518	0.073277	0.829336	0.082870
55--59	0.015066	0.074002	0.825957	0.084976
60--64	0.015933	0.069837	0.831384	0.082847
65--69	0.017649	0.073884	0.818433	0.090033
70--74	0.017019	0.074249	0.812722	0.096010
75--79	0.022529	0.065913	0.810954	0.100604
80--84	0.031357	0.062715	0.780414	0.125514
85+	0.030303	0.060606	0.727273	0.181818
Average	0.018625	0.073378	0.813206	0.094790

It is found from Table 5.26 that the conditional probabilities in the year 2008 were more stable than other years. Neonatal cause of deaths was reducing. However, conditional probabilities of deaths due to non-communicable diseases were higher than other causes.

Table 5.27. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab females, 2008

Age group x to x+n	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
<1	0.058126	0.057634	0.755252	0.128987
1--4	0.048166	0.053943	0.767411	0.130480
5--9	0.048711	0.052129	0.774479	0.124681
10--14	0.048922	0.050780	0.777045	0.123253
15--19	0.048963	0.050823	0.777696	0.122519
20--24	0.048800	0.049775	0.780433	0.120993
25--29	0.046656	0.049985	0.782324	0.121034
30--34	0.044615	0.050210	0.784721	0.120454
35--39	0.044127	0.050368	0.785301	0.120204
40--44	0.043154	0.050082	0.786995	0.119769
45--49	0.043399	0.050365	0.786419	0.119818
50--54	0.044161	0.051250	0.784132	0.120458
55--59	0.045089	0.050324	0.783598	0.120988
60--64	0.044961	0.049024	0.781860	0.124156
65--69	0.048245	0.051227	0.770059	0.130469
70--74	0.054032	0.052356	0.753120	0.140492
75--79	0.058047	0.053261	0.718099	0.170594
80--84	0.073529	0.052725	0.672289	0.201456
85+	0.073529	0.073529	0.602941	0.250000
Average	0.050802	0.052621	0.759167	0.137411

Similar to the other years, conditional probabilities of eventually dying from specified causes, given alive at age x, also showed stable pattern in the year 2008. In addition, the pattern of neonatal condition, injury, and non-communicable causes of deaths presented increasing pattern than males' pattern of death in 2008 for the same causes. Communicable diseases showed decreasing pattern for the same incident.

Table 5.28. Average conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab male

Year	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
2000	0.026523	0.203758	0.363592	0.406126
2004	0.004413	0.099966	0.740281	0.155340
2008	0.018625	0.073378	0.813206	0.094790

It is clear that there were wide variations for different causes of deaths. The highest average value of conditional probabilities was for non-communicable diseases. From year 2000 to year 2004, the average conditional probabilities were almost doubled. The deaths due to non-communicable disease also continued rising in 2008. The average conditional probabilities due to communicable diseases were 0.203758, 0.099966 and 0.073378 respectively in 2000, 2004 and 2008 showing a decreasing pattern. The average conditional probabilities of injury and miscellaneous diseases also showed decreasing pattern from 2000 to 2004 to 2008. Neonatal cause of deaths showed similar decreasing pattern. In order of magnitude too, non-communicable diseases were in top-most position. The second highest cause of deaths was injury and miscellaneous related deaths; then communicable and the last was neonatal deaths.

Table 5.29. Average conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab female

Year	Π_{1x}	Π_{2x}	Π_{3x}	Π_{4x}
2000	0.051643	0.122652	0.308831	0.516873
2004	0.029536	0.052867	0.735147	0.182450
2008	0.050802	0.052621	0.759167	0.137411

As in the case of males, wide variations were observed for different causes of deaths for females. The highest average value of conditional probabilities of eventually dying from specified causes, given alive at age x was non-communicable diseases. From year 2000 to year 2004 the average conditional probability was more than double; the average rate was 0.308831 in 2000 and 0.735147 in 2004. Deaths due to non-communicable disease also rose up in 2008 with an average rate of 0.759165.

The average conditional probabilities due to communicable diseases were 0.122652, 0.052867 and 0.052621 respectively in 2000, 2004 and 2008. The average conditional probabilities due to injury and miscellaneous diseases were 0.516873, 0.182450 and 0.137411 respectively in 2000, 2004 and 2008. Both cases showed decreasing pattern from previous year to next year. Neonatal deaths also showed decreasing pattern.

The male-female difference was also noticeable. The neonatal and injury related average conditional probabilities were higher for females. However, the average conditional probabilities of eventually dying from communicable and non-communicable diseases were low for female person compared to male person.

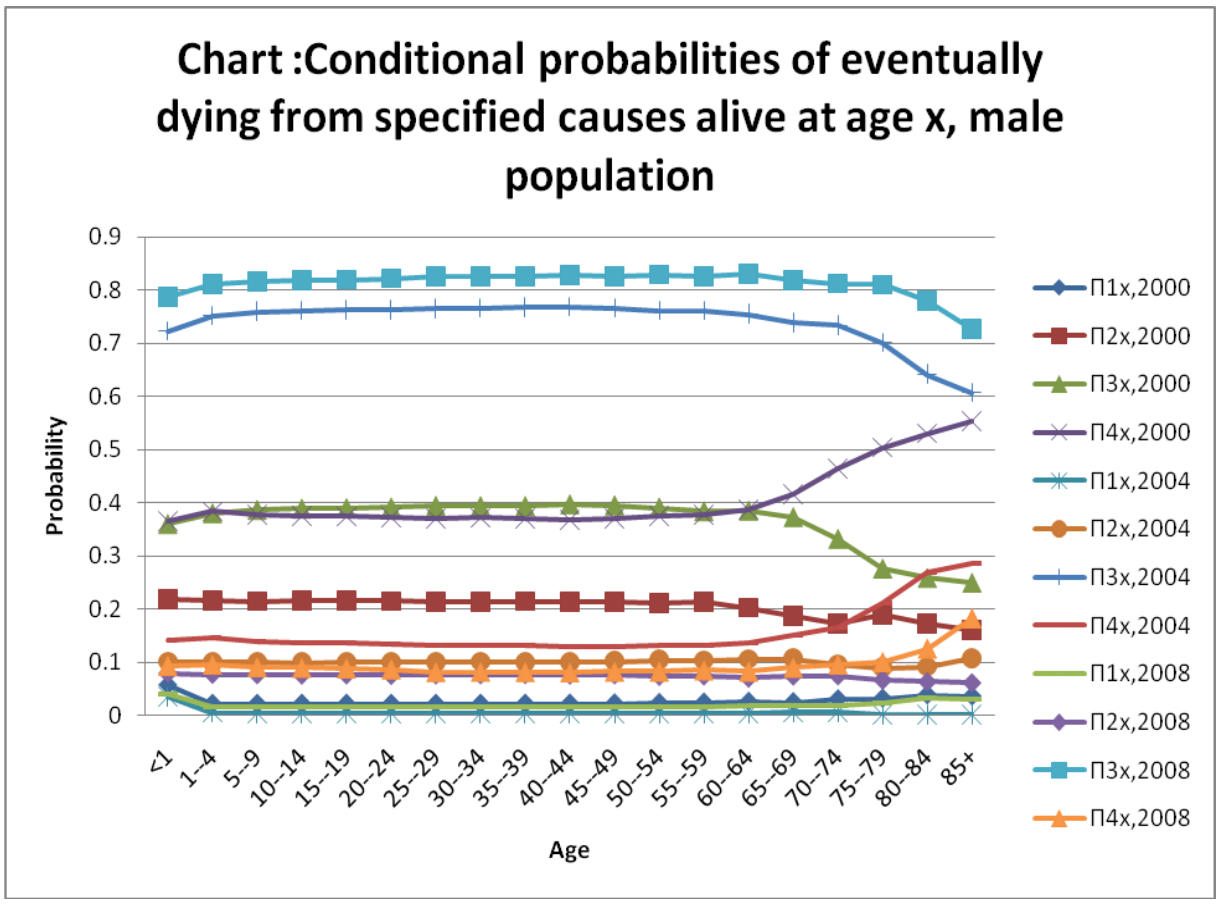


Figure 5.4. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab male population

As seen in the above Figure, both in 2004 and 2008 the conditional probabilities of deaths of non-communicable diseases had topped the position (the top two curves). The conditional probability of eventually dying from injury displayed rising trend.

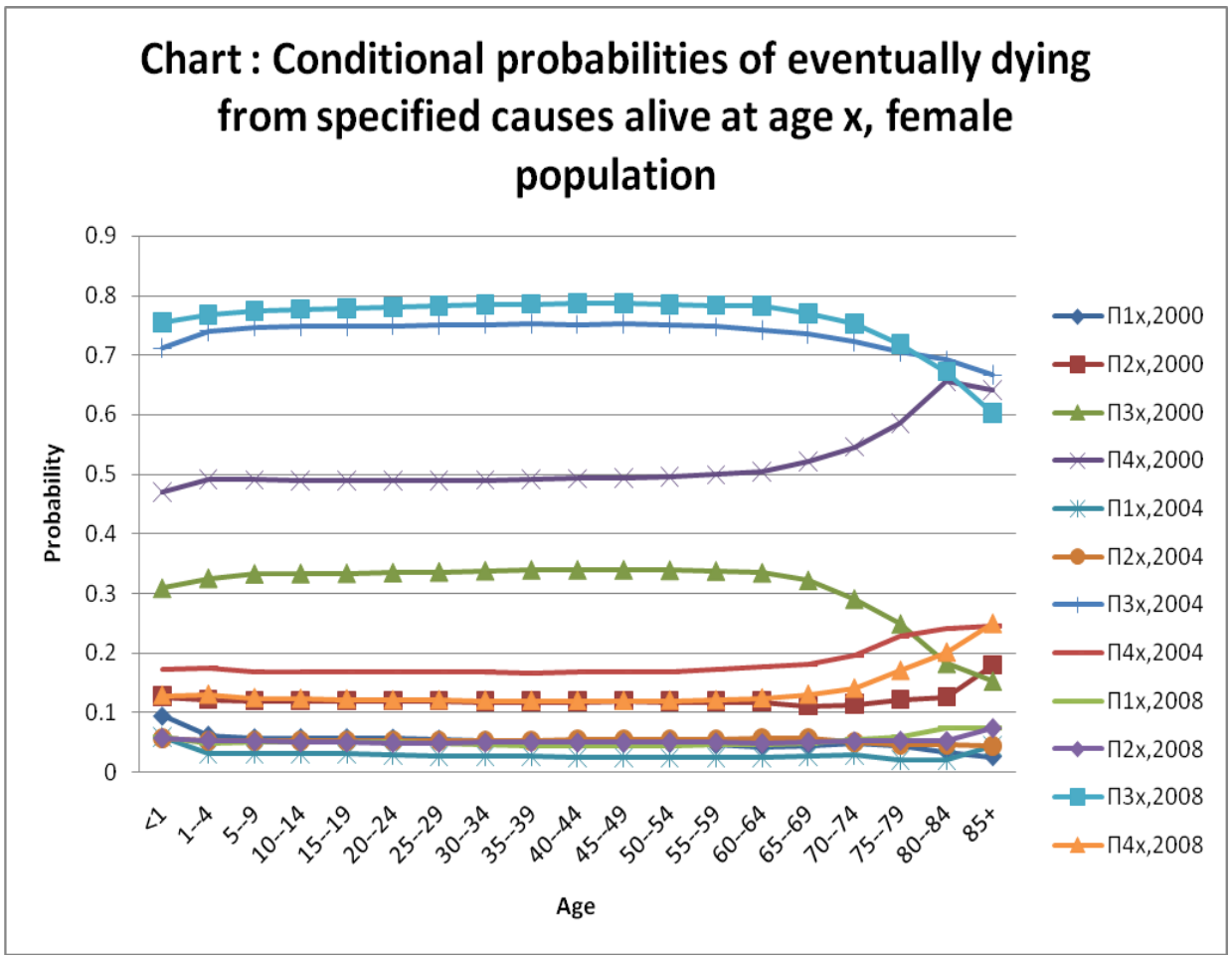


Figure 5.5. Conditional probabilities of eventually dying from specified causes, given alive at age x, Matlab female population

This Figure showed similar pattern as in the cases of males. The top two curves displayed the conditional probabilities of death due to non-communicable diseases in the year 2008 and 2004 respectively. The conditional probabilities of eventually dying of injury related diseases showed increasing trend in 2000, 2004 and 2008.

In this section, it was observed that the probability of dying at an exact age due to α-th cause, D_α, out of the survivors at age zero (0) were exposed to the risk of α-th cause. This was a cumulative distribution function of age at death for α-th cause, D_α, in presence of all causes of deaths.

Table 5.30. Cumulative distribution function of death at age for different causes each acting in the presence of all causes for Matlab male population, 2000

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.053790	0.643652	0.068100	0.001002	0.005796
5--9	0.070920	0.650009	0.086476	0.003033	0.038689
10--14	0.078360	0.650009	0.089730	0.004980	0.055176
15--19	0.081240	0.650009	0.095596	0.005898	0.058676
20--24	0.085860	0.656896	0.100866	0.006956	0.066031
25--29	0.092640	0.656896	0.110444	0.006956	0.078854
30--34	0.098090	0.656896	0.116677	0.014551	0.082572
35--39	0.101000	0.656896	0.116677	0.016554	0.088560
40--44	0.110730	0.656896	0.128592	0.020171	0.104528
45--49	0.126450	0.656896	0.148206	0.042040	0.114289
50--54	0.145930	0.656896	0.171715	0.073396	0.122710
55--59	0.178900	0.656896	0.194079	0.124367	0.149423
60--64	0.229400	0.656896	0.284405	0.175783	0.183081
65--69	0.313020	0.701572	0.412126	0.288576	0.217723
70--74	0.435440	0.701572	0.550891	0.479022	0.282523
75--79	0.564360	0.757726	0.623849	0.665016	0.400011
80--84	0.692380	0.791983	0.757161	0.778337	0.553809
85+	0.824930	0.889634	0.871042	0.878220	0.735003

The cumulative distribution function in Table 5.30 shows a concentration of deaths due to neonatal condition at very young ages. The information showed concentration of non-communicable, communicable, and injury related deaths at older ages.

Table 5.31. Cumulative distribution function of death at age for different causes in the presence of all causes for Matlab female population, 2000

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.051680	0.378855	0.096853	0.000000	0.007392
5--9	0.072360	0.434411	0.129268	0.000000	0.031422
10--14	0.074910	0.434411	0.129268	0.001167	0.036087
15--19	0.077170	0.437790	0.134369	0.002237	0.038153
20--24	0.080050	0.446557	0.134369	0.002237	0.042521
25--29	0.084790	0.466519	0.141826	0.003760	0.045567
30--34	0.093050	0.483946	0.154776	0.007326	0.053768
35--39	0.097250	0.511724	0.158936	0.007326	0.056005
40--44	0.102310	0.529573	0.163331	0.012804	0.058413
45--49	0.106860	0.545627	0.163331	0.017732	0.061629
50--54	0.123050	0.556295	0.187112	0.037376	0.074560
55--59	0.132860	0.579320	0.195668	0.051509	0.079204
60--64	0.152420	0.611956	0.211836	0.081559	0.090175
65--69	0.215780	0.625581	0.313319	0.182145	0.128733
70--74	0.313820	0.641529	0.384350	0.353302	0.202654
75--79	0.473590	0.751056	0.498391	0.575254	0.344084
80--84	0.620340	0.863857	0.624048	0.774158	0.469132
85+	0.797460	0.945184	0.714701	0.898992	0.723425

The cumulative distribution function in Table 5.31 shows a concentration of deaths due to neonatal condition at very young ages, but at a lower rate compared to the male population in year 2000. The Table also showed concentration of non-communicable, communicable, and injury related deaths at older ages.

Table 5.32. Cumulative distribution function of death at age for different causes each acting in the presence of all causes for Matlab male population, 2004

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.041840	0.898126	0.051813	0.003857	0.022186
5--9	0.054660	0.918618	0.068952	0.006249	0.083375
10--14	0.058710	0.918618	0.076283	0.007769	0.098990
15--19	0.061280	0.918618	0.076283	0.009801	0.106762
20--24	0.064540	0.918618	0.076283	0.012621	0.115382
25--29	0.069620	0.918618	0.081831	0.014958	0.135378
30--34	0.073370	0.918618	0.081831	0.017031	0.151205
35--39	0.080460	0.918618	0.095899	0.023888	0.156221
40--44	0.091890	0.918618	0.103032	0.034768	0.176429
45--49	0.111130	0.918618	0.109372	0.057813	0.190066
50--54	0.132600	0.918618	0.109372	0.085364	0.200876
55--59	0.168330	0.918618	0.150981	0.123146	0.230552
60--64	0.212770	0.918618	0.175451	0.177751	0.248004
65--69	0.310460	0.918618	0.276006	0.295257	0.265951
70--74	0.429810	0.918618	0.457004	0.421527	0.334770
75--79	0.571730	1.000000	0.622350	0.585026	0.364304
80--84	0.744900	1.000000	0.770854	0.773781	0.517205
85+	0.858590	1.000000	0.849911	0.881306	0.714548

The cumulative distribution function in Table 5.32 shows a concentration of deaths due to neonatal condition at very young ages, from 1-4 years. The table also showed that the cumulative distributions of non-communicable, communicable and injury related deaths were less than 0.20 till they reached at the age 54 whereas the cumulative proportions of deaths due to neonatal and maternal diseases was 0.91.

Table 5.33. Cumulative distribution function of death at age for different causes each acting in the presence of all causes for Matlab female population, 2004

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.042230	0.503797	0.102066	0.004088	0.021192
5--9	0.052280	0.509873	0.114671	0.005099	0.069283
10--14	0.056890	0.509873	0.121324	0.008864	0.078249
15--19	0.060970	0.516118	0.134279	0.012516	0.080403
20--24	0.066590	0.535021	0.134279	0.017250	0.086924
25--29	0.071550	0.557975	0.134279	0.021057	0.092163
30--34	0.074850	0.576371	0.134279	0.023375	0.095366
35--39	0.079950	0.585992	0.134279	0.026564	0.108582
40--44	0.088780	0.604726	0.134279	0.037409	0.108582
45--49	0.097200	0.624979	0.144783	0.045865	0.112075
50--54	0.113310	0.638481	0.144783	0.063972	0.126164
55--59	0.126220	0.638481	0.144783	0.082094	0.126164
60--64	0.154290	0.638481	0.163690	0.118491	0.132452
65--69	0.204030	0.638481	0.202381	0.177504	0.164590
70--74	0.324020	0.661097	0.389181	0.314215	0.226712
75--79	0.461420	0.804219	0.567402	0.466728	0.285980
80--84	0.658410	0.879831	0.724090	0.667973	0.520552
85+	0.839710	0.879831	0.875350	0.849888	0.771891

The cumulative distribution function in Table 5.33 shows similar pattern for females as was observed in the previous table for males; a concentration of deaths due to neonatal condition at very young ages. It was 0.50 for the age group 1-4. The table also provided the cumulative proportion of non-communicable, communicable, and injury related deaths were less than 0.15 till they reached at the age 59 whereas the cumulative proportions considering same aged male population due to those causes of deaths were less than 0.20. So, males' deaths contributed higher proportions than females' due to these causes of deaths.

Table 5.34. Cumulative distribution function of death at age for different causes in the presence of all causes for Matlab male population, 2008

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.031020	0.616908	0.047437	0.002372	0.011947
5--9	0.041520	0.626301	0.071347	0.006178	0.067947
10--14	0.045490	0.635440	0.080504	0.007549	0.087147
15--19	0.048300	0.635440	0.080504	0.009591	0.099947
20--24	0.052460	0.635440	0.092331	0.011355	0.119680
25--29	0.059060	0.635440	0.092331	0.013029	0.176000
30--34	0.063140	0.656258	0.092331	0.017165	0.176000
35--39	0.068890	0.656258	0.092331	0.023420	0.184747
40--44	0.079380	0.656258	0.112807	0.032630	0.202027
45--49	0.093290	0.656258	0.122600	0.049300	0.202027
50--54	0.113390	0.673267	0.173725	0.067150	0.216320
55--59	0.145610	0.673267	0.195854	0.104716	0.225600
60--64	0.192120	0.673267	0.282462	0.147888	0.286080
65--69	0.270680	0.673267	0.314638	0.242734	0.299627
70--74	0.398310	0.740036	0.431769	0.379610	0.383787
75--79	0.545450	0.740036	0.618975	0.532345	0.512213
80--84	0.673430	0.740036	0.739540	0.676668	0.562773
85+	0.812060	0.855293	0.855144	0.826586	0.635520

It was observed that the cumulative distribution function of deaths due to neonatal and maternal condition showed a concentration of deaths at very young ages. It was 0.62 for the age group 1-4 whereas the cumulative distribution of deaths due to communicable, non-communicable and injury related deaths showed concentration in the later stages of life.

Table 5.35. Cumulative distribution function of death at age for different causes each acting in the presence of all causes for Matlab female population, 2008

Age group x to x+n	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
<1	0.000000	0.000000	0.000000	0.000000	0.000000
1--4	0.017350	0.185790	0.080167	0.001523	0.005969
5--9	0.028350	0.185790	0.121117	0.003615	0.060780
10--14	0.032540	0.185790	0.147493	0.004621	0.075587
15--19	0.033350	0.185790	0.147493	0.004621	0.081867
20--24	0.038940	0.193188	0.169877	0.006898	0.098535
25--29	0.042990	0.231894	0.169877	0.008686	0.102023
30--34	0.047280	0.268708	0.169877	0.010103	0.110319
35--39	0.050270	0.279030	0.169877	0.012473	0.114970
40--44	0.056920	0.299845	0.180462	0.017279	0.124351
45--49	0.062230	0.299845	0.180462	0.023529	0.128925
50--54	0.078410	0.299845	0.180462	0.043165	0.139391
55--59	0.097390	0.299845	0.211869	0.063515	0.153345
60--64	0.120420	0.319628	0.251779	0.089427	0.153345
65--69	0.180300	0.319628	0.271386	0.164224	0.170866
70--74	0.290500	0.340444	0.355370	0.292499	0.227227
75--79	0.441770	0.442629	0.484123	0.469235	0.261726
80--84	0.586230	0.476690	0.621378	0.631672	0.353748
85+	0.781350	0.723379	0.720979	0.825449	0.576246

Table 5.35 shows similar pattern for females as was observed in the previous table for males, but the rates are slightly lower for females. So, the proportional contribution of the males' deaths to the overall deaths continued to be higher than females.

Table 5.36. Year wise cumulative distribution function of death at age 85+ for different causes in the presence of all causes for Matlab male population

Year	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
2000	0.824930	0.889634	0.871042	0.878220	0.735003
2004	0.858590	1.000000	0.849911	0.881306	0.714548
2008	0.812060	0.855293	0.855144	0.826586	0.635520

It is observed from the Table 5.36 that, for the last age group, the value of cumulative proportion was greater than 0.8 which means 80% of the deaths occurred before 85. Among the causes, the highest cause was neonatal complications whose cumulative proportions were 0.88, 1.00 and 0.86 respectively in years 2000, 2004 and 2008.

Table 5.37. Year wise cumulative distribution function of death at age 85+ for different causes in the presence of all causes for Matlab female population

Year	F_x	F_{1x}	F_{2x}	F_{3x}	F_{4x}
2000	0.797460	0.945184	0.714701	0.898992	0.723425
2004	0.839710	0.879831	0.875350	0.849888	0.771891
2008	0.781350	0.723379	0.720979	0.825449	0.576246

Table 5.37 describes that females show similar pattern of trends as males. The overall cumulative proportion was greater than 0.78 in all three years.

In 2008, among the causes, the highest proportion was for non-communicable diseases with the value 0.83 while the overall proportion was 0.78. In all the years, the overall cumulative proportion of aged females was slightly less than males' regarding all causes of deaths.

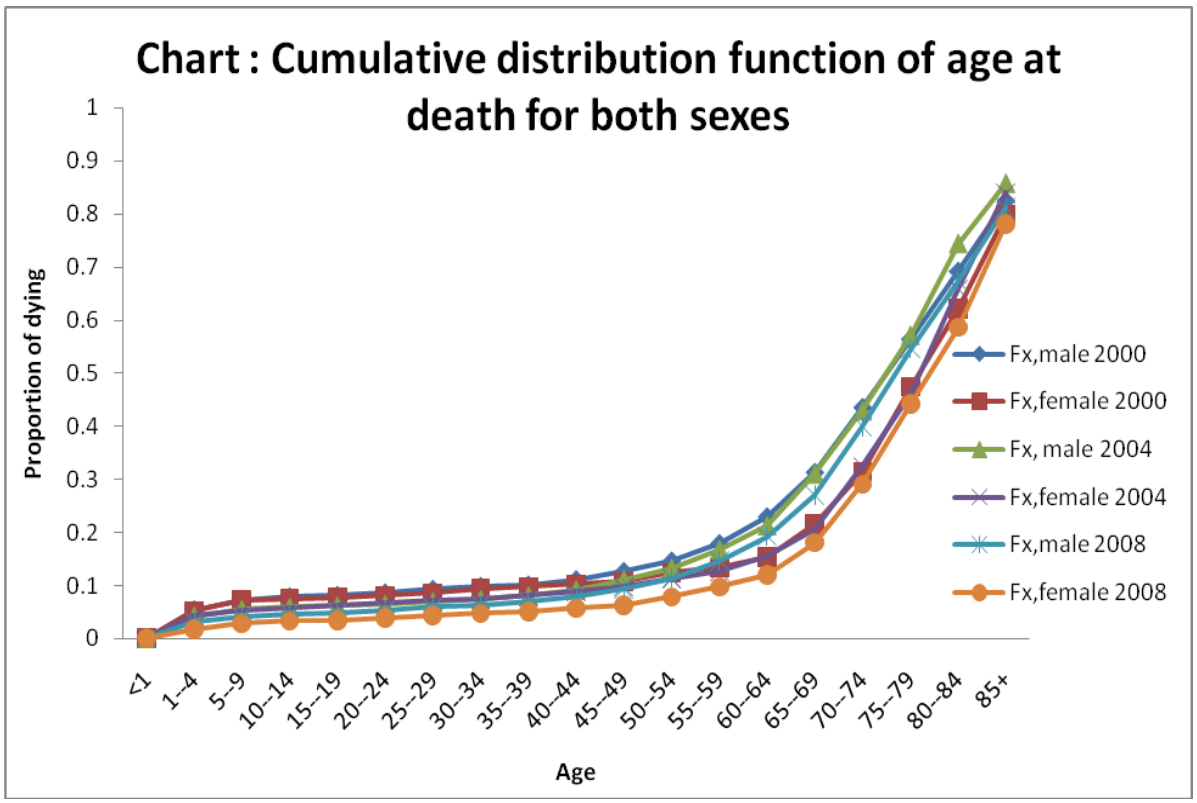


Figure 5.6. Year wise cumulative distribution function of all causes by age for Matlab population

In almost all the years and in almost all age groups, male's cumulative distribution function of death at age showed greater than females. Also the upward trend of the curve in the later stages means that deaths are more concentrated in the later stages of life. It showed the need for better health care system for the elderly people.

In the following tables, approximate density function of deaths due to cause D_α in presence of all causes were examined. The probability of dying between ages x to x+n due to α-th cause, D_α, out of all survivors exposed to the risk of death at age zero is symbolized by $f_{\alpha.}$.

Table 5.38. Approximate density functions from various causes acting simultaneously on the male population evaluated at mid points, x*=x+n/2, in 2000

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.643652	0.068100	0.001002	0.005796
2.0	0.001589	0.004594	0.000508	0.008223
7.5	0.000000	0.000651	0.000390	0.003297
12.5	0.000000	0.001173	0.000184	0.000700
17.5	0.001377	0.001054	0.000211	0.001471
22.5	0.000000	0.001916	0.000000	0.002565
27.5	0.000000	0.001247	0.001519	0.000744
32.5	0.000000	0.000000	0.000401	0.001198
37.5	0.000000	0.002383	0.000723	0.003194
42.5	0.000000	0.003923	0.004374	0.001952
47.5	0.000000	0.004702	0.006271	0.001684
52.5	0.000000	0.004473	0.010194	0.005343
57.5	0.000000	0.018065	0.010283	0.006732
62.5	0.008935	0.025544	0.022559	0.006928
67.5	0.000000	0.027753	0.038089	0.012960
72.5	0.011231	0.014591	0.037199	0.023498
77.5	0.006851	0.026662	0.022664	0.030760
82.5	0.019530	0.022776	0.019977	0.036239
97.5	0.022073	0.025792	0.024356	0.052999

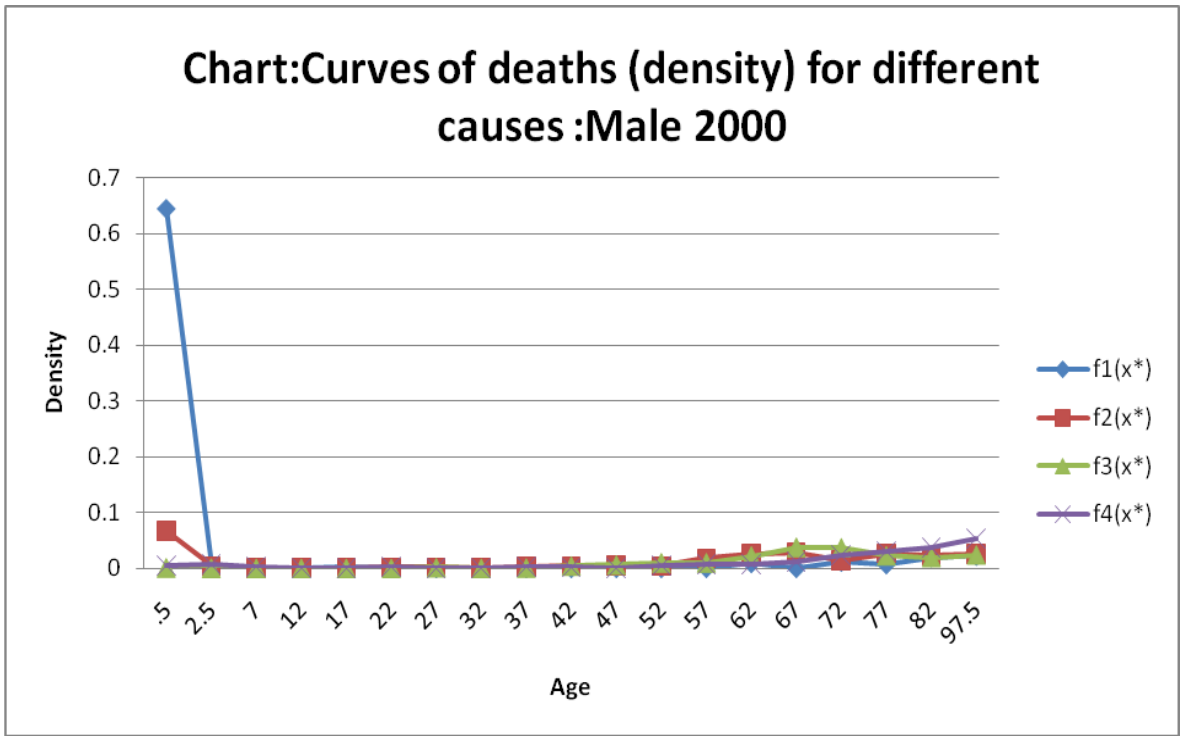


Figure 5.7. Curves of deaths (density) of male in 2000 for different causes

The values of $f_i(x^*)$ at different ages i.e., the probability of death from birth to a central age, $x^*=x+n/2$, for the disease groups is presented in the Table 5.38. At the infancy period, neonatal complications showed maximum value. The curves of death for other age groups for different groups of diseases looked almost similar except for the later ages.

