Bangladesh's Mortality Levels and Patterns in the 1970s: Famine, Cohort Survivorship and Gender Inequality

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SYNOPSIS

This thesis concerns the levels and patterns of mortality in the Bangladeshi past, with special focus on the 1970s, the decade plagued by the outbreaks of war, famine and epidemics. By levels, I mean various measures of mortality rate, such as life expectancy (e_x) and infant mortality rate (IMR), which tend to improve over time. By patterns, I mean both the shape of age-specific mortality rates, which may represent a set of conditions a particular country has regardless of the general level of mortality, on the one hand, and the relationship between male and female mortality rates, on the other. The latter issue is my particular concern since gender inequality has long been a social problem embedded in culture and society in Bangladesh as well as in South Asia in general. My approach is to make an in-depth analysis of mortality data at the time of a crisis. Of the several mortality crises Bangladesh experienced in the 1970s, the most devastating was the famine of 1974. It was so serious that the death toll peaked in the next year, so that the famine period extended from 1974 to 1975. The study makes much use of life tables. I utilize those officially estimated by government bureaus, but at the same time, since official data for the whole country are not always in good quality, I will make extensive use of data collected by a demographic surveillance system in Matlab, a rural area in southeast Bangladesh, from which I will construct generation life tables as well as period life tables.

There are four issues. One is the age patterns of mortality. This will be explored, in Chapter Three, in terms of the Coale-Demeny model life table typology. Since Coale and Demeny present a four-set framework of regional model life tables, I examine the Bangladeshi patterns in this framework and ask if there took place a change in pattern over time. As far as the age-specific shape of mortality in Bangladesh in general and rural

Bangladesh in particular is concerned, on the face of it any of the four C-D model life table families does not fit. But we may conclude that it is comparatively closer to the North pattern at early ages, turning to the West at higher ages. Matlab's age pattern of mortality also shows a comparatively high early childhood mortality rate like national. However, it looks much closer to the C-D South model. It can probably be classified as an extreme case of the South pattern. Indeed, Matlab was consistently of the South type over the decades despite an improvement in the level of mortality from Level 16 of male (i.e., e_0 = 54.12 years by the C-D West and 54.10 years by C-D South model etc. in level 16 for male population) and Level 13 of female (50.0 and 50.0 respectively) in 1966-1970 to Level 20 for both sexes in 2000 (in level 20, e_0 =63.63 and 63.65 respectively for male, and 67.5 and 67.5 for female respectively). The only change we can find is that the Matlab pattern now looks typically South type. All this may be interpreted as reflecting a disease pattern in which diarrhea in early stages of life is particularly marked.

A second set of issues is concerned with the famine of 1974-75. There are two sub-issues in this set and are examine in Chapters Four and Five. The first is a re-examination of the stylized facts in famine demography and the second is gender inequality. Historical and contemporary studies point to a number of generalizations concerning age-sex patterns of mortality at the time of famine. The response of sex differential in mortality to famine is the core issue of study focusing on deaths in early ages. The techniques of analysis are: a proportional-rise method used by Tim Dyson in his South Asian famines, and a separate technique adopted from Bourgeois-Pichat and Hiroshi Maruyama for very early periods of life. This paper finds that from 1974 through 1977 the proportional rise in female mortality relative to that in male mortality was pronounced in childhood, especially in the 5-9 age group, suggesting that the later the greater the female disadvantage. Also found is that in 1975, the peak year of the Bangladesh famine, female IMR tended to rise more than male IMR and the magnitude of proportional rise in IMR leveled with that for the 5-9 age groups. It argue that it was because the female disadvantage started soon after the neonatal period, and that it was heightened, rather than lowered, during the most disastrous year of the famine period.

The final issue is cohort experience. Almost all studies in mortality rely on period measures of mortality, especially life tables. However, mortality situations an actual cohort experiences cut through various period life tables. Different birth cohorts are thus examined in Chapter Six by constructing generation life tables for Matlab. While the generation life table is usually used for population projection, it is a useful tool to measure the effect of age at which one cohort encountered a particular mortality disaster and to assess the combined effect of a few separate disasters on the survival rate over the longer period of life. I focus on war, famine and measles epidemic on the survival rate of the Matlab population. It turns out that the 1971 birth cohort had the lowest survival rate for both sexes if the survival rate is measure up to the age of 25. They were born in the year of civil war, met the famine at ages 3 to 4, then experienced measles at age 5. If measured up to age 4, the infants, both male and female, born in 1975 were most disadvantaged with the lowest survival rates. Generally, females suffered from lower rates of survival among the generations considered. More important is the finding that the period of life when famine hit seems to have been crucial especially for the gender-specific differences in the survival rate. If born in the peak period in the famine process, female children would suffer from an even lower chance of survival than male children.

Overall, Bangladesh, one of the most densely populated areas of the South Asian region, is similar to the South type in terms of climate and agriculture. It is sometimes argued that wet rice allows women to get involved in productive activity in the fields more than in wheat growing areas, but as far as Bangladesh is concerned, its traits are undoubtedly closer to north Indian culture regarding religion and some social behavior that has reflection on its population and demographic behavior. More important perhaps is that the North and Bangladesh patterns seem to share similar cultural and social characters of discrimination against females. Despite several unmistakable improvements in mortality and survivability over the generations, the sex differential in mortality did not change noticeably. Only the level of mortality improved, whereas gender inequality, especially at infant and childhood ages, remained intact.

List of Contents

List of Tables

List of Figures

Chapter One
Introduction

Over the long period, any population can enhance their survival rates with economic development and the advancement in education and medical and public health facilities, with, perhaps, better population policies. As today's developed countries have witnessed, mortality situations did improve over time. However, topography and its correlates such as disease environments can exert influences over the levels and patterns of death rates, and this raises the question of age-patterns of mortality according to the regions of the world. Indeed, there have been attempts to construct "regional" model life table families. Ansley Coale and Paul Demeny's four-family set of model life tables is a notable achievement; each family captures distinct age-patterns of mortality rates derived from actual death data, which is assumed to keep themselves even when the level of overall mortality changes, so that the model life tables enable us to have a better understanding of both geographical and historical aspects of any country's mortality profile. The questions that thus arise are, first, which of the four families of the Coale-Demeny model life tables fits the mortality patterns of Bangladesh, the country this thesis is concerned with, and second, whether a shift in pattern took place with the improvement of mortality conditions in Bangladesh during the post-Independence period.

Moreover, the process of mortality decline is not a smooth process at all. It can be disrupted by different types of events that halt the declining trend. For example, war, natural calamities like flood, drought, cyclone, epidemic diseases, and famine, all have accentuated the mortality history in any country. The pace of the decline can be slowed down by the effect of any such event. In Bangladesh, the overall level of mortality started to decline after 1920, since there was an unmistakable attenuation of mortality crises due to crop failures as well as widespread outbreaks of infectious diseases. Plague, cholera, malaria, and small pox were major diseases in the Indian subcontinent; it seems that many of them became less serious from the interwar period onwards. However, that process of mortality decline was never monotonous. The process was halted several times by war, flood, famine, and cyclone over the periods. The Bangladesh famine of 1974 is one of such events and is recognized as the last large-scale famine yet in the mortality history of South Asia.

There is a set of stylized facts about famine demography, past and present. One of such stylized facts is that during the famine men tend to die proportionally more than women, and adults proportionally more than children. Much of the research effort in this thesis has been made on this aspect of famine demography; and one of the issues I should like to address is gender inequality in famine mortality since in such a crisis situation gender biases that had long been present in Bangladeshi society tends to become revealed in changing mortality rates.

It should be remembered that while a huge number of people dies in the famine years, even more did survive the mortality crisis. However, they experienced the crisis at different ages; and this fact raises a question: how such differential experience affected their probability of survival after the famine. It should also be remembered that their chance of survival was affected not only by the 1974 famine but by other causes of death as well. The causes include epidemics, infectious or communicable disease, starvation, and social disorder caused by war. Different cohorts experienced a different combination of such events, which may well result in a different probability of survival. This can be examined only when generation or cohort, rather than period, life tables are available. Even when such generation life tables are not readily available, it is worth attempting to make estimates of a set of life tables by birth cohorts in order to measure how mortality experience differed among generations of post-independence Bangladesh.

This study, therefore, looks back into the mortality history of Bangladesh and is an attempt to reconstruct different experiences of people, both men and women, in Bangladeshi society, who came through the 1974 famine and other less serious mortality crises.

The contents of the dissertation are as follows:

In Chapter Two, some related issues will be discussed with review of some related literature and the methodology of this study has been illustrated.

In Chapter Three, the level and pattern of mortality over the times in Bangladesh are studied by using the demographic surveillance data from Matlab, a rural area in southeast Bangladesh comparing with the Coale-Demeny mortality model. And it consists of the mortality ratios respecting different patterns of Coale-Demeny model level over the times. I shall be mainly concerned with change over time, not with geographical variations or the ways in which geographical variations may themselves change, because the mortality pattern of a population may change in relation to the related standard mortality pattern with a change in the mortality level and controlling of communicable diseases.

In Chapter Four, the response of sex differential mortality due to famine is the core issue of study emphasizing on the early aged deaths. The technique of analysis is adopted from Bourgeois and Maruyama. Also the age-sex response of mortality through whole age structure is studied by employing the Dyson's proportional rise but with a different base line.

In Chapter Five, different birth cohorts are considered respecting the year at birth and survival effects during famine event have been compared among those cohorts by estimating the survival rates. Though the generation life table is mostly used for population projection generally but in this study it is employed to find the famine effect along with some other events like war and measles epidemic on the survival rate of the Matlab population.

Finally in chapter six, the study ends with the presentation of the findings and conclusion with the related discussion regarding overall change and mortality pattern in Matlab, Bangladesh. Moreover, these findings are discussed in light of the broader regional variations considering the Indian states as Bangladesh was part of the Indian subcontinent before 1947 and have very common and related history of population, culture, and even topology.

Chapter Two
Literature Review

2.1 *Population Growth and Mortality*

Ancient India passed through two highly developed and flourishing civilizations; the urban metropolitan civilization of the Indus Valley (about 3000 B.C.-1500 B.C) and the great pastoral agricultural civilization of the Aryans (1500 B.C.- 600 B,C). The techno-economic and organizational conditions during these civilizations had been sound and continuously improving to provide a firm material base for a dense and slowly rising population. Contemporaneous with or only a little later than the Aryan culture of the Ganges and the Mohen-jo-daro culture of Indus there were almost equally advanced civilizations in South. Before the Christian era, India had a substantial population because of its advanced technology and the fertile environment for the application of this technology (Davis, 1951). However, the various estimates of the population for 1600 indicate that the population of the subcontinent at the beginning of the seventeenth century was between 100 million and 140 million (UN, 1982a). Davis (1951) estimated the population of the subcontinent in 1750 to be 125 million and for the year 1800 Mahalanobis and Bhattacharya estimated the population to be 207 million. With regard to the period 1801-1871, there was a slow growth in population, averaging about 0.34 percent per annum. Three major phases are recognized in the growth of population in India since then. The first phase relates to the period prior to 1920 when the rate of growth was negligible. History shows that famines and epidemic diseases were quite normal occurrence in that period causing a heavy toll of life. The second phase covers the period 1921-1951 when the population grew steadily each decade. In this period, the average annual rate of increase was 1.2 percent and another 110 million persons were added to the country's population. The third phase covers the period since 1951 while each successive decade appears to have exhibited an increase in the average annual rate of growth in population, 21.5 percent, during the decade of 1951-1961 and 24.8 percent during 1961-1971 (UN, 1982a).

The very high death rates observed prior to 1921 were largely due to frequent epidemics of plague, cholera, famines, and the influenza epidemic of 1918-1919 and many, if not all, of them were associated with crop failure. Until 1920, India was afflicted almost every year by drought or famine in some part of the country or other, to which pestilences and epidemics added their toll of human lives. Davis (1951) estimated 19 million people died in India during the decade 1891-1901 as a result of famines. The mortality level during 1911-1921 was the highest, the crude death rate being as high as 47.2 per thousand and it was largely resulted by the influenza epidemic of 1918-1919. Between 1921and 1951 a substantial decline in the crude death rates took place, which was a 42 percent decline from 47.2 in 1911-1921 to 27.4 in 1941-1951 (UN, 1982a). And relatively high birth rates combined with declining mortality resulted in an increase in the population growth rate. This mortality decline in India is largely due to the control of famines and epidemic diseases since 1921.

On the contrary, Bhat (1989) in his analysis of mortality and fertility during 1881-1961 in India argued that estimates of Davis, and Coale-Demeny have exaggerated the true levels of fertility and mortality at the beginning of the 20th century. He suggested that their estimates of the crude Death rate for that period are about 2-5 percent lower than existing estimates, while the estimates of life expectation at birth are one or two years higher. On the mortality differential he suggested that the male life expectancy at birth did not exceed that of females until 1950s though the female advantage in life expectancy was diminishing from the beginning of twentieth century.

However, the population growth was far from uniform over various regions in Indian sub-continent. Visaria and Visaria (1983) showed the average rate of increase of India's population was about 0.6 percent per year between 1871 and 1941 and the bulk of increase took place between 1921 and 1941. The East Zone that comprising undivided Bengal, Bihar, Assam and Orissa accounted for 30 percent population of the sub continent, experienced slow but positive growth throughout 1871-1941. They noted that unlike other regions, it never did experience a decline in its population, not even during 1911-1921 when there happened the virulent influenza epidemics of 1918-1920. Moreover Bengal presidency was remarkably free from any major famine during 1871-1941. As a result it was fastest growing region in the Indian subcontinent in that period.

The average annual growth rate for the South Zone (including Madras, Mysore, Kerala and Andhra Pradesh) was above the national average during this period and the population grew steadily though slowly, despite the famine of 1876-1878 which overwhelmed the whole south India and levied a toll of 3.5 million lives in Madras Presidency alone. Among the various region, the West Zone (Bombay Presidency, including Sind) and the North Zone (Punjab, Rajasthan and Uttar Pradesh) were the worst affected by the famine as well as epidemics. During 1872-1881 there was a decline in population of Bombay Presidency. Along with Madras Presidency, Parts of Bombay also suffered from the 1876-1878 famine while some eight million people were affected, and deaths estimated during 1877-1878 were about 800,000 lives. There was recovery in the decade 1881-1891 but the great famine again of 1896-1897 and the two successive waves of influenza epidemics during 1918-1920 were severe in Bombay and caused a decline in population (Visaria and Visaria, 1983).

The population in the North Zone continued to grow slowly up to 1911, and except during the decade 1872-1881, its rate of growth was lower than the average for the subcontinent as a whole. North Zone reported very small gain partly because of the epidemics of cholera and plague which devastated the Punjab and the United Provinces during this period. The epidemics of malarial fever decimated the irrigated tracts of the eastern and central Punjab, and the Ganges-Jamuna Doab in the United Provinces, where the reported mortality from fever was nearly two millions alone in 1908. In the Central Zone there was some growth in the population during 1872-1891 but after that it declined significantly during 1891-1901. The famines of 1896-1897 and 1898-1900 hit the region hard which were partly responsible for the negative growth rate. However, the average annual growth rate in this region (1.54 percent) during 1901-1911 appeared much higher than that of the sub-continent as a whole (0.65 percent) (Visaria and Visaria, 1983).

If we look through the mortality trend, mortality remained high almost throughout the sub continent during 1871-1921. Death rate fluctuated between 40 and 50 per 1000 population until 1920 and infant mortality ranged between 278 and 295 per 1000 live births during that period. Compared to the all India average death rate ranging between 38 and 50, the death rate in the south was consistently lower as this region escaped the famines of 1896-1897 and 1898-1899, and also spared from the plague epidemic. Both in western and central India, the severe famine conditions coupled with plague epidemics caused such havoc in terms of higher mortality. During 1901-1911, both plague and epidemics of malarial fever ravaged the Punjab and the United Provinces. Bengal had become an endemic centre of malaria. The effect of these epidemics is quite evident in the death rate of 49 in the North Zone and 46 in the East Zone. The southern region never becomes malarial to the same extent as eastern and northern India. There was relatively low death rate of 31 during 1901-1911 for Central Zone. During 1911-1921, the death rate in the four zones except the South, ranged between 47 and 57. The death rate was considerably higher in certain districts which were hard hit by the influenza epidemic. The regional difference appear to have persisted during the 1921-1931, when famine and epidemics were no longer major causes of mortality, and all areas of the subcontinent experienced a more than 20 percent decline in mortality relative to 1911-1921. East Zone experienced a higher death rate (41) than the average for the subcontinent as a whole (38) during this period. The South Zone, on the other hand, continued to experience lower mortality than the rest of the subcontinent (Visaria and Visaria, 1983).

Bangladesh experienced similar population history to that of other parts of the Indian subcontinent. Particularly the history of the eastern Zone or the Bengal, is the history of population including Bangladesh as the then east Bengal which has a long past of slow growth. The pattern of a gradual growth over a short period was followed by an abrupt decline. The excess of births over deaths which built up a population surplus is usually checked by a catastrophe in the form of warfare, famine or epidemic such that this increase is nullified. Up to the mid 1920s the story is of slow growth against environmental and technological constraints, interrupted by large scale setbacks. Ortega Osona (2001) established that the instability of mortality in Bengal and Punjab was great during the late 19th century. According to him, this instability in mortality is associated with ecological characteristics of the regions that lead to differences in the instability of harvest and in exposure. Apart from plague and influenza, mortality fluctuations became attenuated at the beginning of the century, and the trend was clearly established in the early 1920s. The most likely reason for this change, Ortega Osona noted, is the reduction of acute hunger and possible long term improvements associated with the commercialization of wheat in Punjab and the spread of jute in eastern Bengal might be partly responsible for that lower instability. Thus, after 1920, mortality started to decline more or less steadily.

However, again it wasn't smooth process as in Bangladesh, the demographic development has been affected by a succession of man made or natural calamities like famines, devastating floods, cyclones, and wars. In the last 200 years, this population has experienced six major famines: Great Bengal famine of 1769-1776, floods and famine of 1784-1788, famine of 1873-1874, famine of 1884-1885, Bengal famine of 1943, and the Bangladesh famine of 1974 (Arthur and McNicoll, 1978). The mortality pattern and trend of Matlab, Bangladesh in relation to 1974 famine effects are my major concern in this study, and focuses will be placed on age-sex patterns of mortality.

2.2 *Mortality Patterns: Age and Disease*

Any change in mortality is influenced by non-temporal factors. Most important of all such factors are those concerning topological and disease environments. Some regional mortality pattern are established based on this point e.g. the five patterns of UN model (1982b) and the four patterns in Coale-Demeny Model(1966). Based on European mortality history Coale-Demney identified four pattern of mortality; North, South, East and West. For example, North model come from the mortality experience of Iceland (1941-1950), Norway (1856-1880 and 1946-1955) and Sweden (1851-1890). The populations displaying this mortality pattern were very probably subject to endemic tuberculosis. Similarly South model, based on life tables of Spain, Portugal, Italy, southern Italy and the region of Sicily covering the period from 1876 to 1957, exhibits the pattern for those population experienced higher infectious and parasitic diseases. Bangladesh, India and most of the south Asian region might have this disease pattern. However, the UN south Asian model is close to C-D South model in this respect which was developed based on the mortality experience of south Asian nations. The other four patterns of UN model are Latin American, Chilean, Far Eastern and the general pattern. One can raise the argument that whether these models are unique or is there any unique regional pattern in mortality?

The recent debate between Zhao (2003) and Goldman (1980) on the Far Eastern model of mortality (Hong Kong, Republic of Korea, Singapore) regarding such issue can be mentioned here where Zhao disagreed with Goldman and in his view, the Far Eastern pattern of mortality is not a unique model rather the mortality patterns similar to those suggested by the Far Easter mortality model have existed in other parts of the world. Zhao argued that "considerable changes in both age patterns of and sex differential in mortality have occurred in many countries. Just as the East Asian populations have never consistently followed the far eastern mortality schedule, scarcely any population exists with a mortality pattern that has continued to conform to a single mortality model (Zhao, 2003). However, the main concern of this study is to identify the mortality pattern of Bangladesh as well as Matlab in relation to standard mortality models.

The age pattern of mortality is of classical U-shape in Bangladesh with the higher deaths at early ages and old ages. Mortality pattern Bangladesh is been characterized by high infant as well as high child mortality and among both sexes. Females are at higher risk of mortality from post neonatal age to higher ages. But at old age they have the mortality advantage. At the child age mortality tetanus, diarrhea, dysentery, and pneumonia with fever are highly accountable. On the other hand at higher ages, dysentery, diarrhoea, gastro enteric diseases, cholera, typhoid are the important cause. Malaria and tuberculosis were among the important causes of death before the 1970s. Malaria indeed has been less severe (consistency check) in Bangladesh due to its geography (UN, 1981). Urban male are at greater risk of tuberculosis as found in the vital registration data by Bangladesh Bureau of Statistics (BBS). But Bangladesh is of an agrarian society where most of the people are living in the rural area whereas about 23.1 percent people live in urban area according to the estimate of 2001. These all are very much similar with characteristics of the South Asian mortality pattern as it is characterized by high incidence of infectious, parasitic and diarrhoeal diseases at the youngest ages and high mortality from diarrhoeal and respiratory diseases at the oldest age. In fact UN has used the mortality data of Matlab for their study of South Asian mortality. And the disease pattern of Bangladesh is also quite similar of Coale-Demeny's South model of mortality, which is derived from South European experiences where highest death rates are found for diarrhoeal and certain other diseases of infancy (Preston, 1976). The age pattern of mortality by sex is the primary concern with this study in the shade of these standard mortality patterns.

2.3 *Famine and Mortality: Age-Sex Pattern*

Historical demography of west European countries suggests that wide fluctuations in mortality rates, which so much characterized pre-transition societies, tended to attenuate in the course of eighteenth and early nineteenth centuries. In England, for example, this occurred during the eighteenth century due largely to agricultural progress (Wrigley and Schofield, 1981). However, it is also recognized that in the early phase of modern mortality transition, a serious famine or two devastated the society at large, such as the Irish famine of the 1840s and the Finnish famine of 1866-68. Collectively, historical as well as contemporary studies of those famines point to a set of some stylized facts about famines.

Major stylized facts are as follows:

1. Mortality increase during famine times.
2. Famines usually involve an amplification of the normal seasonal distribution. This amplification may be complicated and overlain by famine induced outbreaks of particular diseases such as Measles and typhus.
3. Increased under-nutrition is the principal underlying cause of famine mortality; especially in poor agricultural populations, famines and epidemic often come synergistically.

4. The largest number of famine death happen to young children; this age group and the elderly experience the largest absolute increases in death rates
5. The greatest proportional increases in death rates tend to occur at ages where death rates are relatively low during normal times.
6. The mortality of male increases more than that of females.
7. Another important generalized effect of famine is a reduction in conception.

These stylized facts are established on the basis of effects of most of the major historic famines around the world that took place for the past two centuries. In South Asia too, we know that both the attenuation of mortality fluctuations and the outbreak of famine disasters took place in the first half of the twentieth century. Although it is much less certain whether in the South Asian case agricultural progress contributed to the onset of attenuation or not, the impact of the Bengal famine of 1943 and the Bangladesh famine of 1974-75 were such that it is worth paying much attention to these two relatively recent famine cases.

The study of famine demography from historical periods is rather new in the South Asian research field. Nonetheless couples of good works have been conducted on such historical famines. Among these the pioneering works on historical famines of the Indian subcontinent as well as of the Bangladesh famine have been made by Tim Dyson. He conducted a comparative demographic analysis of the five largest South Asian famines of 1876-1878, 1896-1897, 1899-1900, the Bengal famine of 1943-1944, and the Bangladesh famine of 1974-1975 by focusing upon certain specific short term aspects of these disasters, like (i) the evolution through time of the mortality and fertility response to famine, (ii) the interaction of famine conditions and epidemics, and (iii) the age-sex composition of famine deaths (Dyson, 1991a).

He found conception is a more sensitive index of the development of famine than deaths. Conceptions declined long before the climax of mortality. In the major South Asian famines the death peaks occurred relatively late and continued for comparatively limited time. With exception of 1974-1975, the climax in mortality was essentially a huge magnification of the usual seasonal distribution of deaths. Cholera, dysentery and diarrhoea broke out relatively early in the famine process, broadly coinciding with the times of greatest social disruption. But malaria was a key component in the tragedy in Bengal in 1943-1944. He suggested that malaria was doubtless the most important famine disease and probably the single most important component of the main death rate peaks which accompanied the return of rains. Considering the proportional change in mortality by age and sex, he found a consistent pattern of largest rises in deaths among older children and adults. Neonatal mortality was little affected by famine as indicated by the data of 1943-1944 and 1974-1975. That mortality of males increased more than that of females has been established by all five famines. Difference between the sexes was especially large in the prime adult age groups. However, he found Matlab differs from the general pattern of other famines in indicating no particularly great proportional increase in child death rates. Dyson conclude that it was partly because of large number of child deaths due to measles in the base line period which may invalidate their use of average death rates for 1976 and 1977 to represent normal times (Dyson, 1991b).

A more detailed demographic study of historical famines of 1876-1878, 1896-1897, 1899-1900, and famine 0f 1907-1908 has been conducted by Maharatna. In his study a larger geographical area was covered, while examining the interaction between famine and epidemics, long term demographic, interaction between relief provision and demographic responses (Maharatna, 1996). He suggested that famine involved both substantial excess mortality on the one hand and significant reduction in conceptions on the other that causes a considerable losses of population. But there appears to have been a compensating above-normal rise in conceptions in the immediate post famine periods in most cases, while mortality in some cases declined even below its pre-famine baseline level. Moreover, over the longer term in the post-famine period a continued elevation of the birth rates has generally been found whereas, death rates seem to have been rather less stable than birth rates probably due to a greater responsiveness of mortality to weather and other environmental fluctuations like outbreaks of epidemic diseases such as plague, malaria small pox, cholera.

He found relatively weak positive link between the movements of food prices and the mortality index during famine. The main famine mortality peak occurred relatively late in the process and also within a short span of time when food prices were either stabilized at a high level or were only starting to decline. Conception responds rather quickly to the rise in both food prices for various reasons such as increased occurrence of conjugal separation in search for food, and also to the mortality index. Epidemics and related excess morbidity and mortality exert much stronger fertility-reducing effects when they follow a subsistence crisis than when they do not. He also suggested that the occurrence of epidemics accompanied by famine appears to have been caused partly by widespread acute nutritional deficiency and weakened resistance, and partly by the contamination of food and drinking water, increased exposure associated with wandering and migration, crowding in relief camps and deterioration of sanitation.

Considering the differential in famine mortality by age and sex, Maharatna found the greater absolute vulnerability for infants, young children and older age groups compared to the older children and adults, even during normal times. He suggested that this pattern is typical of a society where widespread undernourishment coexists with very poor public health facilities. But in terms of proportional rise in deaths during famine, infants appeared to have experienced a relative advantage compared to other ages. On the other age differentials in proportionate terms according to Maharatna's study did not fully conform to Dyson's view that young children are less affected by famine mortality compared to the older children and adults. Instead, two patterns broadly correspond to two major Indian regions in his study. As he said "first, in the Berar famines we find a pattern similar to the famines in the western, southern and central regions considered in Dyson's study, i.e. young children and old people appear to be proportionately less vulnerable compared to older children and adults. Second, young and even older children turn out to be more vulnerable compared to teenagers and adults in Punjab and United Provinces famines, both of which are located in north India. In these two northern famines the prime adult age groups experienced relatively small proportional mortality increases. Moreover, in the southern, western, and central Indian famine locations, adults seem to have had a relative mortality disadvantage compared to older ages, while the famines in the northern region showed reverse".

However, the age-sex differential famine mortality will be studied with the estimates of proportional rise in mortality just like other studies mentioned above, but with a new reference period. For the analysis of infant mortality, however, I introduced a new method, which was developed by Bourjeois-Pichat and also independently by Hiroshi Maruyama.

2.4 *Famine Mortality and Sex Differential*

Sex differential mortality is an important issue and by taking this into consideration in famine mortality, the problem becomes a little more complex. The sex differential in famine mortality, Sen (1981) suggested, was remarkably similar with the normal pattern of mortality in pre famine Bengal. While the proportion of men in excess deaths in 1943 was a bit higher than in the pre famine average of 1941 and 1942, the difference was small. And over the longer period of famine mortality the proportionate breakdown of the excess, as he found, is just the same as for the pre famine average. It should be noted that Sen pointed out that “the male population exceeded the female population in Bengal and the recorded death rate per unit population was higher for female in every year during the decade of 1941-1950 through the famine”.

On the questions of sex differentials in famine mortality two regional patterns found with Maharatna’s study, as he found overall higher proportional rise in mortality for males than for females in the cases of south, west, and central Indian famine. Whereas, reversed condition was found in the north Indian famine locations, especially in Punjab. He suggested that “the anti-female changes in the pattern of distribution of food and health care during major famines in northern parts, unlike southern, western, and central regions, probably outweighed the potential biological and other female advantage in coping with such crisis”. Also he concludes that the relative mortality advantage for adults (compared with young children) in north Indian famines would be consistent with the extremely patriarchal nature of the region.

Maharatna also studied the 1943 Bengal famine in detail. The Bengal famine was not directly caused by a drought and food shortage like some earlier famines. Price, as he noted, started to go up in as early as 1941, and reached a maximum in August of 1943.

Mortality whereas, began to rise above its normal level from middle of 1943 and the proportional excess mortality peaked in October. Though the main mortality peak was revealed roughly from July 1943 to June 1944, the mortality level did not return to normal until the middle of 1945. The excess death as he estimated was about 2.1 million and argued that it would be more accurate than Sen's estimate of about 3 million. Fertility response he found during Bengal famine was similar to that found in former Indian famines. Malaria and cholera epidemic were quite important in famine mortality as the cholera mortality peak preceded the malaria peak by two months.

The new variables Maharatna introduced in his study of 1943 famine are the urban rural differential and religion. The Muslim community is found having the relative advantage in terms of proportional rise in mortality and the greatest reduction in births. The percentage rise in famine mortality was higher in urban areas and rural urban differences in the proportional decline in births and rise in deaths were far greater during 1944-1945 than in 1943. Maharatna suggested that this perhaps indicates the greatest movement of people to the towns occurred during the later epidemic phase of the famine, especially in 1944. Malaria was less important in urban mortality compared to that of rural; instead the 'all other' category was prominent, which may have been expected as many starvation deaths may have been recorded in this unspecified category as he suggested. Despite rural urban differences in the cause composition of deaths, the time pattern of excess mortality was similar between rural and urban areas.