Table 5.39. Approximate density function of various disease groups acting simultaneously on the female population evaluated at mid points, x*=x+n/2, in 2000

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.378855	0.096853	0.000000	0.007392
2.0	0.013889	0.008104	0.000000	0.006007
7.5	0.000000	0.000000	0.000233	0.000933
12.5	0.000676	0.001020	0.000214	0.000413
17.5	0.001753	0.000000	0.000000	0.000873
22.5	0.003992	0.001491	0.000305	0.000609
27.5	0.003485	0.002590	0.000713	0.001640
32.5	0.005556	0.000832	0.000000	0.000447
37.5	0.003570	0.000879	0.001096	0.000481
42.5	0.003211	0.000000	0.000985	0.000643
47.5	0.002134	0.004756	0.003929	0.002586
52.5	0.004605	0.001711	0.002827	0.000929
57.5	0.006527	0.003234	0.006010	0.002194
62.5	0.002725	0.020297	0.020117	0.007712
67.5	0.003190	0.014206	0.034231	0.014784
72.5	0.021905	0.022808	0.044390	0.028286
77.5	0.022560	0.025131	0.039781	0.025010
82.5	0.016265	0.018130	0.024967	0.050859
97.5	0.010963	0.057060	0.020202	0.055315

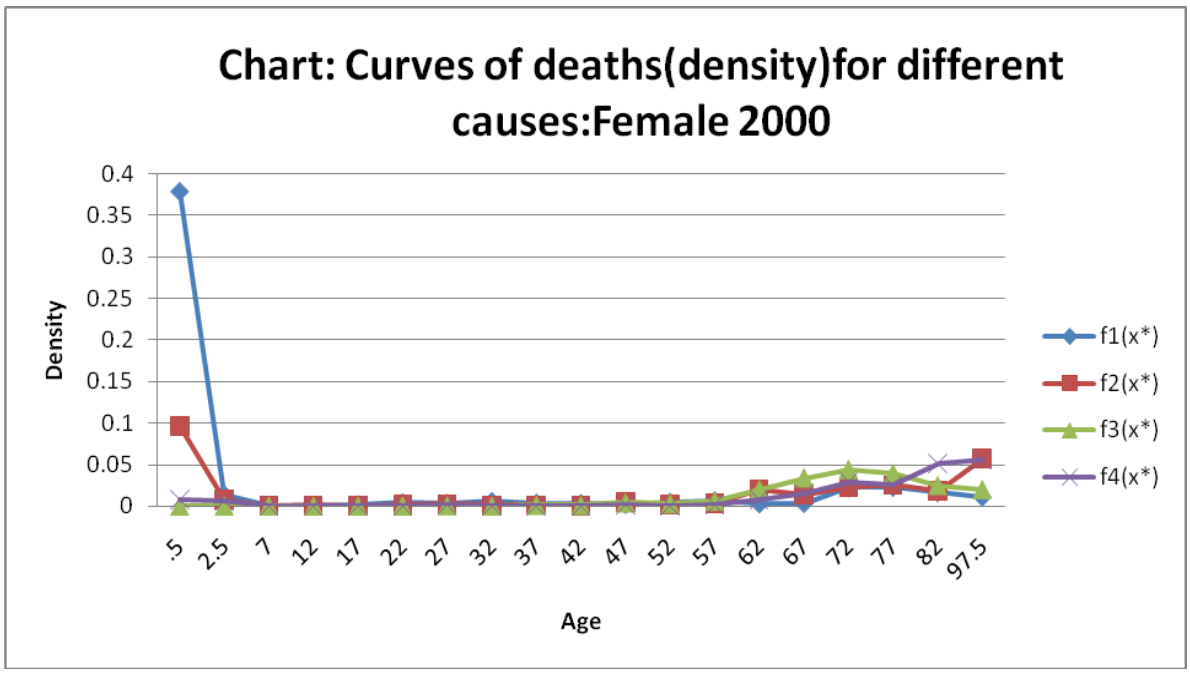


Figure 5.8. Curves of deaths (density) of females in 2000 for different causes

Neonatal and maternal complications had significant impact at infancy. Probability function of the neonatal and maternal cause was the highest there. The pattern of the curves of death of different disease groups for other age groups looked like almost similar till they reached age 52. Injury related causes and communicable cause displayed significance role at the older age group. Non-communicable disease was also a major cause of death after age 60.

Table 5.40 and Table 5.41 below shows, separately for males and females, the approximate density function of various causes of deaths acting simultaneously on the population in the year 2004.

Table 5.40. Approximate density function from various causes acting simultaneously in the population evaluated at mid points, x*=x+n/2, Matlab males, 2004

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.898126	0.051813	0.003857	0.022186
2.0	0.005123	0.004285	0.000598	0.015297
7.5	0.000000	0.001466	0.000304	0.003123
12.5	0.000000	0.000000	0.000406	0.001554
17.5	0.000000	0.000000	0.000564	0.001724
22.5	0.000000	0.001110	0.000467	0.003999
27.5	0.000000	0.000000	0.000415	0.003165
32.5	0.000000	0.002814	0.001371	0.001003
37.5	0.000000	0.001427	0.002176	0.004042
42.5	0.000000	0.001268	0.004609	0.002727
47.5	0.000000	0.000000	0.005510	0.002162
52.5	0.000000	0.008322	0.007556	0.005935
57.5	0.000000	0.004894	0.010921	0.003490
62.5	0.000000	0.020111	0.023501	0.003589
67.5	0.000000	0.036200	0.025254	0.013764
72.5	0.016276	0.033069	0.032700	0.005907
77.5	0.000000	0.029701	0.037751	0.030580
82.5	0.000000	0.015811	0.021505	0.039469
97.5	0.000000	0.030018	0.023739	0.057090

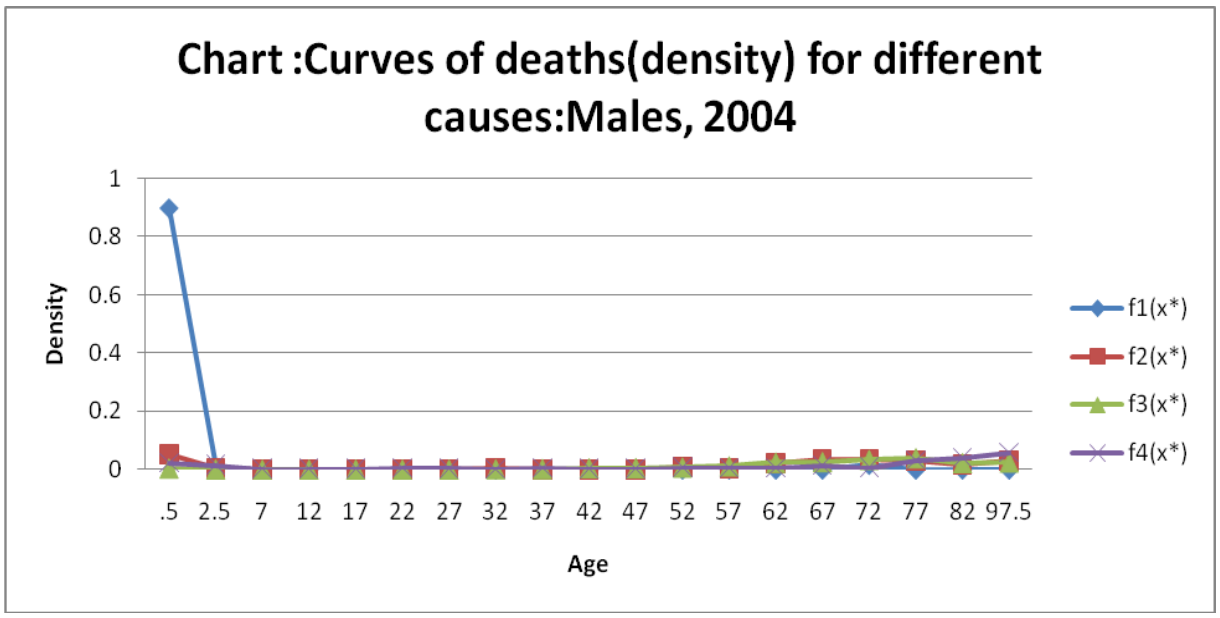


Figure 5.9. Curves of deaths (density) of male in 2004 for different causes

Neonatal and maternal complications had significant impact at infancy as observed in 2000. Also communicable diseases affected the infancy period more for male. The pattern of the curves of death for other age group looked like almost similar due to various causes of deaths. Injury related causes and communicable cause displayed significance role at the older age group.

Table 5.41. Approximate density function from various causes acting simultaneously in the population evaluated at mid points, x*=x+n/2, Matlab females, 2004

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.503797	0.102066	0.004088	0.021192
2.0	0.001519	0.003151	0.000253	0.012023
7.5	0.000000	0.001331	0.000753	0.001793
12.5	0.001249	0.002591	0.000730	0.000431
17.5	0.003781	0.000000	0.000947	0.001304
22.5	0.004591	0.000000	0.000761	0.001048
27.5	0.003679	0.000000	0.000464	0.000640
32.5	0.001924	0.000000	0.000638	0.002643
37.5	0.003747	0.000000	0.002169	0.000000
42.5	0.004051	0.002101	0.001691	0.000699
47.5	0.002700	0.000000	0.003621	0.002818
52.5	0.000000	0.000000	0.003624	0.000000
57.5	0.000000	0.003782	0.007279	0.001258
62.5	0.000000	0.007738	0.011803	0.006428
67.5	0.004523	0.037360	0.027342	0.012424
72.5	0.028624	0.035644	0.030503	0.011854
77.5	0.015122	0.031338	0.040249	0.046914
82.5	0.000000	0.030252	0.036383	0.050268
97.5	0.024034	0.024930	0.030022	0.045622

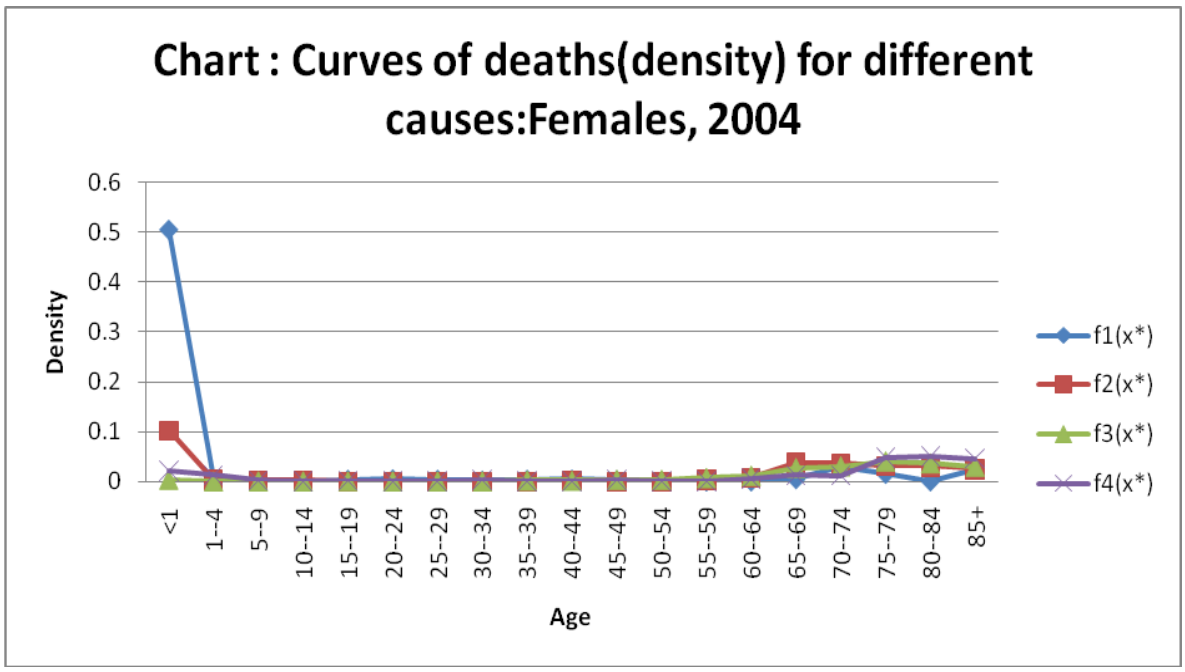


Figure 5.10. Curves of deaths (density) of female in 2004 for different causes

In 2004, for females, neonatal and maternal complications had significant impact at the infancy stage. But the impact was less severe than in the case of male infants. Also communicable diseases affected more females at infancy period than the males. The pattern of the curves of death of different disease groups in other age groups looked almost similar till 64. Communicable diseases had significant impact during age 65-74. Non-communicable diseases and injury related causes displayed significant role at the older age group 75+.

Table 5.42 and 5.43 below showed, separately for males and females, the approximate density function of various causes of deaths acting simultaneously on the population in the year 2008.

Table 5.42. Approximate density function from various causes acting simultaneously in the population evaluated at mid points, x*=x+n/2, Matlab males, 2008

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.616908	0.047437	0.002372	0.011947
2.0	0.002348	0.005977	0.000951	0.014000
7.5	0.001828	0.001831	0.000274	0.003840
12.5	0.000000	0.000000	0.000409	0.002560
17.5	0.000000	0.002366	0.000353	0.003947
22.5	0.000000	0.000000	0.000335	0.011264
27.5	0.004163	0.000000	0.000827	0.000000
32.5	0.000000	0.000000	0.001251	0.001749
37.5	0.000000	0.004095	0.001842	0.003456
42.5	0.000000	0.001959	0.003334	0.000000
47.5	0.003402	0.010225	0.003570	0.002859
52.5	0.000000	0.004426	0.007513	0.001856
57.5	0.000000	0.017322	0.008635	0.012096
62.5	0.000000	0.006435	0.018969	0.002709
67.5	0.013354	0.023426	0.027375	0.016832
72.5	0.000000	0.037441	0.030547	0.025685
77.5	0.000000	0.024113	0.028865	0.010112
82.5	0.023052	0.023121	0.029984	0.014549
97.5	0.028941	0.028971	0.034683	0.072896

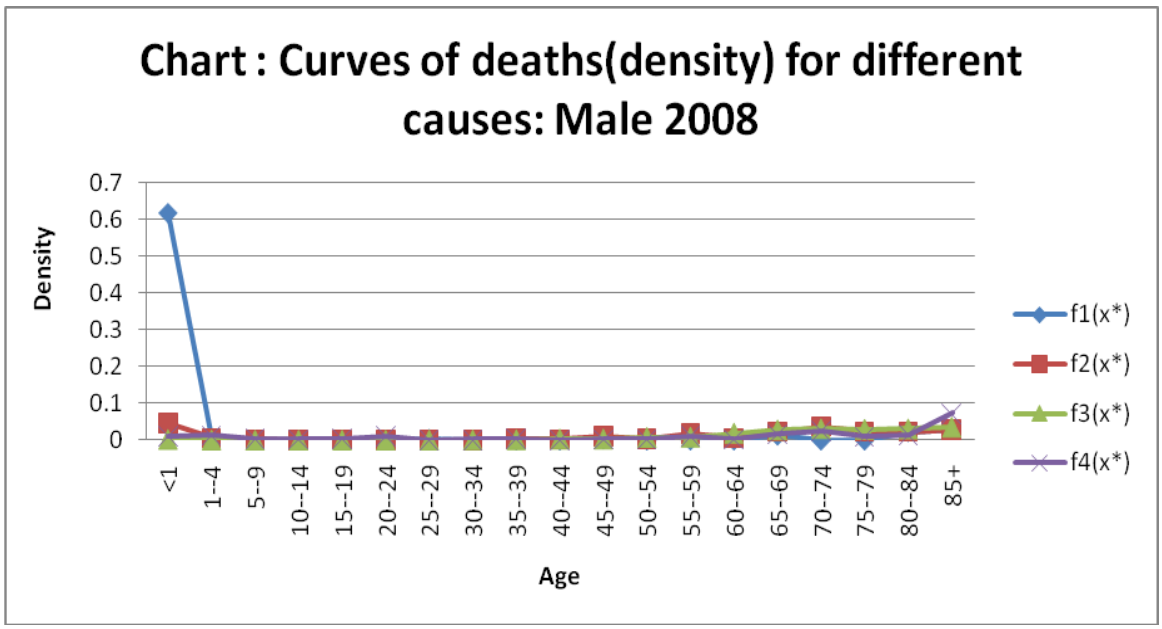


Figure 5.11. Curves of deaths (density) of male in 2008 for different causes

The curves of approximate density function of various disease groups acting simultaneously on the male population in the year 2008 is shown in the above graph. Similar to the years 2000 and 2004, neonatal and maternal complications had major impact at the infancy stage. Except some slight difference in the value level at later age intervals, the pattern of the curves looked almost similar for various groups of diseases.

Table 5.43. Approximate density function from various causes acting simultaneously in the population evaluated at mid points, x*=x+n/2, Matlab females, 2008

Mid age (x*)	$f_1(x^*)$	$f_2(x^*)$	$f_3(x^*)$	$f_4(x^*)$
0.5	0.185790	0.080167	0.001523	0.005969
2.0	0.000000	0.010238	0.000523	0.013703
7.5	0.000000	0.005275	0.000201	0.002961
12.5	0.000000	0.000000	0.000000	0.001256
17.5	0.001479	0.004477	0.000455	0.003334
22.5	0.007741	0.000000	0.000357	0.000698
27.5	0.007363	0.000000	0.000283	0.001659
32.5	0.002064	0.000000	0.000474	0.000930
37.5	0.004163	0.002117	0.000961	0.001876
42.5	0.000000	0.000000	0.001250	0.000915
47.5	0.000000	0.000000	0.003927	0.002093
52.5	0.000000	0.006281	0.004070	0.002791
57.5	0.003957	0.007982	0.005182	0.000000
62.5	0.000000	0.003922	0.014959	0.003504
67.5	0.004163	0.016797	0.025655	0.011272
72.5	0.020437	0.025750	0.035347	0.006900
77.5	0.006812	0.027451	0.032487	0.018405
82.5	0.049338	0.019920	0.038755	0.044500
97.5	0.055324	0.055804	0.034910	0.084751

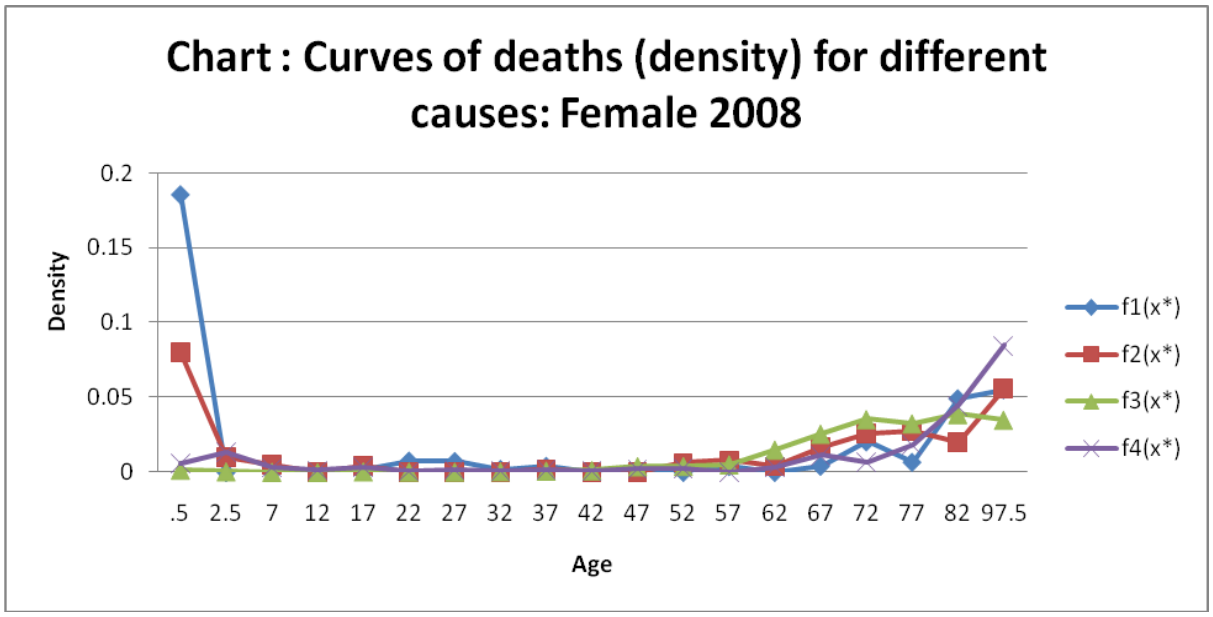


Figure 5.12. Curves of deaths (density) of female in 2008 for different causes

In this graph too, neonatal and maternal deaths is high as usual at infancy. The curves of different disease groups presents almost similar pattern for other age groups (less than 50). After age 50, all the disease groups had somewhat more impact on female health. In the last age group, injury and communicable disease related deaths showed highest probability.

Table 5.44 for males and Table 5.45 for females on the next pages show the approximate density function of various causes of deaths acting simultaneously on the population. The function was evaluated at mid points of the age intervals, x*=x+n/2.

Table 5.44. Approximate density function of various causes of death acting simultaneously on the male population, evaluated at mid points of the age intervals, x*=x+n/2, in Matlab

Mid age (x*)	Probability density in 2000	Probability density in 2004	Probability density in 2008	Major diseases in 2008
0.5	f_1=0.643652	f_1=0.898126	f_1=0.616908	Premature &LBW
2.0	f_4=0.008223	f_4=0.015297	f_4=0.014000	Drowning
7.5	f_4=0.003297	f_4=0.003123	f_4=0.003840	Drowning
12.5	f_2=0.001173	f_4=0.001554	f_4=0.002560	Drowning, suicide
17.5	f_4=0.001471	f_4=0.001724	f_4=0.003947	Drowning, accident
22.5	f_4=0.002565	f_4=0.003999	f_4=0.011264	Accident, suicide, homicide
27.5	f_3=0.001519	f_4=0.003165	f_1=0.004163	Nutritional
32.5	f_4=0.001198	f_2=0.002814	f_4=0.001749	Accident
37.5	f_4=0.003194	f_4=0.004042	f_2=0.004095	Hepatitis
42.5	f_3=0.004374	f_3=0.004609	f_3=0.003334	Diabetes ,heart diseases, digestive
47.5	f_3=0.006271	f_3=0.005510	f_2=0.010225	Tuberculosis ,Hepatitis
52.5	f_3=0.010194	f_2=0.008322	f_3=0.007513	Hypertensive, heart diseases, stroke, cardiovascular
57.5	f_2=0.018065	f_3=0.010921	f_2=0.017322	Tuberculosis ,Hepatitis
62.5	f_2=0.025544	f_3=0.023501	f_3=0.018969	Hypertensive, heart diseases, stroke, cardiovascular, digestive
67.5	f_3=0.038089	f_2=0.036200	f_3=0.027375	‘’
72.5	f_3=0.037199	f_2=0.033069	f_3=0.037441	‘’
77.5	f_4=0.030760	f_3=0.037751	f_3=0.028865	‘’
82.5	f_4=0.036239	f_4=0.039469	f_3=0.029984	‘’
97.5	f_4=0.052999	f_4=0.057090	f_4=0.072896	Senility, accident

The deaths after birth were primarily due to neonatal and maternal complications; more specifically, due to premature birth and low birth weight. For the age group 1-39, all the disease groups showed relatively low probabilities; among them injury and miscellaneous related deaths were high. Deaths affected mostly by drowning and accident. After the age 40, usually the highest values of density function indicated non-communicable cause.

Table 5.45. Approximate density function of various causes of deaths acting simultaneously on the female population, evaluated at mid points of age intervals, x*=x+n/2, in Matlab

Mid age (x*)	Probability density in 2000	Probability density in 2004	Probability density in 2008	Major diseases in 2008
0.5	f_1=0.378855	f_1=0.503797	f_1=0.185790	Premature &LBW, birth asphyxia
2.0	f_1=0.013889	f_4=0.012023	f_4=0.013703	Drowning
7.5	f_4=0.000933	f_4=0.001793	f_2=0.005275	Tuberculosis, meningitis
12.5	f_2=0.001020	f_2=0.002591	f_4=0.001256	Accident
17.5	f_1=0.001753	f_1=0.003781	f_2=0.004477	Septicaemia, diarhoea
22.5	f_1=0.003992	f_1=0.004591	f_1=0.007741	Maternal death
27.5	f_1=0.003485	f_1=0.003679	f_1=0.007363	Maternal death
32.5	f_1=0.005556	f_4=0.002643	f_1=0.002064	Maternal death
37.5	f_1=0.003570	f_1=0.003747	f_1=0.004163	Maternal death
42.5	f_1=0.003211	f_1=0.004051	f_3=0.001250	Cardiovascular, neoplasm
47.5	f_2=0.004756	f_3=0.003621	f_3=0.003927	Neoplasm, hypertensive
52.5	f_1=0.004605	f_3=0.003624	f_2=0.006281	Hepatities
57.5	f_1=0.006527	f_3=0.007279	f_2=0.007982	Hepatities, tuberculosis
62.5	f_2=0.020297	f_3=0.011803	f_3=0.014959	Hypertensive, heartdiseases, stroke
67.5	f_3=0.034231	f_2=0.037360	f_3=0.025655	Hypertensive, heartdiseases, stroke
72.5	f_3=0.044390	f_2=0.035644	f_3=0.035347	Hypertensive, heartdiseases, stroke
77.5	f_3=0.039781	f_4=0.046914	f_3=0.032487	Hypertensive, heartdiseases, stroke
82.5	f_4=0.050859	f_4=0.050268	f_1=0.049338	Nutritional
97.5	f_2=0.057060	f_4=0.045622	f_4=0.084751	Accident, senility

Before age 40, mixed causes influenced deaths but after the age 40, non-communicable disease was more or less the leading cause in the year 2008.

5.5 Conclusion

Life expectancy is an index of mortality. It reflects mortality levels of all ages. Life expectancy is usually the measure of the expectation of life at birth. The benefit of the abridged life table is that the expectation of life can always be related to particular age.

Life expectancy at birth highlighted an increase between years 2000 and 2004. From the year 2000 to year 2004, 0.49 years was added to females' life expectancy at birth whereas 0.76 years was added to the males at the same time. Life expectancy got increased by 1.86 years from 2004 to 2008 for males which was approximately two times greater of the previous increase from year 2000 to 2004. Also 2.70 years was added to females' from year 2004 to 2008 which was approximately six times greater than the previous increase from years 2000 to 2004. So, life expectancy of females grew faster than males'.

The life expectancy at birth in the year 2000 was 63.95 and 67.00 for males and females respectively, which indicated that life expectancy was higher for females. This trend of higher life expectancy for females over males continued throughout the years. In the year 2008 the expectation of life for male was 66.57 on average and 70.19 years for females.

The conditional probabilities of deaths by age-groups from specific disease groups provided that, for Matlab males in age<1, cause-D1 (neonatal and maternal complications) was most influential. For age 1—29, cause-D4 (injuries and miscellaneous) had greater impact to death. For other age groups, cause-D3 (non-communicable) primarily affected the death pattern. Despite some disparities compared to the males in value level, the females' trend showed the same pattern like male except for maternal complications.

Non-communicable diseases were the highest ranked group. The second highest cause of deaths was neonatal and maternal complications which had high intensity of probability for female population compared to the male population. The probability of females' being the NCD victims was low compared to the male population. Overall death rates of males were generally higher than death rates of females.

From the approximate density function of various disease groups, it was observed that the probability of death right after birth was high due to neonatal and maternal complications (premature birth and low birth weight) in 2000, 2004 and 2008. Injury and miscellaneous related causes, specially drowning and accident, affected the age group 1-39 most. After the age of 40, usually non-communicable diseases were of the highest values of the density function.

For females, before the age of 40, multiple causes influenced deaths. However, after the age of 40, non-communicable diseases were more or less the leading cause in the year 2008.

CHAPTER SIX

ELIMINATION OF SPECIFIED DISEASES AND ITS EFFECTS ON THE DURATION OF LIFE

6.1 Introduction

Farr (1875), known as the first medical statistician, posed the question: "What would be the effect of life expectancy if a certain disease were eliminated as a cause of death?" It is important to investigate the effect of elimination of diseases on expectation of life and find the trend in life expectancy.

In the previous chapter, probability pattern of deaths was revealed with the help of conditional probability of deaths, cumulative distribution of age of deaths and so on. In this chapter, it has been focused on the effects of extinction of diseases on expectation or duration of life. Also, it is necessary to find out what would be the pattern of expectation of life if some specified causes were eliminated.

Vacharangkul (1975) examined the relationship between life expectancy and causes of death using the "Causes Eliminated Life Table" method. The objective of this study is to calculate the years of life that would be gained if some specified causes of death were eliminated from 1971 and 1972. Finally the result showed that life expectancy would increase by 1.12, 0.80, and 0.70 years if causes relating to accidents, respiratory tuberculosis and neoplasm were eliminated. If the principal causes were eliminated, then 4.59 years in total would be gained.

This chapter considered two questions:

i. The probability of death by age due to a single category of diseases and the pattern of life expectancy due to a particular category of diseases.
ii. The probability of death by age due to the elimination of a single category of diseases and the pattern of life expectancy due to the elimination.

6.2 Construction Procedure of Single Decrement Life Table (SDMT)

In a cause-eliminated life table, some columns that differed slightly from multiple decrement life table were computed. The notations were also changed. This time ${}_nm_{(i)x}$, ${}_nq_{(i)x}$, $l_{(i)x}$, ${}_nd_{(i)x}$, ${}_nL_{(i)x}$, $T_{(i)x}$, $e^0_{(i)x}$ were calculated instead of ${}_nm_x$, ${}_nq_x$, l_x, ${}_nd_x$, ${}_nL_x$, T_x, e^0_x to find out the life expectancies of male and female after eliminating a single cause of death

in presence of all other causes. The following definitions from Johnson et al. (1980) have been used in this chapter.

i. ${}_nq_{(i)x}$ presented the probability of dying in a specified category of diseases between age *x and x + n,* and was given by

$$ {}_nq_{(i)x} = \frac{{}_nq_{ix}}{1-1/2\times {}_nq_{(-i)x}} $$

and ${}_nq_{(-i)x}$ presented the probability of dying of other causes of death eliminating a specified category of diseases between ages *x and x + n,* and was given by

$$ {}_nq_{(-i)x} = \frac{{}_n{}',q_{-ix}}{1-1/2\times {}_nq_{(i)x}} $$

ii. l_{ix} was the number of people alive at exact age *x* in a specified cause out of some arbitrarily defined number (l_{i0}) at birth. The first value, l_{i0}, was an arbitrary number called the radix or root. It was usually a round number such as 100,000. By definition, the following relationships hold:

$$ \begin{aligned} l_{i,x+n} &= l_{ix}\times\left(1-{}_nq_{(i)x}\right) \\ {}_nd_{ix} &= l_{ix}-l_{i,x+n} \\ &= l_{ix}\cdot {}_nq_{ix} \\ l_{(-i),x+n} &= l_{-ix}\times\left(1-{}_nq_{(-i)x}\right) \end{aligned} $$

Where, ${}_nd_{ix}$ was the number of deaths in a specified cause of death in the life table population between exact ages x and x + n. It was started with l_{i0} =100,000 and $l_{(-i)0}$ =100,000.

Also, l_{ix} was a decreasing function of x, i.e. as age increases, l_{ix} must decrease.

For the last interval, the number of persons dying was the same as the number alive at its start:

$$ d_{i,x+} = l_{i,x} $$

For example, $d_{i,85+} = l_{i,85}$

iii. The ${}_nL_{ix}$ function was defined as the total number of person-years lived (contributed by those alive and those who died) in a specified cause of diseases between exact ages *x* and *x+n*.

$$ L_{i0} = 0.20l_{i0} + 0.80l_{i1} $$

$$ {}_nL_{ix} = n\left(l_{ix}-1/2{}_nd_{ix}\right), \textit{ for other age groups} $$

iv. T_{ix} presents the total number of person-years lived after age x. It was obtained by cumulating the ${}_nL_{ix}$ function from the bottom up (highest age interval). Symbolically

$$T_{ix} = T_{i,x+n} + {}_nL_{ix}$$

$$T_{(-i)x} = T_{i,x+n} + {}_nL_{(-i)x}$$

Note that T_{ix} like l_{ix} referred to exact age x, not an age interval.

v. e^0_{ix} indicates the expected number of years left for a person aged *x* in a specified cause of deaths, i. Thus, for the l_{ix} people alive at age *x*, the total number of years left for them to live was given by T_{ix}. Therefore, on average, each of these l_{ix} individuals had, approximately T_{ix}/l_{ix} years to live.

Hence, $e^0_{ix} = \dfrac{T_{ix}}{l_{ix}}$

Similarly, $e^0_{(-i)x} = \dfrac{T_{(-i)x}}{l_{(-i)x}}$

6.3 Effects of Extinction of Diseases on the Duration of Life

In this chapter the effect of elimination of disease on the duration of life is analyzed accordingly to time period. So far, limited works have been done previously about the effect of extinction of diseases on the duration of life in Bangladesh.

It is interesting to know that if one or more of the avoidable causes of deaths, such as maternal and neonatal cause, communicable cause, non-communicable cause, or miscellaneous cause were eliminated then what types of change would occur to the probability patterns and trends of death.

Manton et al. (1976) examined various causes of mortality relating to chronic disease for the state of North Carolina in 1969. The study consisted 39631 of death over 30 to 95+ years and fixed the terminal age of life expectancy at 2.5. The first age group containing 30 to 34 years had a life expectancy of 36.75 years. They showed that life expectancy would have been increased by 5.80 years for cardiovascular diseases, 2.21 years for neoplasm, 0.06 for respiratory condition and 0.20 for hypertension, if they were eliminated. Manton et al. (1980) further examined the cause elimination life tables for population of the United States selected by race. Their aim was to compare between white and black populations by sex. They reported that for whites, in single causes of death, cancer and stroke, females have more advantage in life expectancy at birth than males. Females gained 2.6 years for cancer and 1.4 years for stroke whereas males gained 2.3 years for cancer and 0.9 years for stroke. Among blacks, females gained 2.5

years for cancer and 2.4 years for stroke whereas males gained 2.3 years for cancer and 1.5 years for stroke. As a result, female had more advantage in life expectancy than males. White (1999) analyzed United States data from 1900 to 2000. The study examined the cardiovascular and tuberculosis diseases by using both multiple decrement and cause elimination life tables. The study showed that elimination of cardiovascular diseases had added significantly more to the life expectancy than elimination of tuberculosis.