Respecting the age pattern in mortality he found no adverse effects on still birth rates in rural during the famine but a very marginal rise in the urban rate of stillbirth. Neonatal mortality appears to have been relatively protected compared with the mortality of infants beyond the neonatal stage. A similar conclusion has also been reached in context of Bangladesh famine of 1974-1975 with the study of Razzaque (Razzaque et al., 1990). However, a greater proportional rise in female infant mortality was found like some earlier famines. Respecting this, Maharatna argued that as the infant mortality may be related to both pre-natal exposure to famine and post-natal conditions, the greater rise in female infant mortality seemed to indicate an anti-female discriminatory bias in both food and parental care during Bengal famine. Infants of both sexes in rural areas are found to be least vulnerable group followed by young children with a relative mortality advantage in the famine year. Older children and adults appear to have experienced comparatively large proportional increase in mortality. On the other hand, urban infants appeared to be more vulnerable than adults and female infants were the most vulnerable. Young children and elderly population in urban area were found having relatively large proportional rises in mortality while adult mortality was less affected by famine. But he argued that this urban pattern probably also reflects the influence of rural-urban migration on the number of registered deaths by age. Maharatna studied the mortality data for undivided Bengal for the 1943-1944 famine like Dyson.

About famine effects Sen pointed out that a decline in total food supply was usually accompanied by a change in its distribution, normally to the disadvantage of the poor, people at the extremes of the age distribution, the less healthy, and possibly women. About sex differential he noted that though females have greater biological capacity to withstand temporary nutritional stress than males due to their certain physiological advantages relating to body-fat content, they would be affected most by the food crisis. Because, the sex differentials in mortality are also influenced by socio-cultural factors including sex discrimination and as there is some evidence of systematic anti-female discrimination in the distribution of food and medical care even in normal times in parts of South Asia, it might be expected that such discrimination against women would worsen during crisis moment (Drèze and Sen, 1989).

Pitkänen conclude that there was no consistent sex difference in mortality increase during the Great Finnish famine of 1866-1868. Only in 1868 while it was the period of highest mortality increase related to famine of 1860s, men suffered remarkably more than women. And he suggested that neither sex benefited from an inherent biological advantage over the other during the examined crisis periods rather the male excess mortality in certain region in 1868 was tentatively linked to famine induced temporary migration which was selective by region, age, and sex (Pitkänen and Mielke, 1993). The same scholar did also very extensive study on another two famines of 1832-1833 and 1857-1858 in Finland, by age and sex. Comparing with the mortality increase due to war of 1808-1809 as well as with major famine of early 1770s in Sweden, he conclude that “the examination of the excess mortality ratios showed for many of these calamities rather consistent differential between the sexes, younger adult males were usually more vulnerable than women of the same age categories, whereas the opposite was true for children and middle aged men”. But he found no systematic disadvantage for either sex with these Finnish famines. The excess death during Finnish famines was largely caused by specific infectious diseases, such as typhus, typhoid fever, and dysentery. Moreover he argued that Finnish subsistence crises suggests the grater male vulnerability that observed in a number of famine studies, is not a biologically determined feature of such occurrence but is related to cultural factors, at least as historical disease-induced crises are concerned (Pitkänen, 2002).

However, Ruzicka and Chowdhury (1978) commented on the fact that male mortality for 1975 exceeded female mortality from age 25 onward during Bangladesh famine. Watkin and Menken (1985) conclude that women are favoured in famine situations; and the greatest percentage increase in death rates occurred amongst children and people over 45. Using same data Chen and Chowdhury (1978) suggested death rates went up most amongst the children of age 1-4 and 5-9 years, and amongst adults aged over 45. Moreover, they argued that except infant age, female are at greater risk of death than male and disaster tended to accentuate even further these sex differentials, particularly among children which contradicted the findings in Dyson (1991(b)). D’Souza and Chen (1980) in their study of rural Bangladesh concluded that there existed higher female mortality than that of male shortly after birth through the child bearing ages in a rural area (Matlab) of Bangladesh and excess female mortality was consistently higher during the food shortage years, suggesting that the increased mortality during disaster was disproportionately experienced by young girls. But mortality in 1975 was higher for males than females of the adult age group 15-44 and this represented a reversal of the pattern of normal years. They noted also that net out- migration of adult males was considerably higher than in other years.

Razzaque and others in their study suggested that the female advantage found in famine mortality at certain ages during the crisis of 1974-1975 may have been due partly to higher male migration and partly to the reduced fertility that resulted in a lower risk of death for females in the reproductive period. Moreover, having examined the sustained effect of famine on infant and child mortality, they concluded that neonates conceived during the famine period were most affected among all cohorts. And famine-born children aged 1-2 years were affected greatly comparing with famine conceived and non famine cohorts at the same age (Razzaque et al., 1990). All these studies in fact used the data from Matlab, but unfortunately the reference periods—and the base line period in the case of the analysis of proportional rise—do not agree with each other, so that it is not quite clear what conclusion we could have for these studies for the age-sex pattern of famine mortality.

Sex differential is a topic of my major interest in this study on Bangladesh famine. The proportional increase with a new base line period can be considered for studying age-sex responded mortality. But the survival rate of different cohorts of births that experienced famine at different ages or not is of prime interest. Razzaque et al. (1990) has worked on the sustained effect on child survival by using regression analysis considering some socioeconomic differential including the famine and non famine reference category. In my study, on the other hand, the life table survival rates of different cohorts will be explored with special emphasis on the use of generation life tables rather than much familiar period life table. The period life table is regarded as suitable for analysis of the short term, while the generation life table can measure the long term mortality experience of an actual cohort.

2.5 *Regional Contrasts in Mortality: Bangladesh and Indian Provinces*

There are two more concerns of this study. One is a question exclusively for Bangladesh. As there took place so many crises and disasters since Independence, it is interesting to trace differential experiences of different cohorts in terms of subsequent chances of survival. This is not just to measure the impact of a particular event but to measure a combined effect of two or three demographic events, such as a combination of civil war and famine and that of famine and epidemics. Such exercise involves the construction of generation, rather than period, life tables. Unfortunately not many studies have so far applied this methodology to historical queries. However, as I will demonstrate, this is a useful tool to reconstruct a demographic experience of a particular cohort over a substantial period in their life course.

The second is a region-wide question. It has been suggested by demographers that the entire Indian sub-continent can be divided into two sub-regions, each of which exhibits a distinct set of demographic correlates. For example, Madras was found to have comparatively lower fertility and mortality than in the northern provinces of Berar and Punjab (Saito and Takahama, 2005). Having explored the contrasts in vital rates of Madras and Punjab during the colonial period, they found harder demographic impacts of famines in the North than in the South, and suggested that the excess female mortality tended to increase in times of such mortality crisis in Berar and Punjab more than in Madras. One reason they suggested is that the son preference and prejudice against daughters in the Northern provinces, which had been embedded in the society from historic periods.

Dyson and Moore (1983) showed that sex differentials in child mortality are much higher in the northern than in the southern States of India. They established that the main reason for the relatively high sex ratios in the northern part of the country is higher female mortality; they attributed this phenomenon to the discrimination against females in access to food and medical care. They also related the differentials observed in the north and south to variations in kinship systems and female autonomy. They argued that the high birth and death rates which continued to prevail throughout most of northern India must be seen within the context of local-level kinship arrangements. And these arrangements not only have demographic implications of their own, but also condition the degree to which women can pursue their self-interest and that of their children. The spatial and social dimensions of the marriage alliance are particularly important in this context. Given the differences in female autonomy between northern and southern cultural areas, they found a generally greater degree of health service and family planning utilization by women living in the south. In South Asia, cultural factors such as kinship systems and religious traditions tend to value males more highly than females. In India and Bangladesh for example, traditional patrilineal kinship systems require women to marry out of their families of origin, and after marriage they are not supposed to be financial or even emotional support to their parents (Greenhalgh, 1991). In the Hindu tradition, only sons can pray for and release the souls of dead parents, and only males can perform birth, death and marriage rituals (Benjamin, 1991).

It has been observed that females are more likely than males to die in early childhood in South Asia owing to poor nutrition, differential feeding and health care practices. Visaria (1969) showed that sex ratios were persistently higher in the northern Indian States and lower in the southern ones in a study of inter-State differences in sex ratios between 1901 and 1961. He argued that mortality differentials by sex were mainly responsible for these differences. The risks to daughters increased while more older female children were in the household. Similar hazards to son survival were not common. The mortality differentials between sons and daughters in northern and southern India were attributed to variations in women's status and the strength of sex preference (Visaria, 1994; Das Gupta, 1994). Similarly, data from Bangladesh showed a higher risk of survival for girls having older sisters than that of boys who have older brothers (Bairagi, 1994).

Given all these, it is interesting to examine whether Bangladesh belongs to the Northern regime or the Southern regime. In the chapter six, this will be discussed together with other results of the study.

According to Dyson and Moor, Bangladesh exhibits somewhat stronger affinities in effect both to northern kinship and to the northern demographic regime. In their words, “The status of women appears to have changed somewhat over the past few decades, largely to their disadvantage. The shift is evidenced, for example, by a major trend away from bride wealth toward dowry and a general reduction of women's control over property transferred with them at marriage. The status of women, contemporarily at least, appears to be very low. The isolated and vulnerable position of women among their husband's kin is similar to that holding under northern kinship. Marriages are generally early and arranged, and fertility is high by sub-continental standards-somewhere on the order of seven live births per woman. Levels of infant and child mortality are comparable to those of states in north India, such as Rajasthan and Uttar Pradesh”.

West Bengal and Bangladesh have apparently experienced quite different demographic conditions over many decades, is intriguing and has been extensively debated. The situation to the east of West Bengal is both more uncertain and more complicated, reflecting the diverse cultural mosaic of the region. The issue of demographic differences between predominantly Hindu West Bengal and predominantly Muslim Bangladesh brings to the fore a subject passed over lightly so far: the possible influence of religious identification on the degree of female autonomy. Dyson argued Islam itself is a relatively unimportant factor as Muslims in South Asia generally live by cultural practices close to those of local non-Muslims. The ideological prescripts of Islam, and especially the protective/restrictive attitudes toward women, bear similarity to values associated with north Indian kinship. But to say this is probably to do little more than pointing out that both have "West Asian" historical origins. The influence of religion no doubt has relevance, in conjunction with the influence of historical migrations, in explaining the contrasting demographic cases of Bangladesh and West Bengal. At the very least, nominal adherence to Islam conditions what people conceive of as correct female behavior.

The findings of this study will be discussed to place the Bangladesh case in the region-wide context in terms of population history, anthropology and culture, many of which India and Bangladesh share.

2.6 *Topology of Bangladesh*

Bangladesh is a low-lying riverine country with a marshy jungle coastline of 710 kilometers on the northern littoral of the Bay of Bengal. The three main rivers of the subcontinent--Indus, Ganges, and Brahmaputra—and most of their tributaries have their sources in the Himalayas and all bring down silt that has made the Indo-Gangetic plains. This plain lies south of the Himalayan ranges and its subsidiary hilly terrain. The Indo-Gangetic Plain is a large and fertile alluvial plain encompassing most of the northern and eastern India, the most populous part of Pakistan, and virtually all of Bangladesh. The region is one of the most populated areas on the earth, being home to nearly 900 million people or in other words over one-eighth of the world population (Davis, 1951).

The Himalayas contribute greatly to the soil and climate. Soil is highly fertile as it formed by a delta plain at the confluence of the Ganges (Padma), Brahmaputra (Jamuna), and and Meghna Rivers and their tributaries. The lower Ganga first enters West Bengal, from which it flows into Bangladesh and after joining the Jamuna, both rivers form the Ganges delta. Hills rise above the plain only in the Chittagong hill Tracts in the far southeast and the Sylhet division in the northeast. Tropical monsoon here is characterized by heavy seasonal rainfall, high temperature, and high humidity. Natural disasters, such as floods, tornadoes, tidal bores affect the country yearly.

2.7 *Population Growth in Bangladesh and different zones of India*

Population grew at different pace among different zones of India. West Bengal is in the eastern zone. The rate of population growth in the eastern zone of India was 6.7 percent in the first two decades of the last century, which was intermediate by Indian standards—lower than that for the south or the west but higher than for the north and central zones. West Bengal recorded 3.15 percent population growth in 1901-1921, while it rose by 50.51 percent in 1921-1951. In 1921-51 the population of India as a whole increased by 43.67 percent, and the increase in the north and eastern zones were almost equal to the national average while that of the south was only slightly higher (by 46.58 percent). It was substantially higher in the western zone by 54.49 percent, while it was considerably lower in the central zone by 35.61 percent. In terms of population growth rates over the past century, therefore, Bengal has been placed in the middle between the two extremes, although one common factor in all the zones is the male mortality advantage over female mortality (UN, 1982a). On the other hand, there was 52.88 percent (estimated by using enumerated population of the corresponding censuses) population growth in 1921-1961 in Bangladesh. The 1961 census results give an average annual increase of 1.96 percent during the inter-censal decade, 1951-1961 (UN, 1981).

Today's Bangladesh was a part of the undivided Bengal state before Partition of 1947. Bangladesh constitutes 80 percent of the greater plain of the Bengal and is mostly agrarian and of Muslim majority. The principal crops of Bangladesh are rice, jute, wheat, tea, tobacco etc. Rice is the principal component of agricultural production in Bangladesh as well as in West Bengal. Indeed rice is heavily cultivated where rainfall allows, whereas millet is grown in drier portions of the Indian subcontinent: thus, rice is extensively grown in the wetter portions of the east and south, wheat in the north and northwest, sorghum and millet over much of the peninsular interior. All this facilitates an understanding of India’s population distribution and density, as the population density tends to be higher in rice growing areas.

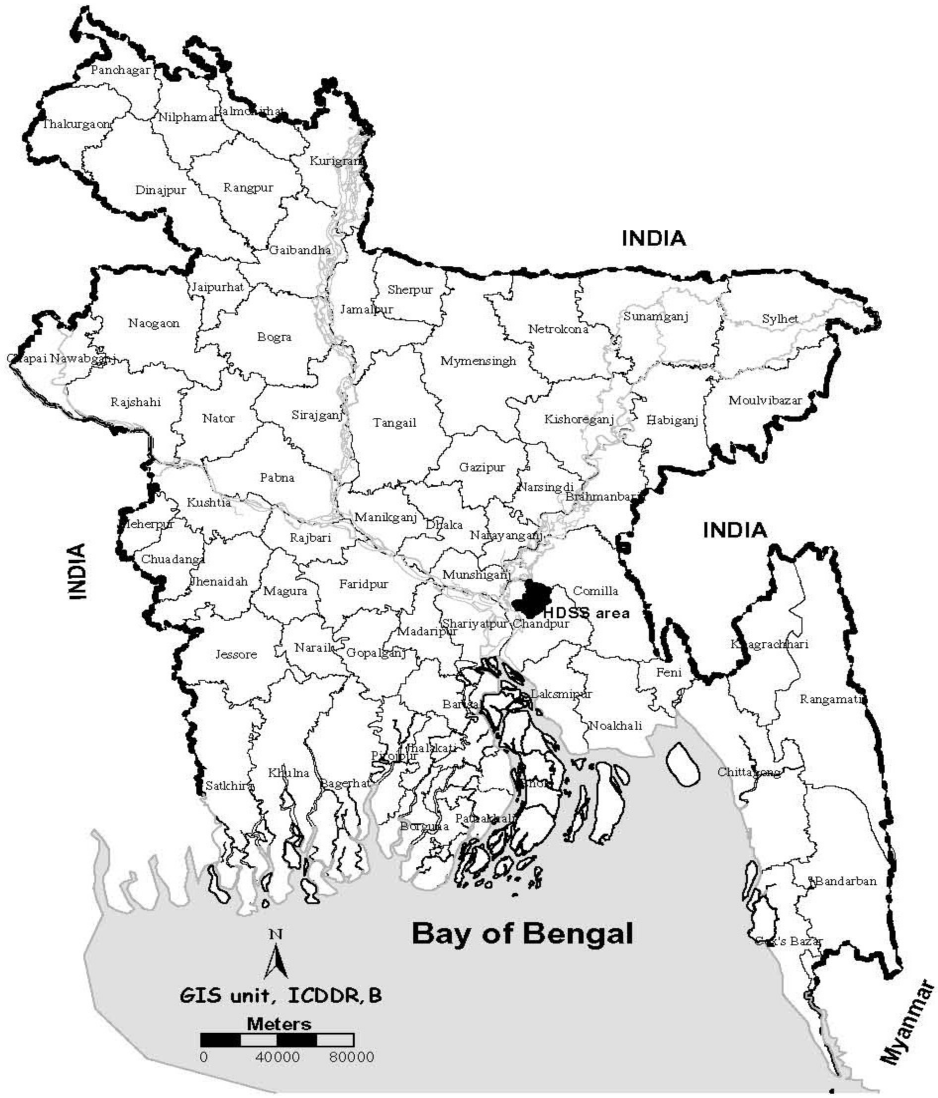
2.8 *Cultural history of Bangladesh*

The culture of Bangladesh has a unique history which dates back more than 2500 years ago. The land, the rivers and the lives of common people form a rich heritage with marked differences from neighboring regions. It has evolved over the centuries and encompasses cultural diversity of several social groups in Bangladesh. The culture of Bangladesh is composite, and over the centuries has assimilated of Hinduism, Jainism, Buddhism, and Islam. It is manifested in various forms of social behavior and values, including music, dance and drama, art and craft, folklores and folktales, language and literature, philosophy and religion, festivals and celebration etc. It is the product of the repeated influx of varied peoples, bringing with them the Dravidian, Indo-Aryan, Mongol-Mughal, Arab, Persian, Turkic, and European cultures. About 1200 A.D., Muslim invaders under Sufi influence, supplanted Hindu and Buddhist dynasties, and converted most of the population of the eastern areas of Bengal to Islam. Since then Islam has played a crucial role in the region’s history and politics. The history of Bangladesh is nearer to the north Indian history as factors such as power struggle between the Turks and Afghan invaders in Delhi and northern India changing hands from one dynasty to another, directly or indirectly, affected Bengal too. The rulers of Bengal were often subjugated by various rulers and dynasties of Delhi and northern India (indiaheritage.org/history). And culturally it is the mixture of Bengali and Islamic cultures.

2.9 *About Research Area ‘Matlab’ and the Data of this Study*

The International Centre for Diarrhoeal Disease Research, Bangladesh has been maintaining a field research station at Matlab since 1963. Matlab is located about 55 kilometres southeast of the country's capital, Dhaka (Figure 1). The Matlab area was initially selected to test a cholera vaccine. The Demographic Surveillance System (DSS) started in Matlab later in 1966. The surveillance system consists of two types of operations: (1) continuous registration of vital events (pregnancy outcome, death, migration (in- and out-), marital union and dissolution, inter-village movement, household division, and household head change (when heads died or migrated out or household divided); (2) periodic censuses and socio-economic surveys (HDSS,2007).

At the onset, 132 villages were brought under the surveillance system, and 101 villages were added to the system in 1968. In the 1974 census, population of the entire surveillance area was 276,984 in 233 villages. A major modification in the field structure and programme activities was undertaken in October 1977 with an exclusion of 84 villages (120 thousand population) from the surveillance area. The new surveillance area since October 1978 consisted of 149 villages with 173,443 population. The Family Planning and Health Services Programme was then launched in 70 villages (88,925 population), and the remaining 79 villages (84,518 population) were considered the Comparison area (Figure 2). The 1982 census covered the population of the 149 villages. The number was further reduced to 142 villages in 1993 because seven villages of the seven villages of the Government service area totally disappeared due to river erosion. However, most of these villagers have resettled in the nearby villages of the DSS area.



Source: HDSS report of 2007

Figure 2.1: Location of HDSS area in Comilla district.

The 2005 Socio-economic Census was carried out in Matlab, and shows results of the socio-economic changes that have taken place in the Health and Demographic Surveillance System (HDSS) area during the 31 years from 1974 to 2005. It shows that population growth has slowed down in recent years with a more marked decline in the ICDDR, B area than in the Government services areas of Matlab. Fertility decreased by nearly half from 47 to 26 per thousand from 1966 to 2000, while the crude death rate fell by more than half during this period, from 15 to 7 per thousand (HDSS, 2002).

The proportion having at least one year of schooling has increased to 70 percent in 2005 and the proportion that received high school education has also increased. The male: female difference in education has remarkably narrowed down. Analysis also suggests that equal number of boys and girls and in some age groups more girls than boys are attending schools.

In terms of possession of farmland, 70 percent of households were either landless or functionally landless (land<0.50 acres). As a result, the pattern of employment has shifted from predominantly farming to concentrate more in agricultural labour or other daily labour and business. Most of the households in this area have now adopted wide-ranging occupations for their earning. Only 15 percent of the households reported to have income from one source only.

Micro-credit and Non-Government Organizations have established a wide network throughout the Matlab HDSS area. 49 percent of the households have NGO memberships. 10 percent of the total households of HDSS area have shortage of food at some point of time. Of them 46 percent have 1-3 month's food shortage and about 22 percent have yearlong food shortage. Half of the food-shortage households fall within the poorest quintile of the society.

In short, Matlab is not atypical as a rural Bangladeshi society, having a subsistence agricultural economy, poor infrastructures and communications, and uneven land distribution, and its socioeconomic indicators are among the lowest in the world (Grant, 1988).

CHAPTER THREE
Mortality Patterns and Changing Levels of Mortality in Bangladesh

3.1 *Introduction*

The risk of death is not uniformly distributed over the human life span. This variable seemed varying age to age. The age pattern of mortality in a population puts the history of death and diseases during the previous generations in a nutshell. It reflects the level of mortality, trends of illness and consequent recovery or death. To the extent, various societies inhabit different environments, composed of different genetic structures, and practice different culture in the society. These all make together the variation in the history of death and diseases among the societies in the world. But again the earth is been divided into some parts or groups according geographic location which results in similar type environment and genetic structures in some societies belongs to a particular part of the earth and they undergo similar cultural transformations. They may have the related histories of diseases and death and therefore similar age pattern of mortality. Model life table serves the mortality study at this respect. This chapter studies mortality pattern of Matlab as well as of Bangladesh.

There are different types of model life table among which the UN model life table (United Nations set of model life table published first in 1956 and the new one is United Nations Model Life Tables for Developing Countries, 1981) and the Coale-Demeny (C-D) model life table are well known. The regional table is the choice of this study which was published in 1966 by Coale and Demeny based mainly on historical European experience. These tables have become the most commonly used set of model life table among the demographic researchers which has four typical age patterns of mortality; North, South, East and West (Coale and Demeny, 1966), named after the geographical location of the actual populations whose data are used for the computation of model life table functions, although this naming does not necessarily correspond to the North, South, East and West region of the world. Recent evidence indicates that age pattern of mortality in many developing countries differ significantly from those of historical European experience, and the Coale-Demeny tables are therefore not fully suitable to demographic research in developing countries. This implies that we cannot automatically assume that the geographical location of a country in question is a guide to the choice of an appropriate model life table from Coale-Demeny's four life table families.

Respecting this the Population Division of the Department of International Economical and Social Affairs of the United Nations Secretariat presents new sets of age-sex patterns of mortality which are based on reliably documented developing country data. The UN model life table for developing countries designed to address the needs of developing countries and five families of models were identified by using 36 life tables covering a wide range of mortality levels from developing countries for each of the sexes. Each family of models is constructed from actual data for a geographical area of the world: Latin American, Chilean, South Asian, Far Eastern and a General with a set of tables ranging from a life expectancy of 35 to 75 years for each sex. And hence this may be more applicable and close fit to demographic analysis within the developing regions. Among all the UN families, the South Asian pattern of mortality which shows very high rates under age 15 and at the oldest age, with relatively low mortality for the prime age groups. Life tables are constructed from data for India, Iran, Tunisia, as well as for the Matlab area of Bangladesh (UN, 1982b).

The inclusion of Matlab makes the comparisons with any of the UN regional life table models pointless. However, one of the characteristics of the UN system is that due attention is given to the cause-of-death aspect of age patterns of mortality. I shall thus touch on this aspect in relation to the Coale-Demeny models.

This chapter is an attempt to find which of the four C-D model life table families would fit the age pattern of the Matlab population with DSS data and also of the Bangladesh population at large.

In the next section the cause pattern and the mortality pattern of Matlab population will be analyzed considering the mortality ratio comparing with the four families of C-D model life table as well as Bangladesh also emphasizing on the disease pattern.

3.2 The Coale-Demeny regional model life tables

Ansley Coale and Paul Demeny identified four distinct patterns of mortality corresponding to geographical areas of Europe in their analysis of empirical life tables recorded in developed societies over the past 150 years. One pattern corresponding to Northern European countries, a second to Southern European countries, a third to Eastern European countries, and the fourth, more heterogeneous, group consisting mainly of Western European countries and oversea populations of Western European stock. The four Coale-Demeny model life table families are considered to be reasonably comprehensive in order to assess the actual life tables from any region of the world. (Murray et al. GPE Discussion paper series-8).

The East model is characterized by high infant mortality and increasingly high mortality rates over age 50 and it comes mainly from Eastern Europe.

The North model is characterized by comparatively low infant mortality, high child mortality and low old age mortality beyond age 50. It is based largely on Nordic populations.

Another pattern is the West model. This is based on the residual tables not used in other regional sets, i.e., countries of Western Europe and most of the non European population and is characterized by a pattern intermediate between North and the East pattern. In fact this pattern doesn't show any systematic pattern of deviations from the average when all regions were combined. This pattern is believed to represent the general mortality pattern.

Lastly, there is the South model, which is based on the life tables from Southern Europe. This model is characterized by (a) high child mortality in relation to infant mortality when overall mortality is high, or (b) low child relative to infant mortality when overall mortality is low, as well as by high mortality over age 65. As far as child mortality is concerned, it should be noted, it is not always easy to distinguish North and South models when levels of overall mortality are high.

It is worth examining disease patterns in relation to the age patterns of mortality since Matlab displays distinct disease patterns in cause-of-death statistics (the patterns are somewhat different at the national and rural levels; see Appendix 3.C) .

Cause-specific death statistics of the Matlab population suggests diseases (both diarrhoea and dysentery) are the largest category accounting for deaths in Matlab. Fever (in all form), Gastrointestinal diseases and Respiratory were the leading cause of the deaths during 1969-1973 which is followed by small pox and measles, and diarrhoeal diseases. But during 1975-1986, dysentery is the leading cause of death which is followed by tetanus, fever, respiratory, diarrhea and finally old age (see table-3.1 and table-3.2). Tetanus is mostly happening to the infant population followed by child. Excluding tetanus, respiratory and fever are the main causes of death for other age groups. But diarrhoea and dysentery causes largest number of deaths together. Over the times infectious disease like tuberculosis, tetanus (non-neonatal) is becoming less important but respiratory, diarrhoeal, malignant neoplasm (nutritional and cardio vascular) and senility are the major causes of deaths.

Table 3.1: Percent death of male by cause in Matlab, 1975-1986

MALE	Fever all forms	Diarrhoea	Dysentery	Respiratory	G.I(other than cholera)	Tetanus	Old age	Others
1975	10.00	4.03	19.85	8.7	2.01	7.34	4.28	43.26
1976	8.53	2.15	11.75	10.2	3.63	9.96	4.75	39.38
1977	8.60	2.21	12.80	8.1	3.31	13.62	5.85	44.84
1978	7.94	4.37	12.49	8.6	3.84	17.31	6.24	36.04
1979	5.97	2.52	9.25	12.3	1.18	15.81	2.94	46.76
1980	8.97	3.39	8.52	10.3	5.04	20.05	3.11	38.28
1981	5.67	2.66	6.78	13.9	3.61	15.97	2.92	45.49
1982	7.20	5.16	8.87	17.4	4.17	16.30	1.97	37.53
1983	7.16	6.33	14.41	13.1	2.97	12.20	0.99	40.78
1984	6.84	6.50	17.93	12.7	3.15	7.67	2.74	39.08
1985	8.90	6.76	14.04	11.0	3.17	13.70	5.31	34.08
1986	7.71	6.88	14.04	17.2	4.31	9.27	3.76	35.23

Source: DSS data

And the age specific deaths by causes has established that infants and early aged child deaths are caused mostly by diarrhoeal diseases, respiratory diseases, and tetanus (neonatal) among all other age group. Senility is the leading cause of death at old age. Including this, respiratory, malignant neoplasm, cardio vascular, and gastro intestinal disease are the important causes of deaths at age after 50 (see HDSS annual reports of 1991-2003).

Indeed, all these characteristics are well reflected in the UN's South Asian life table pattern with high incidence of infectious, parasitic and diarrhoeal diseases at the youngest ages and high mortality from diarrhoeal and respiratory diseases at the oldest ages.

Table 3.2: Percent death of female by cause in Matlab, 1975-1986

FEMALE	Fever all forms	Diarrhoea	Dysentery	Respiratory	G.I*	Tetanus	Old age	Child birth	others
1975	9.19	4.59	18.38	6.9	1.38	7.66	4.06	0.77	42.53
1976	9.70	2.74	13.23	8.8	1.48	10.07	5.43	0.74	37.22
1977	9.23	2.95	14.58	5.8	1.97	12.89	4.37	1.20	45.88
1978	10.08	2.84	14.81	5.3	1.89	16.54	7.06	1.38	37.21
1979	6.13	4.27	11.94	10.4	0.73	13.79	4.52	2.18	41.13
1980	9.52	4.40	10.16	7.6	1.68	19.52	4.80	1.12	37.20
1981	6.15	3.72	8.50	11.4	2.02	14.82	3.48	1.30	44.05
1982	7.68	6.78	15.35	10.4	2.31	15.50	2.16	1.12	35.32
1983	9.03	9.46	15.24	7.2	2.26	10.80	1.41	0.71	41.64
1984	7.36	6.02	24.70	9.6	2.21	5.29	2.28	1.07	36.81
1985	7.32	9.96	15.83	7.7	1.28	12.43	4.94	1.53	34.13
1986	6.63	10.98	16.76	13.9	2.46	8.33	3.41	0.76	33.81

Source: DSS data

* G.I (Gastro Intestinal diseases) is considered other than cholera

3.3 *Data and Design of the Study*

In the report of the Committee on Population and Demography, panel of Bangladesh chose the North family to provide standards for the logit system as characterized by relatively low infant mortality to child mortality(ages between 1 and 5). Using the data from Bangladesh Fertility Survey 1975-76, they argued North mortality pattern best represents the relationship between child and adult mortality. On the other hand, there seems consensus nowadays that the West model is considered as safe choice to explain the mortality pattern in Bangladesh, while others may argue that for a South Asian country the UN's South Asian pattern of mortality should be used. These all makes me interested to study which family of model life table should be applied to Matlab and Bangladesh's mortality regarding the Coale-Demeny regional model. The UN model is not considering here as they have included the similar DSS data from Matlab regarding the South Asian region. Moreover, whether the death pattern of Matlab population is of similar with the national pattern or not, will be of interest here as Matlab is a tiny part of very low lying plane of the great delta of Bangladesh.