The following Figures 6.1 and Figure 6.2 examine the effect of elimination of causes of death on the assumption that when a specific cause of death or a group of causes is eliminated, say maternal and neonatal complications (D1), or non-communicable cause (D3).

6.4 Results and Discussion

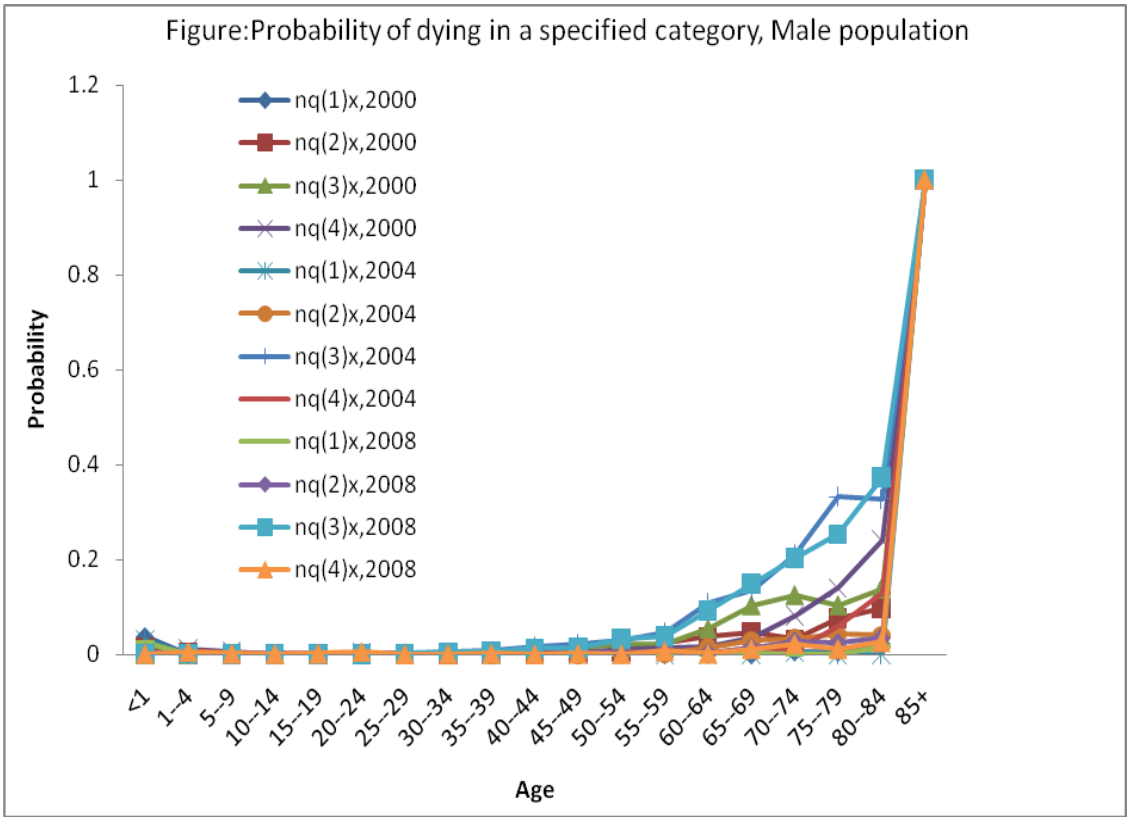


Figure 6.1. Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male population in different years

Figure 6.1 provides the probability of dying in a specified cause of deaths eliminating the effect of other causes of deaths for male population in different years. It was observed that non-communicable diseases showed highest probability pattern of dying for both of the years 2004 and 2008.

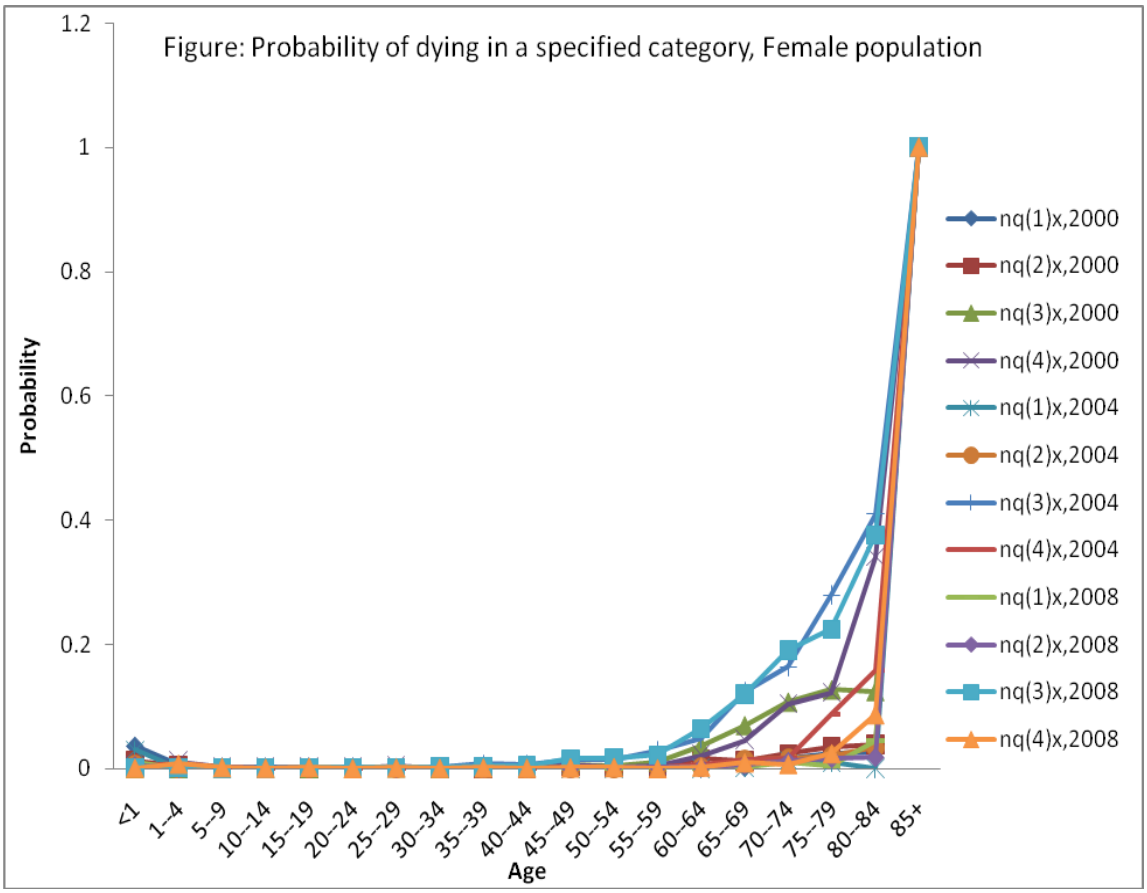


Figure 6.2. Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female population in different years

Figure 6.2 shows similar trend as Figure 6.1. That is non-communicable diseases were found to show the highest probability pattern of dying in both the years 2004 and 2008.

Table 6.1. Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for both sexes in different years

Sex	Year	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
Male	2000	81.01	65.99	77.79	67.32	76.00	68.29	76.33	68.20
Female	2000	79.50	70.26	81.10	68.64	78.40	69.99	76.80	71.39
Male	2004	81.76	66.19	81.47	65.51	69.99	75.33	80.52	66.22
Female	2004	81.15	69.46	82.83	67.80	72.66	76.11	80.65	68.97
Male	2008	82.14	67.83	82.16	67.28	70.77	77.56	81.97	67.58
Female	2008	82.72	70.94	82.95	70.70	73.55	79.01	82.13	71.18

It is interesting to elucidate $e^0_{(1)x}$ and $e^0_{(-1)x}$ for males in 2008. $e^0_{(1)x}$ =82.14 years means that if D1 was the only existing cause of death and D2, D3 and D4 were all eliminated then the expectation of life of male at birth was 82.14 years. $e^0_{(-1)x}$ means that if D1 was eliminated and D2, D3, and D4 were the cause of death, then the expectation of life of male at birth was 67.83 years.

It is found that $e^0_{(i)x}$ was 82.14 years, 82.16 years, 70.77 years and 81.97 years respectively for D1, D2, D3, and D4 for males in 2008. So, D3 was the most influential factor on the expectation of life. If only D3 was present and the rest causes were eliminated, D3 single was lower the expectation of life to 70.77 years whereas for the single presence of other diseases the expectation of life was around 82 years.

Also it is observed that $e^0_{(-i)x}$ was 67.83 years, 67.28 years, 77.56 years and 67.58 years respectively for eliminating of D1, D2, D3, and D4 for males in 2008. It reaffirmed that D3 was the most influential factor. If only D3 was eliminated and the rest causes were present, the elimination of D3 alone raised the expectation of life to 77.56 years whereas for the single elimination of other causes of deaths the expectation of life was around 67 years. It was also noted that females are expected to live longer than males.

So if we want to eliminate a single cause of death to maximize the expectation of life, we have to eliminate D3 because D3 is becoming more influential from year to year.

Table 6.2. Difference of expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for both sexes in different years from observed life expectancies

Sex	Year	$e'_{(1)x}$	$e'_{(-1)x}$	$e'_{(2)x}$	$e'_{(-2)x}$	$e'_{(3)x}$	$e'_{(-3)x}$	$e'_{(4)x}$	$e'_{(-4)x}$	e^0_x
Male	2008	15.57	1.26	15.59	0.71	4.20	10.99	15.4	1.01	66.57
Female	2008	12.53	0.75	12.76	0.51	3.36	8.82	11.94	0.99	70.19

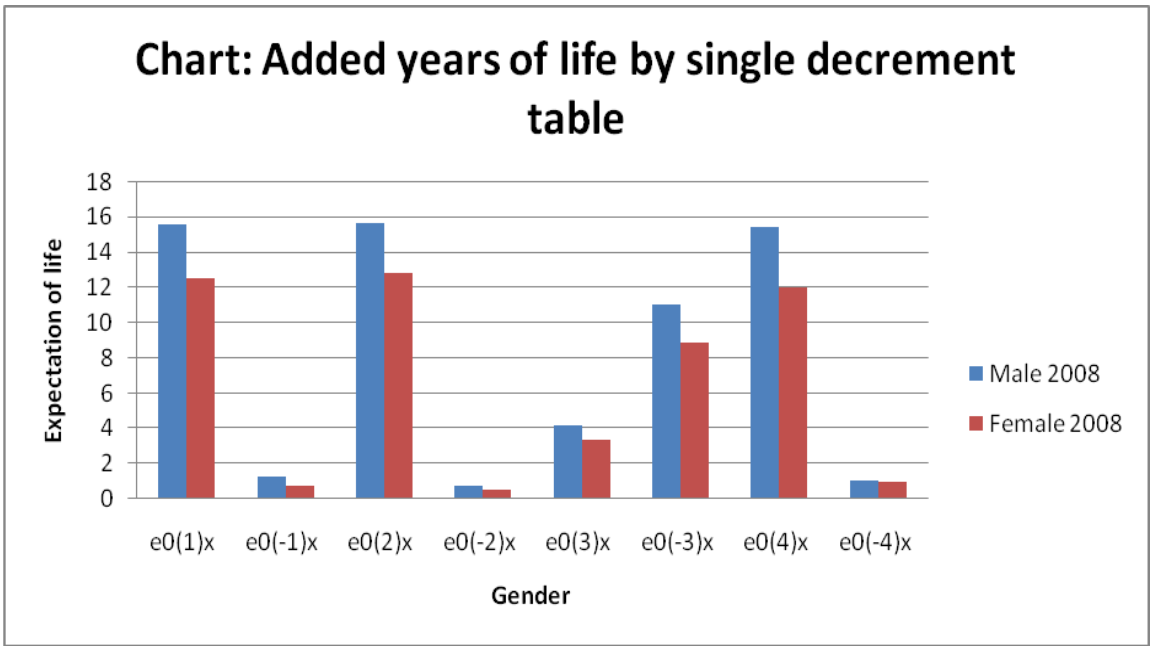


Figure 6.3. Difference of expectation of life in specified cause of deaths (D_α) eliminating the effect of other cause of deaths for both sexes in different years from observed life expectancies

From Table 6.2 and Figure 6.3 it is found that the life expectancies in the presence of non-communicable diseases showed lowest expected years. And the life expectancies eliminating non-communicable diseases showed highest expected years.

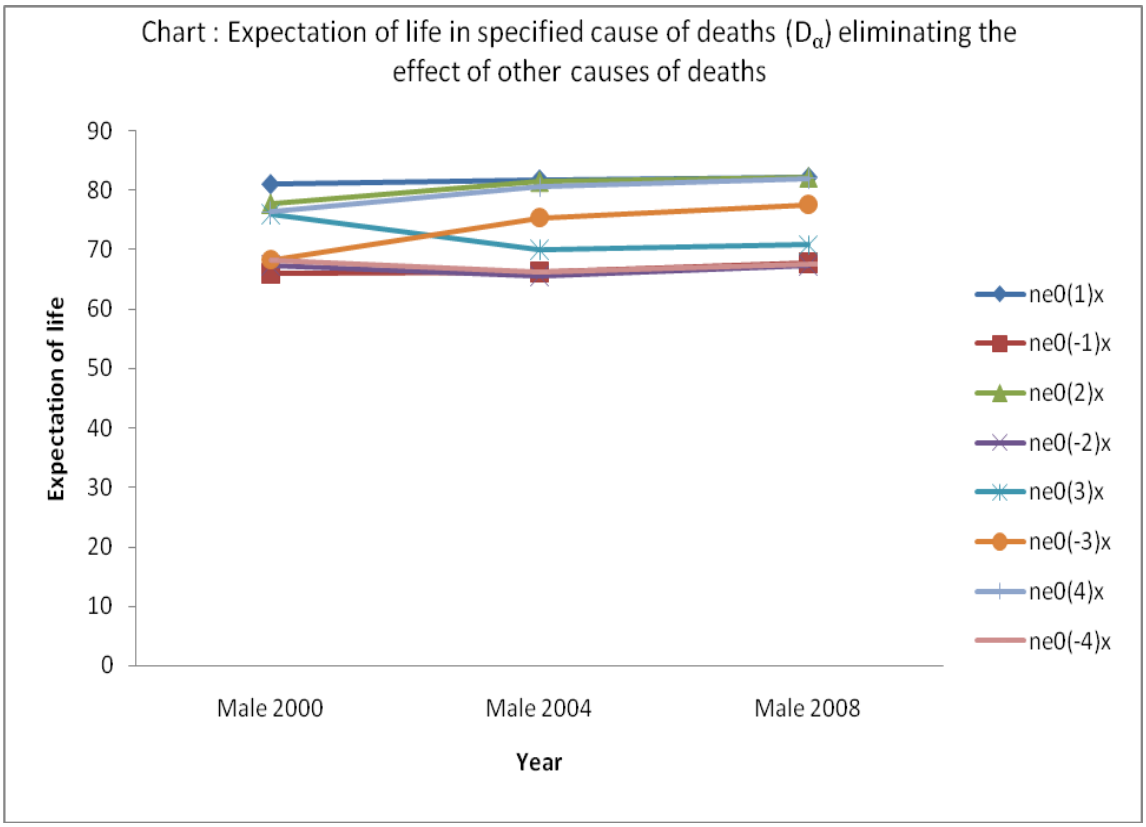


Figure 6.4. Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male population in different years

Figure 6.4 displays the trends of expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male population in different years. After eliminating the leading cause of death (non-communicable diseases) the trend of life expectancy showed on increasing pattern. On the other hand, the trend showed decreasing pattern if non-communicable category was present.

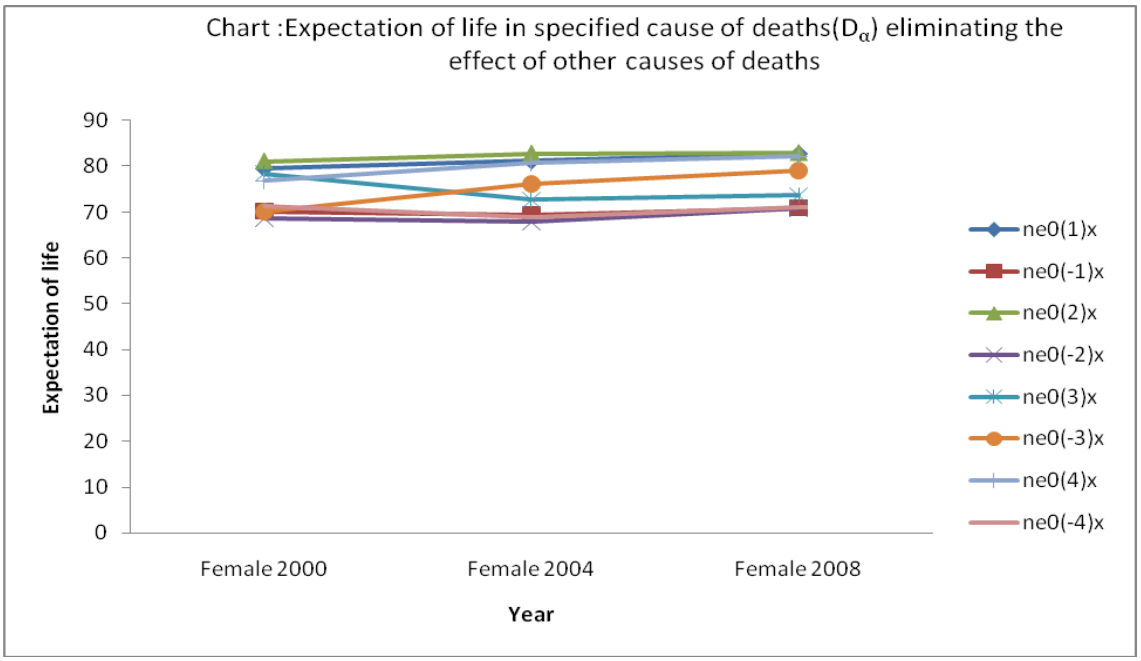


Figure 6.5. Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female population in different years

The expectation of life for females showed similar trends as that in males. The curves were a bit higher than males indicating higher expectation of life for females.

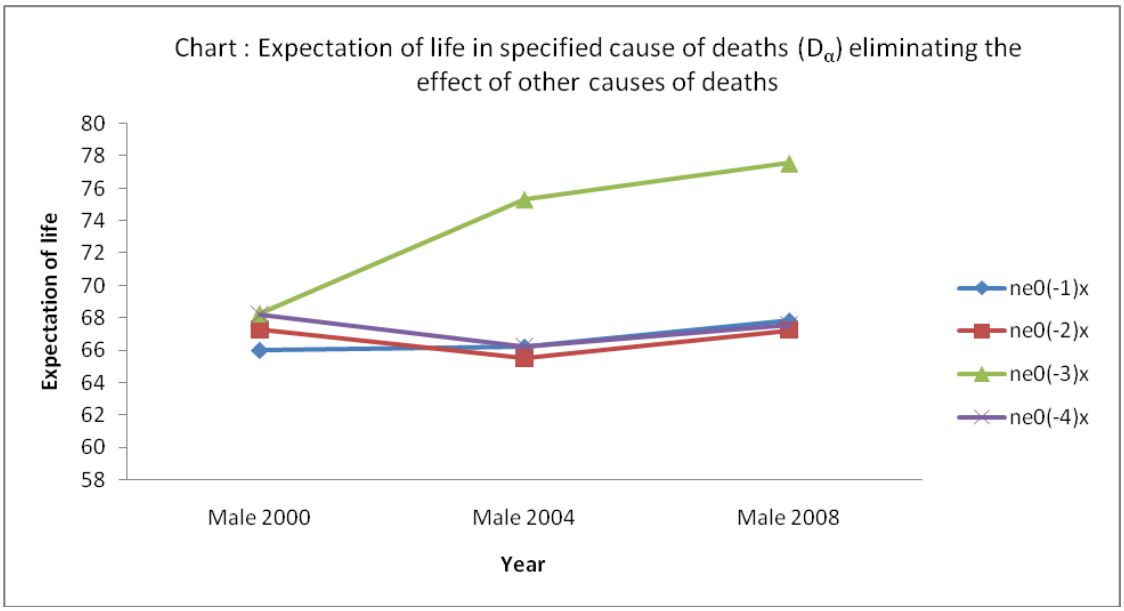


Figure 6.6. Expectation of life in specified causes of deaths (D_α) eliminating the effect of a single cause of deaths for male population in different years

Figure 6.6 depicts the trend of expectation of life eliminating the effect of a single cause of deaths for male population. The elimination of first cause, neonatal and maternal cause showed slow increasing trend in life expectancy. The second cause, communicable diseases, and the forth cause, injuries and miscellaneous, offered similar pattern whereas the third cause, non-communicable diseases, showed significant rising trend.

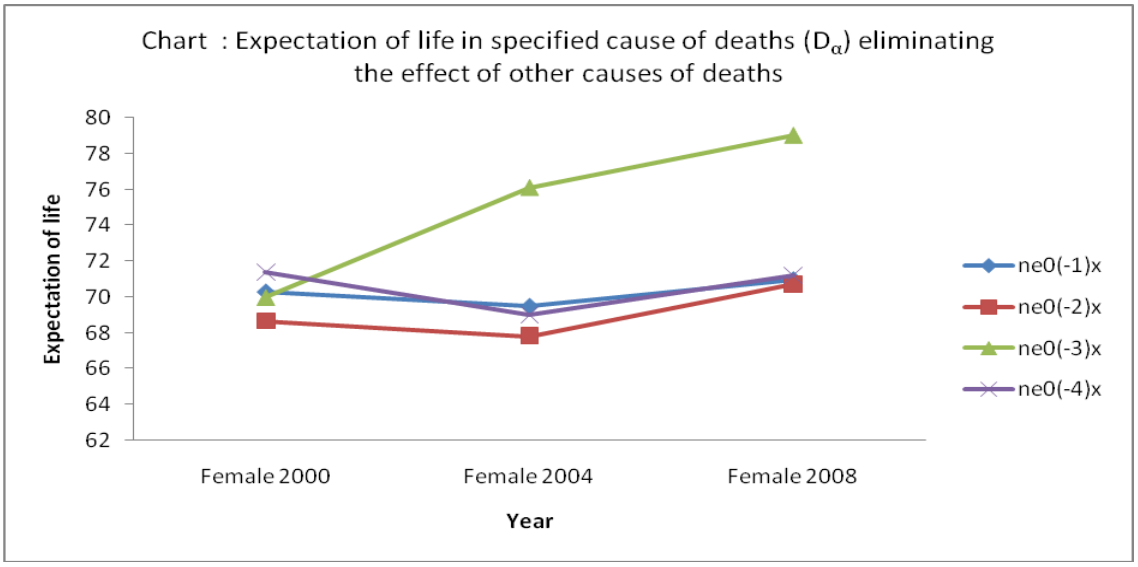


Figure 6.7. Expectation of life in specified causes of deaths (D_α) eliminating the effect of a single cause of deaths for female population in different years

Figure 6.7 shows similar pattern for female population like that in males.

6.5 Comparing Expectation of Life between Observed Pattern and Proposed Pattern Found from Polynomial Regression

Polynomial regression model is used to determine the yearly trend in the number of deaths caused by non-communicable diseases. The underlying model corresponding to each variable is as follows:

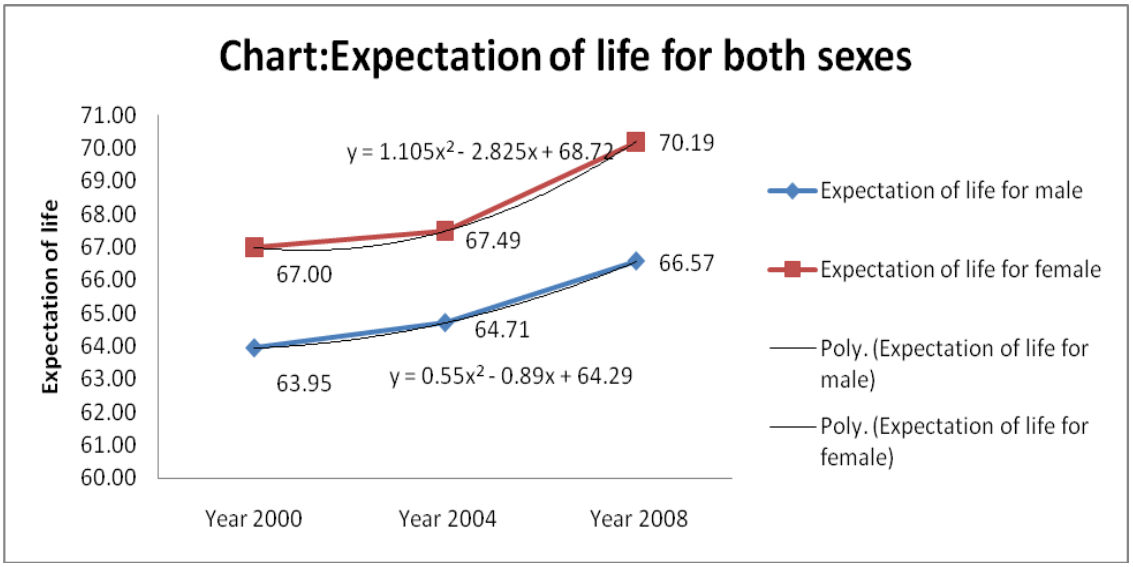
$$Y_i=\beta_o+ \beta_1X_i+ \beta_2X^2_i+ \beta_3X^3_i+\ldots+ \beta_pX^p_i +e_i \qquad (6.1)$$

Where 'X_i' is the year, 'Y_i' is the number of deaths due to non-communicable diseases and 'e_i' is the error terms.

Table 6.3. Observed life expectancy for both sexes

Year	Observed expectation of life, e^0_x for male	Observed expectation of life, e^0_x for female
2000	63.95	67.00
2004	64.71	67.49
2008	66.57	70.19

Figure 6.8. Expectation of life for both sexes by different years



The highest expected years of life were recorded in the year of 2008 for both sexes. It was observed that the expectation of life had increased significantly in the recent years in comparison to the past years. The upward trends indicated that the expectation of life for females was higher than for males.

Table 6.4. Expectation of life in the presence of NCDs eliminating the effect of other causes, and in the presence of other causes eliminating the NCDs

Sex	Year	${}_ne^0_{(3)x}$	${}_ne^0_{(-3)x}$
Male	2000	76.00	68.29
Female	2000	78.40	69.99
Male	2004	69.99	75.33
Female	2004	72.66	76.11
Male	2008	70.77	77.56
Female	2008	73.55	79.01

This Table shows that non-communicable diseases were becoming more influential as the years passed by. For males in 2000 non-communicable diseases was not much significant by itself to the expectation of life. If only non-communicable diseases were eliminated, life expectancy at birth would have been 68.29 years. If the other three categories were eliminated, life expectancy would have been 76.00 years.

But as the years passed by NCDs become the major influential factor on the expectation of life. For males in 2004, if the other three categories were eliminated, life expectancy would have been 69.99 years. But if only non-communicable diseases were eliminated, life expectancy at birth would have been 75.33 years. The difference between the contribution of NCDs and other categories to the expectation of life is more than 5 years. That was significant. Females showed similar pattern like the males. In the year 2008 also showed similar trend. NCDs are becoming more influential.

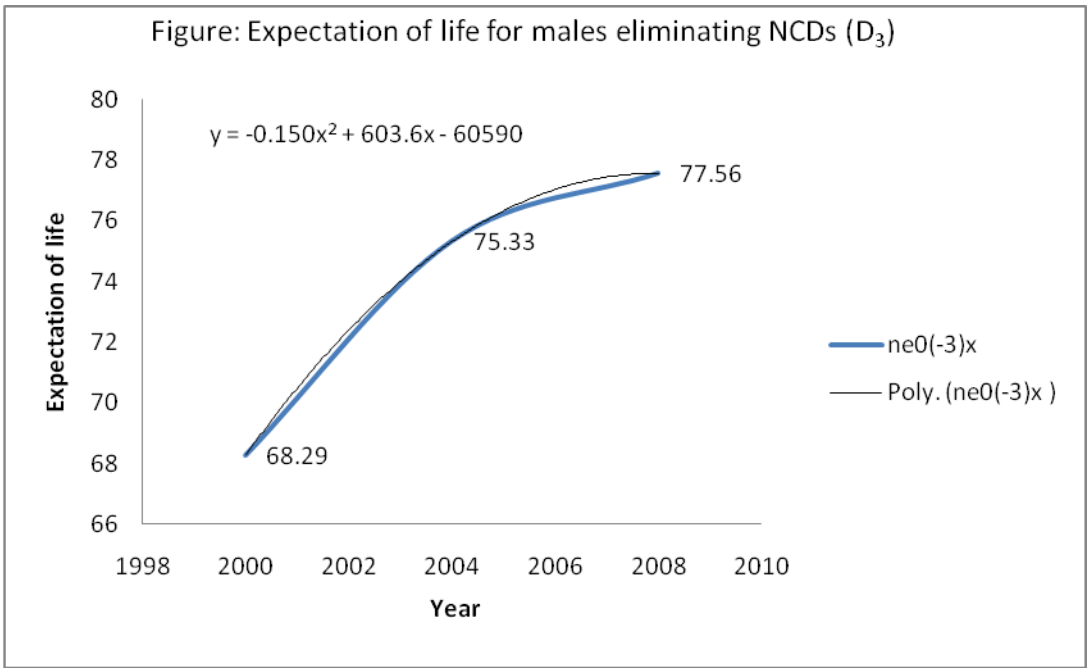


Figure 6.9. Expectation of life in eliminating non-communicable diseases (D_3) in the presence of other causes of deaths, for male population in different years.

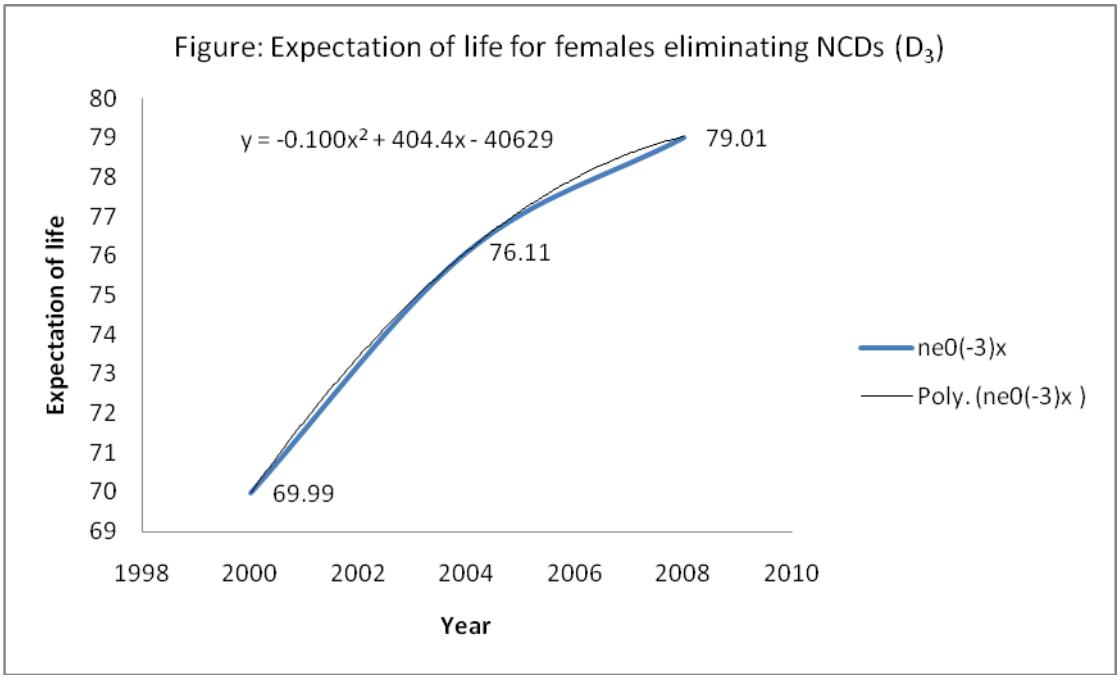


Figure 6.10. Expectation of life in eliminating non-communicable diseases (D_3) in the presence of other causes of deaths, for female population in different years.

Figure 6.9 and Figure 6.10 expresses the effect of eliminating NCDs. The expectation of life at birth was increasing due to the elimination as the years passed by. It revealed that NCDs were becoming more significant. Among the years the highest expected years of life was seen in 2008 for both males and females. It was 77.56 years for the males and 79.01 years for the females in the year 2008. So the elimination of NCDs was becoming more important than ever.

6.6 Conclusion

This study exhibits the differentials of the causes of death classified by sex. Life expectancy for the females was higher than the males. However, the level did not reached the level of the that of the developed countries. The analysis showed that if neonatal and maternal complications related diseases were eliminated, life expectancy at birth would have increased from 66.19 years to 67.83 years for male and 69.46 to 70.94 for female from the year 2004 to 2008. If communicable diseases were eliminated the life expectancy at birth would rise from 65.51 to 67.28 for male and from 67.80 to 70.70 for female from the year 2004 to 2008. If injury related diseases were eliminated, life expectancy at birth would increase from 66.22 to 67.58 years for male and 68.97 to 71.18 years for female from the year 2004 to 2008. The result showed that if non-communicable causes were eliminated, the expectation of life for males and females reached 77.56 and 79.01years in the year 2008.

For male population, the life expectancy would be increased by 1.26 years due to elimination of neonatal diseases, 0.71 years for communicable and 1.01 for injury related causes and for female population the life expectancy would be increased by 0.75 years for neonatal and maternal diseases, 0.51 years for communicable and 0.99 for injury related causes in 2008.

The result showed 10.99 years of life would be added to life expectancy at birth for male population and 8.82 years for female population in 2008 if non-communicable diseases were eliminated.

CHAPTER SEVEN

PROJECTION OF NON-COMMUNICABLE DISEASE RELATED DEATHS: APPLICATION OF EXPONENTIAL GROWTH MODEL AND ARIMA MODEL

7.1 Introduction

Comparing the effect of eliminating various causes of death, the earlier chapter showed that the increase in life expectancy at birth would have been highest for the elimination of non-communicable diseases. Moreover, non-communicable diseases were showing significant rising trend than other diseases. Most of the deaths accounted were result of non-communicable diseases and now the question is how many deaths are going to occur because of this cause in future in Bangladesh. The answer to this question will help taking appropriate healthcare measure addressing the most important cause of death. Since NCDs are the leading cause of death, the analytical discussion in this chapter is confined to non-communicable diseases.

Ahmed et al. (2009) stated that the chronic NCDs such as cancer, diabetes mellitus, chronic respiratory diseases, heart disease and stroke were among the diseases responsible for approximately 60% of the total deaths in the world. The situation is more severe in low and middle income countries where approximately 80% of the chronic NCD-deaths occurred in those countries. It is projected that by 2020, 70% of the deaths in low-income countries will be caused by chronic NCDs. Developing countries are facing a serious threat. The countries in South Asia are at risk. Almost 50% of the deaths occurred in Asia are now due to NCDs. So, it is time to develop efficient strategies to control and prevent this pandemic of the NCDs.

The warning message about non-communicable disease prompted to project the NCD affected population in the ICDDR,B area. If the national population of non-communicable diseases can be projected, it would be very helpful to have an idea about the future health situation of the population. The forecasting will use to control these diseases introducing a policy framework for non-communicable diseases for the health sector.

Table 7.1. Estimated percentage of deaths by cause, South-East Asia Region, 2008 (WHO Global Health Observatory, 2011)

Type of Disease	Percentage
Cardiovascular disease	24.9%
Cancers	7.8%
Chronic respiratory diseases	9.6%
Diabetes	2.1%
Other NCDs	10.2%
Communicable diseases, maternal and perinatal conditions, nutritional deficiencies	34.7%
Injuries	10.7%

The main objective of this chapter is to analyze the information of the population of ICDDR,B and then, based on that, to make a projection of the total number of NCD victims for the national population of Bangladesh in the near future.

Projections can be defined as an extrapolation of past data into the future. It predicts how much of the population will be in a specific territory in a given time in the future. The accuracy of population projections is generally considered directly proportional to the size of the existing population and the historical rate of growth, and inversely proportional to the length of the time of projection.

7.2 Trends in Non-Communicable Diseases Related Mortality by Different Years and Gender

Table 7.2. Percentage distribution of deaths by non-communicable diseases in the year 2004 and 2008 for male (ICDDR, B)

Type of Disease	Frequency (male 2004)	Percent (male 2004)	Frequency (male 2008)	Percent (male 2008)
Neoplasm	82	15%	96	18%
Congenital malformation	0	0%	6	1%
Endocrine disorder	47	9%	30	5%
Neuro-psychiatric	16	3%	8	1%
Circulatory	232	43%	297	54%
Respiratory	78	14%	52	10%
Digestive disease	59	11%	40	7%
Gentio-Urinary	17	3%	16	3%
Other non-communicable	9	2%	4	1%
Total	540	100%	549	100%

Table 7.2 shows that among the total male NCD victims of the year 2004, 232 (43%) fall under the category of circulatory related disease, 82 (15%) of them fall in the neoplasm group, and 78 (14%) of them were respiratory related victims. The others were 11% for digestive disease, 9% for endocrine disorder, 3% for neuro-psychiatric, 3% for gentio-urinary and 2% for other non-communicable diseases.

In the year 2008, among the male NCD victims, 297 (54%) of them fall under the category of circulatory related disease, 96 (18%) of them fall in the neoplasm group, and 52 (10%) of them were victims of respiratory related disease. The others were 7% for digestive disease, 5% for endocrine disorder, 1% for neuro-psychiatric, 3% for gentio-urinary, and 1% for other NCDs.

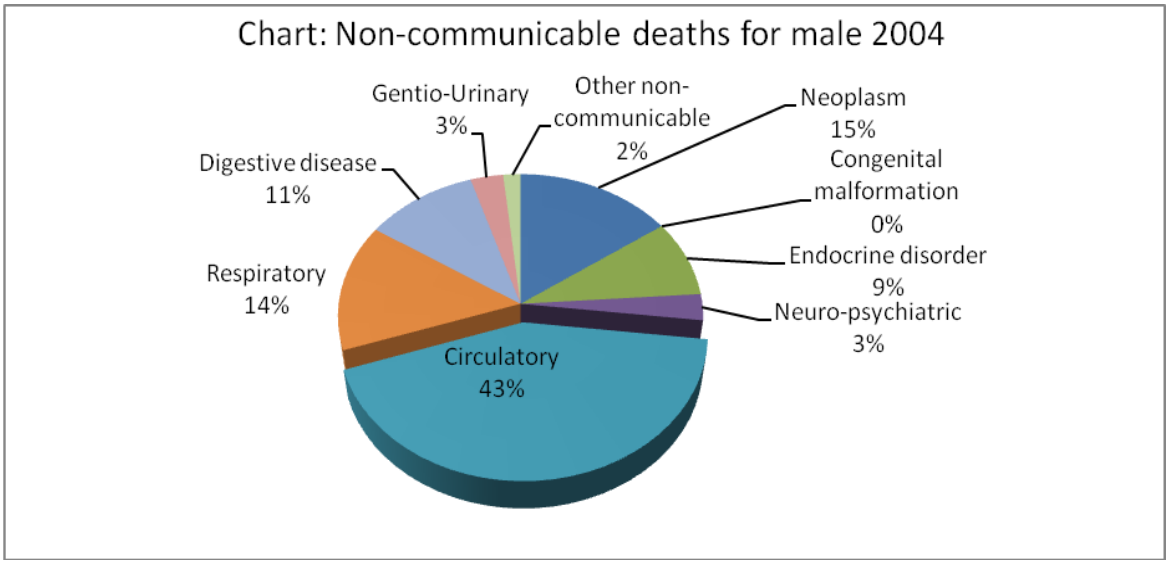


Figure 7.1. Percentage distribution of deaths by different non-communicable diseases for male 2004

It is seen that 43% of the victims belonged to circulatory related disease and 15% belonged to the neoplasm group. Circulatory related deaths were highest in the given area. Neoplasm and respiratory diseases covered 29% of the victims together.

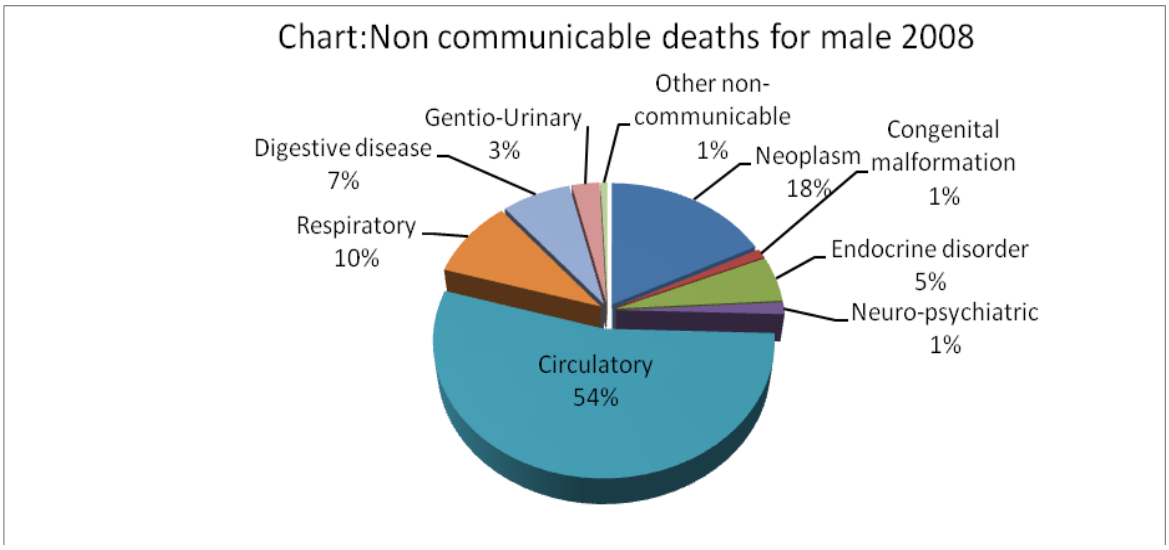


Figure 7.2. Percentage distribution of deaths by different non-communicable diseases for male 2008

From Figure 7.2, it is observed that 54% of the victims belonged to circulatory related disease and18% belonged to the neoplasm group. Respiratory related diseases covered 10% of the victims.

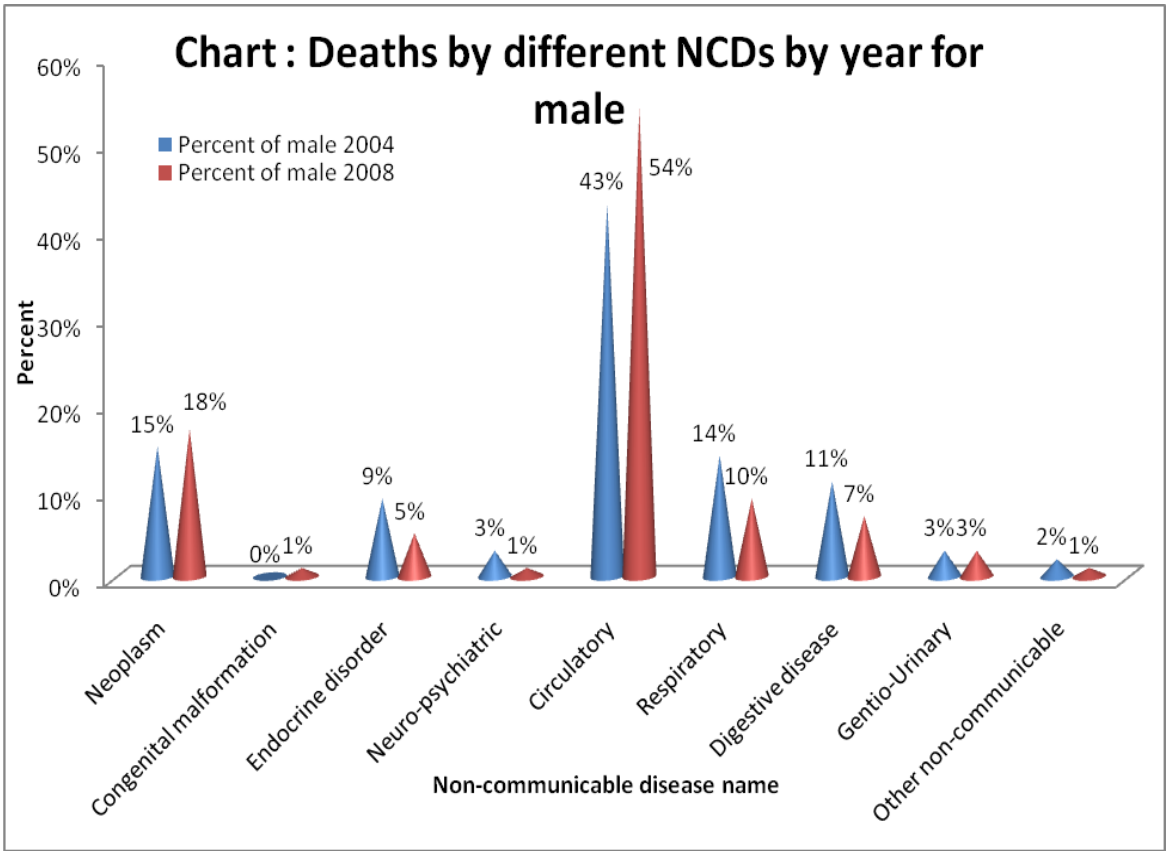


Figure 7.3. Percentage distribution of deaths by non-communicable diseases in the year 2004 and 2008 for male

Figure 7.3 gives a comparative picture of different non-communicable diseases under study population in year 2004 and 2008. The percentage of circulatory related deaths rose from 43% in 2004 to 54% in 2008. Neoplasm disease shifted from 15% in 2004 to 18% in 2008. The other diseases showed unchanging or diminishing pattern.

Table 7.3. Percentage distribution of deaths by different non-communicable diseases in the year 2004 and 2008 for female

Disease name	Frequency for female 2004	Percent of female 2004	Frequency for female 2008	Percent of female 2008
Neoplasm	46	10%	51	11%
Congenital malformation	0	0%	2	0%
Endocrine disorder	29	6%	31	7%
Neuro-psychiatric	13	3%	8	2%
Circulatory	234	54%	282	61%
Respiratory	34	8%	52	11%
Digestive disease	51	12%	21	4%
Gentio-Urinary	17	4%	13	3%
Other non-communicable	12	3%	5	1%
Total	436	100%	465	100%

In Table 7.3, it is observed that among the total female NCD victims, 234 of them (54%) fall under the category of circulatory related disease, 46(10%) of them fall in the neoplasm group, and 34 (8%) of them were victim of respiratory related disease. The others were 12% for digestive disease, 6% for endocrine disorder, and 3% for neuro-psychiatric, 4% for gentio-urinary and 3% for other non-communicable in the year 2004. In the year 2008, among the female NCD victims 282 of them belonged to the circulatory related disease and that was 61%, 51 of them fall in the neoplasm group which was 11%, and 52 of them were respiratory related that was 11% of the female respondents. The others were 4% for digestive disease, 7% for endocrine disorder, and 2% for neuro-psychiatric, 3% for gentio-urinary and 1% for other non-communicable diseases.

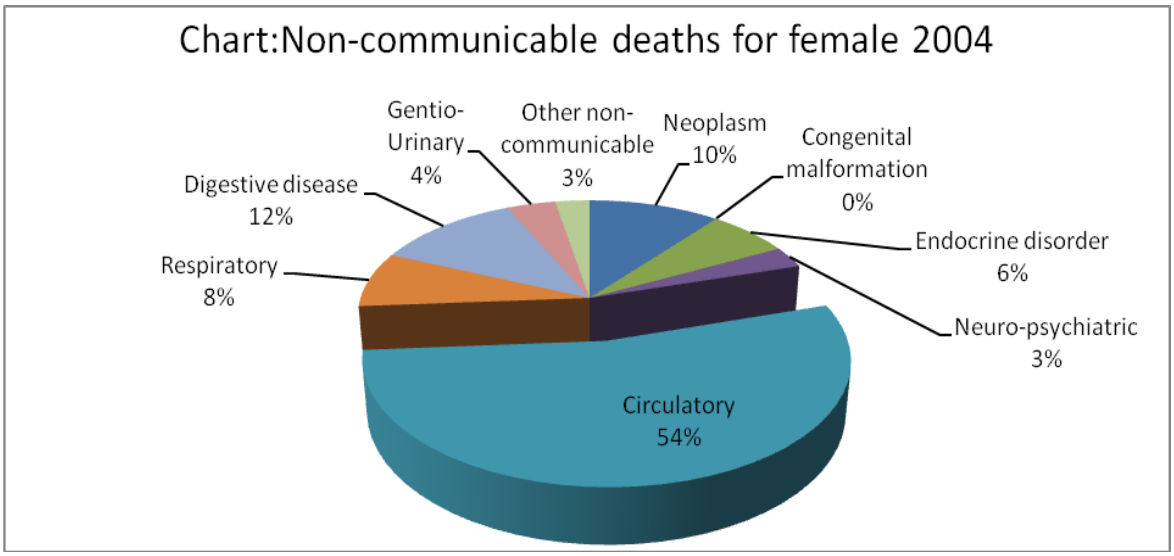


Figure 7.4. Percentage distribution of deaths by non-communicable diseases for female 2004

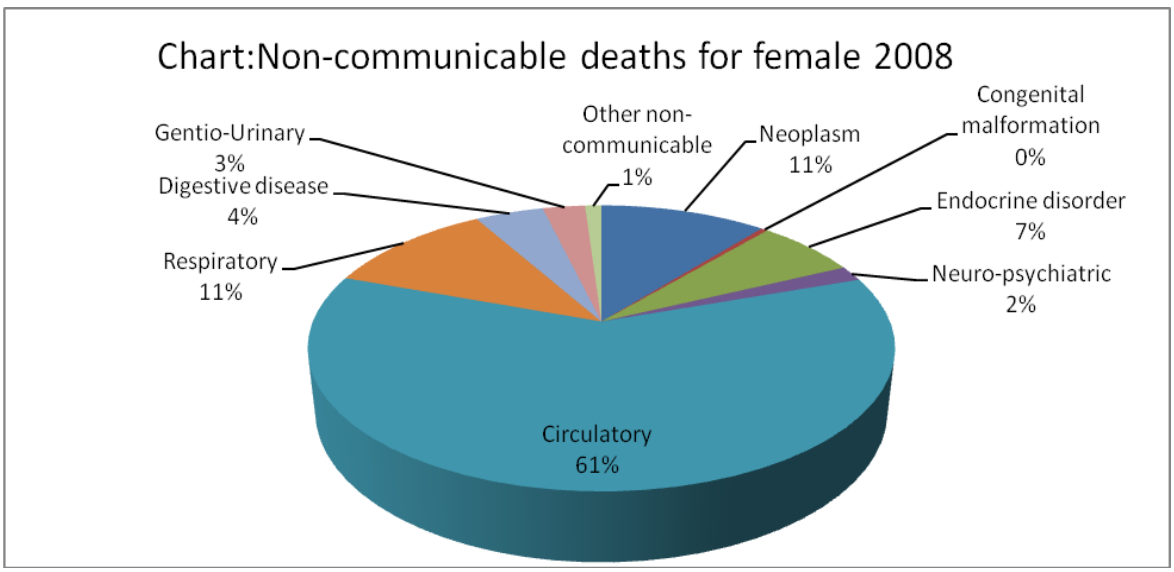


Figure 7.5. Percentage distribution of deaths by non-communicable diseases for female 2008

From the Figure 7.4 and Figure 7.5, it is evident that, among non-communicable diseases, circulatory system related diseases (stroke, ischemic heart disease and hypertensive disease) were most influential on the female mortality in Matlab, causing 54% and 61% NCD deaths respectively in 2004 and 2008. Neoplasm also played a vital role in the year 2004 (10%) and 2008(11%).

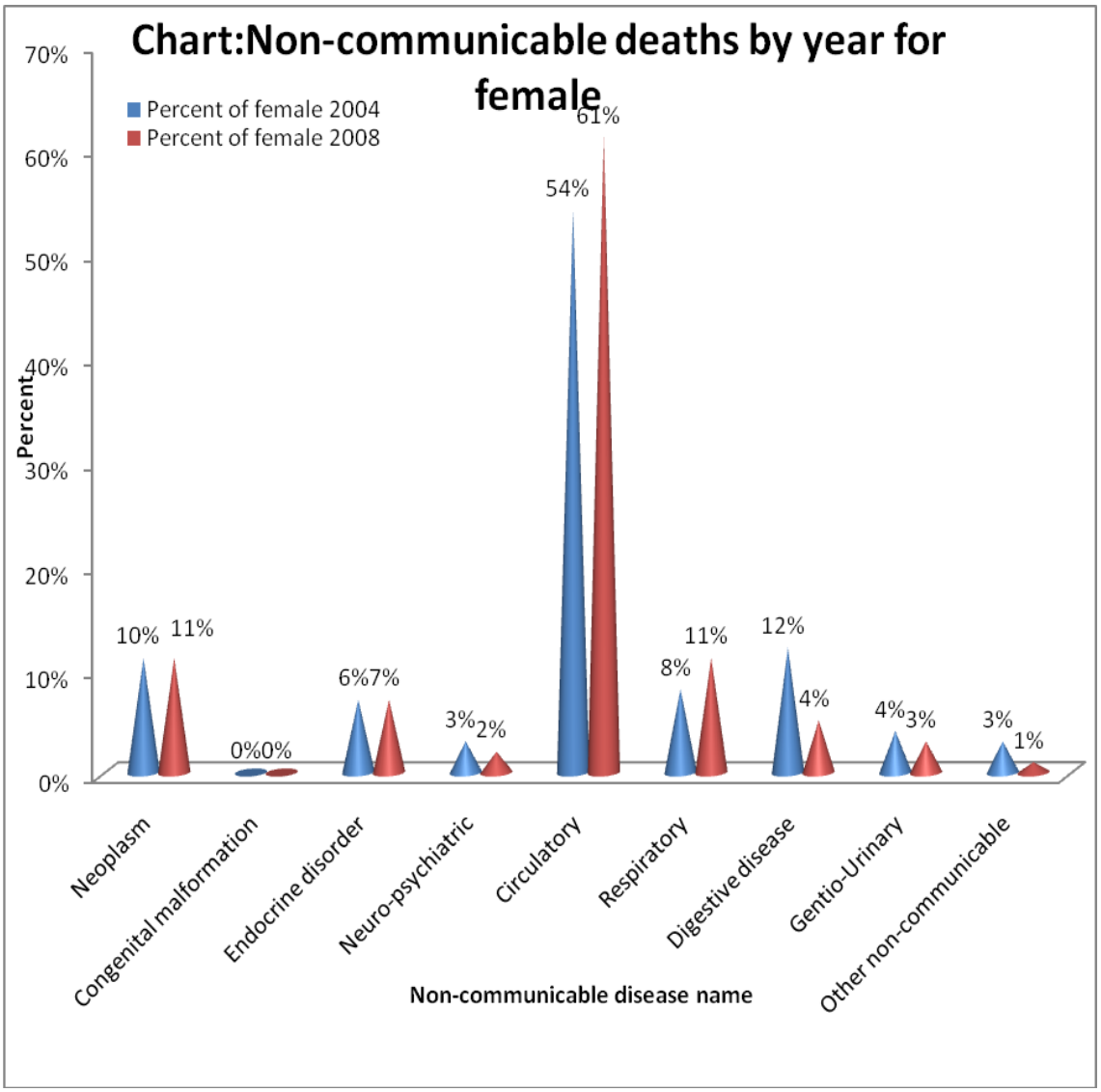


Figure 7.6. Percentage distribution of non-communicable disease related deaths in the year 2004 and 2008 for female

Figure 7.6 for females shows similar pattern to the pattern for males shown in Figure 7.3. The percentage of circulatory related deaths rose from 54% in 2004 to 61% in 2008. Neoplasm disease continued to cover around 10% in both the years. The other diseases showed almost unchanging or diminishing pattern.

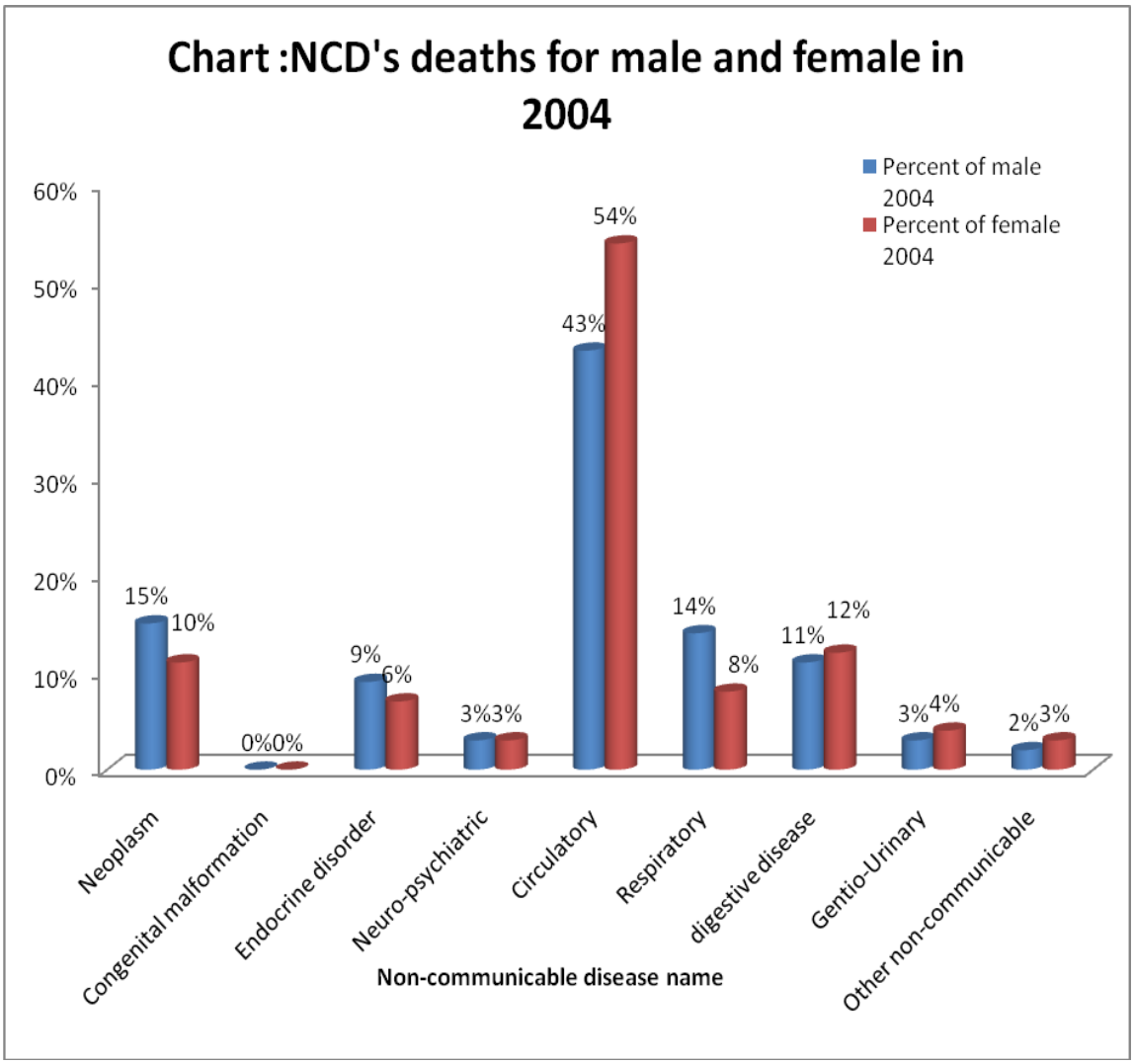


Figure 7.7. Percentage distribution of non-communicable disease related deaths by gender in the year 2004

Figure 7.7 shows that for males it is noticeably higher for the diseases such as neoplasm, endocrine disorder and respiratory than for females. On the other hand, in case of the most influential cause, the circulatory related disease, for females was significantly higher than that of male.

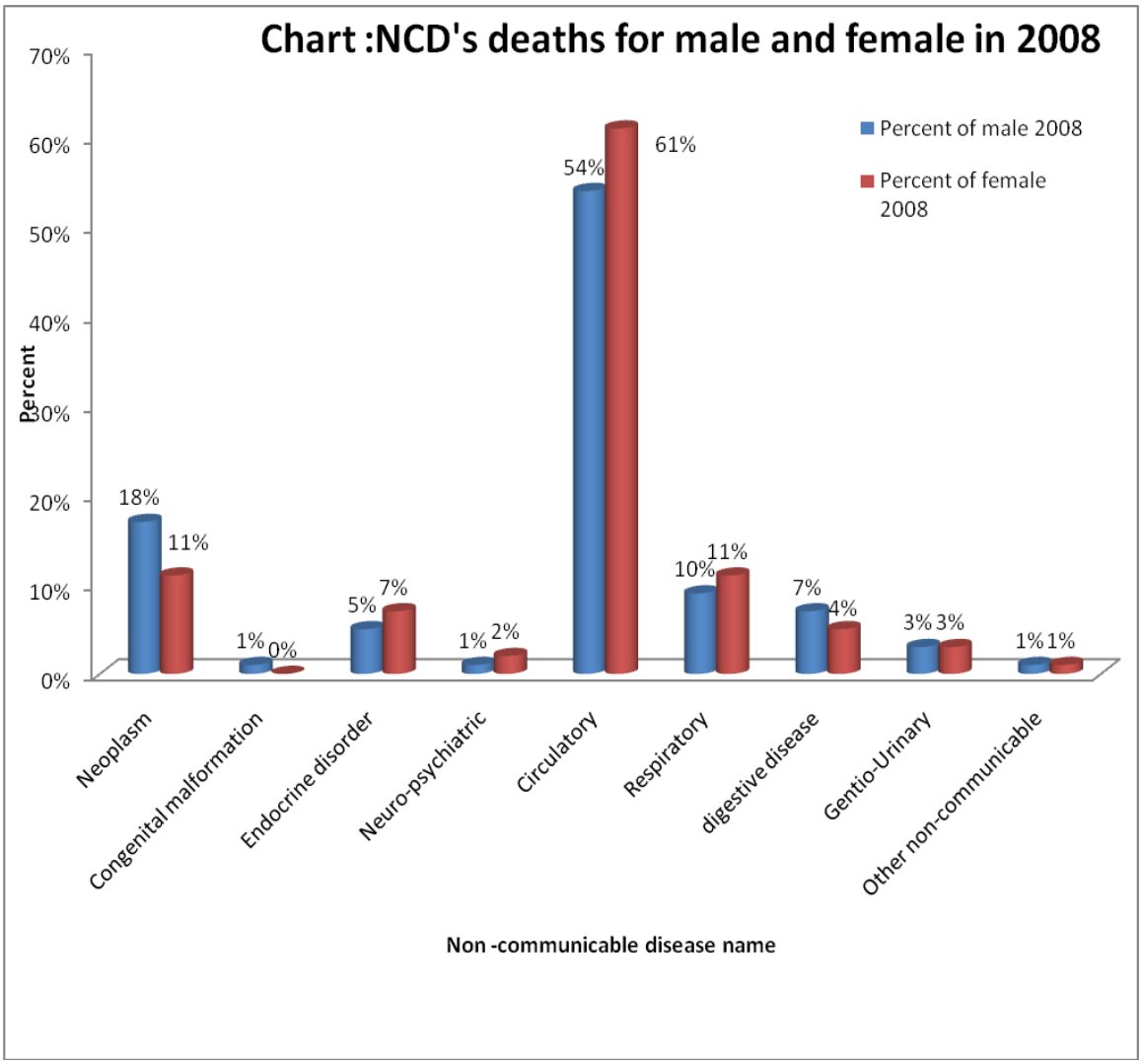


Figure 7.8. Percentage distribution of non-communicable disease related deaths by gender in the year 2008

As in 2004, in the case of the most influential cause, the circulatory related diseases, female deaths continued to be significantly higher than males. For neoplasm, male deaths were comparatively higher than that of female. Both males and females showed notable improvement in case of digestive diseases in 2008.

Fitting of Polynomial Regression

Polynomial regression is a form of regression in which the relationship between the independent variable *x* and the dependent variable *y* is modeled as an *n*th order polynomial. Polynomial regression fits a nonlinear relationship between the value of *x* and the corresponding conditional mean of *y*, denoted by E(*y*|*x*) It is used to describe nonlinear phenomena such as climate prediction, progression of disease epidemics and so on.

Polynomial regression is used here to determine the yearly trend in the number of deaths caused by non-communicable diseases. The underlying model corresponding to each variable was as follows:

$$Y_i=\beta_o+\beta_1X_i+\beta_2X^2{}_i+\beta_3X^3{}_i+\ldots+\beta_pX^p{}_i+e_i \qquad (7.1)$$

where 'X_i' is the year,

'Y_i' is the number of deaths due to non-communicable diseases

and 'e_i' is the error terms.