This study is designed to the estimation of Ratios of estimated life table death rate (q_x) to the death rates of standard life tables. It is an effective tool for a comparative mortality analysis. Coale-Demeny model life table death rate (q_x^a) will be taken for ratio estimation in the denominator. The numerator q_x will be the death rate of Matlab as well as of Bangladesh at national and at rural level. To do this the life table death rate q_x is used to estimate ratios for identifying the mortality pattern. The life expectancy e_x^0 is necessary for measuring the level of mortality, the conventional period life table will be estimated to obtain this.

Bangladesh is one among the countries which have very little source of good quality demographic data. National sample vital registration data becomes available after 1980 but not good enough in view of its coverage and misreporting. During British colonial period, the vital registration system had been established and the data were collected for the Bengal province. Age-sex specific mortality data for Pakistan period and for early Bangladesh periods are little available. Since 1966 a continuous demographic surveillance system has been in operation in Matlab by the organization 'International Diarrhoeal Diseases Research, Bangladesh (ICDDR, B). Matlab is very low lying rural area under the Comilla district in Bangladesh. It is mostly agricultural and vulnerable to flood. But this surveillance system has been providing a good quality and extensive demographic data of Matlab population. It was operated in the 132 villages since established. In 1968, 101 villages were added, a few of which were merged or dropped and 228 villages were under the system. In 1978, data collection ended in 79 villages, leaving 149 villages for which more recent information is available. Different scholars used different size of these data e.g. Chen and Chowdhury used 132 villages where the system was operated after established whereas, Dyson considered 228 villages as in the record of 1968. Despite this variation in the size of data as recorded in the system, this study considered the whole data series since 1966-2003, and exploits as necessary regardless the variability. Annual death rates by age and sex are the basic needs of the study including the cause specific death to explain the trend.

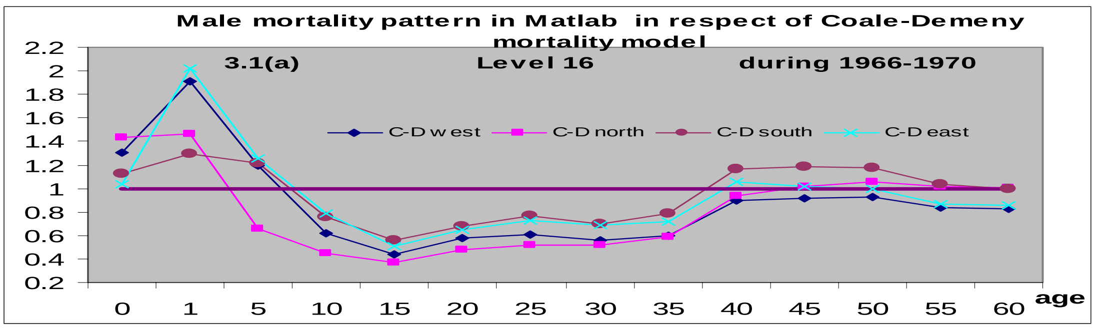
The periods considered 1966-1970, 1971-1976, 1977-1980, 1981-1990, and 1991-2000. The 1970s has been split into two as 1971-1976 and 1977-1980, as the first part was disrupted by War (1971), Famine (1974-1975) and measles epidemic (1976). As this exercise is conducted for entire period (1966-2000), it will draw up the mortality transition according to mortality level. All these will be done by considering the sex also.

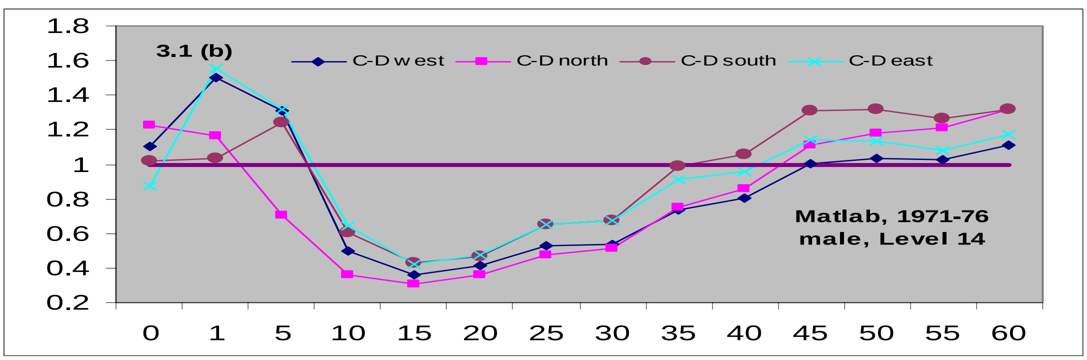
3.4 *Results and Discussion:*

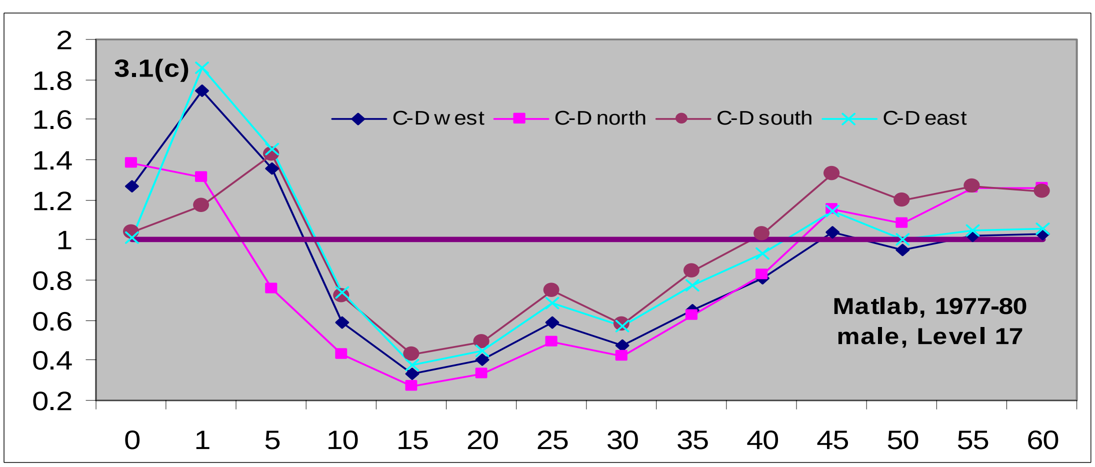
3.4.1 Matlab's mortality pattern comparing to C-D models:

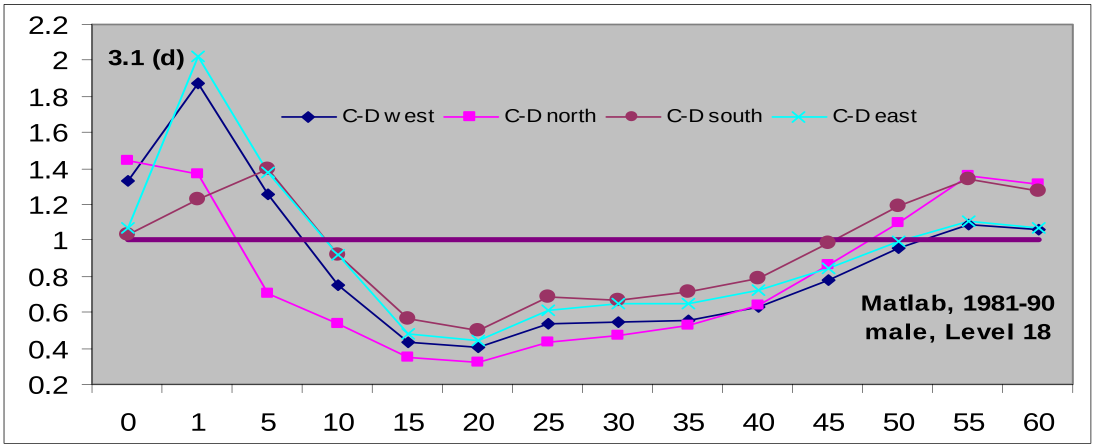
Let's now look through the comparative analysis of mortality pattern of Matlab with the four families of C-D model life table. The ratios of q_x/q_x^a (ratio of q_x from estimated life table of Matlab population to the qx^a of Coale-Demeny) expresses the relatively higher child death rate at age 1 and at age 5 (see figure-3.1 and figure-3.2) by the ratios in respect of any pattern of the C-D models. C-D south model is closer to age specific mortality pattern of Matlab in Bangladesh except at age 5 and at old age. For the ratio estimation, q_x of elderly population is considered up to age 60 because the hypothetical cohort of this period life table estimates is assumed to be end at age 65 and over, where q_x stands for the probability of dying as unity (q_{x+}=1). It is the limitation of this study as it is a bit early old age comparing with model age pattern. It reduces the scope of comparing old-age mortality extensively with that of other model mortality. However, at old age the West pattern looks closer. More particularly, during 1970s when mortality is higher, the West model is the closest match for old age deaths but at comparatively lower mortality level (at 20) C-D east is the closest. With the change over the periods C-D South model is becoming more close to Matlab pattern for both male and female population at level 20 during 1991-2000 except old age deaths. South model comprises the mortality data of Spain, Portugal and Southern Italy which have high mortality under age 5, low mortality from about age 40-60 and high mortality over age 65. This Southern European experience of mortality seemed not to lie very far from South Asian mortality experience. And Matlab population has been experiencing very typical South model mortality pattern through most of the ages except at old age over the period.

Whatever important is that child mortality (both early childhood and late childhood) is relatively higher in Matlab than any of the UN or C-D model pattern without little exception, when early child death of male is closely matched (unity approximately) during 1971-1976 and 1991-2000. Respecting the C-D model overall, mortality of Matlab population looks fairly low at young adult ages, more particularly for the male mortality. But again at low mortality level it is likely to be close, and among four C-D South family is best fit for Matlab mortality pattern except child and old age mortality.









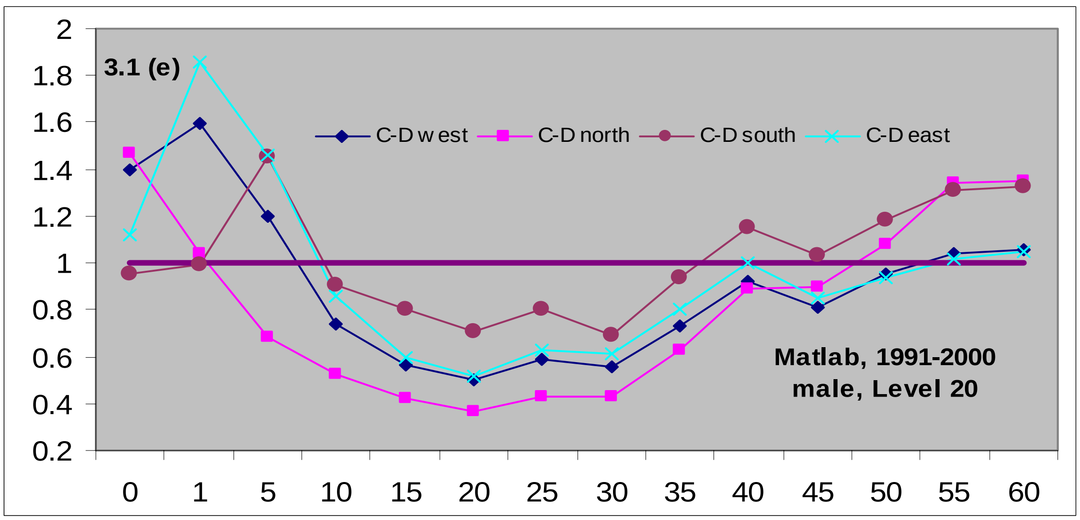
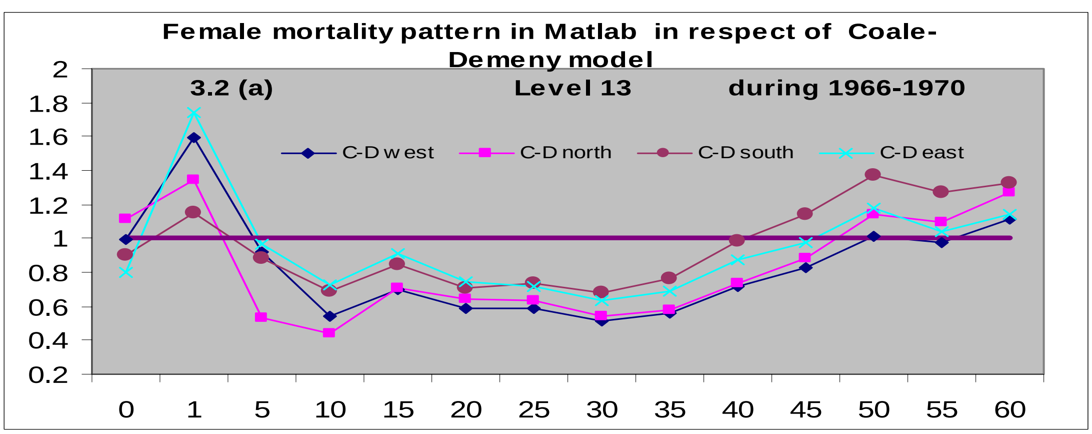
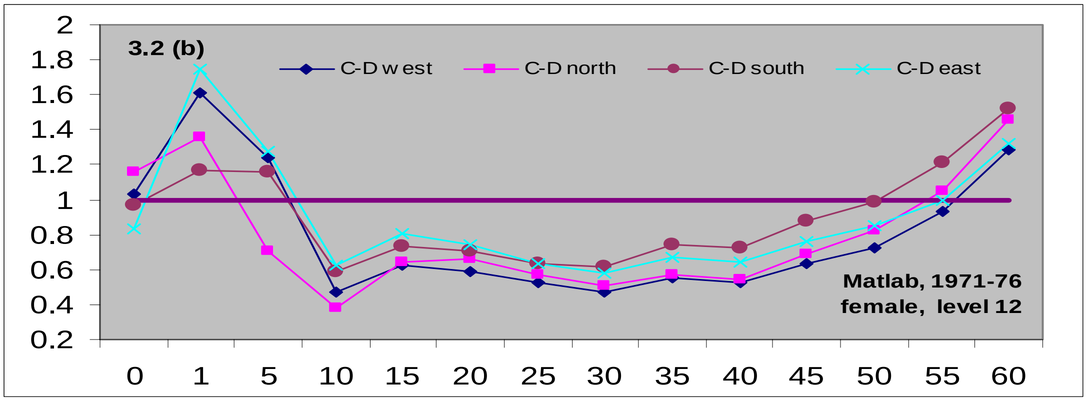
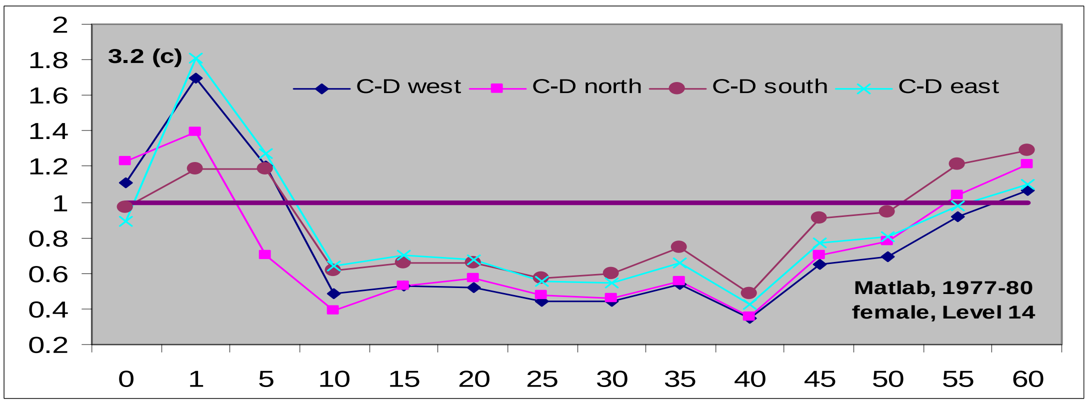
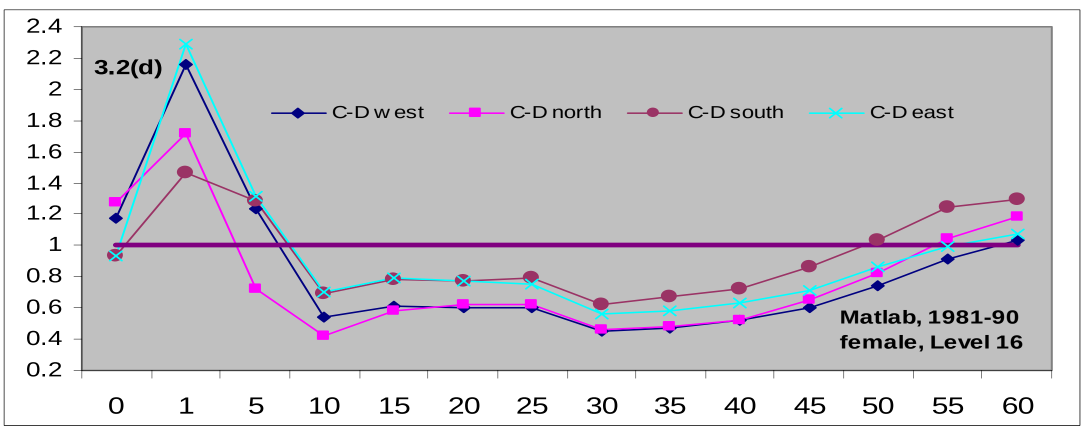


Figure 3.1: Male mortality ratios of Matlab population in respect of Coale-Demeny model




3.2 (b)
C-D west
C-D north
C-D south
C-D east
Matlab, 1971-76
female, level 12


3.2 (c)
C-D west
C-D north
C-D south
C-D east
Matlab, 1977-80
female, Level 14


3.2(d)
C-D west
C-D north
C-D south
C-D east
Matlab, 1981-90
female, Level 16

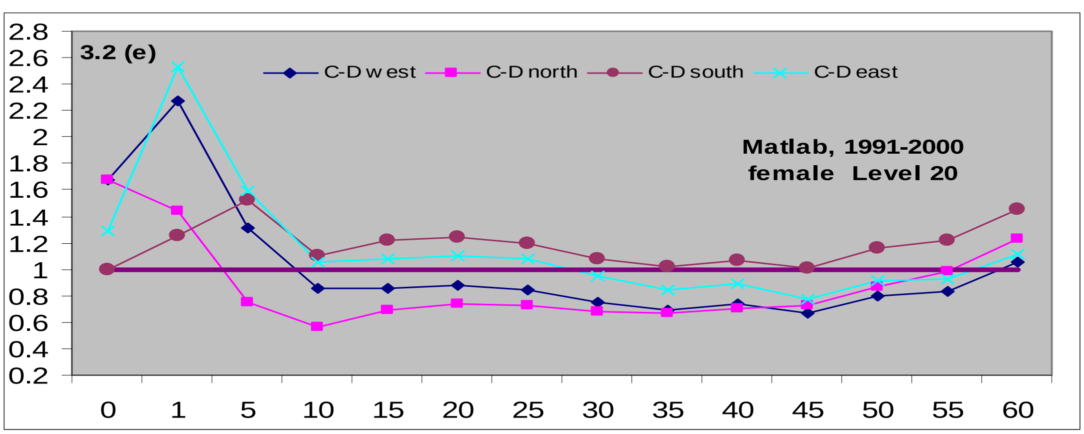

3.2 (e)
C-D west
C-D north
C-D south
C-D east
Matlab, 1991-2000
female Level 20

Figure 3.2: Female mortality ratios of Matlab population in respect of Coale-Demeny model

Old age mortality pattern of male is close to C-D West pattern whereas; female old age mortality is closer to C-D East pattern over the time. Though infant mortality is close to the South pattern, child mortality is quite higher comparing to that standard which indicates that about the child mortality in Matlab. The breast feeding is nearly universal practice in Matlab as well as in Bangladesh which is prolonged for about two years, nevertheless there exist high infant and child mortality.

The cause-of-death structure best explains the variation in model age pattern. The age pattern of the deaths of Matlab population is likely to be closer to South model as the diarrhoeal diseases and respiratory (mainly pneumonia) accounted for most of the infant and child deaths in Matlab.

3.4.2 Mortality pattern in Bangladesh at national and rural level comparing to C-D models:

How well does the Matlab pattern fit the national mortality data? Are both similar to each other? We now turn to the mortality pattern in Bangladesh at national and rural levels as compared with C-D model. One thing that should be born in mind is that the UN took Matlab data, not the national data, for Bangladesh to construct the UN's South Asian life tables because of the low quality of Bangladesh's national death statistics. This may well affect the goodness of fit with respect to the C-D model life table patterns.

High mortality at very young age and at old age is the common feature in Bangladesh. The age specific death rates from different sources like PGE, 1962-1964(Population growth estimation experiment), the Retrospective Survey, 1974, DSS (Demographic Surveillance System) data from Matlab by ICDDR, B and also BBS data (Bangladesh Bureau of Statistics) exhibits the classical U-pattern of mortality which illustrates the most of the deaths occur at very early age groups and at older age groups. In this section mortality ratio of q_x of national level and of rural level to C-D standards (q_x^a) will be presented to outline the compared mortality pattern.

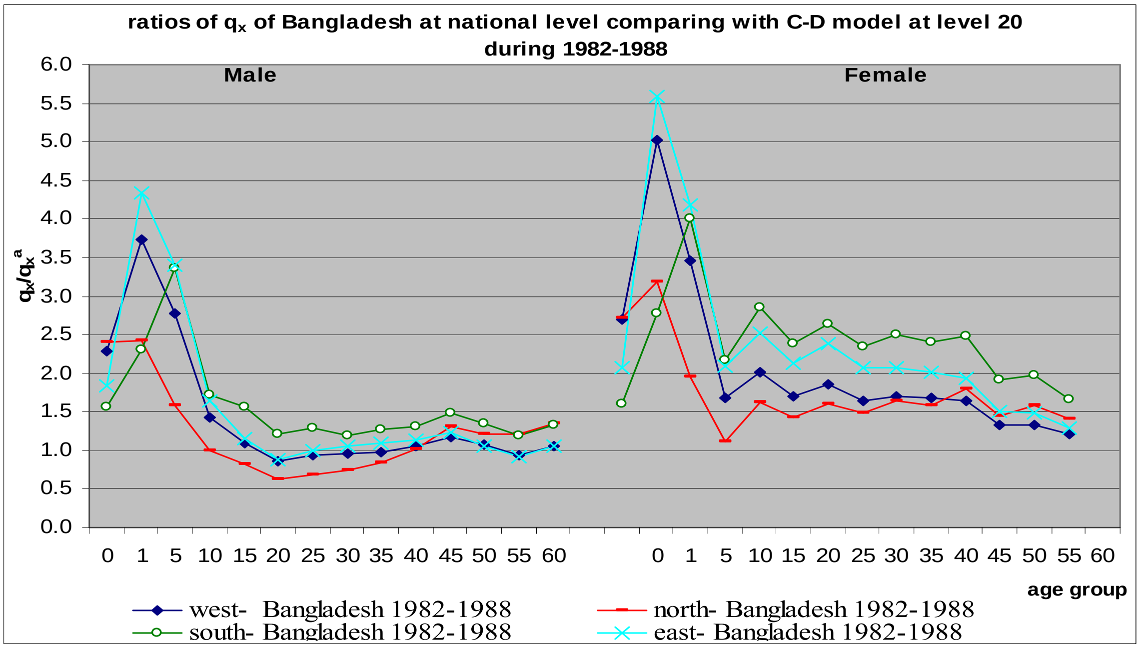


Figure 3.3: Mortality ratio of Bangladesh to the families of Coale-Demeny model life table during 1982-1988

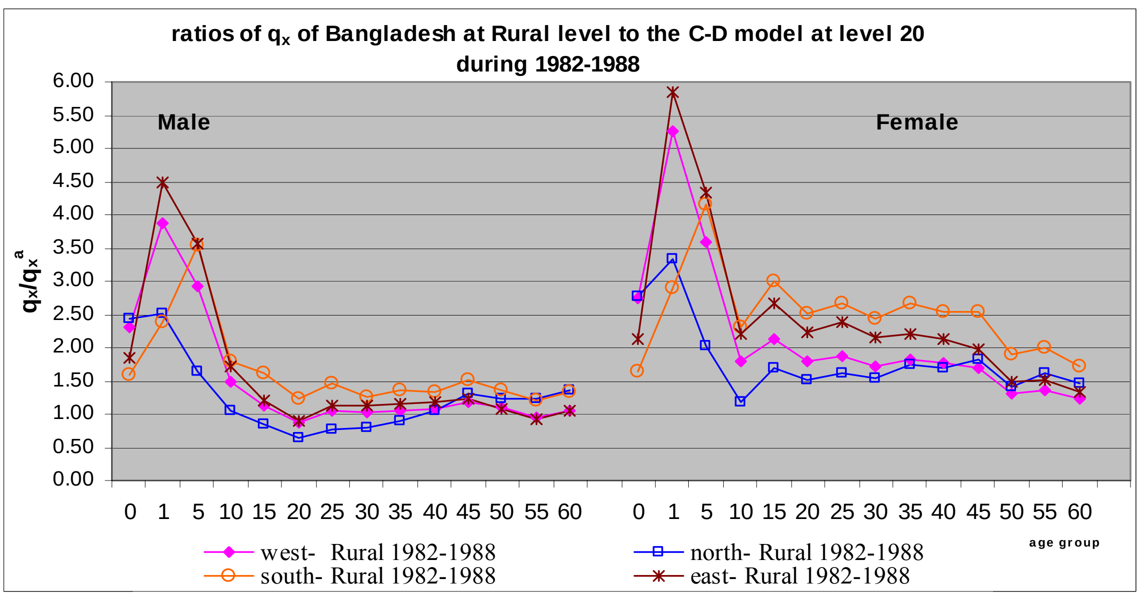
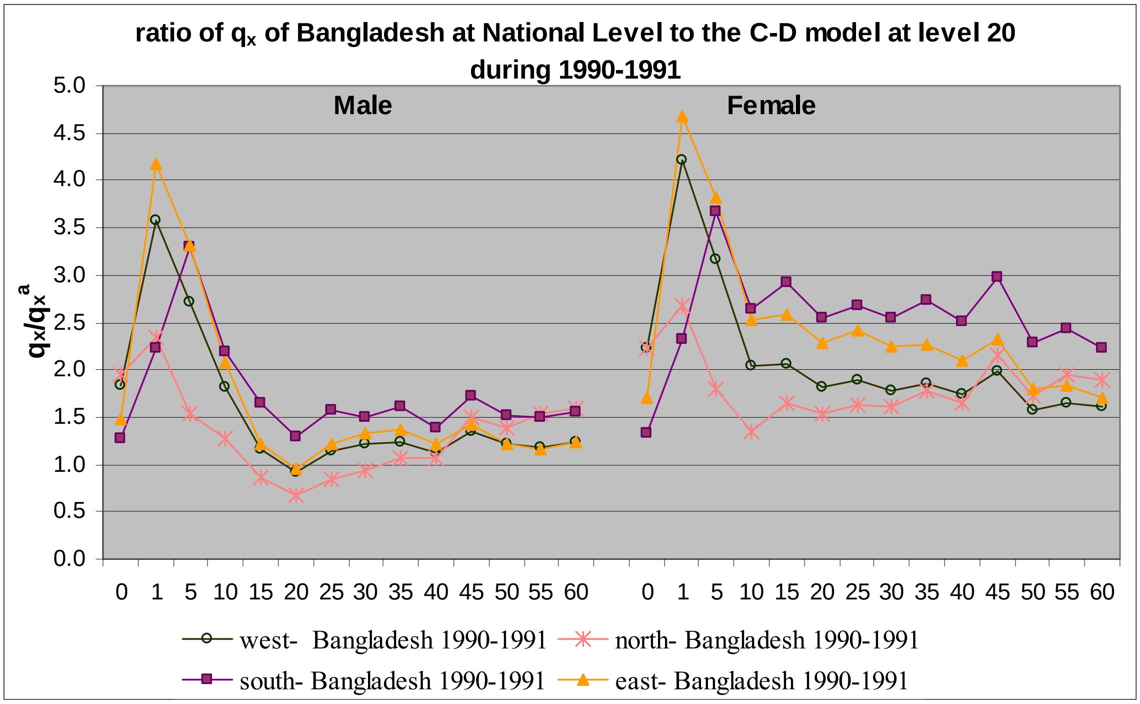
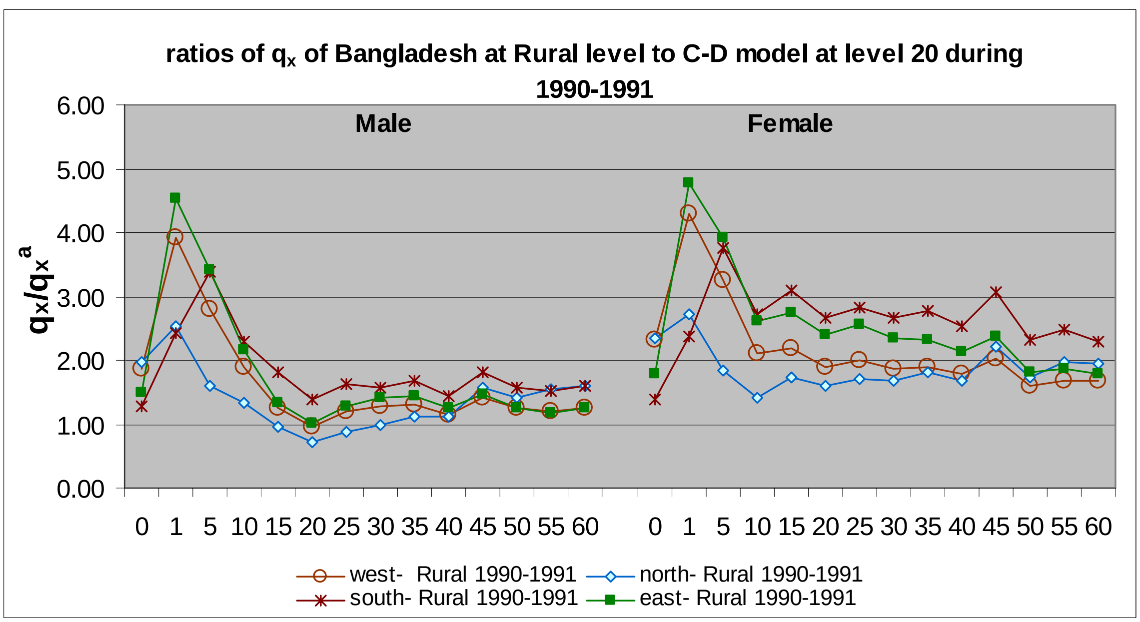


Figure 3.4: Mortality ratio of Rural Bangladesh to the families of Coale-Demeny model life table during 1990-1991



Source: BBS

Figure 3.5: Mortality ratio of Bangladesh at national to the families of Coale-Demeny model life table during 1990-1991



Source: BBS

Figure 3.6: Mortality ratio of Rural Bangladesh to the families of Coale-Demeny model life table during 1990-1991

The ratios are estimated for two different periods, 1982-1988 and, 1990-1991 at both national and rural level. In 1982-88, both national and rural level is showing the same trend where the male deaths after child age are represented as best by the West model but at early ages North type is closer, whereas, female mortality is of North type. In 1990-1991, the trend is similar at national level as it was in 1982-1988. But at rural, both male and female mortality are observed as close to North pattern of C-D model. After 40 years of age, age pattern of deaths is closest to West pattern of mortality. However, it should be noted that the ratio of deviation for the 1-4 age group is much higher than the case for the comparison with Matlab. Thus, although the best fit is the North or West whatever could be among Coale Demeny models, the goodness of fit becomes much lower compared with figure 3.1 and figure 3.2.