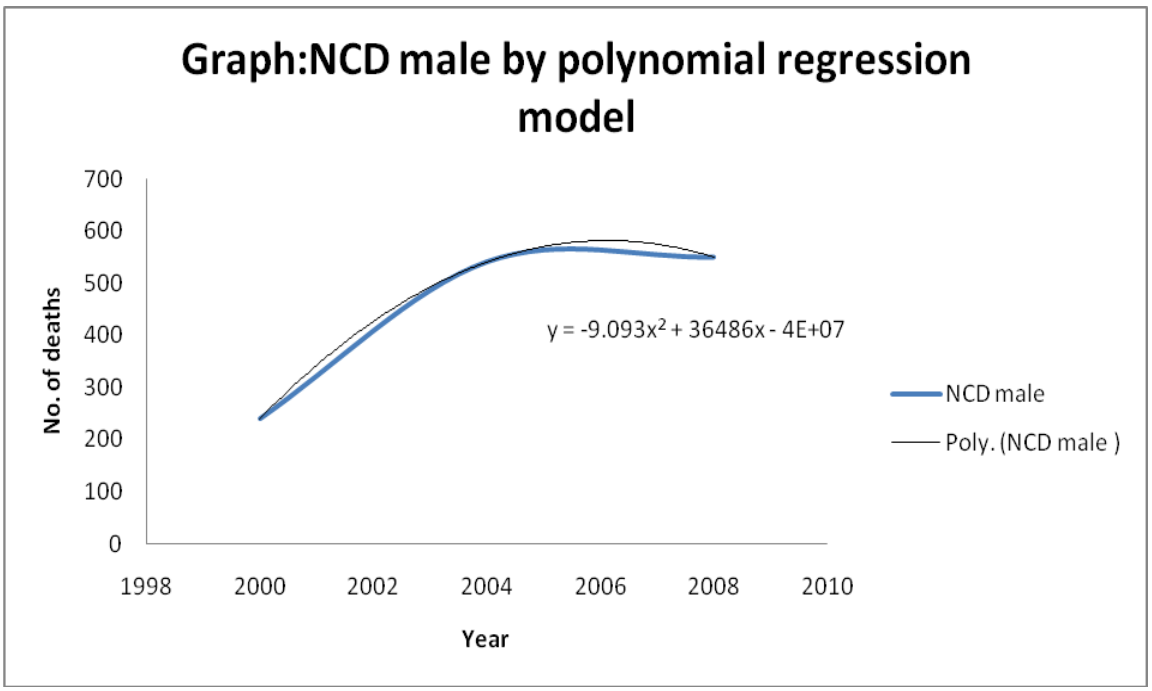


Figure 7.9. Non-communicable deaths for male by different years

The highest number of deaths was recorded in the year of 2008. It was clear that the second degree polynomial gives a reasonable fit as a model for the NCD trend. Figure 7.9 showed the curve that could explain the yearly variation in the number of deaths when the quadratic model was applied to the male group.

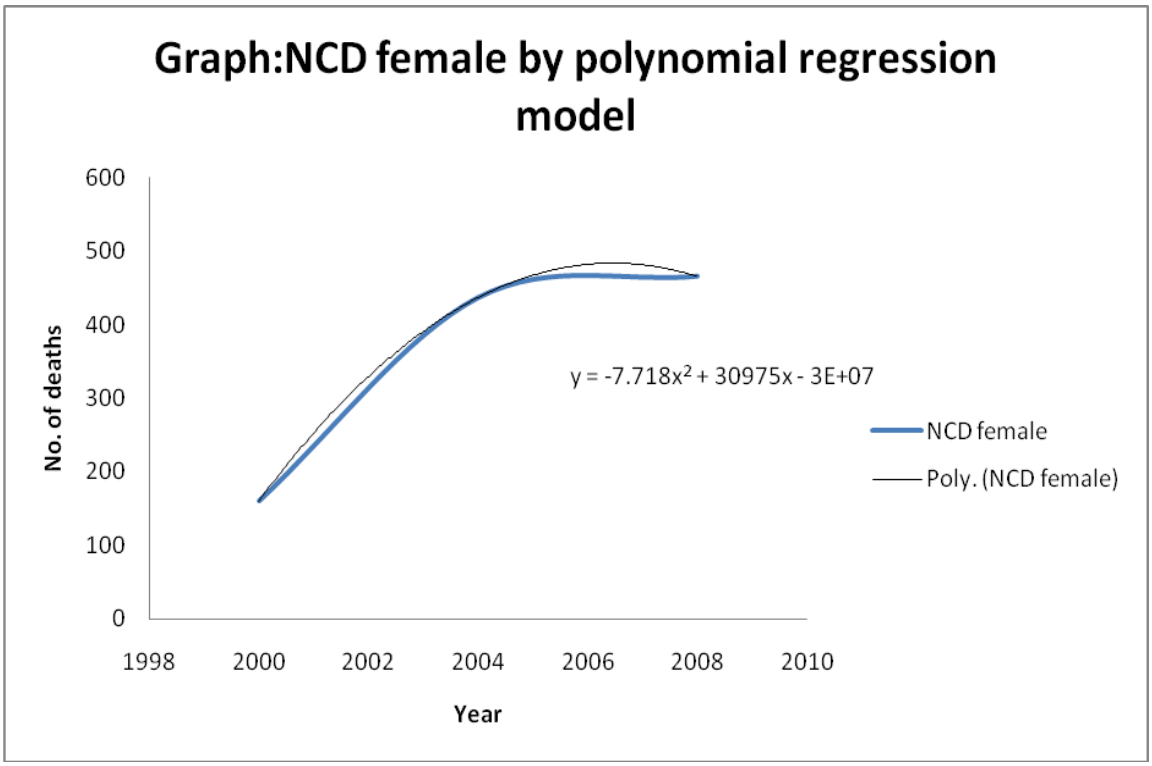


Figure 7.10. Non-communicable deaths for female by different years

The fit was almost the same as the male deaths. The highest deaths were found in the year of 2008 for female population.

7.3 Exponential Growth Model for projection of non-communicable deaths

Generally it is assumed that human population increases exponentially. Exponential growth starts slowly and then gets faster as the population increases. In exponential growth, there is no upper limit. Exponential growth of a population occurs when a population has a continuous birth rate throughout time, and is never hindered by the absence of food or the abundance of disease.

The exponential functions are useful in real world situations. They are used in different areas, such as modeling populations, helping coroners determine time of death, as well as many other areas of application.

Methods of preparing national projections of total population fall simply into two classes, mathematical methods and component methods. Mathematical methods are simpler conceptually; usually requires relatively little time to apply. The mathematical methods involve application of some mathematical formula directly to the total population from one or more censuses, to derive projections of total population.

Among the most commonly used methods is the exponential growth model with continuous compounding. The formula is as follows:

$$P = P_o e^{rt} \tag{7.2}$$

Where, P represents the population after a certain amount of time

P_o represents the initial population or the population at the beginning

r represents the growth or decay rate

t represents the amount of time and

e is the base of the natural system of logarithms

Assumptions of the Model:

It is always important to be aware of the assumptions made by a model.. The assumptions of the exponential growth equation are:

i. No immigration or emigration.
ii. Constant r
iii. No variation among individuals in genetics, size, or age
iv. No time lags

In this section, the calculation for projecting total population was carried out on the data of ICDDR,B and BBS (Bangladesh Bureau of Statistics) considering the growth rate constant.

The formula for growth or decay rate is $r = \ln\left(\frac{P_t}{P_0}\right)$ (7.3)

The goal is to estimate the projected number of deaths based on main cause of diseases.

7.4 ARIMA Model for projection of non-communicable disease related deaths

Projections can be done easily with the help of ARIMA model. ARIMA model is used to forecast a time series data. The number of deaths, especially for non-communicable diseases, was available from Matlab data in the period 1975 to 2011. Therefore, population is projected for the year 2012 onward to 2060 by ARIMA model. Second difference was applied to the data for making the data stationary and the required model was given.

For male, ARIMA (0, 2, 1) model was used. The form of the model was

$$((1-B)^2 P_t = (1-\psi_1 B) \in_t \quad (7.4)$$

For females, ARIMA (1, 2, 2) model was appropriate. It can be written as

$$(1-\emptyset_1 B)(1-B)^2 P_t = (1-\psi_1 B-\psi_2 B^2) \in_t \quad (7.5)$$

Where,

$\emptyset_i$'s and ψ_i's stand for the coefficients of AR and MA respectively.

B is the backshift operator.

ϵ_ii's are white noise error terms.

Table 7.4. Summary of ARIMA model

Variable	Coefficient	Std. Error	t-Statistic	P-value
Male				
MA(1)	-0.94	0.05	-18.67	0.00
Female				
AR(1)	-0.53	0.16	-3.24	0.00
MA(2)	-0.74	0.15	-5.09	0.00

The coefficients of ARIMA model was significant as all the p-values were less than 0.05($p<0.05$). So this model can be used for forecasting the deaths of NCD related population.

Table 7.5. ADF and Phillips Peron unit root test for residuals obtain from ARIMA model

Population	Test method	Test Statistic	Probability
Male	ADF	25.87	0.00
	Phillips Peron	25.93	0.00
Female	ADF	36.13	0.00
	Phillips Peron	35.65	0.00

In Table 7.5, the ADF and Philips Peron tests implied that the residuals obtain from ARIMA (0, 2, 1) model for male and ARIMA (1, 2, 2) model for female were stationary.

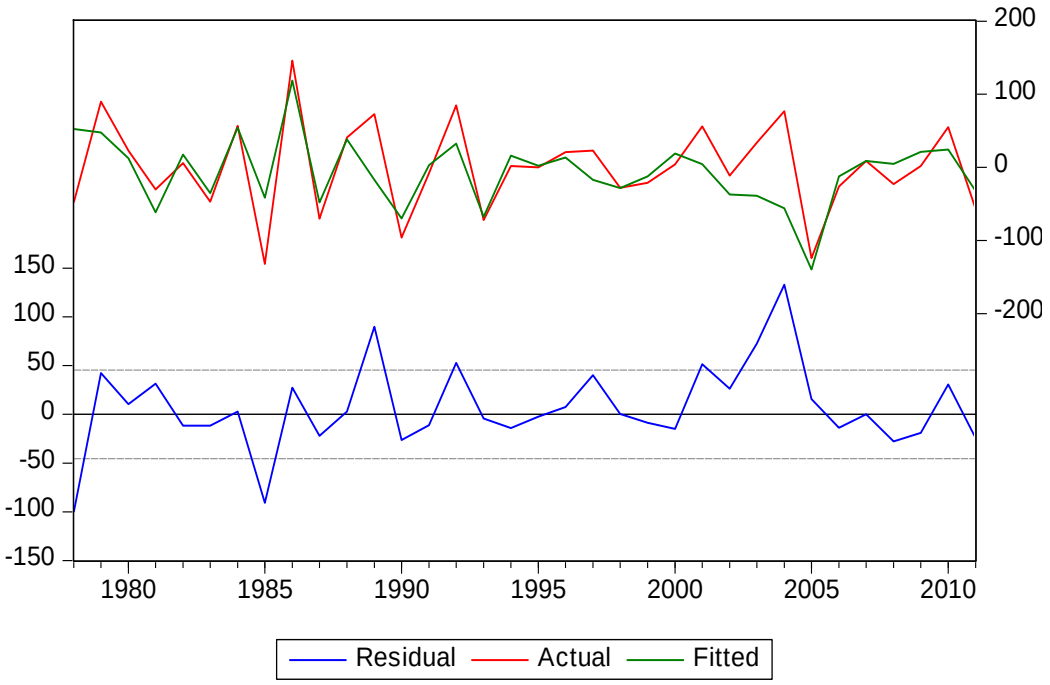


Figure 7.11. Actual, Fitted and Residual graph for the model ARIMA (0, 2, 1)

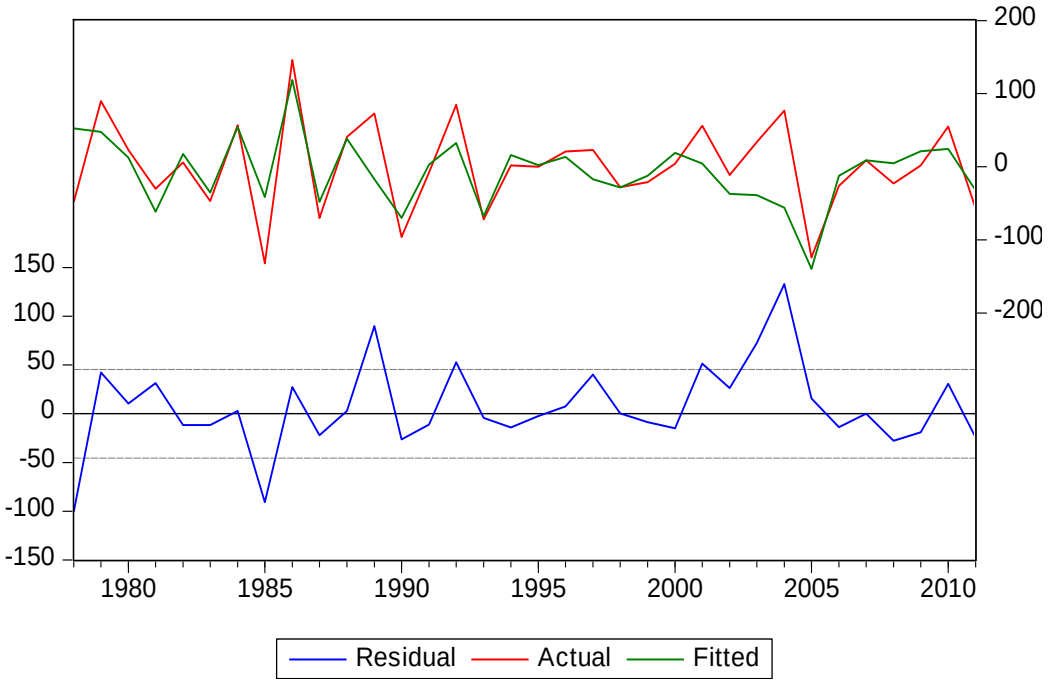


Figure 7.12. Actual, Fitted and Residual graph for the model ARIMA (1, 2, 2)

The Figure 7.12 shows that the actual and fitted line was not quite similar but they were very close.

7.5 Results and Discussion

Table 7.6. Growth rates of NCDs for males between 2004 and 2008 (Matlab)

Disease name	Growth rate
Neoplasm	0.0394
Circulatory	0.0617
Other non-communicable	-0.0927
Total Non communicable	0.0041
Except non-communicable	-0.0738
Total diseased in Matlab	-0.0213

Table 7.6 summarizes the exponential growth rates for male population. The rate was very high for circulatory related diseases (rheumatic heart disease, ischemic heart disease, hypertensive disease, stroke and other cardiovascular diseases) and it was 6.17% for male ICDDR,B population. The growth rate for neoplasm was 3.94% as shown in the Table. Finally the overall growth rate of non-communicable disease was 0.41% for male.

Table 7.7. Projected death of Matlab male population based on year 2008

Year	Mid-Year population	Total diseased male	Percent	Except NCD male	Percent	NCD male	NCD rate per thousand
2008	103579	776	70.75	227	29.25	549	5.30
2012	104620	727	76.75	169	23.25	558	5.33
2016	105671	693	81.82	126	18.18	567	5.37
2020	106733	671	85.99	94	14.01	577	5.41
2024	107806	656	89.48	70	10.67	587	5.45
2028	108890	648	91.98	52	8.02	596	5.47
2032	109984	645	93.95	39	6.05	606	5.51
2036	111089	645	95.50	29	4.50	616	5.55
2040	112206	648	96.76	21	3.24	627	5.59
2044	113333	653	97.55	16	2.45	637	5.62
2048	114472	660	98.18	12	1.82	648	5.66
2052	115623	667	98.65	9	1.35	658	5.69
2056	116785	676	98.96	7	1.04	669	5.73
2060	117958	686	99.27	5	0.73	681	5.77

Table 7.7 presents the projected mid-year male population, NCD population, population except non-communicable, total deaths for male population and percentage distribution of non-communicable deaths and deaths other than non-communicable. NCDs encompassed 70.75% of the total deaths in 2008 and it projected to be 99.27% in year 2060. Except non-communicable causes, the other deaths showed decreasing pattern over the projection period.

The projected population from year 2008 to year 2060 i.e. almost 50 year's projection was presented here. Non-communicable mortality rate per thousand was also shown in the table. The rate displayed increasing behavior with reference to those projection years. A transition period is observed between 2032 and 2036 for entire male deaths. The death rate consistently increased from approximately 5.3 per thousand in 2008 to 5.8 per thousand in year 2060.

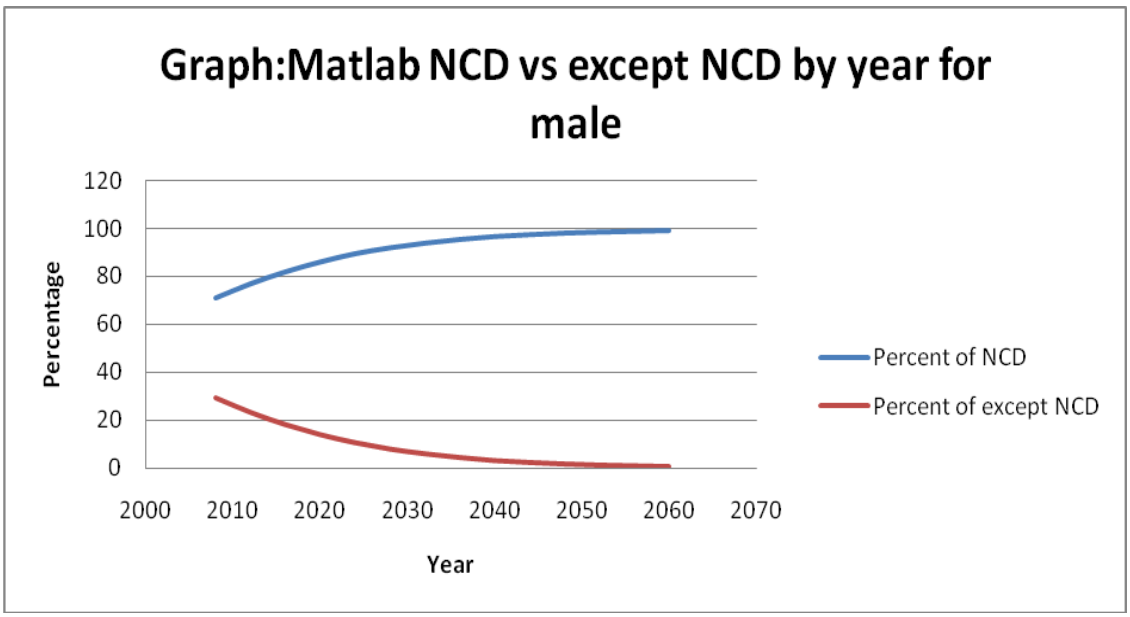


Figure 7.13. Projected Matlab NCD and other deaths by years for male

Figure 7.13 shows strictly increasing death rate for non-communicable diseases. The projection of other deaths (except NCD related deaths) revealed declining trend over the years.

Table 7.8. Growth rates of female between 2004 and 2008 (Matlab)

Disease name	Growth rates
Neoplasm	0.0257
Circulatory	0.0466
Respiratory	0.1062
Other non-communicable	-0.1055
Total Non communicable	0.0161
Except non-communicable	-0.0819
Total diseased in Matlab	-0.0172

Table 7.8 presents the exponential growth (decay) rates of some specific NCDs, the growth rate of other NCDs except those explicitly specified, the overall growth rate of NCDs, growth rate of other diseases except NCDs, and growth rate of all diseases for female population. The rate was very high for respiratory related diseases, such as COPD (Chronic obstructive pulmonary disease), asthma etc. and it was 10.62% for female ICDDR,B population. For neoplasm and circulatory related disease, the rates were 2.58% and 4.66% respectively. The overall growth rate of non-communicable disease was 1.61% for female.

Table 7.9. Projected deaths of Matlab female population based on 2008

Year	Mid-Year population	Total diseased female	Percent	Except NCD	Percent	NCD female	NCD rate per thousand
2008	118639	661	70.35	196	29.65	465	3.92
2012	123744	637	77.84	141	22.16	496	4.01
2016	129068	631	83.86	102	16.14	529	4.10
2020	134621	637	88.49	73	11.51	564	4.19
2024	140414	655	91.93	53	8.07	602	4.29
2028	146455	680	94.40	38	5.60	642	4.38
2032	152757	711	96.14	27	3.86	684	4.48
2036	159329	750	97.36	20	2.64	730	4.58
2040	166185	792	98.20	14	1.80	778	4.68
2044	173335	840	98.78	10	1.22	830	4.79
2048	180793	892	99.17	7	0.83	885	4.90
2052	188572	949	99.44	5	0.56	944	5.01
2056	196686	1011	99.62	4	0.38	1007	5.12
2060	205149	1077	99.74	3	0.26	1074	5.24

Table 7.9 presents the projected female population from year 2008 to year 2060 including the non-communicable mortality rate per thousand. For the year 2060, NCD mortality rate per thousand was projected to be approximately 5.2 for females whereas it was 5.8 for male person. The NCD rate displayed increasing trend with reference to the projection years. Projected female deaths due to other diseases showed diminishing trend over the year. The transition period was observed in the year 2016 for female deaths. The death rate was approximately 4 per thousand in 2008 whereas it was approximately 5.2 per thousand in 2060. This rate was lower compared to that of male population.

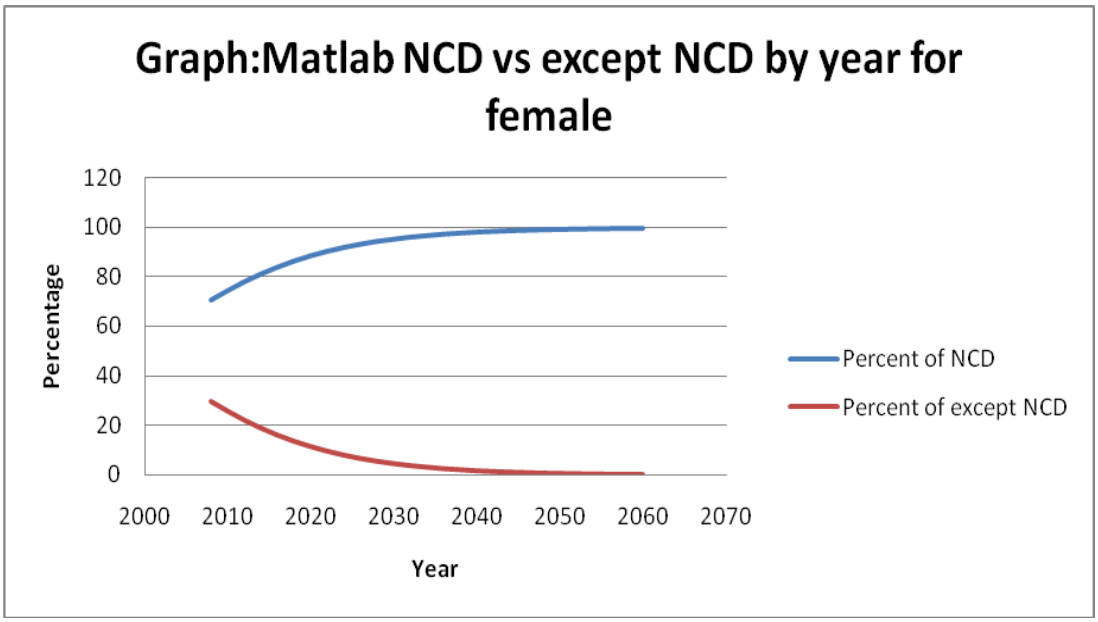


Figure 7.14. Projected Matlab NCD and other deaths by years for female

A rising trend was observed in the percentage of female NCD victims similar to what was observed in the Figure 7.14 for males.

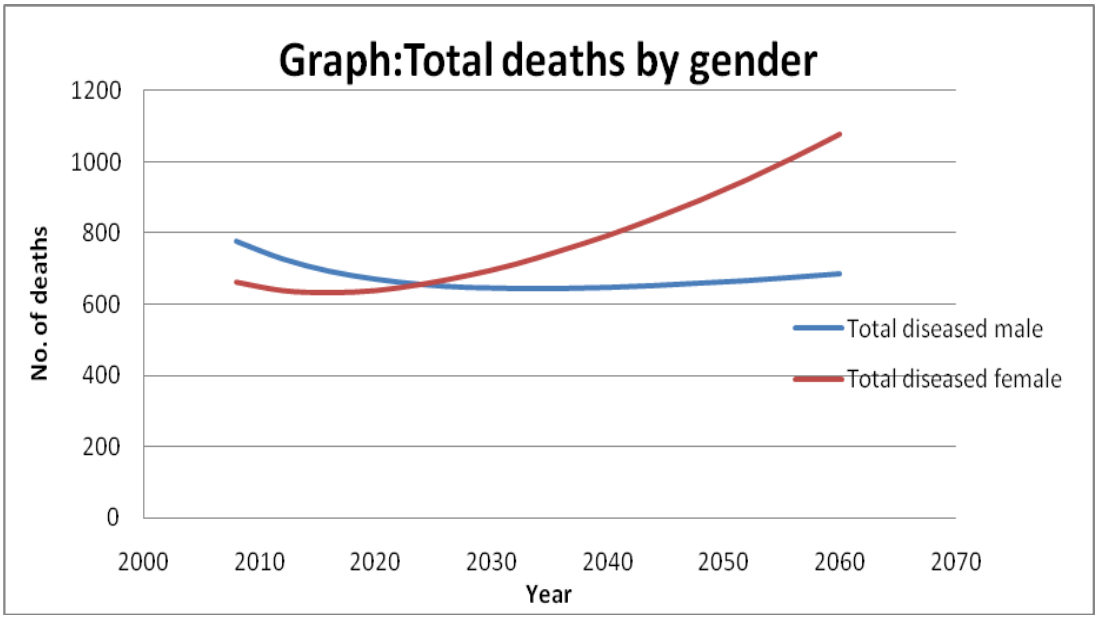


Figure 7.15. Projected deaths of Matlab population for both sex

Female population was at high risk as the rate of increasing was growing sharply in the Figure 7.15. In the recent years, population died of NCDs was higher for males, but it swiftly increased for female. After 2024, it was projected that females will contribute more to the NCD than the males.

Table 7.10. Projected NCD Population of Matlab Using Exponential and ARIMA Models

	EXPONENTIAL MODEL			ARIMA MODEL		
Year	Total	Male	Female	Total	Male	Female
2008	1014	549	465	1014	549	465
2012	1054	558	496	987	563	424
2016	1096	567	529	1053	593	460
2020	1141	577	564	1118	623	495
2024	1189	587	602	1181	652	529
2028	1238	596	642	1245	682	563
2032	1290	606	684	1308	711	597
2036	1346	616	730	1372	741	631
2040	1405	627	778	1435	770	665
2044	1467	637	830	1499	800	699
2048	1533	648	885	1562	829	733
2052	1602	658	944	1627	859	768
2056	1676	669	1007	1690	888	802
2060	1755	681	1074	1753	917	836

A comparative picture is presented here between the projected results of exponential model and ARIMA model. For the year 2012, the forecasted number of victims by ARIMA model was 558 for male and 496 for female whereas it was 563 for male and 424 for female by exponential model. Number of male victims was slightly higher for ARIMA (0, 2, 1) model than exponential model. For female victims, that result was reversed. In 2060, number of male victims was 681 for exponential model and 917 for ARIMA (0, 2, 1) model. So, male victims shows comparatively higher growth rate in ARIMA (0, 2, 1) model. On the other hand, females showed comparatively higher growth rate in exponential model than ARIMA (1, 2, 2) model. It was 1074 for exponential model and 836 for ARIMA (1, 2, 2) model in the year 2060. The number of total victims was almost same for both models.

National populations for different period by exponential model are given below.

Table 7.11. Projected national population and NCD deaths for males.

Year	National projected male population	National projected diseased male	National projected NCD male	Except NCD
2008	69025547	517130	365856	151274
2012	72014008	500386	384093	116293
2016	75131855	492536	403134	89401
2020	78384688	492475	423747	68728
2024	81778353	498115	445280	52835
2028	85318947	507606	466988	40618
2032	89012831	521677	490452	31225
2036	92866641	538959	514954	24005
2040	96887303	559856	541402	18454
2044	101082038	582327	568141	14187
2048	105458385	607880	596974	10906
2052	110024206	634523	626139	8384
2056	114787704	664005	657560	6445
2060	119757438	696341	691386	4955

National projected deaths due to non-communicable diseases showed increasing trend over the years. But projected deaths due to diseases other than NCDs showed diminishing pattern over the years. In case of national projected diseased male, the transition period was observed in the year 2020. The death population showed decreasing trend before 2020. After 2020 the death population showed increasing trend. This transition was because of the rising trend of the NCD deaths and the diminishing trend of deaths other than NCDs.

Table 7.12. Projected national deaths by major NCDs in different years for male

Year	National projected male population	Projected neoplasm	Projected circulatory	Neoplasm Rate per 100000	Circulatory Rate per 100000
2008	69025547	63975	197922	93	287
2012	72014008	77362	261714	107	363
2016	75131855	93552	346066	125	461
2020	78384688	113129	457605	144	584
2024	81778353	136802	605093	167	740
2028	85318947	165430	800118	194	938
2032	89012831	200049	1058001	225	1189
2036	92866641	241911	1399001	260	1506
2040	96887303	292535	1849907	302	1909
2044	101082038	353752	2446142	350	2420
2048	105458385	427779	3234548	406	3067
2052	110024206	517298	4277061	470	3887
2056	114787704	625549	5655583	545	4927
2060	119757438	756454	7478410	632	6245

Mortality pattern of neoplasm and circulatory related diseases was presented in Table 7.12. In the non-communicable disease group, circulatory related diseases were the major disease burden. Neoplasm also played a vital role in the non-communicable disease groups. In the last two columns, it was observed that the mortality rate was very high for circulatory related diseases. It was 287 per 100000 male in 2008 and reaches to 6245 per 100000 male in 2060. Neoplasm showed mortality rate of 93 per 100000 male in 2008 and gets to 632 per 100000 male in 2060.

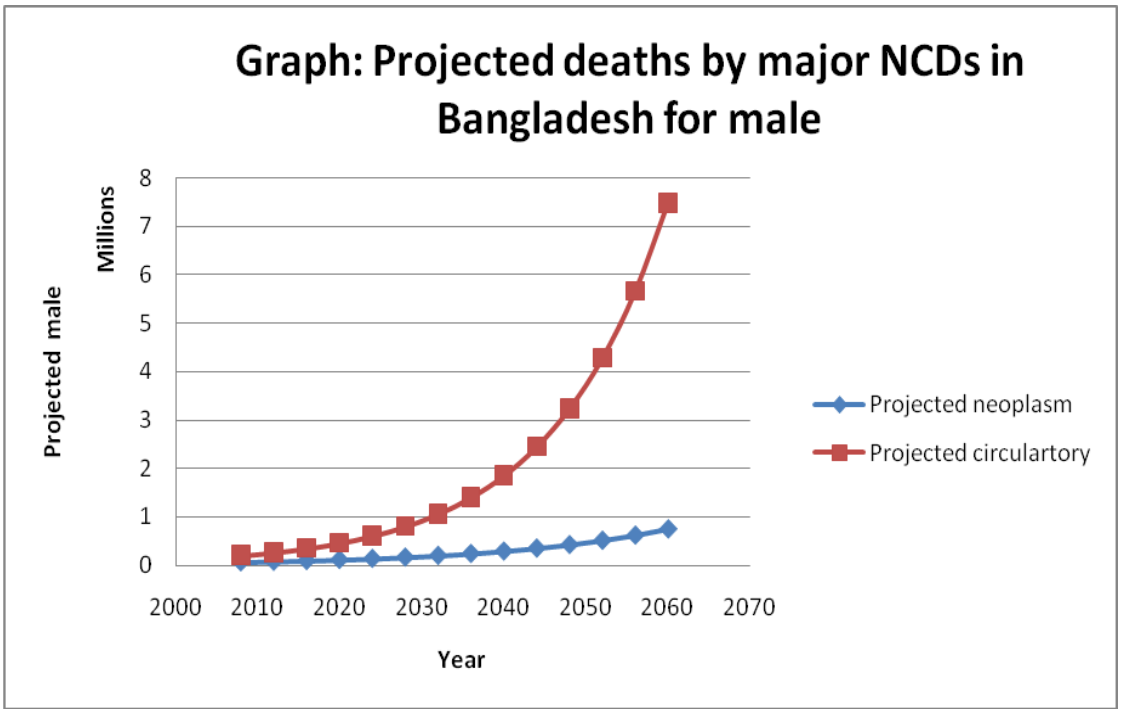


Figure 7.16. Projected deaths by major NCDs for male population in Bangladesh

The Figure 7.16 shows that both Circulatory related diseases and Neoplasm exhibited increasing pattern. Circulatory related disease exhibited higher increasing patterns than neoplasm.

Table 7.13: Projected National population and NCD deaths for female

Year	National projected female population	National projected diseased female	National projected NCD female	Except NCD
2008	67635101	376831	265093	111738
2012	72245177	372038	289579	82459
2016	77169481	377140	316288	60852
2020	82429430	390247	345340	44906
2024	88047902	410630	377491	33139
2028	94049335	436729	412274	24456
2032	100459832	467877	449830	18047
2036	107307274	504968	491650	13318
2040	114621445	546433	536604	9828
2044	122434158	593518	586265	7253
2048	130779392	645530	640177	5352
2052	139693447	703261	699311	3950
2056	149215092	766872	763957	2915
2060	159385741	836572	834420	2151

The Table 7.13 provides some information about national projected deaths of non-communicable diseases, national projected deaths due to diseases other than NCDs and overall national projected female deaths. Projected deaths due to non-communicable diseases presented increasing pattern over the years. Projected deaths in diseases other than non-communicable diseases showed diminishing pattern over the years. In case of overall national projected deaths for female, the trend offered increasing pattern from the year 2016 onward.

Table 7.14. Projected major NCD death population in different years for female in Bangladesh

Year	National projected female population	Projected neoplasm	Projected respiratory	Projected circulatory	Neoplasm Rate per 100000	Respiratory Rate per 100000	Circulatory Rate per 100000
2008	67635101	29075	29645	160766	43	44	238
2012	72245177	33012	46432	198412	46	64	275
2016	77169481	37482	72724	244874	49	94	317
2020	82429430	42557	113905	302216	52	138	367
2024	88047902	48320	178406	372985	55	203	424
2028	94049335	54863	279430	460326	58	297	489
2032	100459832	62293	437662	568120	62	436	566
2036	107307274	70728	685495	701156	66	639	653
2040	114621445	80305	1073666	865344	70	937	755
2044	122434158	91180	1681645	1067981	74	1374	872
2048	130779392	103527	2633902	1318068	79	2014	1008
2052	139693447	117545	4125387	1626718	84	2953	1164
2056	149215092	133463	6461448	2007644	89	4330	1345
2060	159385741	151535	10120338	2477770	95	6350	1555

In the non-communicable disease group, circulatory related disease was the major disease burden. But as time passes, respiratory related diseases became the major disease burden for females showing a higher growth rate. It was alarming. Neoplasm also played a vital role.

Patterns among males and females were found to differ significantly. The observed variation told us that neoplasm affects male population in significantly higher rate as compared to females. Circulatory related disease showed similar patterns to sexes as neoplasm i.e. the population of males suffering from circulatory related disease found to be significantly higher as compared to those of females. But respiratory related disease affected female more severely than males. Above all, in the non-communicable disease group, circulatory related disease was the major disease burden for both sexes.

In the last columns, for circulatory related diseases mortality rate was highest in the beginning. It was 238 per 100000 male in 2008 and reached to 1555 per 100000 male in 2060. Circulatory related disease for females was significantly higher compared to other non-communicable diseases up to year 2036. From 2040 years respiratory system related disease affected the female population highly. Another important disease, neoplasm suggested the mortality rate 43 per 100000 females in 2008 and get to 95 per 100000 females in 2060. This number is small compared to males (93 in 2008 and 632 in 2060).

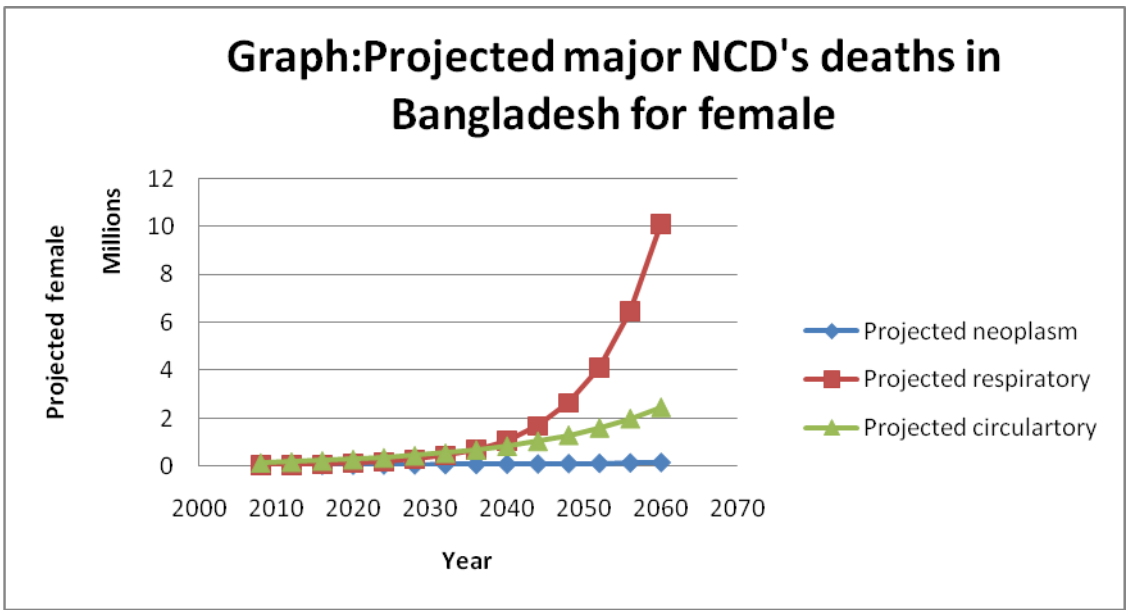


Figure 7.17. Projected major NCD death population for females in Bangladesh

The Figure 7.17 provides information about the projection of major NCDs. The population of males and females were found to be affected differently in different non-communicable diseases to some extent. Males were found to suffer more from circulatory related diseases and neoplasm whereas females are found to suffer comparatively more from respiratory diseases and circulatory related diseases. It was seen that the number of victims of respiratory related disease rose rapidly. Circulatory related diseases also showed a significant rising trend. Neoplasm showed increasing trend but it was slower compared to the other two.

Table 7.15. Projected NCD deaths for both sexes in Bangladesh

Year	National projected population	National projected diseased person	National projected NCD	Except NCD
2008	136660648	893961	630949	263012
2012	144259185	872424	673672	198752
2016	152301336	869676	719422	150253
2020	160814118	882722	769087	113634
2024	169826255	908745	822771	85974
2028	179368282	944335	879262	65074
2032	189472663	989554	940282	49272
2036	200173915	1043927	1006604	37323
2040	211508748	1106289	1078006	28282
2044	223516196	1175845	1154406	21440
2048	236237777	1253410	1237151	16258
2052	249717653	1337784	1325450	12334
2056	264002796	1430877	1421517	9360
2060	279143179	1532913	1525806	7106

The Table 7.15 gives the national projected deaths due to NCDs, and deaths due to diseases other than NCDs, irrespective of sexes. National projected deaths due to NCDs presented increasing pattern over the years. Projected deaths in diseases other than NCDs showed diminishing pattern over the years. In the case of projected national diseased population, the transition period was 2016 year. The death population showed decreasing trend before 2016 and, after that year, the death population gave increasing trend.

Table 7.16. Projected death population for major NCDs in different years for both sexes in Bangladesh

Year	National projected population	Projected neoplasm victims	Projected circulatory victims	Total major group	Neoplasm Rate per 100000	Circulatory Rate per 100000	Major group rate per 100000
2008	136660648	93050	358688	451738	68	262	331
2012	144259185	110374	460126	570500	77	319	395
2016	152301336	131034	590940	721974	86	388	474
2020	160814118	155686	759821	915507	97	472	569
2024	169826255	185122	978078	1163200	109	576	685
2028	179368282	220293	1260444	1480737	123	703	826
2032	189472663	262342	1626121	1888463	138	858	997
2036	200173915	312639	2100157	2412796	156	1049	1205
2040	211508748	372840	2715251	3088091	176	1284	1460
2044	223516196	444932	3514123	3959055	199	1572	1771
2048	236237777	531306	4552616	5083922	225	1927	2152
2052	249717653	634843	5903779	6538622	254	2364	2618
2056	264002796	759012	7663227	8422239	288	2903	3190
2060	279143179	907989	9956180	10864169	325	3567	3892

Table 7.16 shows the projected distribution of deaths caused by major NCDs, specifically neoplasm and circulatory related disease. It was noted that a significant part of the population will die because of non-communicable diseases. The number of persons affected was increasing rapidly year by year. Among NCDs, projected population of circulatory system related diseases (stroke, ischemic heart disease and hypertensive disease) was most common in Bangladesh. The second major cause of NCD-deaths was neoplasm for the national population. The major NCDs were going to have greater impact in the upcoming years. 331 counts per 100,000 in 2008, which turned to 395 in 2012, are projected to reach 3892 per 100,000 in 2060.

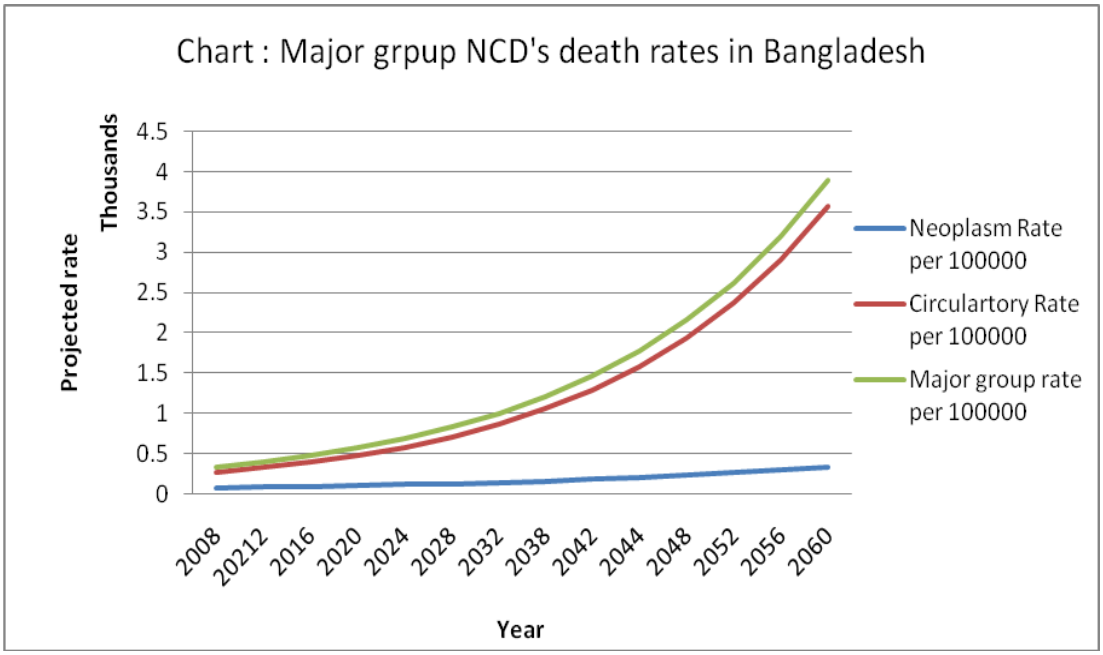


Figure 7.18. Projected major NCD deaths population in Bangladesh

The Figure 7.18 provided information about the projection of deaths of major non-communicable diseases (circulatory disease and neoplasm). It was seen that the population related to circulatory disease rises quickly and had the greater influence on the overall NCD deaths. Neoplasm also showed increasing trend but grew minimally compared to circulatory related disease.

Table 7.17. Percentage distribution of major NCD deaths by age in 2008 for Matlab male

Age group	Circulatory	Neoplasm
0-4	0.00%	2.08%
5-14	0.34%	2.08%
15-29	1.35%	2.08%
30-44	3.70%	6.25%
45-59	13.80%	26.04%
60-69	24.24%	34.38%
70-79	34.01%	21.88%
80+	22.56%	5.21%

Table 7.17 shows the percentage distribution of two major non-communicable diseases by age for male person. Among the age groups, circulatory system related diseases and neoplasm greatly affected at the age groups beginning from 45-59 and above. Circulatory system related diseases had the highest percentage (34.01%) in the age group 70-79 and neoplasm had the highest percentage (34.38%) in the age group 60-69.

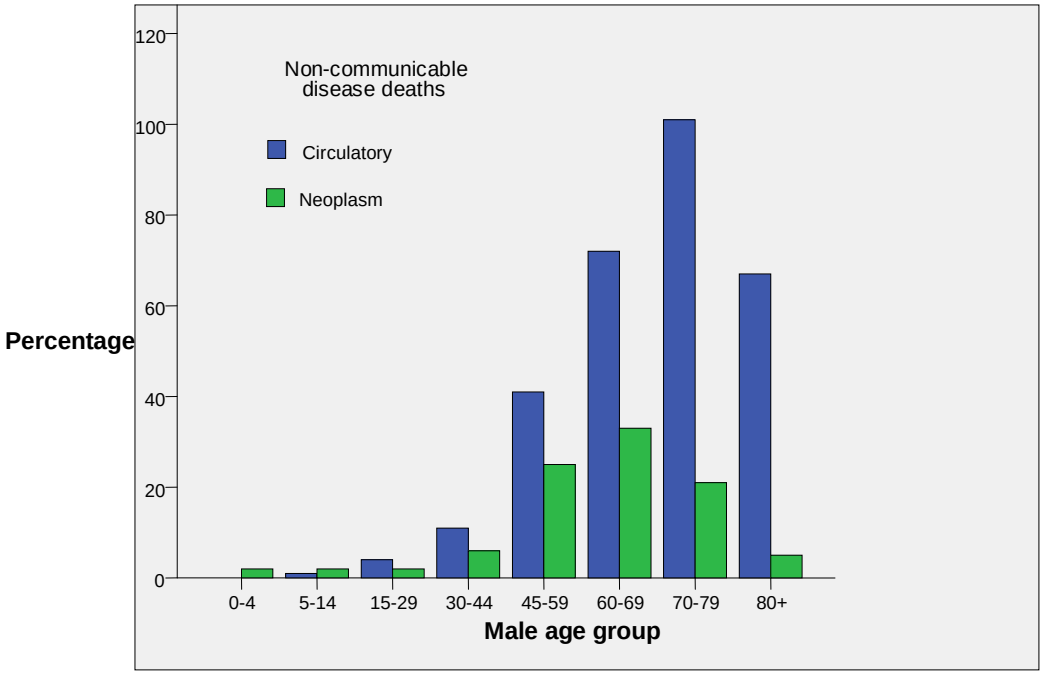


Figure 7.19. NCD population by age in 2008 for male

The Figure 7.19 shows the age-wise distribution of circulatory system related diseases and neoplasm, the two major burdens among the non-communicable diseases for male.

Table 7.18. Chi-Square tests for age of diseased person and gender (male)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.050	7	.000
Likelihood Ratio	36.777	7	.000
Linear-by-Linear Association	30.445	1	.000

The asymptotic significance level was 0.000 which was less than 0.05. So, null hypothesis would be rejected at 5% level of significance. So, there was strong relation between age of diseased person and gender (male).

Table 7.19. Percentage distribution of major NCD deaths by age in 2008 for Matlab female

Age group	Circulatory	Neoplasm	Respiratory
0-4	0.35%	3.92%	00.0%
5-14	0.35%	00.0%	1.92%
15-29	1.06%	3.92%	00.0%
30-44	1.77%	11.76%	1.92%
45-59	7.80%	29.41%	13.46%
60-69	26.60%	27.45%	32.69%
70-79	38.65%	21.57%	26.92%
80+	23.40%	1.96%	23.08%

Table 7.19 provides the information about the percentage age-wise distribution of three major NCDs, circulatory system related disease, neoplasm, and respiratory related diseases for females. Similar to what was observed in the male population, circulatory system related diseases, respiratory related diseases, and neoplasm had greater effect to the age group 45-59 and above. Circulatory system related diseases had the highest percentage (38.65%) in the age group 70-79, neoplasm had the highest percentage (29.41%) in the age group 45-59 and respiratory related diseases had the highest percentage (32.69%) in the age group 60-69.

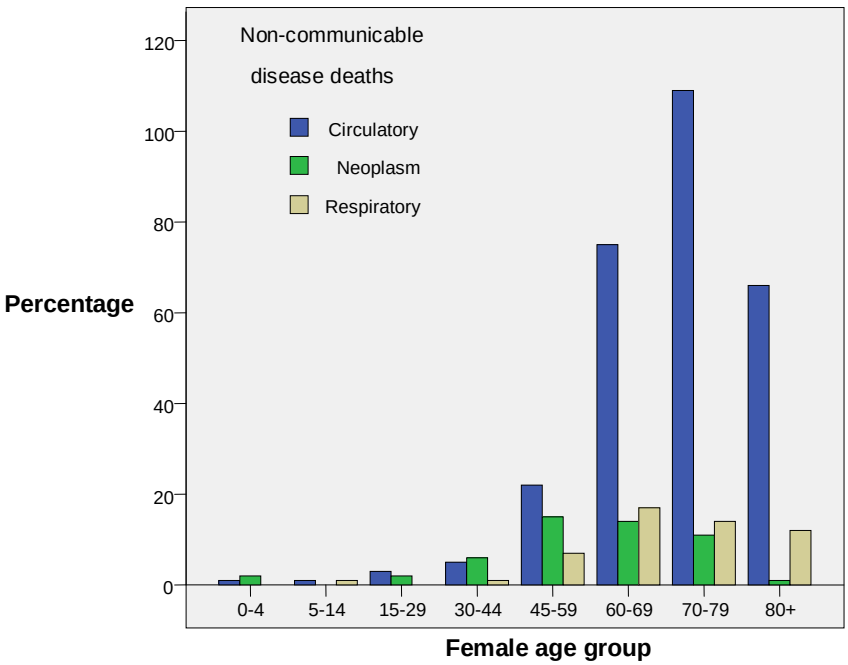


Figure 7.20. NCD population by age in 2008 for female

Figure 7.20 provides the age-wise distribution of circulatory system related diseases, respiratory related diseases, and neoplasm, the three major burdens among the non-communicable diseases for females. It showed that circulatory system related diseases were the major burden among the NCDs for female.

Table 7.20. Chi-Square tests for age of diseased person and gender (female)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	60.533	14	.000
Likelihood Ratio	54.340	14	.000
Linear-by-Linear Association	9.739	1	.002

The calculated asymptotic significance level was less than 0.05. So, null hypothesis would be rejected at 5% level of significance. It indicated the presence of strong relationship between age of diseased person and gender (female).

7.6 Conclusions

In the year 2004, among the male victims 43% (232) fall in the circulatory related disease, 15% (82) fall in the neoplasm group, and 14% (78) were victims of respiratory related disease. The others were 11% for digestive disease, 9% for endocrine disorder, 3% for neuro-psychiatric, 3% for gentio-urinary and 2% for other non-communicable diseases.

The highest deaths due to non-communicable diseases were recorded in the year 2008. Among the male victims 54% (297) fall under circulatory related disease, 18% (96) fall in the neoplasm group, and 10% (52) were victims of respiratory related diseases. The others were 7% for digestive disease, 5% for endocrine disorder, 1% for neuro-psychiatric, 3% for gentio-urinary and 1% for other non-communicable diseases.
In the year 2004, among the female victims 54% (234) fall under circulatory related disease, 10% (46) fall in the neoplasm group, and 8% (34) of them were victims of respiratory related diseases. In the year 2008, among the female victims 61% (282) belong to circulatory related disease, 11% (51) fall in the neoplasm group, another 11% (52) fall victim of respiratory related diseases. Again, there were 4% for digestive disease, 7% for endocrine disorder, 2% for neuro-psychiatric, 3% for gentio-urinary and 1% for other non-communicable diseases.

The growth rate was very high for circulatory related diseases, 6.17% for males and 4.66% for females. For neoplasm, the growth rates were 3.94% and 2.58% for males and females respectively. In case of females, respiratory related diseases also have a very high growth rate which is 10.62%. Finally the growth rates of non-communicable diseases were 0.41% for male and 1.61% for female. Therefore the female population was at higher risk.

It was indicated that a huge number of people will die because of non-communicable diseases. The number of deaths due to NCDs keeps increasing rapidly year by year. Among the NCDs circulatory system related diseases (stroke, ischemic heart disease and hypertensive disease) were most common in Bangladesh. The second major cause of deaths was neoplasm.

Among the age groups, circulatory system related diseases and neoplasm greatly affected the age group beginning from 45-59 and above. Circulatory system related diseases had the highest percentage (34.01%) for the age group 70-79. Neoplasm

contributed the highest percentage (34.38%) for the age group 60-69. Among the age groups like the male person circulatory system related diseases, respiratory related diseases and neoplasm greatly affected the age group 45-59 and above. More specifically, circulatory system related diseases had the highest percentage (38.65%) for the age group 70-79, neoplasm contributed the highest percentage (29.41%) for the age group 45-59 and the highest percentage was 32.69% for respiratory related diseases in the age group 60-69 for female.

In the case of projected national death population, the transition period was in the year 2016. The diseased population showed decreasing trend before 2016 and after that year, the diseased population showed increasing trend.

CHAPTER EIGHT

INTERRELATIONSHIP BETWEEN SOCIO-DEMOGRAFIC FACTORS AND NON-COMMUNICABLE DISEASES: EVIDENCE FROM A MICRO SURVEY STUDY AND MATLAB POPULATION

8.1 Introduction

In 2013 World Health Organization updated their information that each year non-communicable diseases (NCDs) kill more than 36 million people and nearly 80% of NCD deaths occur in low-income and middle-income countries. All age groups were affected by these diseases. Four risk factors were identified: use of tobacco, physical inactivity, the harmful use of alcohol, and unhealthy diets.

Since non-communicable diseases are spreading rapidly and showing significant increasing trend while other categories are decreasing, it is appropriate to analyze non-communicable diseases in this section. When we completed the micro survey, a very small number of other diseases were also found. But samples of other diseases were too small to bring a satisfactory result. So there is a scope to work with other kinds of diseases in a larger scale in future.

Hosseinpoor et al. (2012) collected data consisting of 232,056 adult participants from 48 countries (21 low-income and 27 middle-income countries). NCD risk factors and relevant socioeconomic and demographic variables were included in the analysis of the data. It considered four NCD risk factors: current daily smoking, low fruit and vegetable consumption, physical inactivity, and heavy episodic alcohol drinking. Socioeconomic status was found from individual household wealth status and highest-attained level of education. Some demographic variables such as sex, age, marital status and area of residence were also incorporated in the research. It was found that economic, social, gender, political, behavioral and environmental determinants of health had strong relationship with NCDs.

Kinra et al. (2010) worked with 1600 villages from 18 states in India to analyze the socio-demographic pattern of NCD risk factors. Prevalence of tobacco use, alcohol use, low fruit and vegetable intake, low physical activity, obesity, central adiposity, hypertension, dyslipidaemia, diabetes, and underweight were the main outcome measures in that study.

Different types of socio-demographic factors influence non-communicable diseases. The influence of factors such as profession of the household head, monthly income, education level of the respondent, occupation of the respondent, sex of the diseased person, current age of diseased person, presence of tension etc. are discussed here in the perspective of Bangladesh. These factors may have role on non-communicable diseases. Once identified, non-communicable diseases may be prevented by tackling the risk factors.

In this study, non-communicable diseases were divided into five categories. These are: circulatory system related diseases, neoplasm, respiratory and neuro psychiatric, endocrine disorder and gentio urinary, and digestive. A cross-sectional study was conducted to study the relationship between socio-demographic factors and non-communicable diseases. Prevalence rates were given only for non-communicable diseases that affected most of the population. Finally, logistic regression presents a vivid picture of socio-demographic risk factors of non-communicable diseases.

8.2 Mohonpur Moholla: A Micro Survey Study Area

Mohonpur moholla is part of Meherchandi mouza. Meherchandi mouza is one of the 30^{th} ward under motihar thana in Rajshahi city corporation, Bangladesh. The 30^{th} ward consists of an area of 1754 acre and is surrounded by Poba upazila on the north, south and east, and by Boalia thana on the north, and west.

8.2.1 Questionnaire and Data Collection

Data collection is an important part of any research. Whether it is a survey or census, primary data can be obtained through observation or through direct communication with the respondents. Here the primary data was collected through personal interviews based on questionnaire. The questions were prepared with the help of existing related documents and consulting with the supervisor. A short training session

was arranged on 18 December 2011 regarding the questionnaire: how to collect data, how to ask questions to the respondents, how to get the correct answer asking the same question in a different way, and so on. Pre-test of the questionnaire was conducted on 22 December 2011. There were 4 members in the data collection team who took interviews. Before and after pre-test, a meeting was held among the researchers and working group members in order to obtain suggestions and recommendations for further improvement. After finalizing the questionnaire, 300 copies were made. Data was collected directly from the adult dwellers from 23 December 2011 to 20 January 2012 (29 days in total) from the selected study area.

The method used for data collection was structured interviews. It entailed the use of three sets of questionnaires: one for respondent, one for household head and one for other individual. Since most of the respondents were poor and illiterate, the questionnaire was prepared in such a way that all types of respondents can understand and answer the questions easily. The questionnaire was set up in English and where appropriate, local terms were used to interpret them to the respondents. The questionnaire questions and gradually move detail ones were introduced for maintaining the sequence of the topic.

The household and respondent questionnaire included personal characteristics, morbidity, mortality and health characteristics. An individual household refers to a household in which one or more persons make mutual arrangements for the common provisioning of food and other essential living commodities. The individual questionnaire was used for persons affected by non-communicable diseases. It covered morbidity and health characteristics.

Table 8.1. Percentage distributions of some basic socio-demographic characters of respondents and disease related characteristics

Characteristics	Categories	Number(%)
Educational attainment of household head	Illiterate	94(37.0%)
	Primary	64(25.2%)
	Secondary	63(24.8%)
	Higher	33(13.0%)
Occupation of household head	Service	98(38.6%)
	Business	53(20.9%)
	Agriculture	49(19.3%)
	Others	54(21.3%)
Profession of household head	Non-agricultural	205(80.7%)
	Agricultural	49(19.3%)
Monthly income of household head	<5000	125(49.2%)
	5000-10000	96(37.8%)
	10000-20000	24(9.4%)
	>20000	9(3.5%)
Education level of respondent	Illiterate	136(49.1%)
	Primary	44(15.9%)
	Secondary	76(27.4%)
	Higher	21(7.6%)
Occupation of respondent	Service	1(0.4%)
	Business	1(0.4%)
	housewife	271(97.8%)
	Others	4(1.4%)
Sex of diseased person	Male	38(35.8%)
	Female	68(64.2%)
Name of diseases	Communicable diseases	13(12.3%)
	Circulatory system related	39(36.8%)
	Neoplasm	10(9.4%)
	Respiratory diseases and	9(8.5%)
	Endocrine disorder	17(16.0%)
	Gentio urinary diseases and	18(17.0%)
Disease category	Communicable	13(12.3%)
	Non-communicable	93(87.7%)
Current age of diseased person	<15	3(2.8%)
	15-29	13(12.3%)
	30-44	36(34.0%)
	45-59	35(33.0)
	60+	19(17.9%)

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Disease starting age	<15	7(6.6%)
	15-29	20(18.9%)
	30-44	43(40.6%)
	45-59	21(19.8%)
	60+	15(14.2%)
Cause of death	Senility	5(26.3%)
	Disease	14(73.7%)
Disease caused death	Circulatory system related	5(35.7%)
	Neoplasm	1(7.1%)
	Respiratory diseases	1(7.1%)
	Endocrine disorder	3(21.4%)
	Others	4(28.6%)
Age at death	<15	3(21.5%)
	15-44	1(7.1%)
	45-64	5(35.7%)
Heredity	Genetic	73(78.5%)
	Not genetic	20(21.5%)
Feeling tension	No	8(8.6%)
	Yes	85(91.4%)
Cause of tension	Sickness	22(23.7%)
	Family related	43(46.2%)
	Economic crisis	27(29.0%)
	profession	1(1.1%)
Smoking(Male)	No	70(75.3%)
	Yes	23(24.7%)
Age at starting smoking(Male)	<20	18(78.3%)
	>20	5(21.7%)
Smoking time(Male)	<8 times	10(43.5%)
	8 > times	13(56.5%)
Taking steps after detection	No	9(9.7%)
	In serious condition	12(12.9%)
	Sometimes	40(43.0%)
	Regular	32(34.4%)
Exercise	No	66(71.0%)
	Yes	27(29.0%)

In the above Table 8.1, it is observed that majority (37.0%) of the respondents were illiterate, followed by 25.2% primary educated and 24.8% secondary level educated. It was found that 38.6% of the respondents were service holders, 20.9% were businessmen,

and 19.3% were related to agriculture. So majority of them (80.7%) were on non-agriculture based profession. The list showed that 49.2% of the household head had monthly income less than 5000 Tk, followed by 37.8% earning between 5000-10000 Tk. almost all the respondents (97.8%) were housewives. 49.1% of the respondents were illiterate, 15.9% of them were primary educated, and 27.4% were secondary level educated. Also 7.6% were higher educated. The number of diseased female was higher (64.2%, almost double) than the number of diseased male (35.8%). It was observed that 12.3 percent of the diseased population had communicable diseases, 36.8 percent had circulatory system related diseases, 16.0 percent had endocrine disorder and 17.0 percent had genitourinary and digestive diseases people, 9.4 percent had neoplasm, and 8.5 percent had respiratory and neuro-psychiatric diseases. Only 12.3 percent of diseased people had communicable diseases and the most 87.7 percent of diseased people had non-communicable diseases. The highest 34.0 percent diseased people were aged 30-44 years. Also, diseased persons aged <15 years, 15-29 years, 45-59 years and 60+ years were 2.8 percent, 12.3 percent, 33.0 percent and 17.9 percent respectively of the total. In 40.6% of the cases, the diseases started at age group 30-44, which is significant. Below thirty percent (26.3%) people died by senility while 73.7 percent people died of various types of diseases. Higher levels (35.7%) of deaths were associated with circulatory system related diseases. Neoplasm carries 7.1% of deaths. Endocrine 21.4%, respiratory 7.1% and others 28.6% were responsible for people's death. Most of the people died at 65+ ages which was 35.7% of deaths and age group 45-64 contains 35.7% of deaths. Among the diseased people 73 (78.5%) of them were genetically affected. Again, 91.4% of the diseased people were feeling tension and only 8.6% were not feeling tension. In the Table 8.1, it is observed that 46.2% of the diseased people were feeling tension for family matters, 29.0% belong within the group "economic crisis", and 23.7% were tensed because of their "sickness" and 1.1% was feeling tension about "professional work." Table 8.1 also presented that 75.3% of the diseased people were non-smoker and another 24.7% were smoker. 56.5% of the smokers smoked 8+ times a day and the rest 43.5% smoked <8 times. Among the 23 smokers, 18 (78.3%) of them started smoking when they were under 20 years age. The rest started smoking at later stages of their lives. It is evident from Table 8.1 that among the NCD diseased person 34.4% were taking

regular treatment, 43.0% were taking step "sometime", 12.9% took steps only when the condition got serious, and 9.7% diseased people were not taking any steps. The percentage of diseased persons doing exercise was 71.0% and not doing exercise were 29.0%.