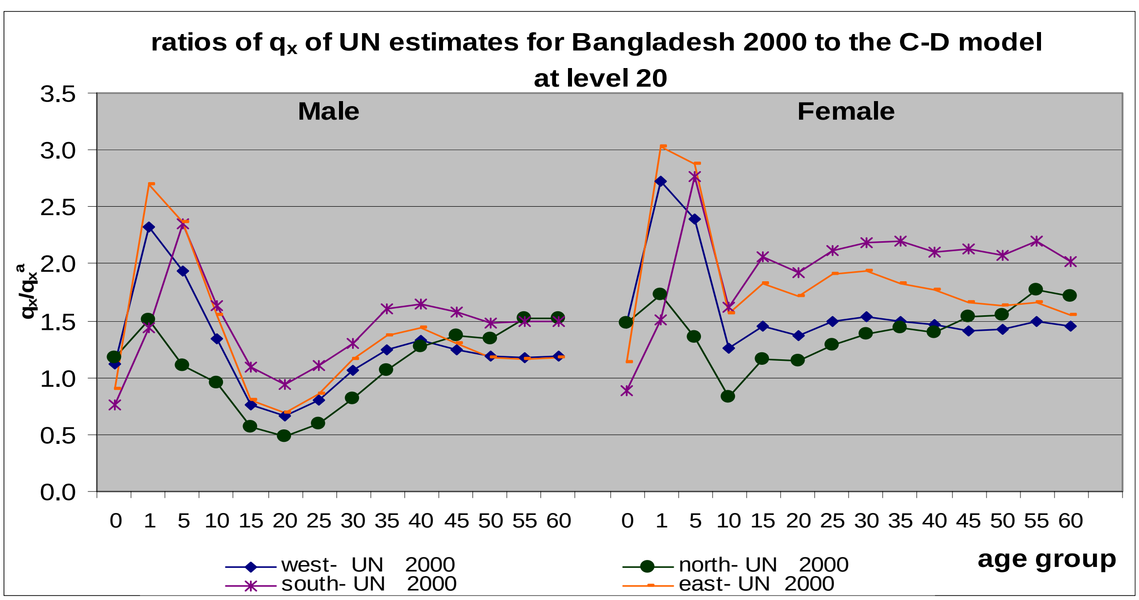
As the age specific cause of deaths for Bangladesh is not available, we couldn't compare it with Matlab experience. But as in Bangladesh high infant and child mortality are common at national and rural levels as well as at Matlab, the cause of death structure would be same approximately in Bangladesh and Matlab. The level of diarrhoeal diseases and other infectious diseases like tetanus (neonate mainly), tuberculosis (as urban population experience higher risk due to this) could make the difference. Recent cause-specific mortality data from Bangladesh and from Matlab suggests that, deaths due to diarrhoeal diseases is decreasing but still important cause, most particularly for early age deaths. Matlab population in fact is having better health care facility, particularly antenatal care, and maternal health care including better access to diarrhoeal treatment as compared to national. But Matlab, as very low lying land, is more diarrhoea prone area than national or other rural areas.

Let's find the difference between age patterns of deaths in Bangladesh (2000) and in Matlab (1975-76) considering the UN estimates. It is also accounting the comparison with C-D model. The ratios are estimated as earlier presented in the figure 3.3 and 3.4 in the next section.

3.4.3 Mortality Pattern of Bangladesh with the UN estimates comparing to C-D models:

It is clearly observed from figures 3.7 and 3.8 that the North family of the C-D model is the best representative of the child death for both male-female in all the periods. But at higher ages, male death rates are closer to C-D West model and female death rate after 40 years is close to that in 2000. Ratios with the UN estimates of 1974-1976 to C-D model death rate, is showing the similar trend as it is in 2000.

The period 1974-1976 (UN used the average mortality for the year 1974 and 1976) is not the normal in sense that the famine started from the second half of 1974 and measles epidemic broke out in 1976. But the mortality pattern is not varying much between these two periods except the marked higher child mortality. It should be noted that measles usually affect at child ages and during epidemic, it had caused huge child deaths and comparatively more female child deaths. However it varies from the South pattern that is found close to mortality of Matlab in this study even in 1971-1976. But it is consistent with the pattern found above for Bangladesh or Rural-Bangladesh. The mortality patterns of Bangladesh and Matlab at different periods are summarized in table- 3.3.



Source: World Health Organization, UN Model Life Table for Developing Countries

Figure 3.7: Mortality ratio of UN estimates for Bangladesh and Matlab to the Coale –Demeny model

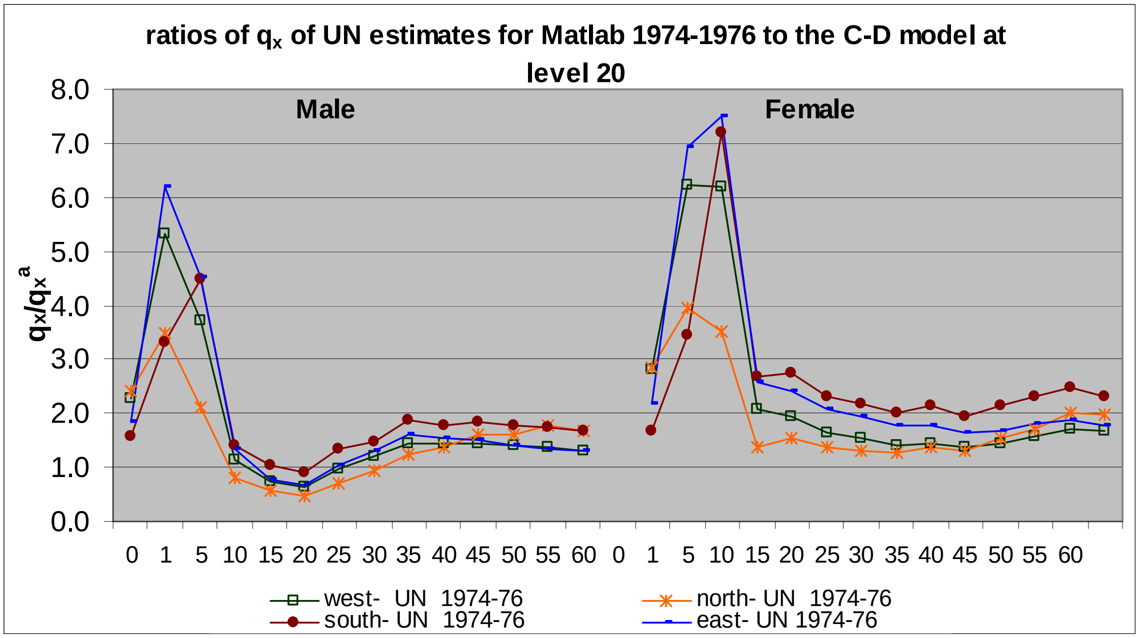


Figure 3.8: Mortality ratio of UN estimates for Bangladesh and Matlab to the Coale –Demeny model

3.5. Conclusion

As far as the age pattern of mortality in Bangladesh in general and rural Bangladesh in particular is concerned, it seems that any of the four C-D model life table families does not fit. If forced to choose, however, we may conclude that it is comparatively closer to the North pattern at early ages, turning to the West at higher ages. As noted earlier, when the general level of mortality is high, it is sometimes difficult to distinguish North and South patterns as both displays a noticeably high mortality for the 1-4 age group. This may particularly be the case with a country whose national death statistics is less accurate.

Matlab's age pattern of mortality also shows a comparatively high early childhood mortality rate. However, it looks much closer to the C-D South model. It can probably be classified as an extreme case of the South pattern. Also the disease pattern of highest death rate for diarrhoeal and certain diseases of infancy by the C-D South model (Preston, 1976) is close to the UN South Asian pattern as it is characterized by high incidence of infectious, parasitic and diarrhoeal diseases at the youngest ages and high mortality from diarrhoeal and respiratory diseases at the oldest age.

It is very difficult to measure cause-specific deaths accurately, particularly for an underdeveloped country like Bangladesh where literacy rate is still lower and the registration of births and deaths in the rural community is likely to be understated. On the other hand, Matlab, a tiny part of rural Bangladesh included in the low-lying Comilla district under the Chittagong division, has long been under a demographic surveillance system.

Table 3.3: Summary Table of the mortality pattern in Bangladesh and Matlab at different periods

Mortality Pattern comparing with four families of Coale-Demeny model life table					
	Year	Best fit	Remarks	Best fit	Remarks
		Male		Female	
Estimated from DSS data					
Matlab	1966-1970	south	for age 40 and above, north type represents well	south	after age 40, east model is the closer
	1971-1976	south	west model is best fitted for age 45 and above	south	south is best fit but after age 55, death rate is higher than any model family
	1977-1980	south	west model is best fitted for age 45 and above	south	from age 50 to 60, east model is closer
	1981-1990	south	after age 50, west model is the closest one	south	from age 55 to 60, east model is closer
	1991-2000	south	south becomes more closer but for age 40 and above both east and west are closer	south	overall south is best fit, almost near about unity except at child ages, and east model is the colsest at age 10-25 and old ages 50-60 years,
UN estimates					

Bangla desh	2000	west	North is good fitted for the age 0-10 years	north	west is more close for aged over 50
Matlab	1974-1976	west	North is good fitted for the age 0-10 years	north	at old age west model is closer
Estimated from BBS data					
Nation al	1982-1988	west	West is best representative for the deaths of male aged 15 and above; at early ages it is north type.	north	after age 40, west is the closer fit
Rural	1982-1988	west	Same as above	north	Same as above
Nation al	1990-1991	west	Same as above	north	Same as above
Rural	1990-1991	north	after age 40, west is the closer	north	Same as above

The Demographic Surveillance System not only provides us with a wealth of data but keeps the data quality high as well. Topologically and climatically, Matlab cannot be isolated from Bangladesh as a whole, so that its cause-of-death statistics may not be very different from that for that nation as a whole. However, differences in the data quality may well account for the different match with respect to the C-D regional life table models.

Indeed, Matlab is consistently of the South type over the decades despite an improvement in the level of mortality from Level 16 of male (i.e., e_0 =54.12 years by the C-D West and 54.10 years by C-D South model etc. in level 16 for male population) whereas, and Level 13 of female (50.0 and 50.0 respectively) in 1966-1970 to Level 20 for both sexes in 2000 (in level 20, e_0 =63.63 and 63.65 respectively for male, and 67.5 and 67.5 for female respectively). The only change we can find is that the Matlab pattern now looks typically South type.

Chapter Four
Famine Mortality and Sex Differentials in Rural Bangladesh: The Case of the 1974 Famine

4.1 *Introduction*

Famine causes one of the two steep rises in mortality in the history of Bangladesh after 1943. The trend line with crude death rate (CDR) in Matlab by the exponential method is showing how the overall mortality situation has been affected. The first rise happened due to Independent War in 1971 and second one in 1975 which resulted from the famine in 1974. Famine started during the last half of the year 1974. But the mortality became highest in 1975. Indeed, these two different events seemed to affect the population on a similar scale of death.

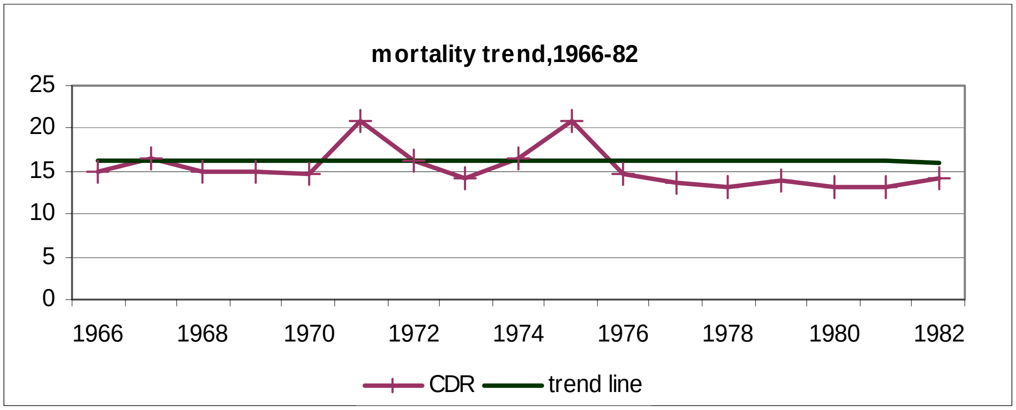


Figure 4.1: Mortality trend in Matlab over the decades

Demographic response to famine has attracted much attention in the field of crisis mortality. A large number of studies have examined the mortality responses in terms of sex differentials. Excess death is the norm during famine. The greater excess in deaths is more likely to be observed for males, especially for adult males as exemplified by Tim Dyson's work on the Indian famines of 1876-1878, 1896-1897, and 1899-1900, the Bengal famine of 1943, and the Bangladesh famine of 1974-1975 (Dyson 1991). Similar results are found for Sudan in 1986, the Great Irish famine, the Tenpo famine of 1833-36 in Japan, and the Dutch Hunger Winter of 1941-1942 (Pitkänen 2002). It is often suggested that the male vulnerability in famine crisis was influenced by more or less biological factors such as men's comparatively thinner body fat and higher risk behaviour, which implies a greater risk of contracting infectious diseases.

However, the sex differentials in mortality are an issue which is far from simple, and can also be culturally determined. In South Asian contexts, for example, it is widely accepted that there exists a sharp north-south divide in terms of female autonomy and, hence, the degree of gender biases against women in society: female autonomy is unambiguously higher in the south than in the north (Dyson and Moore 1983). In their paper on Madras and Punjab in the colonial period, Osamu Saito and others have demonstrated that in the north Indian province of Punjab, the lower the level of estimated life expectancy the greater the difference between male and female life expectancy. This implies that in a year of mortality crisis the male-female gap in mortality became greater (Saito and Takahama 2005). And Bangladesh is a society of the 'north' type. In such a society where gender biases are embedded, female mortality tends to become higher as soon as the neonatal period is over, and this female disadvantage is likely to be more marked at the time of famine. This chapter, therefore, aims to explore the sex differentials in mortality from this perspective at the time of the Bangladesh famine of 1974. Unlike other parts of the Indian subcontinent where drought caused severe famines in history, most of Bangladesh's famines, including these two, were occasioned by floods as the country with huge rivers and canals in flat alluvial plains, is often hit by tropical monsoon. Correspondingly cause-specific death patterns are different: cholera and diarrhoeal diseases have been more prevalent in this flat country than malaria.

This famine has already been studied by many scholars such as Dyson, Chen and Chowdhury, Watkins and Menken (Dyson 1991, Chen and Chowdhury1977, Watkins and Menken 1985), but by focusing on the sex differentials, it is hoped that present study may shed fresh light on famine mortality. I would like to show that as far as infant and child mortality is concerned, the Bangladesh famine of 1974-75 did not reduce gender inequality; more specifically, that the female disadvantage started right after the neonatal period.

Mortality estimates such as all survey data, the national census data, and the vital registration data indicate that there existed sex differentials in mortality. After 1947, two nation wide surveys, PGE (Population Growth Estimation experiment) during 1962-1965 and Bangladesh Retrospective survey in 1974, were conducted, both suggesting consistently higher female than male mortality rates in certain age groups. The retrospective survey found slightly higher female mortality at ages 40 and over, (Bangladesh Retrospective Survey on Fertility and Mortality 1974), whereas the PGE indicated a higher female mortality in childhood (1-4 years) and in the whole range of ages from 10-44 years and, 55 and above(UN 1981). The typical Bangladeshi family has strong son preference as the male household head is always the decision maker. Literacy and school enrollment rates were higher for boys though the trend has recently been reversed; male members of the family are more economically active than females, although the female rate of labor force participation and other indicators have been markedly increasing in recent years. For this reason, while the age specific mortality rates show noticeable gender disparities even today, this study aims to examine how sex-specific mortality rates responded to famine in the crisis year of 1974-1975.

4.2 *Method and Data*

In order to examine sex differentials in mortality at the time of famine, this paper employs a technique used by Dyson, which compares age-specific mortality rates in the famine year with those recorded in the reference year. This method enables us to check if female children were not necessarily disadvantaged in the famine year in proportional terms.

However, since the paper intends to focus on the very early periods of children's life, it is desirable for us to be able to separate the post-neonatal from the neonatal period even within the time-frame of infancy. As Jean Bourgeois-Pichat demonstrated in 1951, infant mortality rate (IMR) can be divided into endogenous and exogenous components. He showed this by plotting cumulative deaths within the first year on a diagram with the horizontal axis subjected to a logarithmic transform ($P_n = \log^3 (n+1)$, where n is the age in days) (Bourgeois-Pichat 1951). According to this exposition, 'exogenous' deaths are concentrated in the post-neonatal period. A very much similar idea had been developed by a Japanese medical scientist, Hiroshi Maruyama, who had plotted cause-specific cumulative death data for USA 1934 on a diagram with both axes logged (he took logarithms to the base 10). According to this transformation, the slope of each graph on the diagram corresponds to the rate of change in deaths from period n to period n+1, and his diagram pointed to virtually the same tendencies: that graphs for prematurity, birth trauma and inherited genetic defects tended to become flatter, while those for infectious diseases and other causes started increasing only after the first month with much steeper slopes (Maruyama 1936, 1938). One important implication of their expositions is that in the neonatal period sex differentials in mortality cannot be substantial as 'endogenous' factors are sex neutral, whereas in the post-neonatal and subsequent periods culturally and socially determined gender biases may affect the probability of death between male and female children. Of the two, the Maruyama method will be utilized later since it allows us to compare the male and female graphs in terms of the rate of change over the period concerned.

For those exercises the DSS data will be exploited. They were collected through the vital registration and also census systems, under the project of International Centre for Diarrhoeal Diseases Research, Bangladesh (ICDDR,B) in Matlab which situated about 70 km southeast of Dhaka. Both census and vital registration data are being taken there since 1966 under this project and quality and coverage are good enough as the field workers are sent to the households in villages in regular basis.

4.3 *Overview of Mortality in Bangladesh and Matlab*

Overall mortality trend in Bangladesh is a declining process. All the sources of demographic study suggest that mortality patterns are characterized by sex differentials as well as age selectivity. Usually females in Bangladesh experience higher mortality. Post neonatal and child deaths are more numerous for female than for male children.

Table 4.1: age-sex specific death rates of Bangladesh

age	PGE 1962-64 male	females	Retrospective survey 1974 male	female	DSS 1974 male	female	BBS 1985-88 male	female	DSS 1985-88 male	female
0	161.1	127.5	179.1	160.6	142.5	132.9	118.09	107.39	93.48	90.48
1-4	22.6	27.4	47.5	45.4	18.2	32.6	12.84	15.13	11.15	19.98
5-9	6.8	6.3	5.6	5.4	4.8	6.4	3.21	3.47	2.5	2.95
10-14	2.1	2.6	2.9	2.9	1	1.8	1.45	1.37	1.05	1.08
15-19	1.9	6.8	4	3.9	1.1	3.5	1.9	2.48	0.98	1.85
20-24	3.2	6.6	7.4	7.3	1.2	3	2.04	2.95	1.45	2.2
25-29	3.1	8.8	7.7	7.6	2.3	2.8	2.47	3.67	1.95	2.73
30-34	5.4	8.3	7.6	7.6	3	4.3	2.75	3.97	2.15	2.25
35-39	6.2	9.8	8.3	8.3	5.6	4.2	3.36	5.22	2.78	3.23
40-44	8.1	9.5	9.6	9.7	6.5	6.9	4.94	6.72	4	2.58
45-49	12	9.7	11.9	12	10.7	6.8	8.26	8.84	6.55	5.65
50-54	17	15.5	15.2	15.5	15.7	11	12.18	10.44	12.58	8.05
55-59	21.3	25.8	20.5	21	21.8	19.8	15.8	16.09	20.28	12.58
60-64	33.4	40.3	28.7	29.6	33	37.4	28.05	22.06	28.63	25.18
65-69	49.9	54.8	41.2	42.9	77.8	103.1	48.57	41.57	75.18	69.55
70-74	76.3	85.7	61.1	63.9			63.23	63.38		
75+	111.3	136	92.4	97.1			142.92	151.38		

Source: Population of Bangladesh, country monograph series-8, New York, 1981; Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality (Dhaka, 1977); Report of Demographic Surveillance System Matlab, 1974, ICDDR,B and Vital registration data, 1985-88, Bangladesh Bureau of Statistics

These patterns are found not only in Matlab but also at national level (see Table 4.1)[1]. Matlab is a rural area which is very flat and crisscrossed by the rivers and canals. Cholera and diarrhoea were more common in the past though it has become cholera free in 1974. It was part of the Comilla district during famine period which is highly agricultural, and occupies the fifth position in the ranking of districts according to population size with population growth rate being 2.2 % per annum in the 1961-1974 periods (2.6% for overall Bangladesh). Comilla was severely affected in 1974 as its rice production was disrupted greatly and thus per capita food availability declined substantially (Sen 1999)

The famine in 1974 started at the end of the year. Its effect was reflected in the death rates for that year, but the mortality peaked in mid 1975, after which it declined but slowly partly because of the outbreak of measles in 1976. Figure4.2 shows how the male and female crude death rates (CDRs) changed from 1974 to 1980. In 1974 the female CDR was higher than the male one; in 1975 the male rate increased more than the female one; then in 1976 both rates declined but did not return to the 1974 pattern. It was during the 1977-1980 period that the pattern of the female disadvantage was reestablished.

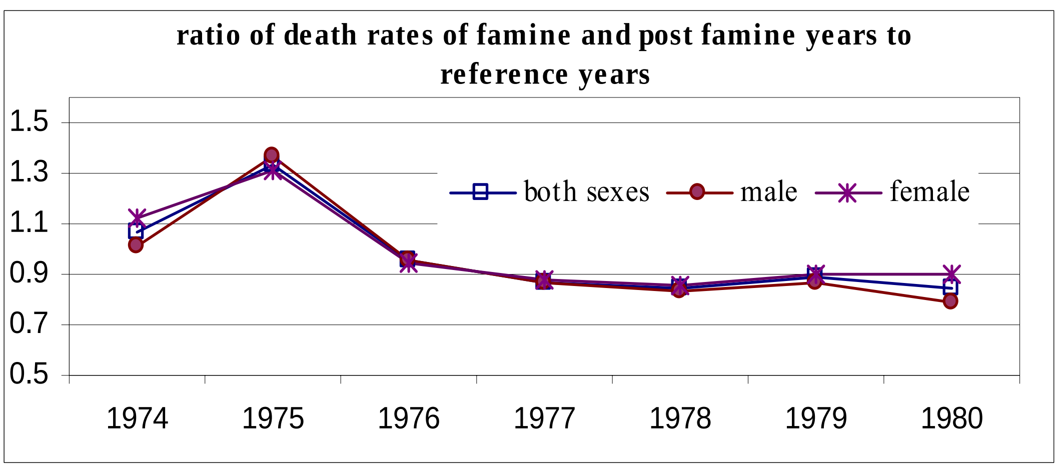


Figure 4.2: Change in mortality rate by sex due to famine of 1974

[1] All the estimates of Bangladesh Bureau of Statistics(BBS) support to the higher female mortality in Bangladesh as age specific death rates during 1981-2001 is showing higher death rates of female at (1-11) months and at (1-4) years of age. At age (5-9) years, adolescent period and also in child bearing age female have higher death rates in compare to male during these periods but not consistently though the probability of dying reduces faster for female than male over the years.

The age-specific death rates for both sexes are presented in table 4.1. In Bangladesh the sample vital registration report of 1999-2001 provided by the Bangladesh Bureau of Statistics (BBS) has found that female mortality is higher during the post neonatal and early childhood periods, and also in the late childhood period (5-9 years) at national level as well as in both rural and urban levels, although there are some cases in which it is only slightly higher for females or years when it is not consistent with the general pattern. However, as shown in Table 4.1, which sets out age-sex specific mortality rates for 1962-1988 from various estimates, IMR (i.e. the combined rate of neo-natal and post-neonatal mortality) as well as old age mortality rates are consistently higher for females than for males. This, on the face of it, suggests that in the Bangladesh famine of 1974 too, what Dyson regarded as a stylized fact holds. However, in order to determine whether the stylized fact holds or not, it is crucial to see if the infant and child mortality rates increased in the famine period in comparison with the normal period, to which I shall now turn.

4.4 *Results*

4.4.1 *Proportional change over the years*

Tim Dyson's analysis of the South Asian famines, including the Bangladesh famine, was conducted in terms of proportional rises in the age-specific death rates at the time of famine calculated in relation to the rates in the reference period. For the Bangladesh famine of 1974-1975 he chose 1976-1977 as the reference year. However, as I suggested above, measles was prevalent in that year 1976, which may well have had an impact on the calculated sex differentials in early childhood mortality. I therefore regard 1966-68 as the reference period and the average of mortality rates in those years as the baseline rates.

Table 4.2 sets out actual age-specific rates in Matlab for the reference period and the famine and post-famine period of 1974-1977, and proportional rises for the latter. The baseline mortality pattern resembles those for national rates in table 1: IMR is higher for males, but since age 1 the mortality rate becomes higher for females all the way to the age group 65 and over. The 1974 and, to a lesser extent, the 1976 and 1977 patterns are similar, but the 1975 pattern differs in that the female IMR exceeds the male one, and also in that the male rate exceeds the female one from the age group 25-29 upwards (see figure-4.H in appendix). The latter is an expected finding, while the former is not, probably a consequence of the change in the reference period.

Turning to the proportional-rise estimates, there are also expected and unexpected findings. What is expected is that adult males were more affected than their female counterparts in proportional terms, just as Dyson's stylized facts and his own findings on the 1974 Bangladesh famine suggest. Despite the use of the different reference period in this study, it is confirmed that male mortality from age 25 upwards increased in 1974 and 1976-77, with a few exceptions, more than female mortality. In 1975, the worst famine year, the male ratio substantially exceeded the female one from age 10 up to old age. This therefore confirms what Dyson and others have already found. On the other hand, the results for the younger age groups differ from his findings. Proportional rises for the under-1 and 5-9 age groups are greater for female than male infants throughout the 1974-1977 periods. In the 1-4 age group, the female ratio exceeds the male one for 1974, 1975 and 1977 while even in 1976 the male ratio fails to exceed the female one. Three facts merit special attention.

Table 4.2: Death rates and Proportional change in Death rates in Matlab by age and sex during famine and post famine periods.

MALE	base periods	Death rates				Ratio(death rate of particular year/1966-68)			
age	1966-1968	1974	1975	1976	1977	1974	1975	1976	1977
0	125.03	142.5	165.1	113.6	113.3	1.14	1.32	0.91	0.92
1-4	22.37	18.2	28.8	25.5	14.5	0.81	1.29	1.14	0.43
5-9	4.2	4.8	4.9	4.6	3.4	1.14	1.17	1.1	0.67
10-14	1.43	1	1.5	1.1	1	0.7	1.05	0.77	0.38
15-19	1.9	1.1	1.9	1	0.9	0.58	1	0.53	0.26
20-24	3.17	1.2	3.1	2.2	2.2	0.38	0.98	0.69	0.56
25-29	3.13	2.3	4.7	2.1	1.8	0.73	1.5	0.67	0.4
30-34	3.77	3	4.6	3.6	2.9	0.8	1.22	0.96	0.62
35-39	3.87	5.6	8.6	3.7	3.5	1.45	2.22	0.96	0.7
40-44	7.33	6.5	14.8	7.9	5	0.89	2.02	1.08	0.65
45-49	9.97	10.7	22.3	8.4	10.8	1.07	2.24	0.84	1.38
50-54	15.77	15.7	34.9	18.8	15.2	1	2.21	1.19	1.02
55-59	18.63	21.8	44.5	19.8	21.8	1.17	2.39	1.06	0.87
60-64	24.57	33	60.9	40.7	31.9	1.34	2.48	1.66	1.07
65+	68.8	77.8	113.4	74	76.2	1.13	1.65	1.08	0.94
FEMALE									
0	115.1	132.9	184.1	110.3	114.2	1.15	1.6	0.96	0.99
1-4	29.57	32.6	41.3	33.8	25.2	1.1	1.4	1.14	0.85
5-9	4.43	6.4	6.8	6	4.6	1.44	1.53	1.35	1.04

10-14	2.27	1.8	2	1.5	1.3		0.79	0.88	0.66	0.57
15-19	3.63	3.5	2.8	2.5	2.8		0.96	0.77	0.69	0.77
20-24	4.17	3	3.9	3.1	3.1		0.72	0.94	0.74	0.74
25-29	4	2.8	3.7	2.6	2.5		0.7	0.93	0.65	0.63
30-34	4.53	4.3	4.5	2.6	2.6		0.95	0.99	0.57	0.57
35-39	4.37	4.2	6.9	4	4.7		0.96	1.58	0.92	1.08
40-44	7.03	6.9	6	3.6	2.5		0.98	0.85	0.51	0.36
45-49	8.8	6.8	11.7	7.1	6.7		0.77	1.33	0.81	0.76
50-54	14.9	11	13.7	12	11.4		0.74	0.92	0.81	0.77
55-59	20.17	19.8	35.9	17.4	19		0.98	1.78	0.86	0.94
60-64	32.47	37.4	49.2	42.2	33.6		1.15	1.52	1.3	1.03
65+	81.77	103.1	111.5	75.5	76.2		1.26	1.36	0.92	0.93

First, in the famine period there seems to have been acceleration in the worsening of female mortality relative to male mortality during the childhood period: the level of proportional rise in female mortality increased from early to late childhood. Second, proportional rise in IMR was consistently greater for female than for male infants. Third, in the year 1975 while famine effect heightened, the female ratio increased substantially in both infant and childhood periods, cumulatively the girl's chance of survival worsened enormously. These are the points not necessarily consistent with the stylized facts.