8.3 Pattern of Non-communicable Diseases by Sex: A Comparison between Study Area (30th ward of Rajshahi City Corporation) and Matlab Population

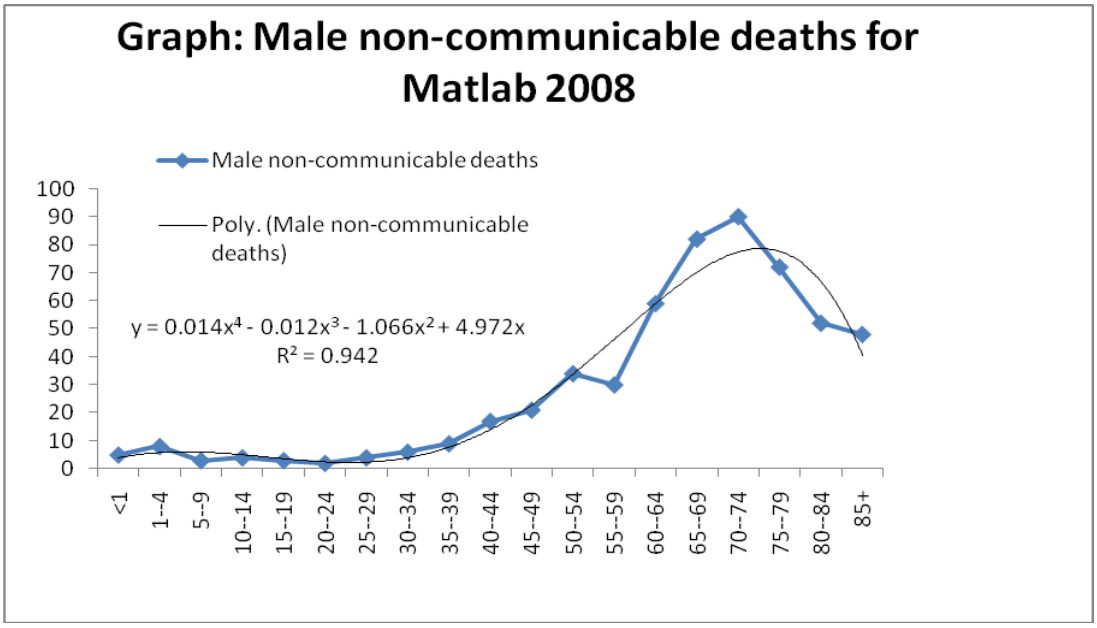

Figure 8.1. Non-communicable deaths for Matlab male, 2008

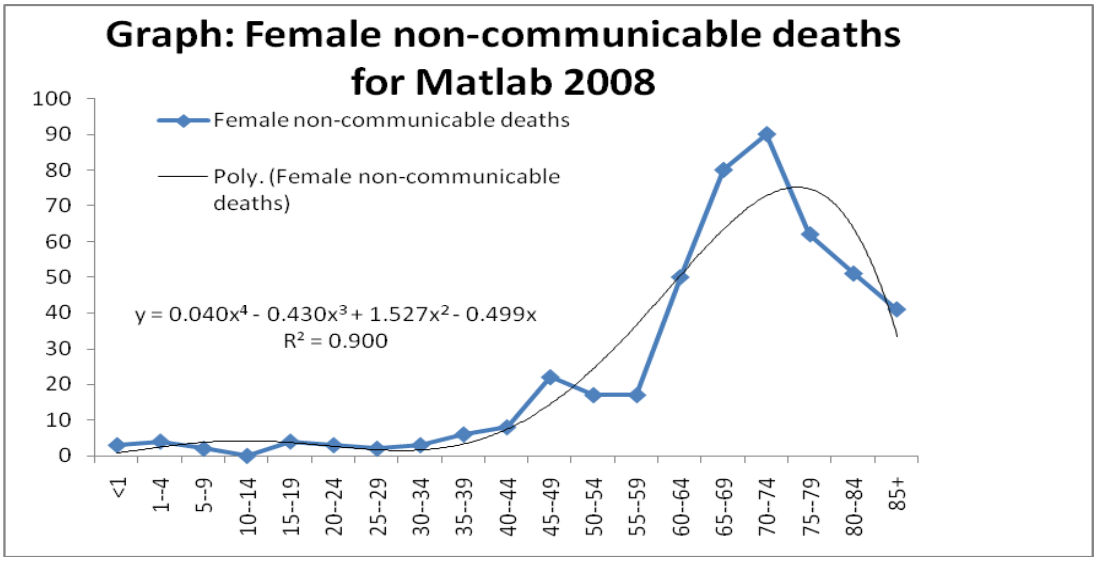

Figure 8.2. Non-communicable deaths for Matlab female, 2008

The graph on Figure 8.1 and Figure 8.2 show almost the same shape across the age distribution. The highest number of deaths was in the age group 70-74 during the year 2008. Four degree polynomial was used to fit the data. The male age group 40-44, 50-54, 60-64, 70-74 and female age group 45-49, 60-64 and 70-74 highly influenced the curve. Number of deaths increased rapidly from age 35 onward, for both sexes.

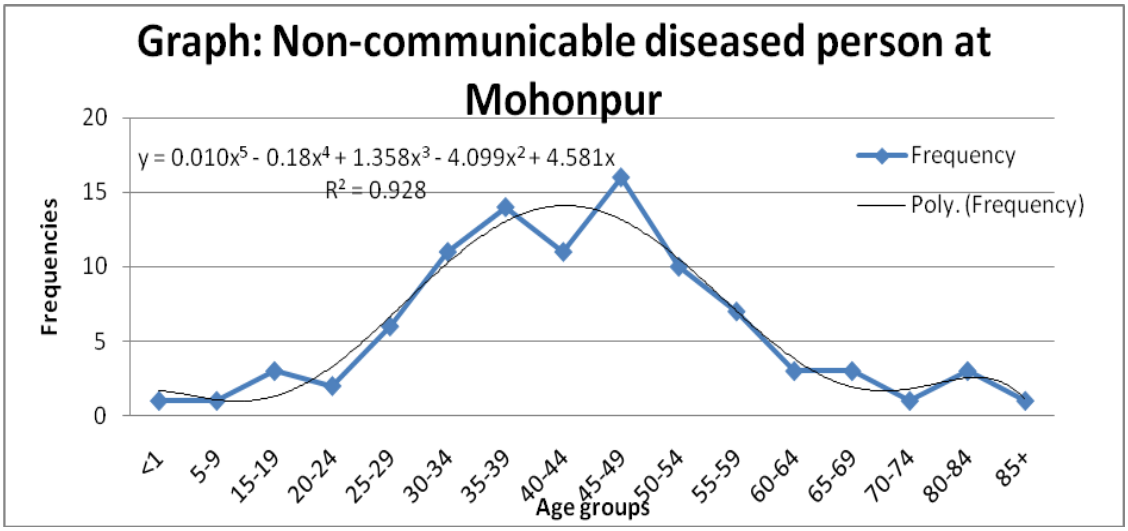

Figure 8.3. Pattern of non-communicable diseases for males and females at Mohonpur, 2012

Figure 8.3 explains the non-communicable disease pattern on the age groups in the recent year 2012 with 5-degree polynomial curve. The highest counts of diseased persons were observed in the age group 35-39 and 45-49. Number of NCD victims increased sharply from age group 25-29 to age group 50-54. If they die within 5 to 20 years, then the mortality pattern of Mohonpur, Rajshahi would be quite similar as the mortality pattern in Matlab.

8.4 Results and Discussion

Table 8.2. Bivariate analysis of socio-demographic characteristics by diseases and their significance level at Mohonpur for male

	Non-communicable diseases							
Selected variables	Categories	Circulatory system related	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and digestive	Others	Total	P-value
Educational attainment of household head	Illiterate	35.3%	00.0%	33.3%	100%	00.0%	38.7%	.23
	Primary	29.4%	100.0%	11.1%	00.0%	00.0%	22.6%	
	Secondary	17.6%	00.0%	11.1%	00.0%	100.0%	16.1%	
	Higher	17.6%	00.0%	44.4%	00.0%	00.0%	22.6%	
Profession of household head	Non-agricultural	76.5%	100.0%	100.0%	66.7%	100.0%	83.9%	.29
	Agricultural	23.5%	00.0%	00.0%	33.3%	00.0%	16.1%	
Monthly income of household head	<5000	47.1%	00.0%	22.2%	100.0%	00.0%	41.9%	.31
	5000-10000	41.2%	100.0%	33.3%	00.0%	100.0%	38.7%	
	10000-20000	11.8%	00.0%	33.3%	00.0%	00.0%	16.2%	
	>20000	00.0%	00.0%	11.1%	00.0%	00.0%	3.2%	
Current age of diseased person(Male)	<15	00.0%	00.0%	00.0%	00.0%	100.0%	3.0%	.02
	30-44	23.5%	100.0%	10.0%	100.0%	00.0%	30.3%	
	45-59	52.9%	00.0%	60.0%	00.0%	00.0%	45.5%	
	60+	23.5%	00.0%	30.0%	00.0%	00.0%	21.2%	
Disease starting age(Male)	<15	00.0%	00.0%	00.0%	00.0%	100.0%	3.0%	.06
	15-44	41.2%	100.0%	20.0%	100.0%	00.0%	42.4%	
	45-59	35.3%	00.0%	60.0%	00.0%	00.0%	36.4%	
	60+	23.5%	00.0%	20.0%	00.0%	00.0%	18.2%	
Genetic disease(Male)	No	88.2%	100.0%	60.0%	100.0%	00.0%	81.3%	.16
	Yes	11.8%	00.0%	40.0%	00.0%	00.0%	18.8%	
Feeling tension(Male)	No	11.8%	00.0%	20.0%	33.3%	00.0%	16.1%	.74
	Yes	88.2%	100.0%	80.0%	66.7%	00.0%	83.9%	

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	Non-communicable diseases							
Selected variables		Circulatory system related	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and digestive	Others	Total	P-value
Cause of tension(Male)	Sickness	00.0%	00.0%	14.3%	00.0%	00.0%	4.5%	.44
	Family related	75.0%	00.0%	57.1%	100.0%	00.0%	68.2%	
	Economic crisis	25.0%	100.0%	14.3%	00.0%	00.0%	22.7%	
	Professional work	00.0%	00.0%	14.3%	00.0%	00.0%	4.5%	
Smoking(Male)	No	47.1%	50.0%	40.0%	33.3%	00.0%	43.8%	.96
	Yes	52.9%	50.0%	60.0%	66.7%	00.0%	56.3%	
Age at starting smoking(Male)	15-20 year	77.8%	100.0%	33.3%	100.0%	00.0%	73.3%	.26
	21-35 year	22.2%	00.0%	66.7%	00.0%	00.0%	26.7%	
Smoking time(Male)	4-7 times	44.4%	00.0%	33.3%	00.0%	00.0%	33.3%	.41
	8-10 times	55.6%	100.0%	66.7%	100.0%	00.0%	66.7%	
Taking steps after detection(Male)	No	00.0%	50.0%	20.0%	33.3%	00.0%	12.9%	.10
	In serious condition	18.8%	50.0%	10.0%	00.0%	00.0%	16.1%	
	Sometimes	37.5%	00.0%	30.0%	66.7%	00.0%	35.5%	
	Regular	43.8%	00.0%	40.0%	00.0%	00.0%	35.5%	
Exercise(Male)	No	82.4%	100.0%	20.0%	100.0%	00.0%	65.6%	.00
	Yes	17.6%	00.0%	80.0%	00.0%	00.0%	34.4%	
Total(Male)		51.5%	6.1%	30.3%	9.1%	3.0%	100.0%	

Table 8.2 presents the bivariate analysis of non-communicable diseases and related factors for male. Likelihood ratio statistic was considered as a test statistic for obtaining p-value. Current age of diseased person, and exercise showed significant association with non-communicable diseases. The percentage of NCD affected people was higher in the non-agricultural professions (83.9%) than in the agricultural professions (16.1%). Among the diseased males, 51.5% fall under circulatory system related diseases and 30.3% fall in the endocrine disorder group. Out of the total 75.0% of the total, who were attacked with circulatory related disease, felt tension about family matters and the rest 25.0% were feeling economic crisis related tension. Each group of non-communicable diseases showed higher percentages in smokers than in non-smokers. For example, for smokers, the percentages were 52.9% for circulatory system related diseases, 60.0% for endocrine disorder, and 66.7% for gentio urinary and digestive diseases. After analyzing the data, it was found that 83.9% of the diseased males felt the presence of tension. So, tension had positive association with non-communicable diseases.

It is observed that 37.5% patients visited doctors occasionally and about the same percentage of patients were regular visitors. But not all the diseased people were taking care of their treatment. In the case of circulatory related diseases, the affected who took regular treatment only 43.8%. It was also found that 65.6% of the affected males were not practicing any kind of exercise. In case of circulatory related diseases, up to 82.4% were not doing any exercise.

Table 8.3: Bivariate analysis of socio-demographic characteristics by diseases and their significance level at Mohonpur for female

		Non-communicable diseases						
Selected variables		Circulatory system related	Neoplasm	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and	Total	P-value
Education level of respondent	Illiterate	55.0%	66.7%	66.7%	50.0%	53.3%	57.4	.96
	Primary	15.0%	22.2%	16.7%	25.0%	6.7%	14.8	
	Secondar	25.0%	11.1%	16.7%	25.0%	33.3%	24.1	
	Higher	5.0%	00.0%	00.0%	00.0%	6.7%	3.7%	
Current age of diseased person(Female)	<15	00.0%	10.0%	00.0%	00.0%	00.0%	1.7%	.15
	15-29	9.1%	00.0%	33.3%	14.3%	40.0%	18.3	
	30-44	63.6%	40.0%	33.3%	28.6%	26.7%	43.3	
	45-59	27.3%	40.0%	33.3%	42.9%	20.0%	30.0	
	60+	00.0%	10.0%	00.0%	14.3%	13.3%	6.7%	
Disease starting age(Female)	<15	00.0%	20.0%	00.0%	00.0%	20.0%	8.3%	.04
	15-29	27.3%	00.0%	33.3%	14.3%	33.3%	23.3	
	30-44	59.1%	60.0%	66.7%	71.4%	20.0%	51.7	
	45-59	13.6%	10.0%	00.0%	00.0%	20.0%	11.7	
	60+	00.0%	10.0%	00.0%	14.3%	6.7%	5.0%	
Genetic disease(Female	No	89.5%	100.0%	83.3%	28.6%	92.9%	83.6	.00
	Yes	10.5%	00.0%	16.7%	71.4%	7.1%	16.4	
Feeling tension(Female	No	5.3%	00.0%	00.0%	00.0%	7.1%	3.8%	.74
	Yes	94.7%	100.0%	100.0%	100.0%	92.9%	96.2	
Cause of tension(Female)	Sickness	43.8%	66.7%	20.0%	20.0%	60.0%	45.2	.35
	Family	31.3%	16.7%	80.0%	60.0%	30.0%	38.1	
	Economic	25.0%	16.7%	00.0%	20.0%	10.0%	16.7	
Taking steps after detection(Female)	No	10.5%	33.3%	00.0%	00.0%	00.0%	9.1%	.27
	In serious	15.8%	11.1%	00.0%	00.0%	7.1%	9.1%	
	Sometime	42.1%	22.2%	66.7%	57.1%	42.9%	43.6	
	Regular	31.6%	33.3%	33.3%	42.9%	50.0%	38.2	
Exercise(Female)	No	63.2%	100.0%	66.7%	28.6%	92.9%	72.7	.00
	Yes	36.8%	00.0%	33.3%	71.4%	7.1%	27.3	
Total(Female)		36.6%	16.7%	10.0%	11.7%	25.0%	100	

In Table 8.3, the respondent of illiterate group has more percentages for circulatory related diseases (55.0%) and neoplasm (66.7%) than the educated group. 36.6% females have circulatory system related diseases, 25.0% have gentio urinary, digestive diseases and 16.7% have neoplasm among the non-communicable diseases. Genetic influence, disease starting age, and exercise were asymptotically significant. The p-value was 0.037 for starting age, 0.004 for genetic influence and 0.003 for exercise. So, disease starting age, genetic influence and exercise were significantly related with non-communicable diseases. 96.2% of the total diseased females were feeling tension. Therefore, tension had positive association with non-communicable diseases. 43.8% of circulatory related disease victims were feeling tension because of their sickness, 31.3% were feeling tension on family matters. In case of circulatory related diseases, patients taking regular treatment were 31.6%, 42.1% were taking sometimes. All the diseased females were not conscious about taking treatment; 10.5% were not taking treatment at all. It was observed that 72.7% of affected female were not having exercise and only 27.3% were doing exercise.

Table 8.4. Prevalence rate of socio-demographic characteristics by diseases at Mohonpur for male

	Non-communicable diseases						
Selected variables		Circulatory system related	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and digestiv	Others	Total
Educational attainment of household head	Illiterate	2.36%	0.00%	1.18%	1.18%	0.00%	4.72%
	Primary	1.97%	0.39%	0.39%	0.00%	0.00%	2.76%
	Secondary	1.18%	0.00%	0.39%	0.00%	0.39%	1.97%
	Higher	1.18%	0.00%	1.57%	0.00%	0.00%	2.76%
Profession of household head	Non-agricultural	5.12%	0.39%	3.54%	0.79%	0.39%	10.24%
	Agricultural	1.57%	0.00%	0.00%	0.39%	0.00%	1.97%
Monthly income of household head	<5000	3.15%	0.00%	0.79%	1.18%	0.00%	5.12%
	5000-10000	2.76%	0.39%	1.18%	0.00%	0.39%	4.72%
	10000-20000	0.79%	0.00%	1.18%	0.00%	0.00%	1.97%
	>20000	0.00%	0.00%	0.39%	0.00%	0.00%	0.39%
Current age of diseased person(Male)	<15	0.00%	0.00%	0.00%	0.00%	0.39%	0.39%
	30-44	1.57%	0.79%	0.39%	1.18%	0.00%	3.94%
	45-59	3.54%	0.00%	2.36%	0.00%	0.00%	5.91%
	60+	1.57%	0.00%	1.18%	0.00%	0.00%	2.76%
Disease starting age(Male)	<15	0.00%	0.00%	0.00%	0.00%	0.39%	0.39%
	15-44	2.75%	0.78%	0.79%	1.18%	0.00%	5.51%
	45-59	2.36%	0.00%	2.36%	0.00%	0.00%	4.72%
	60+	1.57%	0.00%	0.79%	0.00%	0.00%	2.36%

(Continued after previous page)

	Non-communicable diseases						
Selected variables		Circulatory system related	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and digestive	Others	Total
Genetic disease(Male)	No	5.91%	0.79%	2.36%	1.18%	0.00%	10.24%
	Yes	0.79%	0.00%	1.57%	0.00%	0.00%	2.36%
Feeling tension(Male)	No	0.79%	0.00%	0.79%	0.39%	0.00%	1.97%
	Yes	5.91%	0.39%	3.15%	0.79%	0.00%	10.24%
Cause of tension(Male)	Sickness	0.00%	0.0%	0.39%	0.00%	0.00%	0.39%
	Family related	3.54%	0.0%	1.57%	0.79%	0.00%	5.91%
	Economic crisis	1.18%	3.9%	0.39%	0.00%	0.00%	1.97%
	Professional work	0.00%	0.0%	0.39%	0.00%	0.00%	0.39%
Smoking(Male)	No	3.15%	0.39%	1.57%	0.39%	0.00%	5.51%
	Yes	3.54%	0.39%	2.36%	0.79%	0.00%	7.09%
Starting age at smoking(Male)	15-20 year	2.76%	0.39%	0.39%	0.79%	0.00%	4.33%
	21-35 year	0.79%	0.00%	0.79%	0.00%	0.00%	1.57%
Smoking time(Male)	<8 times	1.57%	0.00%	0.39%	0.00%	0.00%	1.97%
	8^{+} times	1.97%	0.39%	0.79%	0.79%	0.00%	3.94%
Taking steps after detection(Male)	No	0.00%	0.39%	0.79%	0.39%	0.00%	1.57%
	Serious	1.18%	0.39%	0.39%	0.00%	0.00%	1.97%
	Sometimes	2.36%	0.00%	1.18%	0.79%	0.00%	4.33%
	Regular	2.76%	0.00%	1.57%	0.00%	0.00%	4.33%
Exercise(Male)	No	5.51%	0.79%	0.79%	1.18%	0.00%	8.27%
	Yes	1.18%	0.00%	3.15%	0.00%	0.00%	4.33%
Total(Male)		6.69%	0.79%	3.94%	1.18%	0.39%	12.99%

It is observed from Table 8.4 that prevalence rate was 4.72% for household head with no education, 2.76% with primary education, and 2.76% with higher education. Prevalence rate of household head was 1.97% for having secondary level education. Prevalence rate was very high for non agricultural group. It was 10.24% for non-agricultural group, but for agricultural group, it was only 1.97%. Circulatory system related diseases carried high prevalence rate (6.69%) among all categories of diseases. The prevalence rate of household head whose monthly income under 5000 was 5.12%, followed by 4.72% whose monthly income were between 5000 to10000. The prevalence rate of male was 0.39% in the age group below 15 years, 3.94% in the age group 30-44, 5.91% in the age group 45-59, and 2.67% in the age group 60+. The highest prevalence rate was 3.54% in the age group 45-59 for circulatory system related diseases. The disease starting age group 15-44 had the highest prevalence rate 5.51%. 4.72% of the total diseased person affected with non-communicable diseases at the age 45-59. The prevalence rate of genetically receiving the disease for male was 2.36% against 10.24% of not receiving the disease genetically. Prevalence rate of feeling (some kind of) tension was 10.24% and the prevalence rate of having no tension was 1.97%. The prevalence rate of tension about family related matters was 5.91%, tension about sickness was 0.39% and tension about economic crisis was 1.97%. The prevalence rates in case of circulatory related diseases were 3.54% and 3.15% for smokers and non-smokers respectively; in case of endocrine disorder those were 2.36% and 1.57% for smokers and non-smoker respectively. People who started smoking at an early age were affected more by circulatory related diseases. The prevalence rate was 2.76% for circulatory related diseases, 0.39% for respiratory and neuro psychiatric, 0.39% for endocrine disorder and 0.79% for gentio urinary and digestive diseases. Males who smoked 8-10 times a day were more likely to be affected by non-communicable diseases. The prevalence rate was 3.94% for the group who smoked 8-10 times and 1.97% for the group who smoked 4-7 times .Prevalence rate was high for the group not doing exercise. It was 8.27% in case of non-communicable diseases.

Table 8.5. Prevalence rate of socio-demographic characteristics by diseases at Mohonpur for female

	Non-communicable diseases						
Selected variables		Circulatory system related	Respiratory and neuro psychiatric	Endocrine disorder	Gentio urinary and digestive	Others	Total
Education level of respondent	Illiterate	3.97%	2.17%	1.44%	0.72%	2.89%	11.19%
	Primary	1.08%	0.72%	0.36%	0.36%	0.36%	2.89%
	Secondary	1.81%	0.36%	0.36%	0.36%	1.81%	4.69%
	Higher	0.36%	0.00%	0.00%	0.00%	0.36%	0.72%
Current age of diseased person(Female)	<15	0.00%	0.36%	0.00%	0.00%	0.00%	0.36%
	15-29	0.72%	0.00%	0.72%	0.36%	2.17%	3.97%
	30-44	5.05%	1.44%	0.72%	0.72%	1.44%	9.39%
	45-59	2.17%	1.44%	0.72%	1.08%	1.08%	6.50%
	60+	0.00%	0.36%	0.00%	0.36%	0.72%	1.44%
Disease starting age(Female)	<15	0.00%	0.72%	0.00%	0.00%	1.08%	1.81%
	15-29	2.17%	0.00%	0.72%	0.36%	1.81%	5.05%
	30-44	4.69%	2.17%	1.44%	1.81%	1.08%	11.19%
	45-59	1.08%	0.36%	0.00%	0.00%	1.08%	2.53%
	60+	0.00%	0.36%	0.00%	0.36%	0.36%	1.08%
Genetic disease(Female)	No	6.14%	3.25%	1.81%	0.72%	4.69%	16.61%
	Yes	0.72%	0.00%	0.36%	1.81%	0.36%	3.25%
Feeling tension(Female)	No	0.36%	0.00%	0.00%	0.00%	0.36%	0.72%
	Yes	6.50%	2.53%	2.17%	2.53%	4.69%	18.41%
Cause of tension(Female)	Sickness	2.53%	1.44%	0.36%	0.36%	2.17%	6.86%
	Family related	1.81%	0.36%	1.44%	1.08%	1.08%	5.78%
	Economic crisis	1.44%	0.36%	0.00%	0.36%	0.36%	2.53%
Taking steps after detection(Female)	No	0.72%	1.08%	0.00%	0.00%	0.00%	1.81%
	Serious	1.08%	0.36%	0.00%	0.00%	0.36%	1.81%
	Sometimes	2.89%	0.72%	1.44%	1.44%	2.17%	8.66%
	Regular	2.17%	1.08%	0.72%	1.08%	2.53%	7.58%
Exercise(Female)	No	4.33%	3.25%	1.44%	0.72%	4.69%	14.44%
	Yes	2.53%	0.00%	0.72%	1.81%	0.36%	5.42%
Total(Female)		7.94%	3.61%	2.17%	2.53%	5.42%	21.66%

From Table 8.5 it is observed that most of the respondent in the study area were housewives. They were mostly affected by circulatory system related diseases (7.22%). Total prevalence rate of females (21.66%) was move than males' prevalence rate (12.99%). The age pattern of diseased female differed slightly from the age pattern of diseased male. The prevalence rate of female in the age <15 was 0.36%, in the age interval 30-44 was 9.39%, in the age interval 45-59 was 6.50% and in the age interval 60+ was 1.44%. The highest prevalence rate was 5.05% at the age group 30-44 for circulatory system related diseases. So, females were affected by NCDs at younger ages than males. In case of disease starting age, age interval 30-44 had the highest prevalence rate (11.19%) whereas males' disease starting age interval 15-44 had the highest prevalence rate (5.51%). It reflected the fact that 51.7% female affected with non-communicable diseases were first affected at the age 30-44. The second highest prevalence rate (5.05%) was of the disease starting age group 15-29, covering 23.3% of the total female. Among the diseased female, the prevalence rate of not receiving the disease genetically was 16.61% which covered 83.6% of the total diseased female. The prevalence rate for genetically receiving the disease was 3.25% which covered 16.4% of the total diseased female. The prevalence rate of presence of tension was 18.41% and the prevalence rate of having no tension was 0.72% for female. The rate was higher for female than male. Most of the female were not doing any kind of physical exercise. The prevalence rate was higher (14.44%) for the group with "no" exercise.

Table 8.6. Logistic regression for socio-demographic risk factors in Mohonpur moholla

Factors	β	S.E.	Wald	Sig.(p-value)	OR	95% C.I. for OR	
						Lower	Upper
Profession of household head			13.633	.003			
Service	1.981	.631	9.857	.002	7.246	2.105	24.950
Business	2.608	.845	9.524	.002	13.566	2.590	71.070
Agriculture	.474	.668	.504	.478	1.607	.434	5.954
Diseased person(Male)	-1.042	.513	4.131	.042	.353	.129	.964
Current age of diseased person			16.116	.003			
<15	.521	.890	.343	.558	1.684	.294	9.635
15-29	2.182	.717	9.254	.002	8.860	2.173	36.127
30-44	20.594	3315.520	.000	.995	90.000	.000	.
45-59	2.022	.576	12.313	.000	7.552	2.441	23.359
Smoking(No)	-2.245	.755	8.834	.003	.106	.024	.466
Monthly Income			4.539	.209			
<5000	1.859	.875	4.512	.034	6.416	1.155	35.649
5000-10000	1.488	.811	3.366	.067	4.429	.903	21.717
10000-20000	19.952	6252.832	.000	.997	50.000	.000	.

Hosmer and Lemeshow Test- Chi-square value=14.280, df =8,p-value=.075
Nagelkerke R Square=.842

Profession of household head (others), Sex of diseased person (female), Current age of diseased person (60+), Smoking (Yes), and Monthly Income (<20000) were considered as reference category in the model

In this analysis profession of the household head, sex of the diseased person, current age of the diseased person, smoking, and monthly income were considered as independent variables; and having non-communicable diseases was considered as dependent variable. Table 8.6 provides information about the logistic regression coefficient (β) corresponding to the independent variables, significance probability and odds ratio(OR) for each categorical variable. P-values were used to find out significant effects of the selected variables in the logistic regression. The effect of the independent variables on having NCDs was measured by odds ratio for each variable category relative to reference category for which the odds ratio was 1.00. The Nagelkerke R Square value 0.842 indicated good fit of the model. In logistic regression, profession of household head, sex of diseased person, current age of diseased person, and smoking were found statistically significant at 5% level of significance; but monthly income was found statistically insignificant on having NCDs. Profession of the household head was found to have significant effect on having non-communicable diseases. Service holding and business were 7.246 and 13.566 times more likely respectively to have NCDs than the household heads with other occupation. Farmers had less risk to have NCDs. The odds ratio for male respondents was 0.353. Therefore, males were 0.353 times less likely to be attacked with non-communicable diseases than females. Current age of diseased person had significant effect on having NCDs. The odds ratio for < 15 age group was 1.684, for the age group 15-29 was 8.860, for the age group 30-44 was 90.000 and for the age group 45-59 was 7.552. They were 1.684 times, 8.860 times, 90.000 times and 7.552 times more likely to have non-communicable diseases than the person of age group 60+. Non-smokers were 0.106 times less likely to be attacked with NCDs than the smokers.

CHAPTER NINE

SUMMARY AND CONCLUSION

9.1 Summary of the Study

Each year a large number of people die from various causes around the globe. But with the advancement in the medical science and the health sector some of the causes of mortality are now almost eradicated by taking preventive measures. An investigation has been made to get a clear concept regarding mortality, morbidity and relevant issues. The purpose of this study was to examine the mortality situation in diverse populations in order to illustrate the options for government for setting strategies to increase life expectancy. This chapter summarizes the general and specific findings of the earlier chapters and draws some conclusions.

This study used the vital registration and maternal and child health data gathered from Matlab, Bangladesh, of the years 2000, 2004 and 2008. The data was collected by the Health and Demographic Surveillance System of ICDDR, B. This study also based on the primary data (278 household) collected from Mohonpur of the 30^{th} ward of Rajshahi City Corporation.

The overall death rates were found to be higher for male persons than females. The death rate was approximately 5.3 per thousand for males in 2008 whereas, in 2060 according to the projection, it would be approximately 5.8 per thousand. For females, the death rate was approximately 3.9 per thousand in 2008 whereas this rate would be 5.2 per thousand in 2060.

Life expectancy of females was found to be higher than the males. The life expectancy at birth in the year 2000, 2004, and 2008 for males and females were 63.95 and 67.00 years, 64.71 and 67.49 years, and 66.57and 70.19 years respectively. It indicates that life expectancy was increasing over the time.

It was observed in the Matlab population that the causes D1 (neonatal and maternal), D2 (communicable disease), and D4 (injuries and miscellaneous) was displaying somewhat downward trend. But the cause D3 (non-communicable disease) was showing strict uprising trend for both males and females.

An increasing trend was observed in the crude conditional probabilities of death by NCDs. The persons of ages over 40 were at greater risk of death by non-communicable diseases. The risk of deaths due to non-communicable diseases increased with age. Also, death from non-communicable diseases was found to be higher for males than females.

For Matlab males, the probability of death after birth was mainly due to neonatal and maternal complications (premature birth and low birth weight). For the age group 1-39, D4 (injury and miscellaneous-specially drowning and accident) was found to be the major cause of deaths. But after age 40, the highest values of density function almost always were D3 (non-communicable disease).

In the case of females, before age 40, multiple causes had impact deaths. But after the age 40, non-communicable disease was almost always found to be the leading cause of death in the year 2008.

National projected deaths of non-communicable diseases presented increasing pattern over the years. On the other hand, national projected deaths excluding non-communicable disease related deaths showed diminishing pattern over the years. In case of national projected deaths, the transition period was the year 2024 for males and year 2016 for females. The death population showed decreasing trend before the year 2024 for males and 2016 for females and after that year it gave increasing trend. This transition will happen because the deaths will make a balance between the deaths of non-communicable diseases and deaths except non-communicable diseases. It means non-communicable diseases will take over as the major cause of deaths after that period.

Comparing the growth rates of males and females, for male ARIMA (0, 2, 1) model showed comparatively higher growth rate compared to exponential model; and females showed comparatively higher growth rate in exponential model than ARIMA (1, 2, 2) model. But the number of total victims was almost same for both models.

The result showed that if non-communicable diseases had been eliminated, males would have achieved the expectation of life of 77.56 years and females 79.01 years in the year 2008. For male population, the life expectancy would have seen an increase of 1.26 years if neonatal diseases had been eliminated. 0.71 years would have been added for the elimination of communicable diseases, 1.01 years for elimination of injury related

causes; and a massive 10.99 years if non-communicable diseases had been eliminated. Females in 2008 showed similar pattern. After the elimination of neonatal and maternal complications, life expectancy increased 0.75 years. Similarly, 0.51 years increased in case of communicable cause, 0.99 years for injury related causes, and 8.82 years for non-communicable cause. It recognized the fact that non-communicable disease plays a vital role in this field.

The mortality rates for circulatory related disease were 6.17% for males and 4.66% for females. The second major cause of NCD-death was neoplasm. For neoplasm, the mortality rates were 3.94% for males and 2.58% for females. For females, the rate was found very high (10.62%) for respiratory related diseases (Chronic obstructive pulmonary disease, asthma etc).

The overall death rate of non-communicable disease was 0.41% for male and 1.61% for female. This indicated that the female population is at higher risk than males. The different NCDs on different ages in the year 2008 are now focused on. In case of males, among the age groups, persons of ages 45 and above were greatly affected by circulatory system related diseases and neoplasm. Circulatory system related deaths had the highest percentage (34.01%) in the age group 70-79. Neoplasm contributed its highest percentage (34.38%) to the age group 60-69. Similar pattern was observed for females.

Circulatory system related diseases, respiratory related diseases and neoplasm greatly affected females of the age group 45-59 and above. The highest percentage (38.65%) of circulatory system related deaths were found in the age group 70-79; neoplasm contributed the highest percentage (29.41%) to the age group 45-59; and the highest percentage (32.69%) of respiratory related diseases were found in the age group 60-69.

Socio-demographic factors were found to be of significant influence on the NCDs. Prevalence rate was higher (10.24%) in case the profession of the household head belonged to the non-agricultural group. For household heads associated with agriculture, the prevalence rate was only 1.97%. Circulatory system related disease carried high prevalence rate (5.12%) in the non-agricultural group. Endocrine disorder showed the second highest prevalence rate in the non-agricultural group (3.54%).