4.4.2 *Infant and Child Death: The Bourgeois-Pichat/Maruyama Method*

For any deeper analysis of infant death, however, it is crucial to separate the neonatal from the post-neonatal period when examining IMR. In the neonatal period, endogenous factors determine the probability of death; so that there can be no deliberate discrimination against girls, while in the post-neonatal period cultural and social norms may well intervene. Indeed, Bangladesh's recent statistics reveal that the female death probability is consistently higher than the male one for the period after the first month while the reverse is the case during the first month after birth. Such differences in male-female mortality in the post-neonatal and childhood periods are said to be explained by differential practices favoring boys over girls in child rearing and/or in treatment of illness (Mitra et al 1997). And, fortunately, it is possible to divide infant deaths into sub-periods for Matlab too (see appendix).

As we have already seen, there are two slightly different methods of analyzing infant mortality: one is Bourgeois-Pichat's and the other Maruyama's. Bourgeois-Pichat uses the transformation P (n) =log3 (n+1) for the horizontal axis while the vertical axis is kept on the ordinary scale. Maruyama, on the other hand, plotted the cumulative death totals (or rates) on a log-log plane. I have plotted out 1966-1967 data on these two diagrams, from which sex-specific death rates are available for one-week-olds, one-month-olds, nine-month-olds, four-year-olds and nine-year-olds. Figure 4.3 and Figure 4.4 are on the Bourgeois-Pichat's and Maruyama's log-log plane respectively, and it is easier for us to compare the male and female death curves on the Maruyama plane as the slope of each curve corresponds exactly to the rate of change in the cumulative number (or rate) of deaths from one point to another in time. Given the uneven nature of subdivision of the infant period in the original data (length of period varied from time to time), I will adopt the Maruyama method in the analysis below.

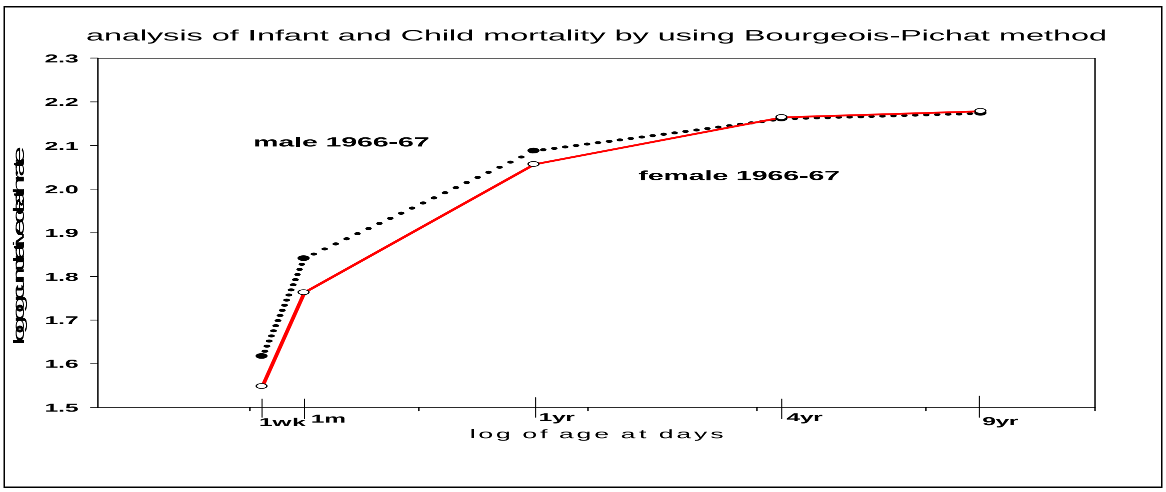


Figure 4.3: Change in Infant and Child mortality over the age by Bourgeois-Pichat method

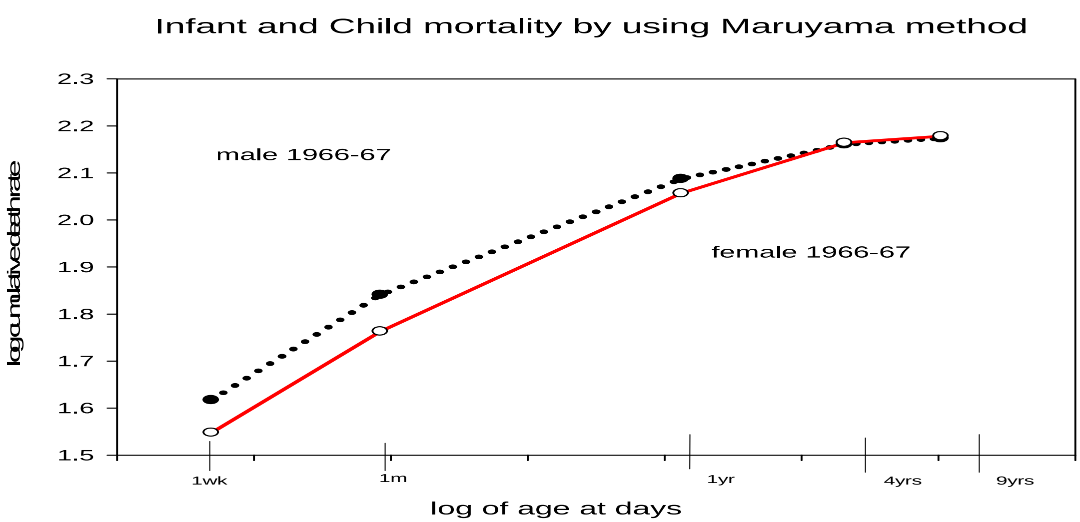


Figure 4.4(a): Change in Infant and Child mortality over the age by Maruyama's technique in 1966-1967

Figure 4.4(a), which is for the normal years of 1966-1967, merits attention. The graph indicates that the rate of increase in the cumulative death rate between the first week and the first month was a little steeper for the male than the female group, while after the first month the female curve became steeper and steeper, so that the male and female curves crossed over in the late childhood. This picture of normal years suggests that female disadvantage began soon after the neo-natal period was over, although it was in the 5-9 age group when the level of female mortality exceeded that of male mortality.

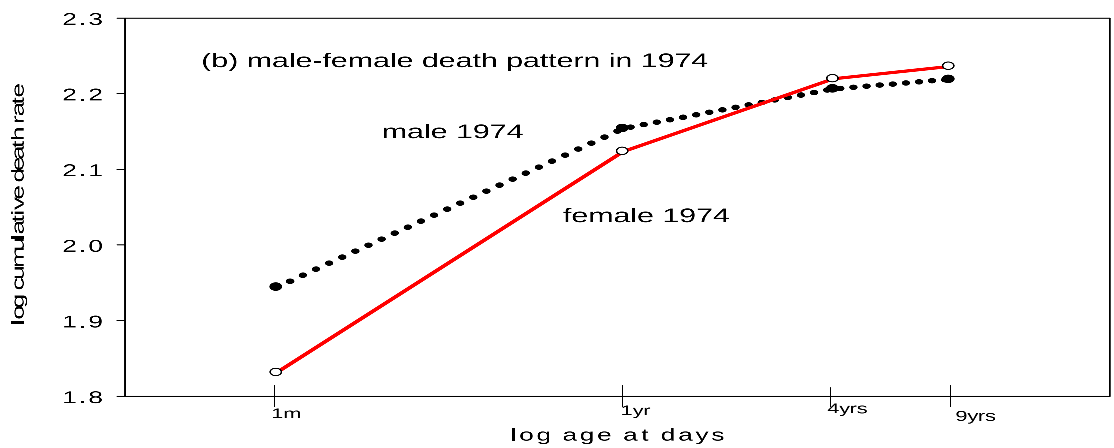


Figure 4.4(b): Change in Infant and Child mortality over the age by Maruyama's technique in 1974

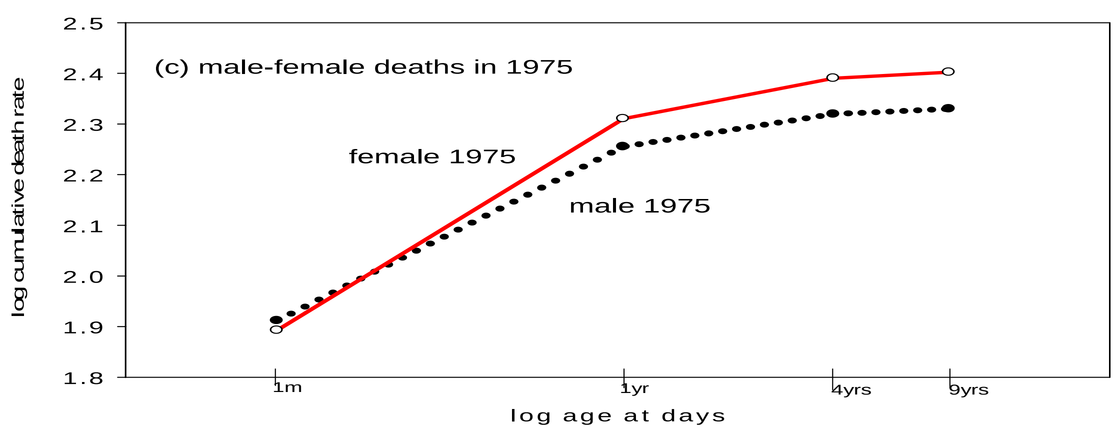


Figure 4.4(c): Change in Infant and Child mortality over the age by Maruyama's technique in 1975

Figure 4.4(b) is for 1974 when the famine started. Data do not allow us to see what happened during the neonatal period, but it is probably not unrealistic to assume that the male-female pattern was very much similar to that in figure 4.4(a). For the post-neonatal and childhood periods too, a similar pattern is observed. The only difference is that the cross-over point moved from late to early childhood.

A totally different pattern appeared in 1975, when the famine mortality peaked. Figure 4.4(c) reveals that the levels of male and female mortality came much closer in the first month, and soon after that period the female curve exceeded the male one. In 1976-1977, the pattern in figure 4.4(d) returned to the 1974 pattern, while as shown figure 4.4(e), which is for 1978-1983, again higher female mortality started earlier, i.e. from the post neonatal period. From October 1977, ICDDR,B provided Maternal and Child Health Care in Matlab, but ironically it seems to have made female children even more vulnerable from age below one upwards[2].

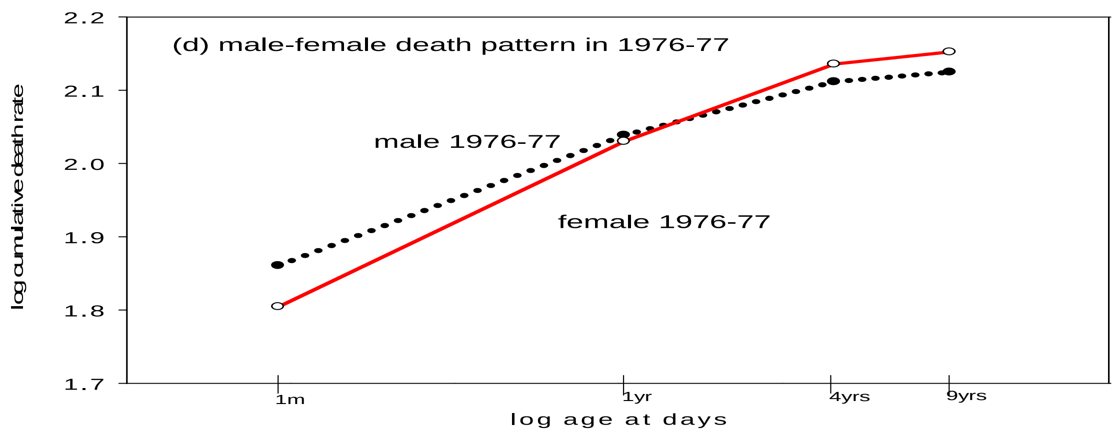


Figure 4.4(d): Change in Infant and Child mortality over the age by Maruyama's technique in 1976-1977

[2] The difference between 1966-67 and 1978-83 is interesting but not unaccountable. ICDDR,B started their program in 1966. Before 1966, it is evident from other study cholera and diarrhoeal diseases had accounted for huge deaths in Matlab as well as in Bangladesh. In the absence of enough treatment and health care many children had died irrespective of their sex. Under such conditions deaths in neonatal and post neonatal periods were less sex-selective. But from age four on, disparity in mortality became clear. However, the scenario of 1978-83 matches with the mortality experience during famine peak period of 1975 and raise a new question here; why is it so? How about it in recent period? This study hasn't given much attention regarding this as it is not relevant here but in future study.

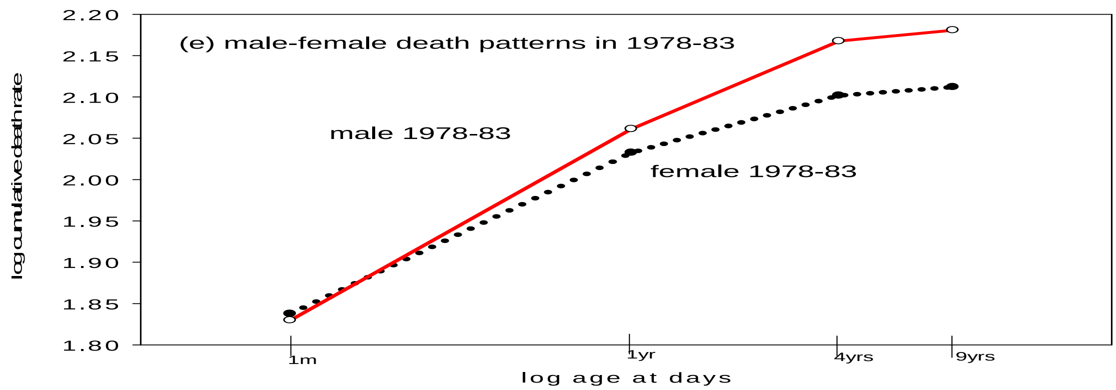


Figure 4.4(e): Change in Infant and Child mortality over the age by Maruyama's technique in 1978-1983

Despite all these differences from year to year, however, it is worth noting that the female curve in all the Maruyama diagrams becomes steeper than the male one in the post-neonatal period. This means that the female disadvantage began right after the first month. In 1975, the peak year of famine mortality, the slope of the female curve became so steep that it overtook the male one well before the first birthday, which in turn increased the total number of female deaths more than that of male deaths in the first year of life, allowing the female IMR overtaking the male IMR in 1975.

4.5 *Discussion and Conclusion*

In most historic famines, infants and young children were proportionally less affected than adults and it was male adults who were most affected. However, this paper has found that from 1974 through 1977 the proportional rise in female mortality relative to that in male mortality was pronounced in childhood, especially in the 5-9 age group, suggesting that the later the greater the female disadvantage. Also found is that in 1975, the peak year of the Bangladesh famine, female IMR tended to rise more than male IMR and the magnitude of proportional rise in IMR leveled with that for the 5-9 age groups. I have argued that it was because the female disadvantage started soon after the neonatal period, and that it was heightened, rather than lowered, during the most disastrous year of the famine period.

How can this female disadvantage be explained? Is it biological, bacteriological, cultural or anything else? One thing that is worth mentioning here is that in the Bangladesh famine there was no outbreak of any acute infectious disease. Unlike many other famines on the Indian sub-continent, it was free from malarial outbreaks. The case fatality of an infectious disease such as malaria, i.e. the proportion of individuals contracting malaria who die of that disease, is so high that their impact is unlikely to be sex selective. In other words, there must have been more room for gender-related factors to operate in this case of the Bangladesh famine.

This allows us to turn to the issues of nutrition, lactation and health care. Nutritional surveys in Bangladesh from 1985 to 2000 have found the prevalence of underweight, wasted and stunted children among girls far greater than boys. Severe or moderate malnutrition is also higher for female children (Child Nutrition Survey, Bangladesh 2000). Per-head food intake of boys consistently exceeds that of girls in all age groups. Male caloric consumption in Matlab exceeded female consumption by an average of 16 percent among children, 11 percent among 5-14 years, 29 percent for 15-44 years, and it exceeded most at ages over 45 years by 61 percent (Chen et al. 1981). Malnutrition is one of the major causes that accounted for high infant and child mortality rates. About 9 and 17 percent of live births result in death from severe malnutrition in the first month and the first year respectively, while 26 percent die before reaching the age of 3 (Rosenberg 1973). In another study, one-third of the total deaths in 1986-87 of children of Matlab between 6 and 36 months of age were found associated with severe malnutrition, and 79 percent of those deaths were associated with diarrhea. Moreover the risk of dying from severe malnutrition was more than twice as high among girls as among boys. Also important is that mortality due to severe malnutrition was found significantly lower in a surveillance area covered by an intensive mother-child health and family planning (MCH-FP) programme than in the other half covered by the regular national health services (Fauveau 1990). Bairagi (1986) notes that during the famine, severely malnourished children increased by 68 or 100 percent depending on the definition of 'severe malnutrition', but children of all socioeconomic status groups were adversely affected by the famine. Food crisis during the famine period can be a factor for this bias in nutrition level according to sex at these ages, but in the period before age 1, it should be noted, that factor must be less important as breast feeding is common for both girls and boys in this post neonatal age group.

Treatment of illness or health care seeking behaviour in Bangladesh is also biased. Work on neonatal morbidity and care seeking behaviour illustrates that seeking care from a trained provider is associated with the gender of neonate, birth order, and antenatal care of the mother from trained providers, father's education and monthly expenditure of the family (Ahmed et al.2001). Vaccination coverage or treatment of illness provided by trained doctor or through pharmacy are better for boys. Male children are more likely to be taken to a health facility or medically trained provider than female children while ill with acute respiratory infection, fever or with diarrhea (Bangladesh Demographic and Health Survey, 1993-1994, 1999-2000, and 2004). Larson suggests that the care taker practice tends to favor male children and higher income households in diarrhea management (Larson et al. 2006). Of the three factors considered, it is probably safe to assume, breast feeding is least sex-selective. As the child grows, the importance of food intake and treatment increases. Thus the compound effect of differential feeding of food and differential treatment must result in higher mortality risk for girls, explaining the tendency that the later in the childhood period the greater the female disadvantage.

Chapter Five
Life-table Mortality and Cohort Survivorship

5.1 Introduction

With socio-economic progress and medical advancement human being has successfully increased their life span as illustrated by historical demographers' work. This progress does not happen on the same scale and at the same time across the nations over the world. The so-called developed countries achieved it with economic development. In developing countries, on the other hand, it is mainly due to advances in medical areas where Government has taken policy of immunization, maternal and child health care to reduce infant and child mortality in order to reduce fertility, regardless of progress made in economic development. Bangladesh is one of such countries. However, what we have in mind is that mortality never responds to such progress in similar way, since cultural, social and economic conditions never remain the same while we are not entirely free from calamities. In other words, a different generation of the same population will have a different experience even in the process of mortality change.

In the pervious two chapters mortality trends and patterns in Matlab as well as in Bangladesh, and the age-sex differential in mortality have been discussed, with special focus on famine mortality and its variations across age and sex groups. Observed mortality trends indicate unmistakable improvement in the long-run level of mortality in Bangladesh and in Matlab also. The improved level of mortality of a certain population means the increased survival probability of that population. However, period life table estimates found that during 1971-1976 the improving trend was halted. In this period Bangladesh suffered from damages of Liberation War (1971) and famine (1974-1975).

In this chapter the survival rates of different birth cohorts will be explored. Mortality conditions over the life course will be compared for different generations. For this purpose we need to trace death records longitudinally, which means that we have to construct generation life tables rather than conventional period life tables. A generation (or cohort) life table is a life history of mortality experiences that an actual cohort of individuals had. The cohort begins at birth and their mortality experiences are recorded until the death of the last member of that cohort. In most cases generation life tables, calculated for an entire period during which one generation completed their life course, allows us to make comparison in terms of life expectancy ($\mathbf{e_0}$). Unfortunately DSS data, on which we base our analysis, are available only for 38 years from 1966, so that it is not possible to calculate $\mathbf{e_0}$ for any cohort we are going to examine. However, it is of considerable interest to examine survival rates of each cohort even if the period is limited up to the 30s, for much of $\mathbf{e_0}$ can be accounted for by mortality experiences in the infancy and childhood periods.

Period life tables are estimated by using death and population data for a single calendar year. The death total is divided into age groups. Each age specific mortality rate ($\boldsymbol{q_x}$) is calculated by dividing the total number of deaths that took place for those who died at that age during the calendar year by the estimated population at the beginning of that age interval. With the entire set of those q_x, we can calculate e_x at birth, age 1, age 2, etc. However, each q_x is based on the experience of different group of people. For example, mortality of persons aged 70 may be affected by diseases and environmental factors which were important many years ago but which will have little bearing on mortality at age 70 of persons now aged 20. Yet the period life table assumes that the population in question will experience the whole array of mortality rates experienced by different cohorts at different stage of the life course. This method of studying mortality may thus produce misleading results if conditions are changing or if a particular calendar year is an unusually bad year. It is, therefore, desirable to study an actual generation and to trace its mortality history year by year from the year of birth to the end period. This is a true survivorship approach and is called the generation life table method, which is very useful in studying actual mortality trends (Pollard et. al., 1990).

In this chapter survival rates among various cohorts will be studied based on generation life tables estimated. Emphasis will be placed on the famine of 1974-75. A famine like this causes a large scale death in one year or two, which is termed as a short-term response.

However, two points should be made if we are interested in the mortality history of a particular cohort. One is that actual cohorts who encountered the 1974-75 famine also experienced a more or less similarly serious mortality crisis in the year of Liberation War, and, to a lesser extent, an epidemic outbreak in 1976. In order to assess the overall impact of all these mortality events on each cohort, it is not enough to assemble the results of an examination of each mortality crisis. We have to measure a combined effect of these events on their survival rates, which is supposed to vary according to the age at which a cohort experienced which of those events. This is just to reiterate why we have to construct generation life tables.

The other is that a famine may also have long-run consequences for the health of survivors, as suggested in a discussion of a current body of stylized facts about famine demography (Dyson and Ó Gráda, 2002). There is one study by Banerjee et al. who examined long-term effects on height and health of a sudden income shock experienced in early childhood in 19th-century France when Phylloxera attacked the roots of grape vines. They found that the shock decreased long-run height. At age 20, those born in affected regions were about 1.8 millimeters shorter than others, but that shock did not affect other dimensions of health, including life expectancy (Banerjee et al., 2007). Another study, on the other hand, the great famine of China in 1959-1961 caused serious health and economic consequences for the survivors, especially for those in early childhood during the famine as it is found that in the absence of famine, individuals of the 1959 birth cohort would have otherwise grown on average 3.03 cm taller in adulthood (Chen and Zhou, 2007). Dyson and Ó Gráda have taken this kind of findings into consideration when considering the above-mentioned set of stylized facts, but no mention of long-term effects has so far been made in the work on South Asia by Dyson himself.

This question is not the same as one of how mortality levels changed. We have already seen from period life table estimates in chapter three that life expectancy decreased during 1971-1976. But those life tables do not tell how famine survivors fared. This leads me to study their survival rates, for which generation life tables are also essential.

5.2 *Objective and Methodology*

The life table provides the most complete description of mortality in any population indeed. The period life table represents the combined mortality experience by age of the population in a particular short period of time but not the experience of an actual cohort. The generation life table on the other hand reflects the actual combination of changing health conditions and intracohort influences to which particular cohorts were subject. Usually the life expectation at birth in a generation life table is higher than in the period table if compared for the starting year of the generation life table. So, a comparison of life expectation at birth in two generation life tables reflects the average improvement in mortality for the actual cohort over its life time whereas a period life table understates the life expectancy that would probably be obtained over their entire life course.

The generation life table involves the combination of mortality rates that are significantly different in nature, owing to the improvement in mortality over a long period of time. Similarly it can take several events into account that a particular cohort has experienced over their life time by which their life expectancy or the survival rate could be affected. The period life tables in this regard cannot measure a combined effect of two or three separate events. This in fact leads me to study the survivability among the cohorts from different periods taking war (in 1971), famine (in 1974-1975), and measles epidemic (in 1976) into consideration by using generation life table technique. But such kind of uses of survival rate is not so familiar; rather it has in most cases been used for the projection of population, migration study, actuarial study etc. In this study an attempt has been made to exploit the survival rate of different generations to find if any effect of crises on survivability among the generations exists. Five birth cohorts that are considered have experienced these events at different ages (see table-5.1).

Table 5.1: Crisis events that are experienced by the cohorts at different ages

Events	Cohort				
	1966	1971	1974	1975	1976
War of Liberation	5	0	—	—	—
Famine: initial stage	8	3	0	—	—
peak stage	9	4	1	0	—
Measles	10	5	2	1	0

The War of Liberation of 1971 took about 500,000 deaths during the nine months of War since 25 March. The impact of the Bangladesh civil war on birth and death rates among the civilian population by using the DSS data for the years 1966-1971 has suggested that during the year of that conflict (1971-1972) the birthrate remained stable but the death rate climbed up to 40%. The baseline (1966-67 to 1970-71) stillbirth and neonatal infant mortality rates remained stable during the crisis, 37.6 and 86.8/1000 live births, respectively but post neonatal infant mortality rate increased by 46%, the 1-4 year death rate by 43%, and the 5-9 year death rate by 208%. The group of 5-9 year old children was at the highest risk, mainly due to outbreaks of infectious diarrhoeal diseases. This was due to malnutrition, increased transmissibility from large and sudden movement of refugees, and withdrawal of health services. There was also a post conflict epidemic of smallpox. During the year after the war (1972-1973) death rates remained elevated in the 5-9 year group (213% increase) and the 10-14 year age group (about 30% increase). Most of these deaths occurred due to outbreaks of smallpox and measles brought back by refugees returning from India, and their effects made worse by the underlying malnutrition of the population. The actual number of excess deaths (2,688) in 1971-72 was found equally shared by the two sexes, but the impact varied at different ages. Particularly striking was the larger number of deaths among female children aged 1-4; there were nearly twice as many female deaths in this age group as of males. Counterbalancing this predominance of female deaths was, as the aforementioned stylized facts indicate, the larger number of male deaths in the age groups of 45-64 years and 65 years and over. In these two age groups combined, there were 162 male excess deaths compared with only 68 excess female deaths (Curline et al., 1976)

Two years later, in 1974 famine started from the second half of the year and mortality peaked at 1975. This famine also took a huge death toll. Although officially it was approximately 30,000, other estimates were much higher. For example, varying estimates suggest that the number of deaths was in the range of 500,000 to 80,000 in Rangpur district alone (Arthur and McNicoll, 1978). In 1976 a measles epidemic broke out and caused of large number of child deaths. According to DSS estimates, 34 percent of deaths among boys aged 1-4 years and 28 percent of deaths among girls of the same age were attributed to measles in Matlab. All these will affect the survival rates for the five cohorts differently and the generation life table method is the choice here to examine the combined effect of these events for different cohorts. It could also be noted here that these cohorts have experienced flood in 1980, 1984, 1987, 1988, 1993 which were destructive and caused serious threat to live and economy in Bangladesh (about 30 % land area affected by all these floods). But the demographic consequences are not known.

The five cohorts are chosen for which abridged generation life tables are to be constructed. The generation of births are considered for 1966 (pre famine period; who born in 1966 but experience famine at age 8), 1971 (born in 1971 and experience famine at age 1), 1974 (during famine periods; born in 1974 and experience famine at age 0and 1), 1975 (who conceived in 1974-1975 but born in 1975), 1976 (who born in 1976, post famine period). All the cohorts are being considered for five year age interval. For example, generation life table for the birth cohort of 1974 would employ the observed death rates for infancy in 1974, for age 1 in 1975, for age 2 in 1976, for age 5-9 in 1979, and so on. For 0 age to age 4, the interval is of single year except for the cohort of 1966 and of 1971. For these two cohorts, child death rate comes from age group of 1-4 years. The mortality rate q_x will be then derived from these observed death rates. At age zero (0), Infant Mortality Rate (IMR) is taken as q_x (q_0) as conventionally used. The age pattern is considered as long as data permit for the generation cohort and the observed death rate are used for that age group by converting to q_x and for the last age group q_x is approximated as ($\infty L_x = l_x \times log_{10}\, l_x$) as the specific death rate for the persons at the old ages are not known for these generations. A complete generation life table for the births of 1966 will be estimated considering the last age limit of 30-34 years as data permit, by using cubic spline interpolation to break down the group age mortality to single age mortality distribution (details are included in appendix 5.A).

The other estimations of the generation life table are of similar of the period or current one. Here one new life table function named 'survival rate (S_x)', rather than e_x, will be estimated (because the generations are not complete yet).

The most common form that is used here is as follows,

$$S_{x+5} = \frac{{}_5L_{x+5}}{{}_5L_x}$$; which gives the proportion of population of age group x which will survive 5 years.

Usually 5-year age group is considered. For complete life table or for the single ages survival rate is calculated as

$$S_{x+1} = \frac{L_{x+1}}{L_x};$$ the proportion of the population x years of age on a given date, which will survive to the same date in the following year.

Besides this common form of survival equation which were repeated for most of the age groups, slight modifications are required to first and last age groups of the age structure. Thus the equations used to estimate the survival rate in this study regarding these exceptions are described below.

Survival rates as estimated for particular age group are as follows:

At age 0:

$$\frac{l_1}{l_0}$$; s_0 , the proportion of the newborn infants who will reach their first birth day. And

$\frac{L_0}{l_0}$; S_0, the proportion of infants born in a year who will survive to the end of that year.

At age 1-4 and at 5-9:

For the single year distribution of child death, Survival from birth to age interval 5-9 is estimated by,

$$S_x = \frac{L_x}{n \times l_0}$$

Where, n cohorts are subject to death.

The number l_0 =100,000 is multiplied here by 5 because, hypothetically 100,000 new born babies are added to the table each year for a 5-year period. For the grouped child age as 1-4, the similar equation is used for n = 4.

At the last age group of complete generation life table:

$$S_x = \frac{T_x}{T_{x-5}}$$

x is stands for age 35 years in the complete generation life table for the 1966 birth cohort and 30 or 25 for others of this study. It is measuring the proportion of the population say, 30 years and over which will live another 5 years. In this study as survival rate are estimated in some cases using actual population (l_x) in the beginning a given age cohort that is denoted by s_x and S_x otherwise.

But the preparation of generation life table requires compilation of data over a considerable period of time on an annual basis as stated in the earlier section. Sometimes projection is needed of some or many incomplete cohorts. This study has not such interest of projection of mortality though DSS data are far from making a complete cohort. It is thought better to study the actual mortality experience by the certain cohorts as long as possible that is supported by the annual series of DSS data from Matlab.

This limitation decreases the scope of studying the life expectation of the cohort at ages effectively. But the trend of life table death rate (q_x) of different generations and also survival rate (s_x) could be effective measure to study generation mortality experience among the cohorts including the famine effect that is to be compared among the generations.

5.3 Findings and Discussion

5.3.1 Complete generation (i.e., single age) life table for the births in the year 1966

In table-5.2 the complete life table of the 1966 cohort is presented for males and females separately. Only q_x, l_x, L_x, and S_x are included in this table but the details are available in Appendix tables 5.A-1 and 5.A-2. There is no irregularity observed from this estimate. High infant death rate and relatively higher child death rate are found as usual and the death rate is gradually declining after this age period. Female population of this cohort has higher child mortality and slightly higher mortality at reproductive ages. This generation has experienced war at age 5, famine at age 8-9 and measles epidemic at age 10 in 1976. But there is no such reflection of these events in mortality or survival rate of the mortality experience of the cohort. As the cubic spline is giving the smooth estimates of interpolated data between two data points and the points are the observed death rates of two age intervals here, so whatever found from this estimation, it would be in the absence of any irregular causality during the intermediate period between two age groups.

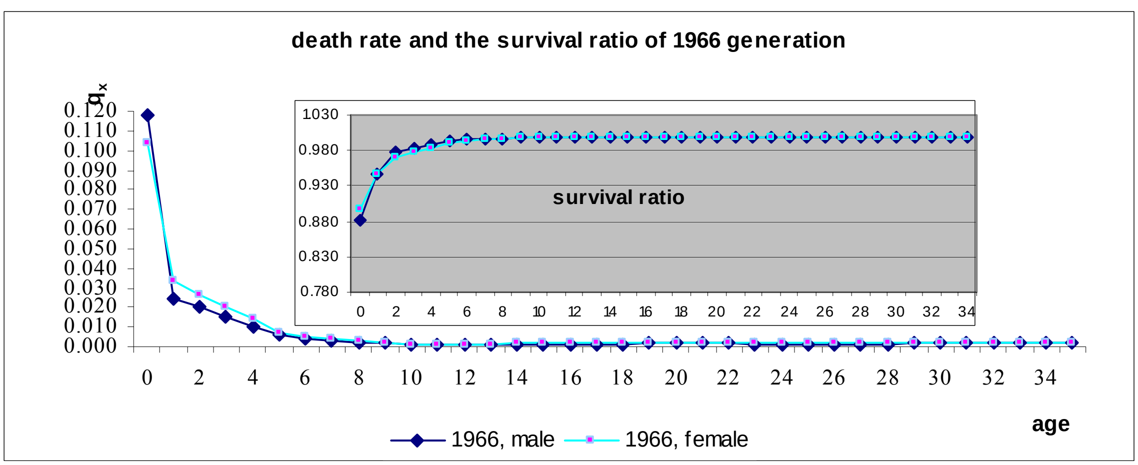


Figure 5.1: death rate, q_x and survival ratio, S_x of 1966 generation by sex.
Table 5.2: Complete Generation Life Table for the births in 1966

Year	MALE age	q_x	l_x	L_x	S_x	FEMALE age	q_x	l_x	L_x	S_x
1966	0	0.118	100000	91740	0.88200	0	0.104	100000	92720.00	0.89600
1967	1	0.025	88200.00	86896.55	0.94720	1	0.033	89600.00	87808.70	0.94703
1968	2	0.020	86027.59	84996.16	0.97813	2	0.027	86614.50	85214.85	0.97046
1969	3	0.015	84308.54	83534.18	0.98280	3	0.020	84281.75	83245.34	0.97689
1970	4	0.011	83017.94	82489.59	0.98750	4	0.014	82554.41	81860.64	0.98337
1971	5	0.006	82137.36	81895.77	0.99280	5	0.007	81398.13	81094.02	0.99064
1972	6	0.004	81654.17	81474.87	0.99486	6	0.005	80789.92	80572.27	0.99357
1973	7	0.003	81295.57	81165.68	0.99621	7	0.004	80354.63	80201.53	0.99540
1974	8	0.002	81035.79	80943.96	0.99727	8	0.003	80048.43	79941.22	0.99675
1975	9	0.002	80852.13	80788.38	0.99808	9	0.002	79834.01	79757.00	0.99770
1976	10	0.001	80724.62	80680.25	0.99866	10	0.001	79680.00	79620.28	0.99829
1977	11	0.001	80635.87	80603.4	0.99905	11	0.001	79560.57	79507.89	0.99859
1978	12	0.001	80570.93	80544.07	0.99926	12	0.001	79455.22	79401.95	0.99867
1979	13	0.001	80517.21	80490.83	0.99934	13	0.001	79348.68	79289.76	0.99859
1980	14	0.001	80464.45	80434.59	0.99930	14	0.002	79230.85	79163.81	0.99841
1981	15	0.001	80404.72	80368.56	0.99918	15	0.002	79096.78	79021.71	0.99820
1982	16	0.001	80332.39	80288.28	0.99900	16	0.002	78946.64	78865.64	0.99802
1983	17	0.001	80244.16	80191.68	0.99880	17	0.002	78784.63	78699.74	0.99790
1984	18	0.001	80139.19	80079.15	0.99860	18	0.002	78614.86	78527.56	0.99781
1985	19	0.002	80019.10	79953.53	0.99843	19	0.002	78440.27	78351.50	0.99776
1986	20	0.002	79887.96	79820.11	0.99833	20	0.002	78262.72	78172.82	0.99772
1987	21	0.002	79752.26	79686.12	0.99832	21	0.002	78082.92	77991.84	0.99768
1988	22	0.002	79619.97	79558.32	0.99840	22	0.002	77900.76	77808.55	0.99765
1989	23	0.001	79496.68	79440.71	0.99852	23	0.002	77716.35	77623.34	0.99762
1990	24	0.001	79384.75	79334.02	0.99866	24	0.002	77530.33	77437.07	0.99760
1991	25	0.001	79283.29	79235.74	0.99876	25	0.002	77343.81	77251.11	0.99760
1992	26	0.001	79188.20	79140.62	0.99880	26	0.002	77158.41	77067.23	0.99762
1993	27	0.001	79093.03	79042.62	0.99876	27	0.002	76976.05	76887.14	0.99766
1994	28	0.001	78992.22	78937.08	0.99866	28	0.002	76798.24	76712.12	0.99772
1995	29	0.002	78881.94	78821.03	0.99853	29	0.002	76625.99	76542.86	0.99779
1996	30	0.002	78760.11	78693.22	0.99838	30	0.002	76459.73	76379.53	0.99787
1997	31	0.002	78626.33	78554.13	0.99823	31	0.002	76299.33	76221.74	0.99793
1998	32	0.002	78481.92	78405.91	0.99811	32	0.002	76144.16	76068.60	0.99799
1999	33	0.002	78329.89	78252.4	0.99804	33	0.002	75993.04	75918.66	0.99803
2000	34	0.002	78174.91	78099.1	0.99804	34	0.002	75844.28	75769.96	0.99804

Now let us turn to the cohort experience with grouped age mortality data which is supposed to be nearer to actual mortality experience. Five generation life tables have been estimated for the birth cohort from 1966, 1971, 1974, 1975, and 1976. We begin with the survival rate among various cohorts as it is our prime concern here.

5.3.2 Survival rates (S_x) among the cohorts with the combined effects of different events:

Life table function S_x shows the survival rate from one age to another of a cohort except at S_0, S_{1-4} and S_{5-9}. For example, at age 0, S_0 gives the proportion of newborn infants who will survive to the end of that year; S_{1-4} and S_{5-9} give the survival rates from birth to the point entering age group 1-4 and 5-9 respectively. But for age group 10-14, the survival rate (S_x) is for the population of 5-9 years who will survive for the coming 5 years and so on. The S_x thus calculated are shown in tables 5.3 and 5.4. The discussion will be limited here on the survival rate for the early ages indeed, because of approximated L_x at the last age limit of the very short age structure for the incomplete cohorts.

Table-5.3: S_x for males and females by age group and cohort

male					age	female				
66	71	74	75	76	group	66	71	74	75	76
0.9174	0.8927	0.9003	0.8844	0.9205	0*	0.9272	0.9019	0.9070	0.8711	0.9228
0.8321	0.7982	0.8429	0.8223	0.8788	1-4**	0.8284	0.7869	0.8461	0.7997	0.8764
0.7872	0.7572	0.8240	0.8081	0.8684	5-9***	0.7689	0.7274	0.8215	0.7822	0.8584
0.9825	0.9843	0.9858	0.9893	0.9920	10-14	0.9776	0.9823	0.9843	0.9885	0.9856
0.9950	0.9933	0.9953	0.9945	0.9963	15-19	0.9915	0.9933	0.9933	0.9940	0.9935
0.9935	0.9950	0.9950	0.9958	0.9938	20-24	0.9896	0.9920	0.9928	0.9920	0.9920
0.9928	0.9943	0.9903	0.9948	0.9814	25-29	0.9883	0.9928	0.9940	0.9903	0.9786
0.9928	0.9695	0.9733	0.9761		30-34	0.9888	0.9655	0.9769	0.9706	

* L_0/l_0 ; ** $L_{1-4}/(4*l_0)$; *** $L_{5-9}/(4*l_0)$

At first sight, among all the cohorts the 1971 birth cohort seems to have the worst experience; the survival rates, S_{1-4} and S_{5-9} of this cohort are very low compared with other cohorts because it is these age groups who met famine and then measles when they were at 3-4 and at 5 years old. Even at age 30-34, low survival rates stand out for the 1971 birth cohort. However, as far as s_0 is concerned, it is the 1975 cohort who exhibits the lowest survival rate.

Considering single-year survival rates for early childhood ages, among the cohorts of famine and post famine periods generally, the year 1975 was worse than the year 1974 at age 0 and 1, but 1974 was worse than 1975 for 2 to 4, although the pattern is a little more complex if male and females rates are considered separately. But this is just to confirm what we have seen from period life table q_x.

Table-5.4: S_x for males and females by age group and cohort, considering the single age at early child period

1974	1975	1976	age interval	1974	1975	1976
0.90025	0.88443	0.92048	0*	0.90697	0.87113	0.92279
0.93106	0.92139	0.94942	1**	0.92453	0.90621	0.94900
0.96751	0.97423	0.97891	2	0.95628	0.95911	0.97072
0.98079	0.98429	0.98468	3	0.97137	0.97588	0.97561
0.99050	0.98980	0.99092	4	0.98238	0.98452	0.98346
0.98591	0.99018	0.99133	5-9	0.98180	0.98634	0.98359
0.98579	0.98929	0.99202	10-14	0.98429	0.98853	0.98555
0.99526	0.99451	0.99626	15-19	0.99328	0.99402	0.99352
0.99502	0.99576	0.99378	20-24	0.99277	0.99204	0.99204
0.99031	0.99477	0.97718	25-29	0.99402	0.99030	0.97275
0.96822	0.97141		30-34	0.96913	0.96309	

* L_0/l_0 **L_1/L_0

However, the infants of 1975 of both sexes have the lowest survival rate as both the proportion of infants born in 1975 who will survive to the end of that year (S_0) and the proportion of infants of 1975 who will survive one year more (S_1) is lowest for 1975 cohort again. The most important findings is that after 1 year of age, both male and female cohort of 1974 have the lowest survival rate for reaching from age 1 to 2 years (S_2) and from age 2 to 3 years (S_3) rather than 1975 cohort. This is very consistent indication with the findings of significantly higher neonatal mortality among infants conceived during the famine while death rates at post- neonatal as well as at age 1 are significantly higher for the famine-born (born between July 1974 and March 1975 as considered in their study) cohorts comparing with non famine cohort (Razzaque et.al., 1990). In this respect, the mortality rate q_x can be considered. It states that both male and female cohort of 1974 experienced highest deaths at age 1-4 among others. Whereas, the single age distribution of child mortality shows that males of 1974 were at higher death risk particularly at age 1 and age 2 than those of 1975. But the cohort of 1974 females of early child age was consistently at higher risk of death from age 1 to age 4 than of 1975 female (see appendix table 5.C and 5.D).

It means like that the females born in 1974 have experienced higher death rates in the successive ages comparing with other cohorts as they experienced peak period of famine deaths in 1975, measles epidemic in 1976. And it is not unexpected because it is evident with many studies that the post neonatal and child death are higher for female usually in Matlab as well as in Bangladesh. Here it can also be mentioned that officially famine was declared in late September, 1974 but the starvation could be heard immediately following the floods of June (started at the end of the June and repeatedly cross the danger level of the rivers till September) (Sen and Drèze, 1981). And famine mortality reached at peak in the first half of 1975 and in 1976, measles epidemic broke out. All these together made the female children more vulnerable to death.

Now, let us turn to the survival rates from birth to childhood and then to adulthood that are presented by cohort in table 5.5.

Table 5.5: Combined effect of different mortality events on Survival Rate S_x at different ages

Survival rate as affected by different events					
survival from birth to age interval 1-4 among the cohorts= $L_{1\text{-}4} / (4{*}l_o)$					
	1966	1971	1974	1975	1976
male	0.832075	0.798231	0.842934	0.822319	0.878755
female	0.828402	0.786901	0.846133	0.799682	0.876448
difference	0.003673	0.0113299	-0.0032	0.022636	0.002307
survival from birth to age interval 5-9 among the cohorts= $L_{5\text{-}9} / (5{*}lo)$					
	1966	1971	1974	1975	1976
male	0.787182	0.757211	0.823954	0.808072	0.868447
female	0.768920	0.727392	0.821476	0.782222	0.858386
difference	0.018261	0.0298195	0.002478	0.025851	0.010062
survival from birth to age interval 25-29 among the cohorts= $L_{25\text{-}29} / (5{*}l_o)$					
	1966	1971	1974	1975	1976
male	0.759077	0.732403	0.796576	0.787513	0.837047
female	0.728929	0.698969	0.792562	0.75511	0.815963
difference	0.030148	0.0334337	0.004014	0.032403	0.021084
% change in the chance of survival from birth to age 25-29 from the previous cohorts*					
male	-	-3.51	8.76	-1.14	6.29
female	-	-4.11	13.39	-4.73	8.06

* % change is calculated for two adjoining columns.

First of all, the survival rate for the first four years of life, the 1971 cohort was the most unfortunate. Again for the survival rate over the period beyond early childhood, this cohort recorded the worst for both the sexes. This cohort born during the war time periods was passing through the difficult post war periods due to completely ruined economy and social disorder at infancy and afterwards. Moreover the famine crisis, severe flood and resultant crop damages, aggravated the situations. Also global politics played a part as the United States withheld 2.2 million tones of food aid to apply pressure on Bangladesh to abandon plans to try Pakistani war criminals and to export jute to Cuba. Bangladesh gave way to this American pressure and stopped jute export but resumed food aid was too late for the famine victims (Sharma, 2002).

Among the births during famine and post famine periods, the 1975 cohort was the most affected. They were born in the peak period of famine and then met the outbreak of measles at age 1. It is worth stressing that their chance of survival (S_{1-4}, S_{5-9} and also S_{25-29})was worse than that for the 1974 cohort who was born in the initial phase of famine and came through all the stages of the famine process.

Last of all, females exhibit lower survival rates than males in all the cohorts; in table 5.5, the difference between the male and female survival rates is always positive except for the 1974 generation in the top panel (the survivability from 0 to age 1-4 years). And the 1975 female cohort, compared with the male counterpart, experienced a drastic and substantial decrease in the survival rate from that of 1974. Indeed, across all the age groups of the 1975 cohort in table 5.6, the female disadvantage is clearly revealed; in other cohorts, it merges from the 1-4 age group onwards.

Table 5.6: Male to female ratios of S_x and q_x by cohort

age group S_x	66	71	74	75	76	age group q_x	66	71	74	75	76
0	0.9894	0.9898	0.9926	1.0153	0.9975	0	1.1346	1.0934	1.0722	0.8968	1.0299
1-4	1.0044	1.0144	0.9962	1.0283	1.0026	1-4	0.7503	0.6752	0.7025	0.7581	0.5791
5-9	1.0237	1.0410	1.0030	1.0330	1.0117	5-9	0.7898	0.7693	0.8669	0.8540	0.5608
10-14	1.0051	1.0021	1.0015	1.0008	1.0066	10-14	0.7341	1.5431	1.0906	1.1661	0.5343
15-19	1.0035	1.0000	1.0020	1.0005	1.0028	15-19	0.4749	0.6259	0.4385	0.6673	0.6370
20-24	1.0040	1.0030	1.0023	1.0037	1.0018	20-24	0.7402	0.6259	1.0000	0.4512	0.8578
25-29	1.0045	1.0015	0.9963	1.0045	1.0028	25-29	0.5015	1.0000	2.3548	0.6327	1.9965
30-34	1.0040	1.0042	0.9964	1.0057		30-34	0.8103	1.0831	1.3623	0.7378	

The ratios with q_x give the similar results, although surprisingly the cohorts of 1971, 1974 and 1975 had higher-than-1 male-female q_x ratios at age 10-14. This male-female difference suggests that, as we have seen, gender biases in food allocation and sickness treatment were at work differently between the periods of famine and war-related social disorder. Gender inequality was worse in the case of famine especially when the victim was in the post-neonatal period.

5.3.3 Survival rates (s_x) for survivors of the 1974 famine

To find the most affected population after the famine crisis, now it will be better to consider the survival rate after the age when the particular cohort experiences the crisis. Table 5.6 presents the survival rate for the generations from age after crisis to age 25, the highest age interval available. The survivors at the certain age (l_x) after the crisis are considered. The 1976 cohort is considered here as non famine reference cohort for the comparison with other cohorts those who experienced this crisis at different ages. Whereas, 1976 cohort didn't suffer from that food crisis as the famine ended around mid of 1975. This estimate shows the similar pattern as the poor survivors are those who experienced the famine comparing the non famine birth cohort.

The results are consistent for all the cohorts that experienced famine at particular age, as their post-disaster survival rates over the period up to age 25 for both males and females are lower than those for the 1976 cohort. It is very likely, therefore, that the experience of the famine had an adverse effect on the probability of survival in the subsequent period, and by this measure too, those who were born in the peak year of famine was most unfortunate. Also it is females who suffered most in all counts.

Table 5.7: Survival rate s_x for survivors of the famine

		s_x		s_x at same age for 1976 cohort	
cohort		male	female	male	female
1966	$l_{25}/(l_{10})$	0.98167	0.971902	0.983635	0.976774
1971	$l_{25}/(l_5)$	0.959348	0.949801	0.971902	0.955997
1974	$l_{25}/(l_2)$	0.915765	0.886923	0.934689	0.894722
1975	$l_{25}/(l_1)$	0.896654	0.852954	0.912756	0.871296

5.4 *Conclusion*

Mortality improves over the long run despite the inevitable occurrence of natural and socio-military calamities. In the period studied, i.e. 1966-2003, the 1974 famine's impact was felt on the mortality of all the cohorts of 1966, 1971, 1974 and 1975. But there were some other irregularities over their life time. For example, the two pre-famine birth cohorts of 1966 and 1971 experienced, in addition to the 1974-75 famine, War of 1971, measles epidemic in 1976, and severe flood in 1980, all in their teenage period. Similarly the 1974 and 1975 cohorts, not just experienced the famine, but met the measles epidemic in 1976, floods in 1980 during their teenage period.

One unexpected result from the study based on generation life-tables is the impact of Liberation War in 1971. If measured up to age 5 or even to age 25 ($s_0^{5\text{-}9}$ and $s_0^{25\text{-}29}$), for example, the 1971 birth cohort had the lowest survival rate for both sexes, suggesting the seriousness of disorder caused by war and its impact on the chance of survival if experienced in infancy. Also rather unexpected is the suggestion that the famine had some lasting negative influence on those who could survive the famine period over the subsequent stages of life. Nevertheless, this study has found some consistent findings with the findings in the earlier chapters, as it is found that infants, both male and female, born in 1975 were most disadvantaged with the lowest survival rates from birth to age 1 and from birth to age 4 (s_0^1 and $s_0^{1\text{-}4}$).

The observed male and female differences in the rate of survival are what have been expected from the previous chapters. Generally, females suffered lower rates of survival among the generations considered. More important is the finding that the period of life when famine hit seems to have been crucial especially for the gender-specific differences in the survival rate. If born in the peak period in the famine process, female children would suffer from an even lower chance of survival than male children. This is consistent with the previous finding that female infants in the post-neonatal period were most vulnerable to malnutrition and mal-treatment, and also explains the differential experiences between males and females of the 1971 war and the 1974-75 famine.

Chapter Six
Conclusion: Changes and the Persistent Patterns

6.1 Changes, confirmations, some new findings

Mortality in Bangladesh indeed has been passing through the stage of very high mortality to moderate low mortality phase. The country has achieved significant improvement in Crude Death Rate, Infant Mortality Rate and life expectation in accordance with lowering the population growth rate. Infant mortality has declined steadily from 92 per thousand live births in 1992 to 53 in 2002. Similarly, under five mortality rate has declined from 144 per thousand live births in 1990 to 76 in 2002 (UN-BD, http://www.un-bd.org/bgd//index.html). Life expectancy becomes higher as 62 years for male and 63 for female in 2004 (World Health Statistics, 2006). The Bangladesh health sector has been providing primary health care services so as to eradicate the incidence of communicable diseases since long. Over the past decade there has been a significant decline in mortality and morbidity from communicable diseases (BDHS, 2001. Bangladesh Demographic and Health Survey, 1999-2000, National Institute of Population Research and Training (NIPORT), Dhaka).

This thesis has been concerned with the pattern, differential and change in Bangladesh's mortality history, with special attention to the intensively surveyed rural area of Matlab. As the above quotes indicate, Bangladesh has recently made a significant, if not spectacular, progress in public health areas. However we have to ask if such achievements can be traced back to the period when the country proclaimed Independence and what actually changed and what remain unchanged.

It is, for example, revealed that, in terms of Coale and Demeny's regional life table typology (Coale and Demeny, 1966), Matlab has consistently been of the South type over the decades despite an improvement in the level of mortality. Comparatively high early childhood mortality rates in Matlab are one characteristic of the C-D South model. Also the disease pattern associated with the south model, in which highest death rates are recorded for diarrhoeal and certain diseases of infancy, is found close to the United Nation's South Asian life table pattern which is characterized by the high incidence of infectious, parasitic and diarrhoeal diseases at the youngest and of diarrhoeal and respiratory diseases at the oldest age (UN, 1982b) The disease pattern is more or less the same across areas in the Indian sub continent. In the case of Bangladesh as a whole the pattern is of little difference as it is found as neither C-D North nor C-D West alone, but the pattern appears to be a combination of the two. The age pattern of mortality both in Bangladesh and in rural area is comparatively closer to the North pattern at early ages, turning to the West pattern at higher ages. When the general level of mortality is high, it is sometimes difficult to distinguish North and South patterns as both displays a noticeably high mortality for the 1-4 age group as stated before. On the face of it, this seems inconsistent with the findings for Matlab. However, both C-D North and South patterns point to high child mortality at early ages, which is indeed a very strong determinant of mortality in Bangladesh. Though mortality during childhood has improved over time, Bangladesh's infant and early child death is still quite high. The national disease pattern is not so different from the one for Matlab, but cholera as well as diarrhoeal diseases could be more endemic in Matlab as it is crisscrossed by numerous rivers and canals and most of this area is inundated during the monsoon when boats are the only means of transport. And in Bangladesh access to safe water is not secured even today for all the inhabitants (71 percent in 1990 and 75 percent of population in 2002 were with the access to improved drinking water sources); moreover the rural population is more vulnerable as 68 percent in 1990 and 72 percent in 2002 of the rural population have this access whereas it is 83 percent and 82 percent for the urban respectively.

Sanitation is also poor in rural areas (UNSTAT, 2005). Again it should be remembered that Matlab people have a better access to health facilities in comparison with other rural areas in the country. But the pattern of the highest mortality at very old ages is common in both Matlab and Bangladesh populations.

As for famine mortality in the 1974-75 period of severe food crisis, it is confirmed that it was higher for males than for females and for adults than for children. This is revealed with the estimates of proportional rises as in the case of other Indian famines explored by Tim Dyson. However, this does not apply to females in infancy and early childhood, especially in the 5-9 age group, though female disadvantage started right after the neonatal period. In 1975, the peak year of the Bangladesh famine, female IMR tended to increase more than male IMR and the magnitude of proportional rise in female IMR leveled with that for the 5-9 age group. Dyson in his study found no such rise in mortality during childhood since he used the deaths of 1976-1977 as the reference period, although he rightly suspected about this finding as there were a larger number of child deaths due to measles in 1976 (Dyson, 1991.b). This finding is very important in the sense that although female child mortality is higher than male one at age 5-9 in normal circumstances, the higher proportional rise stands out for female. However, the measles epidemic broke out in 1976 and children were its victims. 34 percent of deaths among boys aged 1-4 years and 28 percent of deaths among girls of the same age group were attributed to measles. It was followed by dysentery: 19 percent of male deaths and 22 percent of female deaths. Tetanus, another leading cause in infant mortality, accounted for 29 percent of male deaths and 31 percent of female deaths. And female death rates were consistently higher in most instances (HDSS Report of 1976). According to Matlab studies by other researchers, it is very much likely that the compound effect of differential feeding practice and differential treatment resulted in higher mortality risk for girls; therefore, all the records of excess female mortality must have been a reflection of worsened environments in female children's life during the period of mortality crisis, explaining the tendency that the later in the childhood period the greater the female disadvantage.

Mortality may improve from generation to generation. The examination of varying survival rates based on generation life tables reveals that females of all the cohorts were more disadvantaged than males due primarily to higher mortality risks during childhood. Indeed, despite a decline in the female childhood mortality rate from the 1975 cohort on, girls remained disadvantaged throughout the subsequent generations. The comparison between the cohorts shows that, although infant mortality of the 1975 cohort was the highest of all the generations examined here, it was the 1971 cohort whose survival rate over the entire childhood period recorded the lowest. If the period is extended to age 25, however, there emerges a gender difference: the most unfortunate was the 1971 cohort as far as males are concerned while it was the 1975 cohort for females. This suggests that when the mortality crisis worsened, the female disadvantage became even worse as female infants were exposed to a higher risk of death due to food shortage. In other words, both proportional rise and generation life table exercises point to the same conclusion: that the female disadvantage persisted over the entire childhood years right after the neonatal period and through all the generations in question. In recent years there did emerge a new sign that as general mortality levels have improved substantially, the life expectation in Bangladesh as well as in Matlab has become slightly higher for female. As far as childhood periods are concerned, however, females still have higher mortality rates so that the females still suffer from lower survival probabilities over the first phase of the life course.

6.2 Discussion

Now, all these findings may be discussed from perspectives of broader time trend and regional patterns.

The population history of Bangladesh was accompanied by different kinds of disasters. Flood was common and sometimes it was seasonal. The record of Famine was also quite frequent just as in other parts of India. And in the case of Bangladesh most of severe famines were triggered by a large scale flood and resultant crop failure. Also common were cyclones and tidal waves, epidemic diseases like cholera, small pox, malaria and other infectious diseases. The major causes of deaths were cholera, small pox, plague, fevers, dysentery and diarrhea, and respiratory diseases. Over the century, mortality due to three epidemic diseases, i.e. plague, small pox and cholera declined considerably. The most impressive decline of all the three was plague mortality. With wide fluctuations, it unmistakably declined and, from 1929 on, it became a cause of death less lethal than small pox (from the turn of the nineteenth century small pox mortality decreased no faster than the overall death rate; one reason behind this is that the main progress in controlling the disease was made prior to 1900). Cholera was probably the old disease in India. Kingsley Davis (1951) in his book wrote that "*Yet the first great outbreak did not occur until 1817-1819. This epidemic, probably the most terrible of all Indian cholera epidemics, started in Bengal, where the disease had long been endemic, and spread to nearly all parts of India. Great epidemics subsequently occurred in 1863-1865, 1875-1877, 1891-1892, 1894-1897, 1900, 1905-1908, 1918-1919, and 1921. The theory prevailing for more than a century was that all cholera epidemics originated in Bengal*". Cholera became a pandemic in 1817 and deaths according to this disease reached peak around 1900 while plague spread over the whole country. And its last peak before the decline was in 1924 (Guha, 2001). Also tuberculosis, malaria, and dysentery were also severe in certain areas especially the riverine plains, the Himalayan foothills, and the rainy slopes of the coastal area. The population exposed to tuberculosis and showed an extreme susceptibility when the society was brought into contact with the outside world through the growth of cities, industry, and transport. The populations of industrial, urban, and semi-rural areas were highly exposed to tuberculosis (Davis, 1951). Diarrhoea and dysentery killed on gigantic scale in the Indian subcontinent and their major victims were infants. Deaths due to these two diseases did not declined as steadily as total mortality did with their percentage of all registered deaths having remained almost constant. As expected, all these are found in the list of diseases supposed to characterize the UN's South Asian mortality pattern (derived from Bangladesh, as well as India, Pakistan, Nepal and some other countries). The important point to be made here is that most of these epidemic diseases have now been controlled in Bangladesh, but diarrhoeal diseases are not. Although diarrhoeal mortality has been lowered if compared with earlier periods, in Matlab the mortality pattern is still very much close to the C-D South pattern.

As for epidemic diseases, which had taken huge death tolls in the nineteenth and very early twentieth centuries, they became much less rampant after about 1920, leading to a faster growth in population. However this growth was halted by several events such as the Bengal famine of 1943, the cyclone and tidal wave of 1970, the War of 1971, and the flood and Famine of 1974-75, the last severe famine yet in Bangladesh. In order to measure the combined effects of this kind of exogenous events, especially the last two attempts have been made to trace the mortality change over time, based on the generation life tables I estimated.

One of the issues explored in this thesis is if those events affected males and females differently. Sex differentials were apparent in most of the periods covered in this study. The infant mortality rate was almost always higher among males than females, but the female rate exceeded the male rate in most of the other age groups. The higher male rate in infancy reflects universally observed higher biological risks of new-born males, whereas and the relatively higher female rate in childhood is likely to reflect differential parental concern and differential care, and in the reproductive ages would lead to higher female death rates. The famine of 1974-1975 saw the male-female mortality differential reversed, as the stylized facts about famine demography suggest. However, in 1975 the female IMR did exceed the male rate. Also, Curlin (1976) suggests that sex differentials remained intact in most age groups during the year of war with a notable exception for the 1-4 year range where the increase in the female rate was disproportionately greater. He argues that this probably reflected a heightened parental concern in the care of sons at times of stress and crisis. Indeed this is consistent with the findings from the current study[3].

Excess female mortality has been documented in certain high mortality situations, in particular in South Asia (Garenne, 1993). In the study of regional variations in Indian demography and culture, Dyson and Moore (1983) also found that sex differentials in child mortality are much higher in the northern than in southern States of India. They

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[3]The only difference between the effects of such two events is that famine reduced conception substantially as found in Dyson's study while in 1971, according to Curlin's study, there was no significant change in conception.

established that the main reason for the relatively high sex ratios in the northern part of the country is higher female mortality; they attributed this phenomenon to the discrimination against females in access to food and medical care. They also related the differentials observed in the north and south to variations in kinship systems and female autonomy. Does Bangladesh belong to the North Indian or to the South Indian type? Both topology and socio-cultural history may be able to answer in part this question as briefly discussed in Chapter two.