Monthly income also seemed to influence the NCDs. Household heads whose monthly income were under 5000Tk had a prevalence rate of 5.12%, followed by 4.72% for monthly income in 5000-10000, 1.97% for monthly income between 10000-20000, and 0.39% with monthly income above 20000.

Among the female NCD victims, 36.7% had circulatory system related diseases, 25.0% had gentio-urinary and digestive diseases, and 16.7% had neoplasm. Among the males, 51.5% had circulatory system related diseases and 30.3% had endocrine disorder. In the case of males, the prevalence rate in the age group below 15 years was 0.39%; in the age interval 30-44 year, it was 3.94%; in the age interval 45-59, it was 5.91%; and in the age interval 60+, it was 2.76%. Circulatory system related disease had the highest prevalence rate (3.54%) in the age group 45-59.

The age pattern of diseased females was slightly different from that of males. The prevalence rate of females in the age group <15 were 0.36%, in the age 15-29 were 3.97%, in the age 30-44 were 9.39%, in the age 45-59 were 6.50%; and 1.44% in the age group of 60+ years. So, females were affected more by non-communicable diseases at earlier ages than the males.

In case of the disease starting age, males have the highest prevalence rate (5.51%) in age interval 15-44 years. Among males 42.4% of the total NCD victims were first affected at this age interval. The age interval 45-59 had the second highest prevalence rate (4.72%). This interval carries 36.4% of the total diseased males.

Females' disease starting age was found to be different than the males. This was consistent with the prevalence rate by age discussed earlier. Age interval 30-44 years contributed the highest prevalence rate (11.19%). Among females 51.7% of the total NCD diseased person was first affected at the age 30-44. The age interval 15-29 years had the second highest prevalence rate (5.05%) which carried 23.3% of the total diseased people.

Presence of tension had high prevalence rate with circulatory system related diseases. The prevalence rates were 5.91% and 6.50% for males and females respectively. Absence of tension had prevalence rates of 0.79% and 0.36% for males and females respectively.

In the year 2004, 43% of the male deaths were from circulatory related diseases; 15% were from neoplasm, 14% from respiratory related disease, 11% from digestive diseases, 9% for endocrine disorder. In the year 2008, 54% of deaths were from circulatory related diseases; 18% were from neoplasm, 10% from respiratory related disease, 7% from digestive diseases, and 5% for endocrine disorder.

In case of the females, in the year 2004, 54% of the deaths were from circulatory related diseases; 10% were from neoplasm, 8% from respiratory related disease, 12% from digestive diseases, and 6% for endocrine disorder. In the year 2008, 61% of deaths were from circulatory related diseases; 11% were from neoplasm, 11% from respiratory related disease, 4% from digestive diseases, and 7% for endocrine disorder.

The prevalence rates were 3.54% for smoker group and 3.15% for non-smoker group in case of circulatory related diseases; those were 2.36% for smoker group and 1.57% for non-smoker group in case of endocrine disorder. In case of gentio-urinary and digestive diseases, the prevalence rates were 0.79% for smoker group and 0.39% for non-smoker group. Smoking mostly affected the non-communicable diseases.

The person who had started smoking at an early ages, were more affected with circulatory related diseases. It was true for almost all groups of non-communicable diseases. The prevalence rate was high for the age group 15-20.

It was evident that circulatory related diseases, with a very high mortality percentage, are the major disease burden in the non-communicable disease group. The mortality rate for circulatory related diseases was 287 per 100000 male in 2008 and will reach to 6245 per 100000 in 2060. For females, it was 238 per 100000 in 2008 and it reaches to 1555 per 100000 in 2060.

Another important disease, neoplasm suggested the mortality 93 per 100000 male in 2008 and reaches to 632 per 100000 in 2060. In case of females, the mortality rate was 43 per 100000 in 2008 and reaches to 95 per 100000 in 2060. Neoplasm and respiratory related diseases also played significant roles in the non-communicable disease category.

9.2 Policy Implications

The major findings of this research have some policy implications and recommendations that would help to take plan and make effective policies to achieve longer life expectancy. WHO has published six objectives in its 2008-2013 action plan

regarding NCDs. The first task is to make the prevention and control of NCDs a high priority national agenda. Government should mobilize and coordinate multi-sectored organizations and monitor NCD prevention and control. Policies aimed at increasing governmental and non-governmental services shall generally contribute to a reduction of non-communicable death rates.

A result from this study suggests that lower income is associated with higher prevalence rate. Lower income families are usually less able and willing to spend money for treatment. The government should implement minimum package of cost-effective clinical preventive screening intervention care, such as urinalysis, measurement of blood pressure, blood sugar, body weight and height as well as screening for some common and easily detectable cancers and chronic diseases in health facilities, in schools and workplaces as a strategy for early case detection. It is essential to improve structural facilities to both serve and train at health-centers in all levels. Effective and efficient use of the available health care institutions for detection and treatment of NCDs must be ensured.

Circulatory system related diseases, neoplasm, and respiratory related diseases are the top three NCDs which have massive impact on the health of the population. They should be given utmost attention. These three and their associated risk factors and remedies should be exclusively highlighted in all the plans and awareness programs.

Impact of NCDs is noted to vary based on age and gender. Females are observed to be with higher prevalence rate than their male counterparts. Also NCDs are observed to attack more in the mid and later stages of life. So the national policy and action plan should take these points into consideration. The plan should also include nutrition priorities i.e. an emphasis on healthy diet related to non-communicable diseases.

Physical activity and exercise have shown high prevalence rate. Government should create designated place for carrying out physical activities like walking, cycling, sports etc. and encourage people about them.

Access to mental health care should be made easy. This particular area needs a big campaign to modify public attitude and raise awareness. People should have free access to mental care services, psychologists and psychiatrists.

Bangladesh has already banned smoking in public places. The law should be strictly applied. Government should monitor tobacco use and prevention policies, offer help to people who want to stop using tobacco, warn people about the dangers of tobacco, enforce ban on tobacco advertising, promotion and raise tobacco taxes and prices. Community-based rehabilitation programs may be established.

Public awareness about common NCDs and the risk factors should be raised. Adding health content in both male and female education and thus raising awareness-can bring an improvement in reducing NCD's. Basic education and expansion of public health system should be paid due attention. Mass media like television, newspapers, radios, and modern technologies like Internet can play an effective role to promote consciousness and aware people of the danger posed by NCDs. Awareness campaigns can be used to positively modify attitudes.

Finally, the Ministry of Health and Family Welfare should extensively utilize upgraded equipments, train personnel, achieve national coverage, and encourage researchers to conduct more research, produce publications and reports, and thus ensure high standards.

9.3 Recommendation of Further Research

The study worked with four major categories of diseases analyzing the impact of elimination of diseases on life expectancy in Bangladesh with the focus on how to gain longer life expectancy. In the process, future estimation of overall non-communicable diseases and some fastest growing NCDs has been made.

This study did not discuss all the factors that contribute to the spread of non-communicable diseases in perspective of Bangladesh. Only a few of the socio-demographic factors were considered. Also the sample size was small for some of the factors to reach a conclusive decision. A larger sample would provide more accurate analysis. There are ample scopes for future researches addressing those factors which were not considered in the present study.

From the analytical point of view, this study was based on frequency distributions, prevalence rates, and mortality rates, cross table analysis, single decrement life table, multiple decrement life tables, exponential growth model, polynomial regression model, multiple logistic regression and ARIMA model. Other techniques

those are used in demography such as component method, Principle Component Analysis (PCA), Discriminant Analysis, Multiple Classification Analysis (MCA) and Odds ratio analysis etc. may be used in future works.

9.4 Conclusion

This study indicates that the neonatal and maternal (D1) cause, communicable (D2) cause, injuries and miscellaneous (D4) cause displayed downward trend and only non-communicable (D3) cause revealed uprising trend for both males and females. Again, the overall death rates were higher for males than females.

The life expectancy at birth in the year 2000 was 63.95 for males and 67.00 for females which indicates the life expectancy was higher for females than males. In addition, the average remaining life time (in years) for a person survived to the beginning of the indicating age interval was 64.71 for males where as it was 67.49 for females in the year of 2004. For the year 2008, the expectation of life for males was 66.57 and for females it was 70.19 years.

It was observed that in the year 2000 to year 2004, only 0.49 years was added to females' life expectancy at birth whereas, to males, 0.76 years was added at the same time. Furthermore, life expectancy increased 1.86 years from 2004 to 2008 for males which was approximately two and half times greater than the previous period of 2000 to 2004 and. It also had increased 2.70 years from 2004 to 2008 for females which was approximately six times greater than the years 2000 to 2004. So, life expectancy of female increased faster than males.

There was an increasing trend in the crude conditional probabilities of death of NCDs. The persons of ages over 30 were more or less at risk of death because of non-communicable diseases. The risk of deaths due to non-communicable diseases increased with age.

Specially thus, it is concluded from the study that non-communicable diseases are the highest ranked. The second highest cause of death is neonatal and maternal complications. Male death rates are generally higher than female death rates from major causes of death such as non-communicable diseases.

The deaths after birth were occurred mainly due to neonatal and maternal complications, because of premature births and low birth weight. For the age group 1-39

for males, injury and miscellaneous related causes affect most, specially by drowning and accident. After age 40, roughly have the highest values of density function for non-communicable cause.

For female, before age 40, mixed causes influenced deaths i.e. neonatal and maternal, communicable, injuries and miscellaneous causes. But after the age 40, more or less, non-communicable disease was the leading cause in the year 2008.

The study recognized that a huge number of people would die because of non-communicable diseases. This number increases year by year at a large scale. Among non-communicable diseases, deaths due to circulatory system (stroke, ischemic heart disease and hypertensive disease) were most prominent in Bangladesh. Circulatory related disease was significantly higher as compared to other non-communicable diseases. The mortality rate was very high for circulatory related diseases including rheumatic heart disease, ischemic heart disease, hypertensive disease, stroke and other cardiovascular diseases for female. The second major cause of death was neoplasm for the national population. Considering the age groups, circulatory system related diseases and neoplasm greatly affected the age group 45-59 and above.

For female, the rate was very high for respiratory related diseases, say COPD (Chronic obstructive pulmonary disease), asthma and other respiratory diseases.

Female population is at high risk as the rate of change is growing quickly.

Thus, eliminating the effects of non-communicable diseases is more useful than eliminating communicable diseases in Bangladesh.

The prevalence rate of females (21.66%) exceeds males' prevalence rate (12.99%). A sex differential consistent with the higher biological risks faced by females in the recent year.

The age pattern of diseased female slightly differed from the age pattern of diseased male. Females were affected more by non-communicable diseases at younger ages than male.

The results suggest that policies aimed at increasing governmental and non-governmental services will contribute to a reduction of non-communicable death rates. The Government should consider strategies to reduce non-communicable diseases as a top "national agenda" to mobilize the people for NCD prevention and control.

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Appendix A

Probability of dying in a specified cause of death (D_α) eliminating the effect of other causes of deaths for male in the year 2000

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.036766	0.017661	0.015157	0.039215	0.000364	0.053441	0.002179	0.051718
1--4	0.000388	0.017724	0.004268	0.013897	0.000777	0.017343	0.012747	0.005427
5--9	0.000000	0.008010	0.000766	0.007250	0.000766	0.007250	0.006489	0.001531
10--14	0.000000	0.003125	0.001390	0.001737	0.000347	0.002778	0.001390	0.001737
15--19	0.000420	0.004611	0.001259	0.003774	0.000420	0.004611	0.002937	0.002098
20--24	0.000000	0.007410	0.002286	0.005136	0.000000	0.007410	0.005136	0.002286
25--29	0.000000	0.006008	0.001505	0.004509	0.003009	0.003009	0.001505	0.004509
30--34	0.000000	0.003225	0.000000	0.003225	0.000807	0.002420	0.002420	0.000807
35--39	0.000000	0.010833	0.002901	0.007955	0.001451	0.009396	0.006514	0.004347
40--44	0.000000	0.017676	0.004852	0.012886	0.008877	0.008877	0.004045	0.013686
45--49	0.000000	0.022292	0.005915	0.016474	0.012967	0.009447	0.003553	0.018805
50--54	0.000000	0.038610	0.005816	0.032984	0.021636	0.017346	0.011598	0.027326
55--59	0.000000	0.061497	0.024458	0.037953	0.022946	0.039442	0.015356	0.046849
60--64	0.003471	0.105401	0.037530	0.073677	0.054127	0.057412	0.017235	0.092837
65--69	0.000000	0.178195	0.047238	0.137147	0.103710	0.082678	0.037159	0.146228
70--74	0.006346	0.223354	0.031329	0.203032	0.125298	0.116872	0.082393	0.158266
75--79	0.005205	0.290049	0.075339	0.234914	0.103909	0.210181	0.140708	0.176106
80--84	0.022624	0.416667	0.097933	0.364827	0.138446	0.333651	0.241449	0.241449
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix B

Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2000

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.036152	0.016101	0.012589	0.039581	0.000000	0.051678	0.003557	0.048291
1--4	0.005596	0.016300	0.004399	0.017483	0.000000	0.021806	0.011953	0.009971
5--9	0.000000	0.002749	0.000000	0.002749	0.000393	0.002356	0.002356	0.000393
10--14	0.000349	0.002096	0.000700	0.001747	0.000349	0.002096	0.001049	0.001398
15--19	0.000893	0.002230	0.000000	0.003121	0.000000	0.003121	0.002230	0.000893
20--24	0.002063	0.003093	0.001032	0.004122	0.000516	0.004636	0.001548	0.003608
25--29	0.001812	0.007227	0.001812	0.007227	0.001208	0.007827	0.004222	0.004823
30--34	0.002901	0.001742	0.000581	0.004058	0.000000	0.004637	0.001161	0.003480
35--39	0.001871	0.003739	0.000625	0.004983	0.001871	0.003739	0.001248	0.004362
40--44	0.001694	0.003385	0.000000	0.005073	0.001694	0.003385	0.001694	0.003385
45--49	0.001143	0.016998	0.003423	0.014748	0.006834	0.011365	0.006834	0.011365
50--54	0.002497	0.008712	0.001249	0.009950	0.004987	0.006230	0.002497	0.008712
55--59	0.003596	0.019029	0.002398	0.020207	0.010749	0.011936	0.005986	0.016670
60--64	0.001584	0.073283	0.015724	0.059954	0.037325	0.038851	0.021944	0.053971
65--69	0.002049	0.123219	0.012235	0.114142	0.069321	0.059713	0.046101	0.082612
70--74	0.016966	0.219377	0.023672	0.213935	0.106899	0.140037	0.103828	0.142992
75--79	0.023283	0.261137	0.034723	0.252188	0.126862	0.172229	0.121681	0.177135
80--84	0.026110	0.450820	0.038911	0.442843	0.124070	0.384616	0.340286	0.180506
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix C

Probability of dying in a specified cause of deaths (D_α) eliminating the effect of causes of deaths for male in the year 2004

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.030855	0.011331	0.005328	0.036706	0.002845	0.039106	0.003200	0.038763
1--4	0.000728	0.012663	0.001819	0.011583	0.001819	0.011583	0.009062	0.004359
5--9	0.000000	0.004281	0.000779	0.003504	0.001170	0.003115	0.002337	0.001948
10--14	0.000000	0.002734	0.000000	0.002734	0.001563	0.001173	0.001173	0.001563
15--19	0.000000	0.003469	0.000000	0.003469	0.002169	0.001302	0.001302	0.002169
20--24	0.000000	0.005430	0.000604	0.004828	0.001813	0.003623	0.003021	0.002417
25--29	0.000000	0.004028	0.000000	0.004028	0.001613	0.002419	0.002419	0.001613
30--34	0.000000	0.007651	0.001535	0.006126	0.005362	0.002301	0.000768	0.006889
35--39	0.000000	0.012437	0.000782	0.011665	0.008568	0.003903	0.003124	0.009343
40--44	0.000000	0.021187	0.000713	0.020488	0.018388	0.002851	0.002139	0.019088
45--49	0.000000	0.024147	0.000000	0.024147	0.022441	0.001745	0.001745	0.022441
50--54	0.000000	0.041202	0.004937	0.036443	0.031661	0.009849	0.004937	0.036443
55--59	0.000000	0.053428	0.003045	0.050535	0.047633	0.006080	0.003045	0.050535
60--64	0.000000	0.124093	0.013652	0.111922	0.108854	0.017036	0.003430	0.121065
65--69	0.000000	0.173083	0.028587	0.148559	0.135208	0.043502	0.015349	0.160085
70--74	0.005558	0.244619	0.032895	0.222882	0.211811	0.046284	0.008327	0.242469
75--79	0.000000	0.404354	0.042918	0.375939	0.333062	0.101757	0.061407	0.362983
80--84	0.000000	0.445661	0.039447	0.420970	0.328007	0.166052	0.131580	0.355666
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix D

Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2004

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.030037	0.012565	0.005933	0.036509	0.002970	0.039373	0.003712	0.038658
1--4	0.000377	0.010123	0.000754	0.009750	0.000754	0.009750	0.008629	0.001883
5--9	0.000000	0.004863	0.000406	0.004459	0.002840	0.002029	0.001624	0.003245
10--14	0.000395	0.003937	0.000788	0.003544	0.002757	0.001577	0.000395	0.003937
15--19	0.001200	0.004790	0.000000	0.005984	0.003594	0.002398	0.001200	0.004790
20--24	0.001453	0.003868	0.000000	0.005315	0.002903	0.002420	0.000968	0.004351
25--29	0.001184	0.002368	0.000000	0.003550	0.001777	0.001777	0.000593	0.002959
30--34	0.000615	0.004906	0.000000	0.005517	0.002456	0.003069	0.002456	0.003069
35--39	0.001205	0.008403	0.000000	0.009598	0.008403	0.001205	0.000000	0.009598
40--44	0.001325	0.007926	0.000663	0.008584	0.006610	0.002649	0.000663	0.008584
45--49	0.000900	0.016961	0.000000	0.017845	0.014302	0.003595	0.002697	0.015188
50--54	0.000000	0.014556	0.000000	0.014556	0.014556	0.000000	0.000000	0.014556
55--59	0.000000	0.032122	0.001254	0.030906	0.029689	0.002507	0.001254	0.030906
60--64	0.000000	0.058816	0.002690	0.056276	0.049895	0.009382	0.006710	0.052452
65--69	0.001810	0.149203	0.014388	0.138279	0.124044	0.030329	0.014388	0.138279
70--74	0.013870	0.191918	0.016620	0.189633	0.164102	0.046384	0.016620	0.189633
75--79	0.010122	0.358932	0.020141	0.352054	0.279965	0.115053	0.087549	0.302246
80--84	0.000000	0.530750	0.033822	0.511945	0.410210	0.187110	0.158395	0.431655
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix E

Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male in the year 2008

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.024377	0.006811	0.003790	0.027336	0.001897	0.029181	0.001138	0.029919
1--4	0.000389	0.010445	0.001943	0.008905	0.003106	0.007748	0.005430	0.005430
5--9	0.000377	0.003765	0.000754	0.003388	0.001131	0.003013	0.001884	0.002260
10--14	0.000000	0.002949	0.000000	0.002949	0.001686	0.001265	0.001265	0.001686
15--19	0.000000	0.004374	0.000974	0.003404	0.001460	0.002918	0.001946	0.002432
20--24	0.000000	0.006961	0.000000	0.006961	0.001396	0.005573	0.005573	0.001396
25--29	0.000869	0.003469	0.000000	0.004334	0.003469	0.000869	0.000000	0.004334
30--34	0.000000	0.006139	0.000000	0.006139	0.005264	0.000879	0.000879	0.005264
35--39	0.000000	0.011266	0.001741	0.009541	0.007814	0.003480	0.001741	0.009541
40--44	0.000000	0.015108	0.000845	0.014275	0.014275	0.000845	0.000000	0.015108
45--49	0.000747	0.021439	0.004474	0.017775	0.015571	0.006703	0.001493	0.020707
50--54	0.000000	0.036342	0.001998	0.034412	0.033445	0.002996	0.001000	0.035377
55--59	0.000000	0.054441	0.008157	0.046660	0.040128	0.014903	0.006802	0.047961
60--64	0.000000	0.097240	0.003292	0.094251	0.092753	0.004933	0.001647	0.095747
65--69	0.003946	0.171697	0.013745	0.163398	0.149963	0.029223	0.011792	0.165064
70--74	0.000000	0.244553	0.027479	0.222823	0.204639	0.049407	0.022540	0.226813
75--79	0.000000	0.281544	0.023981	0.263436	0.254238	0.035757	0.012063	0.272537
80--84	0.017513	0.413455	0.034723	0.402259	0.373563	0.076466	0.026155	0.407877
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix F

Probability of dying in a specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2008

Age	${}_nq_{(1)x}$	${}_nq_{(-1)x}$	${}_nq_{(2)x}$	${}_nq_{(-2)x}$	${}_nq_{(3)x}$	${}_nq_{(-3)x}$	${}_nq_{(4)x}$	${}_nq_{(-4)x}$
<1	0.010832	0.006591	0.004657	0.012754	0.001166	0.016203	0.000777	0.016586
1--4	0.000000	0.011191	0.002409	0.008804	0.001607	0.009600	0.007208	0.004011
5--9	0.000000	0.004310	0.001569	0.002745	0.000785	0.003527	0.001961	0.002353
10--14	0.000000	0.000837	0.000000	0.000837	0.000000	0.000837	0.000837	0.000000
15--19	0.000446	0.005345	0.001339	0.004456	0.001785	0.004012	0.002231	0.003566
20--24	0.002342	0.001874	0.000000	0.004212	0.001406	0.002810	0.000469	0.003745
25--29	0.002244	0.002245	0.000000	0.004483	0.001123	0.003364	0.001123	0.003364
30--34	0.000628	0.002509	0.000000	0.003135	0.001882	0.001255	0.000628	0.002509
35--39	0.001279	0.005740	0.000639	0.006376	0.003830	0.003193	0.001279	0.005740
40--44	0.000000	0.005625	0.000000	0.005625	0.005002	0.000627	0.000627	0.005002
45--49	0.000000	0.017254	0.000000	0.017254	0.015827	0.001449	0.001449	0.015827
50--54	0.000000	0.020599	0.001980	0.018655	0.016708	0.003957	0.001980	0.018655
55--59	0.001292	0.024250	0.002581	0.022989	0.021726	0.003869	0.000000	0.025511
60--64	0.000000	0.068080	0.001329	0.066838	0.064350	0.003982	0.002656	0.065595
65--69	0.001582	0.133057	0.006315	0.128908	0.119154	0.017271	0.009458	0.126131
70--74	0.009315	0.205710	0.011631	0.203824	0.190516	0.027688	0.006995	0.207591
75--79	0.004064	0.255681	0.016155	0.246340	0.224150	0.043807	0.024135	0.240057
80--84	0.044365	0.444601	0.017986	0.460893	0.375829	0.143218	0.086805	0.416666
85+	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Appendix G

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male in the year 2000

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	81.01	65.99	77.79	67.32	76.00	68.29	76.33	68.20
1--4	83.09	66.17	77.99	69.06	75.03	71.13	75.50	70.91
5--9	82.13	66.36	77.32	69.03	74.09	71.38	75.47	70.29
10--14	77.13	61.88	72.38	64.52	69.14	66.88	70.94	65.39
15--19	72.13	57.06	67.47	59.62	64.17	62.06	66.04	60.50
20--24	67.16	52.31	62.56	54.84	59.19	57.33	61.23	55.63
25--29	62.16	47.69	57.69	50.11	54.19	52.74	56.53	50.75
30--34	57.16	42.96	52.78	45.33	49.35	47.90	51.61	45.97
35--39	52.16	38.09	47.78	40.46	44.39	43.01	46.73	41.00
40--44	47.16	33.48	42.91	35.77	39.45	38.39	42.02	36.17
45--49	42.16	29.04	38.11	31.20	34.78	33.71	37.18	31.64
50--54	37.16	24.64	33.32	26.68	30.20	29.01	32.30	27.19
55--59	32.16	20.53	28.50	22.51	25.81	24.48	27.65	22.89
60--64	27.16	16.71	24.15	18.30	21.36	20.38	23.05	18.89
65--69	22.24	13.39	19.99	14.55	17.44	16.47	18.41	15.57
70--74	17.24	10.75	15.86	11.47	14.17	12.73	14.02	12.81
75--79	12.34	8.12	11.29	8.76	10.84	9.08	10.06	9.74
80--84	7.39	5.42	7.01	5.68	6.81	5.83	6.29	6.29
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Appendix H

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2000

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	79.50	70.26	81.10	68.64	78.40	69.99	76.80	71.39
1--4	81.47	70.41	81.13	70.46	77.40	72.79	76.07	74.01
5--9	80.93	70.57	80.49	70.71	76.40	73.40	75.98	73.75
10--14	75.93	65.76	75.49	65.90	71.43	68.57	71.16	68.77
15--19	70.96	60.89	70.54	61.01	66.45	63.71	66.23	63.87
20--24	66.02	56.02	65.54	56.19	61.45	58.90	61.37	58.92
25--29	61.15	51.19	60.60	51.41	56.48	54.16	56.46	54.13
30--34	56.25	46.54	55.71	46.77	51.55	49.57	51.69	49.38
35--39	51.41	41.62	50.74	41.95	46.55	44.79	46.75	44.54
40--44	46.50	36.76	45.77	37.15	41.63	39.95	41.80	39.72
45--49	41.58	31.88	40.77	32.32	36.70	35.08	36.87	34.85
50--54	36.62	27.39	35.90	27.77	31.93	30.45	32.11	30.22
55--59	31.71	22.61	30.94	23.02	27.08	25.63	27.18	25.47
60--64	26.81	18.00	26.01	18.45	22.35	20.91	22.33	20.86
65--69	21.85	14.22	21.39	14.47	18.12	16.65	17.77	16.90
70--74	16.89	10.87	16.62	11.01	14.28	12.55	13.51	13.20
75--79	12.14	8.22	11.96	8.32	10.69	9.19	9.79	9.99
80--84	7.37	5.25	7.31	5.29	6.88	5.58	5.80	6.60
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Appendix I

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male in the year 2004

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	81.76	66.19	81.47	65.51	69.99	75.33	80.52	66.22
1--4	83.36	65.94	80.91	66.99	69.19	77.39	79.78	67.88
5--9	82.42	65.78	80.05	66.77	68.31	77.29	79.51	67.17
10--14	77.42	61.05	75.11	62.00	63.39	72.52	74.69	62.30
15--19	72.42	56.21	70.11	57.16	58.49	67.60	69.77	57.39
20--24	67.42	51.40	65.11	52.35	53.61	62.69	64.86	52.51
25--29	62.42	46.67	60.15	47.59	48.70	57.91	60.05	47.63
30--34	57.42	41.85	55.15	42.78	43.78	53.04	55.19	42.71
35--39	52.42	37.15	50.23	38.03	39.00	48.16	50.23	37.99
40--44	47.42	32.59	45.27	33.44	34.31	43.34	45.38	33.32
45--49	42.42	28.24	40.30	29.09	29.91	38.45	40.47	28.92
50--54	37.42	23.87	35.30	24.75	25.54	33.52	35.54	24.53
55--59	32.42	19.79	30.46	20.59	21.29	28.82	30.70	20.36
60--64	27.42	15.77	25.55	16.55	17.23	23.98	25.79	16.31
65--69	22.42	12.65	20.87	13.33	14.03	19.36	20.87	13.21
70--74	17.42	9.77	16.41	10.21	10.84	15.12	16.15	10.26
75--79	12.50	7.13	11.88	7.43	8.08	10.74	11.27	7.74
80--84	7.50	5.27	7.30	5.40	5.86	6.67	6.84	5.72
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Appendix J

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2004

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	81.15	69.46	82.83	67.80	72.66	76.11	80.65	68.97
1--4	82.66	69.34	82.33	69.36	71.87	78.23	79.95	70.74
5--9	81.69	69.05	81.39	69.04	70.93	77.99	79.64	69.87
10--14	76.69	64.37	76.42	64.34	66.12	73.14	74.77	65.09
15--19	71.72	59.62	71.48	59.56	61.30	68.26	69.79	60.33
20--24	66.80	54.89	66.48	54.90	56.51	63.41	64.88	55.61
25--29	61.90	50.09	61.48	50.18	51.67	58.56	59.94	50.84
30--34	56.97	45.21	56.48	45.35	46.76	53.66	54.97	45.99
35--39	52.00	40.42	51.48	40.59	41.86	48.82	50.10	41.12
40--44	47.06	35.74	46.48	35.96	37.20	43.88	45.10	36.50
45--49	42.12	31.00	41.51	31.25	32.43	38.99	40.13	31.79
50--54	37.16	26.50	36.51	26.77	27.86	34.12	35.23	27.24
55--59	32.16	21.85	31.51	22.13	23.24	29.12	30.23	22.61
60--64	27.16	17.49	26.55	17.76	18.87	24.18	25.26	18.25
65--69	22.16	13.43	21.61	13.67	14.73	19.39	20.42	14.12
70--74	17.19	10.35	16.89	10.46	11.46	14.92	15.68	10.99
75--79	12.40	7.21	12.13	7.32	8.22	10.52	10.90	7.97
80--84	7.50	4.85	7.33	4.94	5.45	6.56	6.71	5.34
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Appendix K

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for male in the year 2008

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	82.14	67.83	82.16	67.28	70.77	77.56	81.97	67.58
1--4	83.19	67.30	81.47	68.16	69.91	78.88	81.06	68.66
5--9	82.22	67.00	80.63	67.77	69.12	78.49	80.50	68.03
10--14	77.25	62.24	75.69	62.99	64.20	73.72	75.65	63.18
15--19	72.25	57.42	70.69	58.17	59.30	68.81	70.74	58.28
20--24	67.25	52.66	65.75	53.36	54.38	64.01	65.87	53.42
25--29	62.25	48.01	60.75	48.72	49.46	59.35	61.23	48.49
30--34	57.30	43.17	55.75	43.92	44.62	54.40	56.23	43.69
35--39	52.30	38.42	50.75	39.17	39.84	49.45	51.27	38.90
40--44	47.30	33.83	45.84	34.53	35.14	44.61	46.36	34.26
45--49	42.30	29.31	40.87	29.99	30.61	39.65	41.36	29.74
50--54	37.33	24.90	36.04	25.49	26.05	34.90	36.42	25.32
55--59	32.33	20.75	31.11	21.31	21.87	30.00	31.45	21.16
60--64	27.33	16.80	26.35	17.23	17.68	25.41	26.65	17.10
65--69	22.33	13.34	21.43	13.76	14.23	20.53	21.69	13.64
70--74	17.41	10.58	16.69	10.96	11.30	16.07	16.92	10.84
75--79	12.41	8.20	12.09	8.38	8.56	11.77	12.25	8.29
80--84	7.41	5.43	7.33	5.49	5.63	7.12	7.37	5.46
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Appendix L

Expectation of life in specified cause of deaths (D_α) eliminating the effect of other causes of deaths for female in the year 2008

Age	$e^0_{(1)x}$	$e^0_{(-1)x}$	$e^0_{(2)x}$	$e^0_{(-2)x}$	$e^0_{(3)x}$	$e^0_{(-3)x}$	$e^0_{(4)x}$	$e^0_{(-4)x}$
<1	82.72	70.94	82.95	70.70	73.55	79.01	82.13	71.18
1--4	82.62	70.41	82.33	70.61	72.64	79.31	81.19	71.38
5--9	81.62	70.20	81.53	70.24	71.76	79.07	80.78	70.66
10--14	76.62	65.50	76.65	65.42	66.81	74.34	75.93	65.82
15--19	71.62	60.55	71.65	60.48	61.81	69.40	70.99	60.82
20--24	66.65	55.86	66.75	55.74	56.92	64.67	66.15	56.03
25--29	61.80	50.96	61.75	50.96	51.99	59.85	61.18	51.23
30--34	56.93	46.07	56.75	46.18	47.05	55.04	56.24	46.40
35--39	51.97	41.18	51.75	41.32	42.13	50.11	51.28	41.51
40--44	47.03	36.40	46.78	36.57	37.29	45.26	46.34	36.73
45--49	42.03	31.59	41.78	31.76	32.46	40.29	41.37	31.90
50--54	37.03	27.10	36.78	27.27	27.94	35.34	36.42	27.38
55--59	32.03	22.62	31.85	22.74	23.37	30.47	31.49	22.85
60--64	27.07	18.12	26.92	18.22	18.84	25.58	26.49	18.38
65--69	22.07	14.26	21.95	14.35	14.96	20.67	21.55	14.50
70--74	17.10	11.07	17.08	11.10	11.65	15.99	16.73	11.23
75--79	12.24	8.29	12.25	8.30	8.80	11.38	11.84	8.52
80--84	7.28	5.28	7.41	5.20	5.62	6.78	7.07	5.42
85+	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50