In general females have a lower mortality than males at all ages. In South Asia, however, excess female mortality has been documented in times of mortality crisis. In South Asian societies, sex preference is manifested mainly in the form of excess mortality of female children. It is found to be due to the discrimination against females in the allocation of food and health care within the household. In many South Asia societies, sons are the only source of security for parents in old age. This is particularly so where women have little economic independence or cannot inherit property. Son preference is also strong when daughters are excessively expensive to marry off with a dowry system; in addition, women have few opportunities to earn income and invest household resources in female children (Cain, 1984). However in India, son preference showed the impact of son preference on child survival in India. A significant finding is that the more elder sisters in the household the greater the risk to daughters. The daughter mortality differentials between northern and southern India were attributed to variations in women's status and the strength of sex preference (Visaria, 1994; Das Gupta, 1994).

Data from Bangladesh showed a higher risk of survival for girls having older sisters than that of boys who have older brothers. The study showed that the complex interaction of regional variations in service availability, attitudes, preferences, practices, and social and economic status affects the determined outcomes (Bairagi, 1994). Sex preference does not have a strong effect on contraceptive use in Matlab. The effect of sex preference on childbearing is becoming stronger as fertility declines, because couples must achieve their desired number of sons within a smaller overall number of children (Bairagi, 2001).

Sex differential in fact is a complex phenomenon. Economic development, social development, or mortality improvement can not explain the reason behind this disparity alone. Rather, the anthropological and the history of cultural development of the society can make it possible to explain why does it exist?

6.3 Conclusion

Overall Bangladesh, one of the most densely populated areas of the South Asian region, is similar to the "South" type in terms of climate, topology and agriculture. It is sometimes argued that wet rice culture allows women to get involved in productive activity in the fields more than in wheat growing areas. Despite this, and despite that the country's population growth records have been similar to those of South Indian regions, judging from the findings on gender inequality, Bangladesh's traits are undoubtedly closer to north Indian reproductive culture regarding religion and some social behavior that has reflection on its population and demographic behavior. More important perhaps is that the North and Bangladesh seem to share similar cultural and social characters of discrimination against females. Despite several unmistakable improvements in mortality and survivability over the generations, the sex differential in mortality did not change noticeably. Only the level of mortality improved, whereas gender inequality, especially at infant and childhood ages, remained intact. It may well be that the behavioral traits such as son preference are deeply rooted in our culture, and despite the difference in religion, this is shared by both north Indian and Bangladeshi cultures. All this suggests that it is not necessarily the material base of the society that determined its attitude to gender inequality, and that a combination of cultural and social factors carried a more weight in accounting for the observed gender differentials in mortality measures.

In the past decades, the Government of Bangladesh, UN and some Non-Governmental Organizations have been working on this gender issue and several policies have been implemented for female education and empowerment. This study suggests that policy makers should be aware of the deepness of the behavior rooted in the society over the centuries in order first to address the imbalances and then adopt proper policies and actions. Otherwise the age-sex mortality differentials would remain virtually intact despite any achievement in mortality reduction, both male and female.

However, there remains several issues which should be answered in a future study. One is related to the observation that the seemingly puzzling resurgence of male dominancy in 1978-83: the age-sex pattern of infant and child mortality for the 1978-83 period appears to be close to that of the 1974-75 famine period. If it be due to gender discrimination in the society, then could it be argued that this discrimination behavior became stronger over time? This raises a second issue, i.e. an interesting, new question with a good scope of further study. Moreover, there is a third issue: the life table analysis will be an effective and interesting way of exploring the questions of gender inequality and son preference by applying this technique on different sub groups too. Finally, micro-level data concerning the individual's family and socioeconomic statuses, if available, will further enhance the scope of research. The present study has been limited to the question of how mortality or survivability varied according to age and sex in different times of crisis. In the next step I would like to explore the reasons beyond this purely demographic terrain. And it will also be interesting to examine this issue with data at regional levels, which will enable us to set the Matlab findings in a larger context.

REFERENCES

Ahmed, A.U.1986. Analysis of mortality trends and patterns in Bangladesh, http://www.popline.org/docs/200423

Arthur, W. Brian, and McNicoll, G.1978. An analytical survey of population and development in Bangladesh, ***Population and Development Review***. Vol.4, no.1, pp.29.

Bairagi, Radheshyam. 1986. 'Food Crisis, Nutrition, and Female Children in Rural Bangladesh', ***Population and Development Review***, 12(2):pp.307-315.

Bairagi, Radheshyam and Ray L. Langsten. 1986. "Sex preference for children and its implications for fertility in rural Bangladesh", ***Studies in Family Planning***, 17(6).

Bairagi, Radheshyam .1994. "Excess female child mortality: its levels, trends and differentials in rural Bangladesh". Paper presented at International

Symposium on Issues related to Sex Preference for Children in Rapidly Changing Demographic Dynamics in Asia, Seoul, Republic of Korea, November.

Bairagi, Radheshyam. 2001. Effects of Sex Preference on Contraceptive Use, Abortion and Fertility in Matlab, Bangladesh, ***International Family Planning Perspectives***, Vol. 27, No. 3.

Bhat, P.N. Mari 1989. 'Mortality and Fertility in India, 1881-1961: a Reassessment' in India's Historical Demography, edited Tim Dyson, Curzon Press.

Banerjee, A., Esther Duflo, Gilles Postel-Vinay and Tim Watts. 2007. Long Run health Impacts of Income Shocks: Wine and Phylloxera in 19th Century France.http://econ-www.mit.edu/files/807

Benjamin, J. (1991). "Socio-religious status of girl child in India", In: Devasia, L. and Devasia, V.V. (eds.) Girl Child in India (New Delhi: Ashish Publishing).

Bourgeois-Pichat, J..1951. 'La mesure de la mortality II', ***Population*** 6 (3): 459-480.

Bourgeois-Pichat, J..1951. 'La mesure de la mortality. I', ***Population*** 6 (2): 233-248.

Cain, M. 1984. Women's Status and Fertility in Developing Countries: Son Preference and Economic Security, Population and Development Series No. 7, (Washington, D.C.: World Bank).

Census reports of 1974, 1981, 1991 and 2001.

Chen, L. C., Emdadul Huq, and Stan D'Souza. 1981. Sex Bias in the Family Allocation of Food and Health Care in Rural Bangladesh, ***Population Development Review*** 7 (1): 55-70.

Chen, L.C. and A.K.M. Alauddin Chowdhury. 1977. The Dynamics of Contemporary Famine, Mexico International Population Conference, vol.1, Liège: International Union for the Scientific Study of Population, pp.409-426.

Chen Yuyu and Li-An Zhou. 2007.The long-term health and economic consequences of the 1959–1961 famine in China, ***Journal of Health Economics,*** Vol. 26, Issue 4, pp. 659-681.

Child Nutrition Survey of Bangladesh 2000, Bangladesh Bureau of Statistics.

Coale, J. A and Demeny, P. 1966. Regional Model Life Tables and Stable Population, Second Edition, Academic Press, New York.

Committee on Population and Demography.1981. Estimation of Recent Trends in Fertility and Mortality in Bangladesh, report no. 5.

Curlin, T. George, Lincoln C. Chen, Sayed Babur Hussain. 1976. Demographic Crisis: The Impact of the Bangladesh Civil War (1971) on Births and Deaths in a Rural Area of Bangladesh, ***Population Studies***, Vol. 30, No. 1. , pp. 87-105.

Das Gupta, Monica. 1994. "Discrimination against female children in India". Paper presented at International Symposium on Issues Related to Sex Preference for Children in the Rapidly Changing Demographic Dynamics in Asia, Seoul, Republic of Korea, November.

Davis Kingsley.1951. The Population of India and Pakistan. Princeton University Press.pp.36

Drèze, J., and Sen, A.1989. Hunger and Public Action, Oxford: Clarendon Press.

D'Souza, S. and L.C.Chen. 1980. Sex Differential in mortality in Rural Bangladesh, ***Population and Development Review***, vol.6, no.2, pp.257-270.

Dyson, T. and M. Moore. 1983. On kinship structure, female autonomy, and demographic behavior in India, ***Population and Development Review*** 9 (1): p.35-60.

Dyson, T. 1991. (a) On the Demography of South Asian Famines, part I, ***Population Studies***, 45, pp.5-25.

(b) On the Demography of South Asian Famines, part II, ***Population Studies***, 45, pp.279-297.

Dyson, T. 2002. 'Famine in Berar, 1896-7 and 1899-1900: Echos and Chain Reactions' in Famine Demography: Perspectives from the Past and Present, Oxford University Press.

Dyson, T. and Cormac Ó Gráda. 2002. Famine Demography: Perspectives from the Past and Present, Oxford University Press.

Elahi, K. M. Recent trends in fertility, mortality, and population increase in Bangladesh, in L. A. Koiniski and J. Webb, eds., Population and Scale: Macro-Populations (footnote 36 in Chapter- IV, Country Monograph Series no.8).

Fauveau, V, André Briend, Jyotsnamoy Chakraborty, and Abdul Majid Sarkar. 1990. The contribution of severe malnutrition to child mortality in rural Bangladesh: Implications for targeting nutritional interventions. ***Public Health Nutrition, Food and Nutrition Bulletin***, 12 (3), The United Nations University Press.

Garenne, M.1993. Sex Differences in Measles Mortality: A World Review, ***International Journal of Epidemiology***, vol.23, no.3, pp. 632-642.

Goldman, Norren. 1980. Far Eastern Patterns of mortality, ***Population Studies**,* 34:5-19

Greenhalgh, S. (1991). Women in the Informal Enterprise: Empowerment or Exploitation? (New York: Population Council).

Guha, S.2001. Health and Population in South Asia, Permanent Black, New Delhi, pp-77.

Kabir, M. and Ruhul Amin.1995. Factors Influencing Child Mortality in Bangladesh and their Implications for the National Health Programme, ***Asia-Pacific Population Journal***, vol.8, no.3, ESCAPE, Thailand.

Kari J. Pitkänen. 2002. Famine Mortality in Nineteenth Century Finland: Is there a Sex Bias? in Famine Demography-Perspective from the Past and Present, Oxford: Oxford University Press.

Larson, Charles P., Unnati Rani Saha, Rafiqul Islam, and Nikhil Roy. 2006. Child Diarrhea management Practices in Bangladesh: private sector dominance and continued inequities in care, ***International Journal of Epidemiology*** 35 (6): 1430-1439.

Learmonth, A. T.A 1958. Medical geography in Indo-Pakistan, ***The Indian Geographical Journal***, vol.33, no. 1-2, pp.1-59.

Maharatna, A.1996. The Demography of Famines: An Indian Historical Perspectives. Oxford University Press.

Maruyama, H. 1936. Jikan kansu toshite mitaru nyuji shibosu [Infant deaths as a function of time], ***Minzoku eisei*** 5 (5-6):541-544.

Maruyama, H. 1938. Taimu sukeru o kaeru kotoni yoru nyuji shibo no kaisekiteki kenkyu [An analytical study of infant mortality on a different time scale], ***Minzoku eisei*** 6 (5-6):462-463.

McKinley,S. and Levine, M. Cubic Spline Interpolation, Math 45: Linear Algebra.

Menken, J. and C. Campbell. 1992. Age-patterns of famine-related mortality increase: implications for long-term population growth, ***Health Transitional Review***, vol.2, no.1, pp.91-101.

Mitra S.N., Ahmed Al-Sabir, Anne R. Cross, Kanta Jamil. 1997. Bangladesh Demographic and Health Survey 1996-1997.

Murray, C.J.L, Ahmed, O.B, Lopez, A.D, and Salomon, J.A. GPE Discussion Paper Series: no.8, EIP/GPE/EBD, World Health Organization. (http://www.who.int/healthinfo/paper08.pdf.)

Newell, C.1988.Methods and Models in Demography, Belhaven press, London, pp.69-75

Osona.O.A.J.2001. The Attenuation of Mortality Fluctuations in British Punjab and Bengal, 1870-1947, in Asian Population History, edited by Liu, T.-J et al, Oxfor University Press.

Patterns, Levels, Trends in Mortality and Regional Life Tables for Bangladesh: evidence from sample vital registration system, 1981-88, May 1990, BBS.

Pollard, A.H, Yusuf Farhat, Pollard, G.N. 1990. Demographic Techniques, Third Edition, Pergamon Press, Sydney, Oxford, New York, Beijing, Frankfurt, Sao Paulo, Tokyo, Toronto.

Preston, H. S. 1976. Mortality Patterns in National Populations With special reference to recorded causes of death, Academic Press, New York, pp.112-116.

Razzaque,A., N.Alam, L. Wai and A. Foster.1990. Sustained Effects of the 1974-1975 Famine on Infants and Child Mortality in Rural Area of Bangladesh, ***Population Studies***, vol.44, no.1, pp.145-154.

Report on the 1974 Bangladesh Retrospective Survey on Fertility and Mortality, Census Commission, Ministry of Planning, Dhaka (1977).

Report of Bangladesh Demographic and Health Survey 1993-1994, 1999-2000, and 2004.

Report of Sample Vital Registration System 1997 & 19998, July 2000. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the Republic of Bangladesh, Dhaka.

Rosenberg, I.H. 1973. Nutrition: food production, dietary patterns and nutritional deficiencies, in L.C.Chen, ed., Disaster in Bangladesh, London: Oxford University Press, pp. 31-51.

Roy, S.G.1985. Estimating child mortality and modelling its age pattern for India, Demographic Research Unit, Publication no. 80. POPLINE Document Number: 225131

Ruzicka, L.T., and A.K.M.A. Chowdhury. 1978. Vital Events and Migration-1975, Demographic Surveillance System-Matlab, vol.4, Scientific Repot no.3, Dacca, Cholera Research Laboratory.

Saito, O. and M. Takahama with R. Kaneko. 2005. Contrasts in vital rates: Madras and Punjab in the colonial period, Hi-Stat Discussion Paper Series, no.68, Institute of Economic Research, Hitotsubashi University (http://hi-stat.ier.hit-u.ac.jp/research/discussion/2004/068.html).

Sample Vital Registration System 1997 &1998. July 2000, BBS

Sample Vital Registration System 1999-2001. June 2003, BBS

Sen, Amartya, 1999. 'Poverty and Famines' in The Amartya Sen and Jean Drèaze Omnibus, Oxford University Press, pp.133-153.

Shameem Ahmed, Farzana Sobhan, Ariful Islam, and Barkat-e-Khuda. 2001. Neonatal Morbidity and Care-seeking Behavior in Rural Bangladesh, ***Journal of Tropical Pediatrics***, 47(2): 98-105.

Sharma, D.2002. Famine as commerce. India Together. Sun 20, Jan 2008. http://www.indiatogether.org/agriculture/opinions/dsharma/faminecommerce.html

U N. 1981. Population of Bangladesh, country monograph series no. 8. Economic and Social Commission for Asia and the Pacific,

UN.1982a. Population of India, country monograph series no. 10. Economic and Social Commission for Asia and the Pacific, ST/ESCAP/220

UN.1982b. Model Life Tables for Developing Countries, Department of International Economic and Social Affairs, Population Studies, no. 77, United Nations Publication, sales no. E.81.XIII.7

UN.1983. Indirect Techniques for Demographic Estimation, Manual X, Department of International Economic and Social Affairs, Population Studies, no. 81,United Nations Publication, sales no. E.83.XIII.2

UNSTAT. 2005. Millennium Indicator Database, http://unstats.un.org/unsd/mi/mi_goals.asp

Visaria, Pravin M. (1969). The Sex Ratio of the Population of India, Census of India 1961, Vol. 1, Monograph No. 10.

Visaria, L. and Visaria, P.1983. 'Population (1757-1947)' in The Cambridge Economic History of India, volume 2: c.1757-c. 1970 edited by Dharma Kumar, Cambridge University Press.

Visaria, Leela (1994). "Deficit of women, son preference and demographic transition in India". Paper presented at International Symposium on Issues Related to Sex Preference for Children in the Rapidly Changing Demographic Dynamics in Asia, Seoul, Republic of Korea.

Watkins, S.C and J. Menken. 1985. Famines in historical perspective, ***Population and Development Review***, 11(4): 647-675.

Wrigley and Schofield.1981. The Population History of England 1541-1871: A reconstruction, Edward Arnold Ltd., London.

Zhao, Zhongwei. 2003. On the Far Eastern Pattern of Mortality, ***Population Studies**,* vol.2 (2), pp.131-147

Grant, J.P.1988. The State of the World's Children, 1988. New York: Oxford University Press.

HDSS, 2002. Health and Demographic Surveillance system Matlab, volume 33. Registration of Health and Demographic Events 2000, Scientific Report no. 89. ICDDR,B: Centre for Health and Population Research.

HDSS, 2007. Health and Demographic Surveillance system Matlab, volume 38. 2005 SOCIO-ECONOMIC CENSUS, Scientific Report No. 96. ICDDR,B: Centre for Health and Population Research.

APPENDIX

Appendix 3.A

To measure the level of mortality as compared to the certain level of mortality of model life table the life expectation at birth (e_x^0) is considered as the level as usual. And it is estimated by the process of period life table estimation for the certain periods in this study. Period life table are estimated under the assumption that the population is closed to migration. Conventional abridged life table estimation process has been chosen. The observed death rates (${}_n\boldsymbol{m}_x$) in respect of mid year adjusted population published by DSS report are the basic data for this estimation which is converted to ${}_n\boldsymbol{q}_x$ (the life table death rate, or the probability of dying between ages x and $x+n$). The conversion of ${}_nm_x$ to ${}_nq_x$ is done by the following formula

$${}_n\boldsymbol{q}_x = (n \times {}_n\boldsymbol{m}_x) \div (1000 + n \times (1-{}_n\boldsymbol{a}_x) \times {}_n\boldsymbol{m}_x)$$

when ${}_n\boldsymbol{m}_x$ are given per 1000.

${}_na_x$ refers to the average number of person-years lived in the interval x to $x+n$ by those dying in the interval. Here n is the length of age interval. For zero age group population, in this study, Infant Mortality Rate (IMR) is taken as ${}_1\boldsymbol{q}_0$ and The value of ${}_na_x$ at age group (1-4) years is considered 0.4 (${}_4a_1$=0.4). For the higher age groups ${}_na_x$ takes values 0.5. And these values are considered as ideal for the mortality of developing country (Newel, 1988). The other life table functions are as follows:

$\boldsymbol{l}_x$ at age 0, $\boldsymbol{l}_0$ = 100000 ; is called the radix of the life table.

$\boldsymbol{l}_{x+n} = \boldsymbol{l}_x \times (1-\boldsymbol{q}_x)$; $\boldsymbol{l}_x$ is the number of persons who, on the average, attain exact age x.

${}_n\boldsymbol{d}_x = \boldsymbol{l}_x - \boldsymbol{l}_{x+n}$; number of deaths between age x and $x+n$.

${}_n\boldsymbol{L}_x = n \times (\boldsymbol{l}_{x+n} + {}_n\boldsymbol{a}_x \times {}_n\boldsymbol{d}_x)$; the number of person-years that would be lived within the indicated age interval by the cohort of 100,00 births assumed.

$\boldsymbol{T}_x = \sum {}_n\boldsymbol{L}_x$; the number of person years lived above age x.

And finally, $\boldsymbol{e}_x = \boldsymbol{T}_x \div \boldsymbol{l}_x$; life expectancy at age x which is the average number of additional years to be lived by a member of the cohort who survives to age x.

One important thing should be pointed here that life expectation at birth is a little bit larger by this estimates comparing with the estimates of ICDDR, B; particularly for the earlier periods. The different process of dealing the mortality at open aged interval to estimate ${}_nL_x$ might be accounted for this difference. They used the approximation as

$${}_\infty\boldsymbol{L}_x = \boldsymbol{l}_{x+} \times \boldsymbol{log}_{10}\, \boldsymbol{l}_{x+}$$

Whereas,

The value of ∞Lx has been estimated as $_{\infty}L_x = l_{x+} \div {}_{\infty}m_{x+}$

x_+ refers to age group of 65 and above.

It causes about three years difference between the estimates of this study and of ICDDR, B (International Centre for Diarrhoeal Diseases Research, Bangladesh). It is mostly for earlier periods but for the recent periods the difference becomes narrow.

Table 4: Life Table for Male of the periods over 1960s-1970s

MALE 1966-70				Life Table For 1971-76				1977-80		
q_x	l_x	e_x	age	q_x	l_x	e_x	age	q_x	l_x	e_x
0.12938	100000	54.0194	0	0.137983	100000	49.53873	0	0.1097	100000	56.58689
0.082503	87062	61.00247	1	0.090652	86201.67	56.42039	1	0.061633	89030	62.52239
0.01666	79879.1	62.34406	5	0.023797	78387.28	57.8854	5	0.016119	83542.79	62.52386
0.00638	78548.31	58.35796	10	0.006645	76521.92	54.23553	10	0.005236	82196.16	58.50723
0.006976	78047.21	53.7166	15	0.007058	76013.47	49.58158	15	0.004614	81765.76	53.80205
0.012916	77502.78	49.07637	20	0.011599	75476.94	44.91626	20	0.007968	81388.47	49.03987
0.014593	76501.75	44.68583	25	0.016201	74601.48	40.41402	25	0.012299	80739.95	44.41368
0.015381	75385.38	40.31055	30	0.018658	73392.86	36.03838	30	0.011311	79746.94	39.93559
0.019802	74225.9	35.90119	35	0.030769	72023.52	31.67603	35	0.018944	78844.95	35.36386
0.038254	72756.08	31.57596	40	0.041935	69807.41	27.60225	40	0.030406	77351.32	30.99845
0.050777	69972.86	27.73248	45	0.066154	66880.03	23.701	45	0.052225	74999.41	26.89213
0.070988	66419.83	24.08225	50	0.091148	62455.67	20.20287	50	0.067283	71082.58	23.2362
0.088594	61704.84	20.73139	55	0.121404	56762.98	16.97827	55	0.101904	66299.95	19.73203
0.126025	56238.18	17.50358	60	0.186078	49871.71	13.97888	60	0.148898	59543.72	16.68729
1	49150.78	14.66706	65+	1	40591.67	11.60317	65+	1	50677.78	14.16932

Table 6: Life Table for Female of the periods over 1960s-1970s

Female	1966-70			1971-1976				1977-80		
q_x	l_x	e_x	age	q_x	l_x	e_x	age	q_x	l_x	e_x
0.11812	100000	50.39711	0	0.13665	100000	47.23	0	0.11775	100000	53.49687
0.115205	88188	56.10718	1	0.134184	86335	53.66	1	0.102309	88225.00	59.59683
0.019704	78028.27	59.20432	5	0.030204	74750.21	57.73	5	0.022372	79198.79	62.20667
0.009059	76490.81	55.34408	10	0.008877	72492.49	54.45	10	0.006976	77426.96	58.57299
0.015873	75797.9	50.82716	15	0.015873	71848.97	49.92	15	0.010693	76886.86	53.96688
0.017053	74594.75	46.60663	20	0.01923	70708.51	45.68	20	0.013656	76064.75	49.52314
0.01941	73322.66	42.37184	25	0.019148	69348.78	41.53	25	0.013286	75026.00	45.17418
0.019116	71899.49	38.16107	30	0.019557	68020.88	37.29	30	0.014765	74029.19	40.74879
0.02352	70525.09	33.85603	35	0.025423	66690.6	32.98	35	0.020292	72936.14	36.322
0.033625	68866.33	29.61129	40	0.027127	64995.15	28.78	40	0.014888	71456.12	32.02254
0.044488	66550.7	25.55463	45	0.037211	63232.02	24.51	45	0.032585	70392.25	27.46872

0.072846	63590	21.62803	50	0.056208	60879.08	20.36	50	0.046279	68098.50	23.30974
0.093241	58957.7	18.13092	55	0.095767	57457.19	16.43	55	0.082684	64946.99	19.31952
0.156767	53460.45	14.73822	60	0.19209	51954.69	12.90	60	0.141264	59576.89	15.83558
1	45079.62	12.01346	65+	1	41974.69	10.37	65+	1	51160.83	13.02932

Table 5: Life Table for Male of the periods over 1980s and 1990s

Male	1981-90				1991-2000		
age	q_x	l_x	e_x	age	q_x	l_x	e_x
0	0.09987	100000	58.24074	0	0.07292	100000	64.07946
1	0.052493	90013	63.66931	1	0.023815	92708	68.09607
5	0.012521	85287.95	63.10802	5	0.00767	90500.18	65.71829
10	0.005634	84220.05	58.87652	10	0.003693	89806	61.20695
15	0.005187	83745.55	54.19595	15	0.004789	89474.33	56.42457
20	0.006827	83311.2	49.46547	20	0.006032	89045.88	51.68403
25	0.009604	82742.47	44.78829	25	0.007323	88508.78	46.9825
30	0.011237	81947.84	40.19835	30	0.007869	87860.62	42.31065
35	0.014051	81027.03	35.62676	35	0.012817	87169.25	37.6264
40	0.02088	79888.55	31.09884	40	0.022347	86051.98	33.08247
45	0.035219	78220.5	26.70871	45	0.02878	84128.93	28.78154
50	0.06225	75465.68	22.59243	50	0.050635	81707.72	24.56033
55	0.101701	70767.92	18.92622	55	0.083741	77570.47	20.73692
60	0.144368	63570.73	15.78592	60	0.127823	71074.67	17.40367
65+	1	54393.14	13.02762	65+	1	61989.7	14.58789

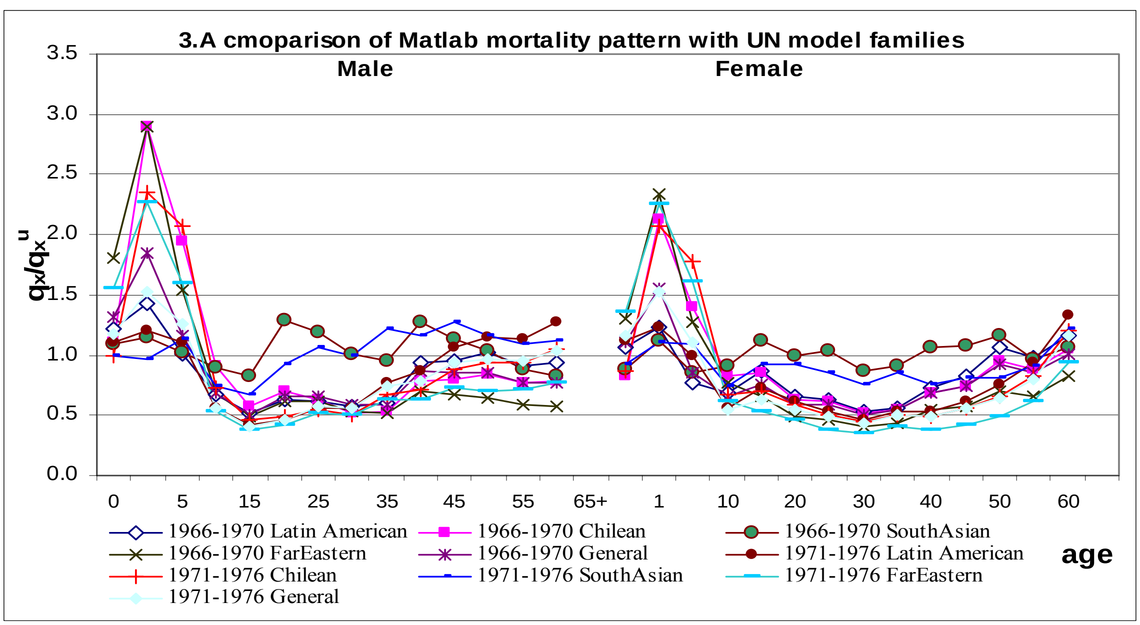
Table 7: Life Table for female of the periods over 1980s-1990s

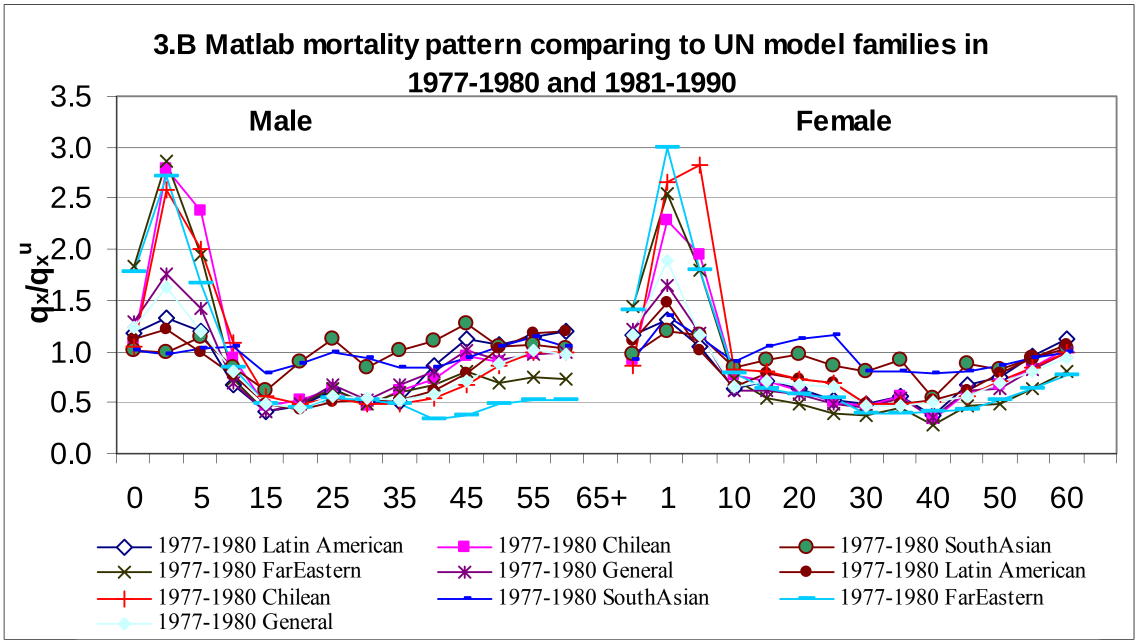
Female	1981-90				1991-2000		
age	q_x	l_x	e_x	age	q_x	l_x	e_x
0	0.09663	100000	57.10009	0	0.06797	100000	66.74253
1	0.089698	90337	62.17578	1	0.029315	93203	70.58798
5	0.016513	82233.95	64.14471	5	0.006678	90470.74	68.67145
10	0.005584	80876.06	60.17971	10	0.003394	89866.61	64.11628
15	0.009108	80424.42	55.50362	15	0.005435	89561.58	59.32614
20	0.01183	79691.89	50.99083	20	0.00772	89074.8	54.63669
25	0.013607	78749.17	46.57133	25	0.008761	88387.13	50.04232
30	0.011484	77677.64	42.17927	30	0.009207	87612.73	45.46254
35	0.014051	76785.62	37.64023	35	0.010396	86806.05	40.86179
40	0.01779	75706.73	33.141	40	0.014396	85903.64	36.26477
45	0.025325	74359.88	28.69599	45	0.017839	84667	31.75794
50	0.04243	72476.71	24.37665	50	0.030818	83156.59	27.28936

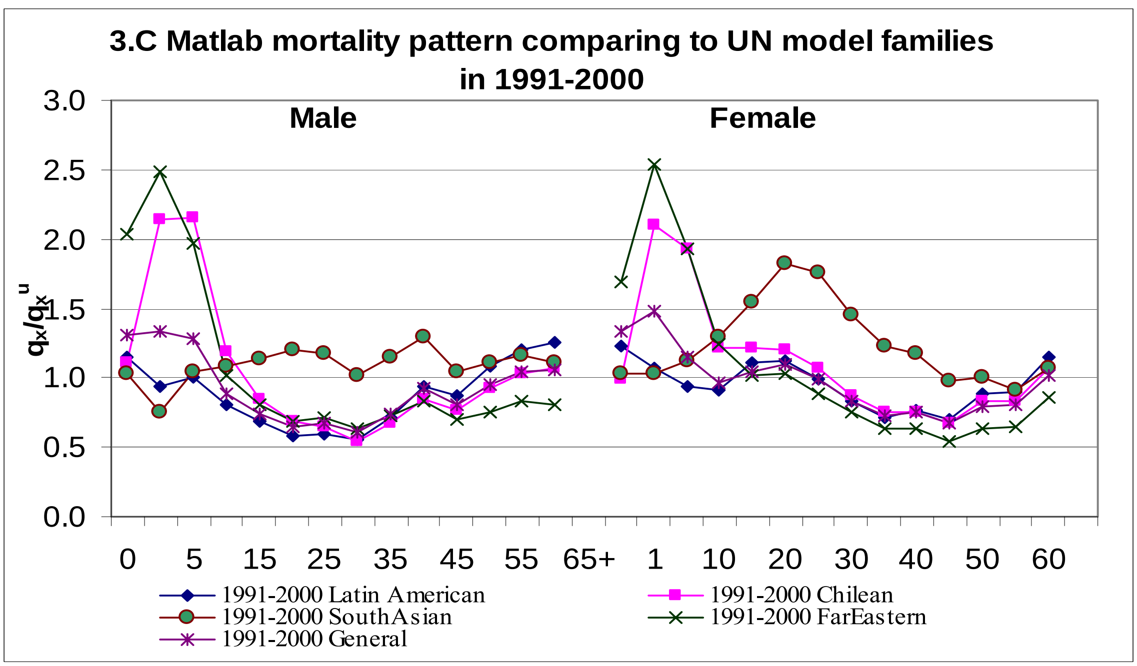
55	0.071778	69401.5	20.34601	55	0.046684	80593.89	23.07761
60	0.120831	64419.99	16.72602	60	0.091057	76831.43	19.0853
65+	1	56636.09	13.6812	65+	1	69835.42	15.74679

Appendix 3.B

According to the UN estimates, it is said that the South Asian mortality pattern appears in less reliable life tables constructed for Bangladesh but Matlab, Nepal, Pakistan and Turkey (UN, 1982). This is why the Matlab pattern of mortality is very similar to the UN South Asian mortality pattern (except in 1991-2000 where female death pattern at child bearing ages is looking a little bit strange comparing with South Asian pattern but closer to Latin American pattern). The mortality ratios of the estimated death rate (q_x) of Matlab population to the UN model death rate of different patterns (q_x/q_x^u) have reflected the higher mortality at infant and child ages and at old ages among both the sexes which is characterized by the South Asian pattern of the UN model (see appendix figure-3.A, figure-3.B and figure 3.C). It is not unexpected as UN have used the data from some countries like Philippines, Singapore, Thailand and Matlab (Bangladesh), India, Iran and Sri Lanka.







Appendix 3.C

Sample vital registration system (SVRS) presents the data on causes of death that have been collected through non-medical personnel like ICDDR, B. The percentage distribution of deaths by cause, sex and residence suggests that among total deaths at national, 26.13 and 19.82 percent were due to Fever (typhoid/ paratyphoid/ influenza and other types of fevers) in 1986 and 1987 respectively. Old age was the second highest (17.31 percent in 1986 in 1986 and 14.82 percent in 1987) cause followed by Tetanus (11.12 and 10.13 respectively). These are followed by Diarrhoea (acute/ chronic, 8.41 percent and 6.40), Asthma (including respiratory/ pneumonia/ whooping cough, 4.11, 6.58 percent), Dysentery (acute/chronic/blood dysentery, 5.09 percent and 3.83 percent). Tuberculosis among all other causes, accounted 1.81 percent and 2.07 percent death respectively in 1986 and 1987 (SVRS Report, 1990). Urban population experience higher mortality than rural residence at this regard. Again, males are at higher risk due to tuberculosis than female.

But the recent data shows a different trend. In the year 1999, Old age causes 15.39 percent deaths among all other causes which is followed by Diarrhoea (acute/ chronic,15.71), Fever (typhoid/ paratyphoid/ influenza and other types of fevers, 13.86). Whereas, in 2000 and 2001, death due to Old age (12.5, 13.5 percent) is followed by Asthma (including respiratory/ pneumonia/ whooping cough, 11.6, 12.2 percent), Fever (9.7, 9.1 percent), High Blood Pressure and Heart disease (7.5, 10.5 percent). Diabetes and Veneral disease (3.7, 3.0 percent), Cancer (3.3, 4.5 percent), Malnutrition (3.0, 2.4 percent), Diarrhoea (2.2. 4.7 percent), Dysentery (2.4, 1.7) etc. respectively (SVRS Report, 2003). In rural Bangladesh, causes of deaths are at similar rank with a little bit increase or decrease level.

Appendix 4. A. Mortality Trend in Matlab

Table -4.1: Infant and Child Mortality Rate

Year	IMR	0-7 days	8-29 days	1-12 months	1-4years	5-9years
Male						
1966	117.4	37.9	27.6	52	20	3.7
1967	126.7	44.9	28.3	53.9	25	5
Female						
1966	104	29.1	24.5	50.5	30	4.5
1967	124	41.5	20.8	61.5	34	5.1
Year	IMR	<1month	1-11 months	1 year	1-4years	5-9years
Male						
1974	142.5	87.9	54.6	22.6	18.3	4.7
1975	165.1	81.6	98.4	38.4	28.8	4.9
1976	113.6	72	33.3	40.9	25.5	4.6

1977	113.3	73.1	40.2	23.8	14.5	3.4
1978	116.6	73	43.6	24.2	16.9	2.2
1979	118.7	77.2	41.4	26.1	16.1	4.5
1980	90.2	61.8	28.4	24.4	16.5	2.9
1981	104.8	68.6	36.2	24	16.2	2.4
1982	115.8	68	47.8	24	24	3
1983	100.9	64.2	36.6	35.2	21.9	3.2
Female						
1974	132.9	67.8	65.1	44.8	32.9	6.4
1975	184.1	78.1	126.3	56.8	41.3	6.8
1976	110.3	58.1	42.1	55.9	33.8	6
1977	114.2	69.4	44.8	26.6	25.2	4.6
1978	124.3	75.3	49.1	44	28.2	4.9
1979	114	68.5	45.5	40.8	27.6	5.2
1980	118.5	71.6	46.8	33.6	28	3.4
1981	113.7	67.6	46.1	44.4	28.3	4.3
1982	108.9	58.6	50.2	42.6	42.6	4.5
1983	111.5	63.8	47.7	48.7	37	4.8

The DSS data give the following figures with death rates for male and female where it is seen that infants, child and elderly population are more likely to die generally. Figure 4.A and 4.B is sowing the age-sex specific death rates from the year prior and posterior to famine including the famine year also. Apparently, Female infant mortality has got higher rise than male one due to famine. On the other hand male adults and old aged population has experienced higher mortality than female. Female population hasn't seen here to have any sharp change between age group of (10-14) years to (50-54) years. But the male experienced the rise in mortality clearly from the age group of (35-39) due to famine in 1975. Figure 4.C to Figure 4.G, all are presenting the scenario of early aged deaths in Matlab by sex where male advantaged mortality is clear.

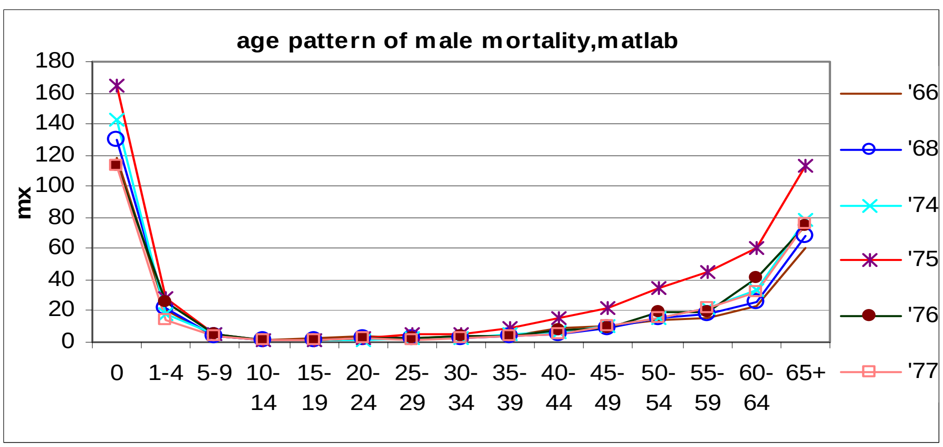


Figure 4.A: Age pattern of male deaths in Matlab

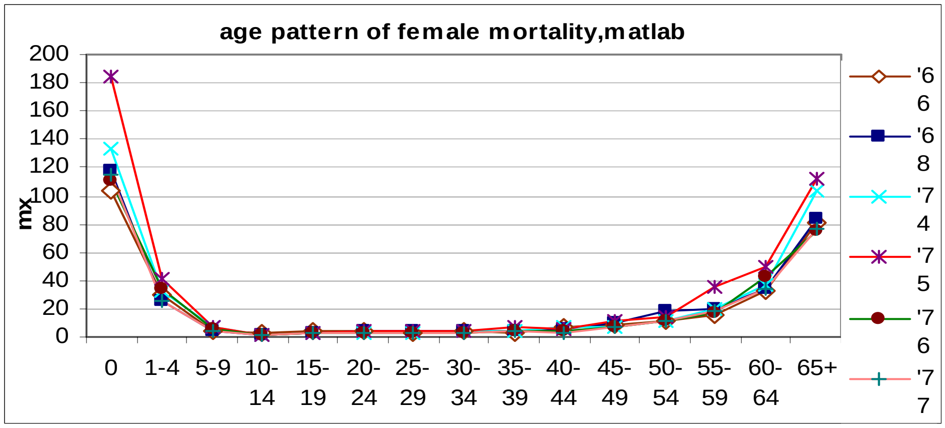


Figure 4.B: Age pattern of female deaths in Matlab

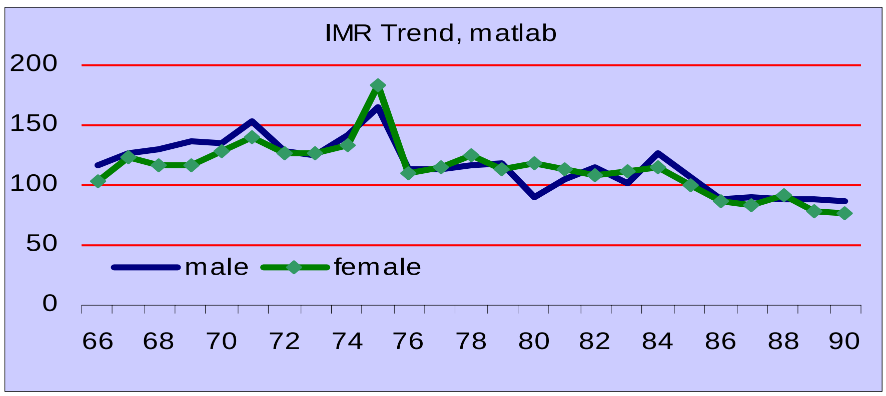


Figure 4.C: Infant Mortality Rate over the years in Matlab

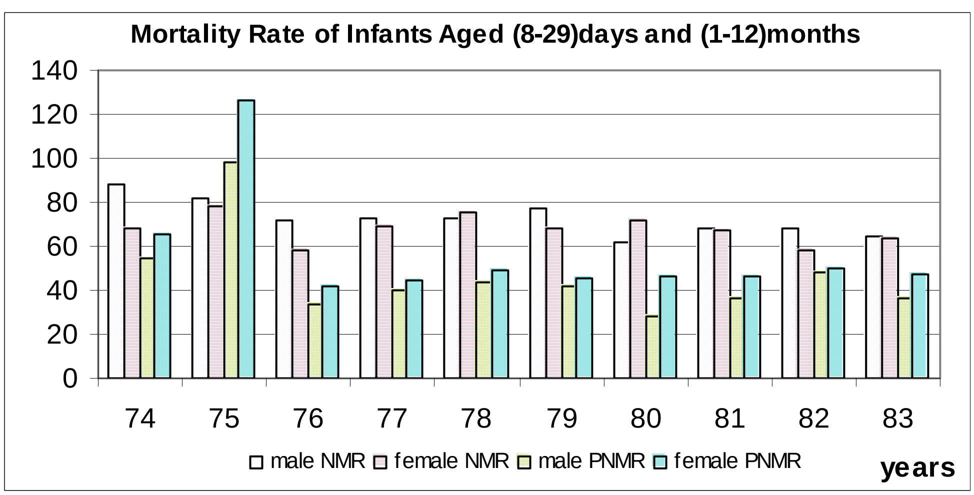


Figure 4.D: Post neonatal mortality by sex in Matlab

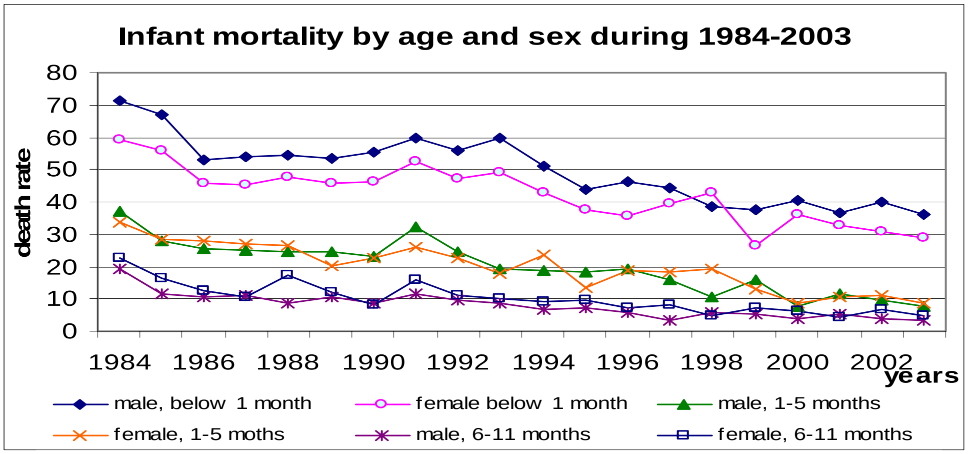


Figure 4.E: Recent condition of infant deaths by age and sex, Matlab

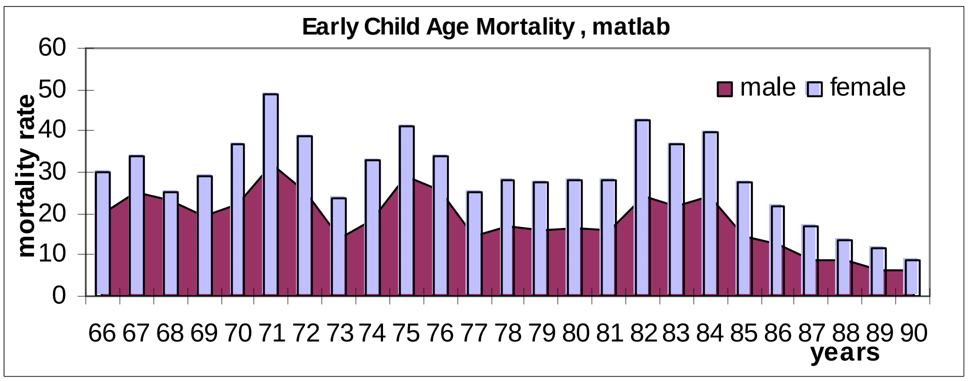


Figure 4.F: Child mortality by sex over the decades in Matlab

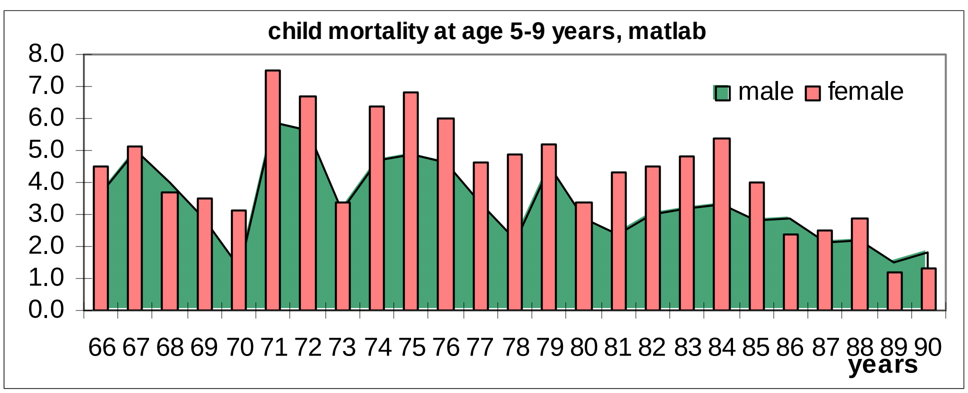


Figure 4.G: deaths by sex at late childhood ages in Matlab

4. B Proportional Measure of Mortality

The Figure 4.H is the graphical presentation of ratios of the death rates presented in Table-2 in the text. It is easy to get with this figure how famine made the change in death rates by sex.

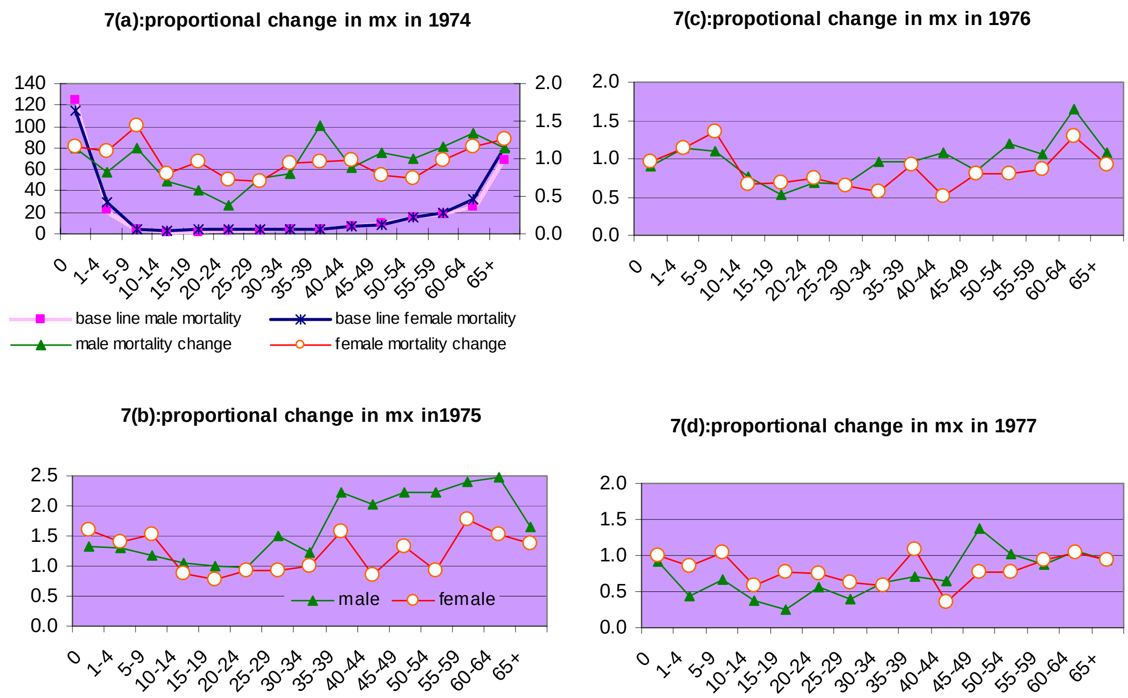


Figure 4.H: Proportional change due to 1974 Famine in the age-sex specific mortality of Matlab population

Appendix 5. A. MATLAB programme commands and resultant interpolated data.

MATLAB Programme commands are presented below which is used to break down the age interval to single age by using cubic spline interpolation and the corresponding figures and .results.

Program-1: Age intervals: 5-9(1971) ~35-39(2001) covers age5 in 1971 through age 35 in 2001, **death rates of Male.**

```
t=1971:5:2001;

p=[5.9 1.1 0.9 1.7 1.2 1.7 1.8];

x = 1971:1:2001;
```

```
y = interp1(t,p,x,'spline');
 plot(t,p,'o',x,y)
```

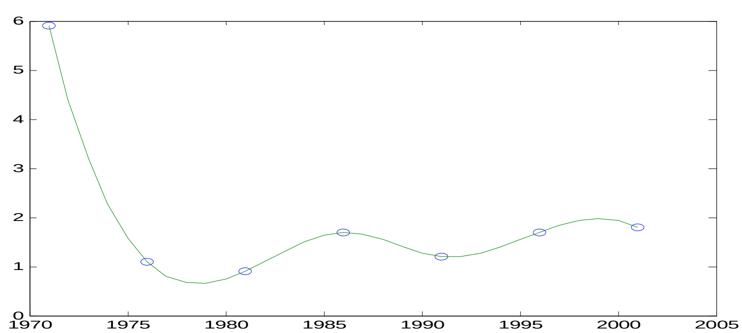
Results:1

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
5.9	4.4014	3.2006	2.269	1.5783	1.1	0.8057	0.667	0.6554	0.7426	0.9	1.0989

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1.309	1.4997	1.6402	1.7	1.6602	1.5497	1.409	1.2789	1.2	1.2026	1.2754

1994	1995	1996	1997	1998	1999	2000	2001
1.397	1.5457	1.7	1.8383	1.939	1.9806	1.9414	1.8

Figure:1



Program-2: death rates of Female, 5-9 ~ 35-39

```
t = 1971:5:2001;
p = [7.5 1.5 1.9 2.3 2.4 2.1 2.0];
 x = 1971:1:2001;
```

```
y = interp1(t,p,x,'spline');

plot(t,p,'o',x,y)
```

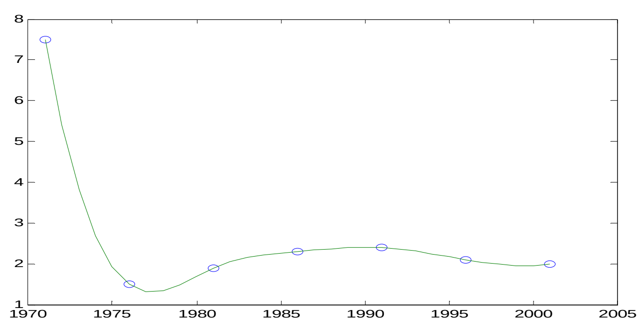
Results:2

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
7.5	5.4025	3.8179	2.6822	1.931	1.5	1.325	1.3418	1.4861	1.6935	1.9	2.0542

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2.1573	2.2232	2.2661	2.3	2.3357	2.37	2.3965	2.4086	2.4	2.3663	2.3125	2.2454

1995	1996	1997	1998	1999	2000	2001
2.1722	2.1	2.0358	1.9866	1.9595	1.9617	2

Figure: 2



Program 3: Death rates of Male for age group 1-4. Intervals taken for 1-4 years in 1967 and 5-9 years in 1971

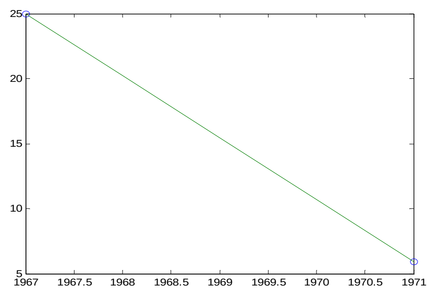
```
t = 1967:4:1971;

p = [25 5.9];

 x = 1967:1:1971;
```

```
 y = interp1(t,p,x,'spline');

 plot(t,p,'o',x,y)
```

Results:3

1967	1968	1969	1970	1971
25	20.225	15.45	10.675	5.9

Figure:3



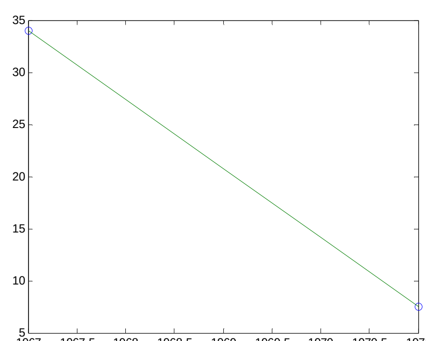
Program 4: death rates of female aged 1-4 years. Age Interval 1-4 of the year 1967(34) and 5-9 years group of 1971(7.5)

```
t = 1967:4:1971;

p = [34 7.5];

 x = 1967:1:1971;

 y = interp1(t,p,x,'spline');

 plot(t,p,'o',x,y)
```

Results:4

1967	1968	1969	1970	1971
34	27.375	20.75	14.125	7.5

Figure:4



IMR: male-118(1966)

Female-104(1966)

These all covers age 0 in 1966~35 in 2001 for the single age life table.

MATLAB Function Reference

interp1

1-D data interpolation (table lookup)

Syntax

yi = interp1(x,Y,xi)

yi = interp1(Y,xi)

Description

The interp1 command interpolates between data points. It finds values at intermediate points, of a one-dimensional function that underlies the data.

yi = interp1(x,Y,xi) interpolates to find yi, the values of the underlying function Y at the points in the vector or array xi. x must be a vector. Y can be a scalar, a vector, or an array of any dimension, subject to the following conditions:

If Y is a scalar or vector, it must have the same length as x. A scalar value for Y is expanded to have the same length as x. xi can be a scalar, a vector, or a multidimensional array, and yi has the same size as xi.

If Y is an array that is not a vector, the size of Y must have the form [n,d1,d2,...,dk],

Where, n is the length of x. The interpolation is performed for each d1-by-d2-by-...-dk value in Y.

The sizes of xi and yi are related as follows:

If xi is a scalar or vector, size(yi) equals [length(xi),d1, d2, ..., dk].

If xi is an array of size [m1,m2,...,mj], yi has size [m1,m2,...,mj,d1,d2,...,dk].

Table 5. A-1 Generation life table estimates for males by using interpolated data.

Year	age	m_x	q_x	p_x	l_x	d_x	L_x	T_x	s_x
Male									
1966	0	118	0.118	0.882	100000	11800	91740	3206288	0.88200
1967	1	25	0.024631	0.975369	88200	2172.414	86896.55	3114548	0.94720
1968	2	20.225	0.019983	0.980017	86027.59	1719.047	84996.16	3027651	0.97813
1969	3	15.45	0.015308	0.984692	84308.54	1290.603	83534.18	2942655	0.98280
1970	4	10.675	0.010607	0.989393	83017.94	880.5764	82489.59	2859121	0.98750
1971	5	5.9	0.005883	0.994117	82137.36	483.185	81895.77	2776632	0.99280
1972	6	4.4014	0.004392	0.995608	81654.17	358.6035	81474.87	2694736	0.99486
1973	7	3.2006	0.003195	0.996805	81295.57	259.7789	81165.68	2613261	0.99621
1974	8	2.269	0.002266	0.997734	81035.79	183.6618	80943.96	2532095	0.99727
1975	9	1.5783	0.001577	0.998423	80852.13	127.5083	80788.38	2451151	0.99808
1976	10	1.1	0.001099	0.998901	80724.62	88.74827	80680.25	2370363	0.99866
1977	11	0.8057	0.000805	0.999195	80635.87	64.94216	80603.4	2289683	0.99905
1978	12	0.667	0.000667	0.999333	80570.93	53.72289	80544.07	2209079	0.99926
1979	13	0.6554	0.000655	0.999345	80517.21	52.75369	80490.83	2128535	0.99934
1980	14	0.7426	0.000742	0.999258	80464.45	59.73073	80434.59	2048044	0.99930
1981	15	0.9	0.0009	0.9991	80404.72	72.3317	80368.56	1967610	0.99918
1982	16	1.0989	0.001098	0.998902	80332.39	88.22879	80288.28	1887241	0.99900
1983	17	1.309	0.001308	0.998692	80244.16	104.9709	80191.68	1806953	0.99880
1984	18	1.4997	0.001499	0.998501	80139.19	120.0947	80079.15	1726761	0.99860
1985	19	1.6402	0.001639	0.998361	80019.1	131.1398	79953.53	1646682	0.99843
1986	20	1.7	0.001699	0.998301	79887.96	135.6942	79820.11	1566729	0.99833
1987	21	1.6602	0.001659	0.998341	79752.26	132.2949	79686.12	1486908	0.99832
1988	22	1.5497	0.001549	0.998451	79619.97	123.2915	79558.32	1407222	0.99840
1989	23	1.409	0.001408	0.998592	79496.68	111.932	79440.71	1327664	0.99852
1990	24	1.2789	0.001278	0.998722	79384.75	101.4603	79334.02	1248223	0.99866
1991	25	1.2	0.001199	0.998801	79283.29	95.08289	79235.74	1168889	0.99876
1992	26	1.2026	0.001202	0.998798	79188.2	95.1745	79140.62	1089654	0.99880
1993	27	1.2754	0.001275	0.998725	79093.03	100.811	79042.62	1010513	0.99876
1994	28	1.397	0.001396	0.998604	78992.22	110.2751	78937.08	931470.3	0.99866
1995	29	1.5457	0.001545	0.998455	78881.94	121.8337	78821.03	852533.2	0.99853
1996	30	1.7	0.001699	0.998301	78760.11	133.7785	78693.22	773712.2	0.99838
1997	31	1.8383	0.001837	0.998163	78626.33	144.4061	78554.13	695018.9	0.99823
1998	32	1.939	0.001937	0.998063	78481.92	152.0291	78405.91	616464.8	0.99811

2000	34	1.9414	0.00194	0.99806	78174.91	151.6216	78099.1	459806.5	0.99804
2001	35	1.8	0.001798	0.998202	78023.29	78023.29	381707.4	381707.4	0.49335

Table 5. A-2 Generation life table estimates of females by using the interpolated data.

Year	age	m_x	q_x	p_x	l_x	d_x	L_x	T_x	s_x
Female									
1966	0	104	0.104	0.896	100000	10400	92720	3146042	0.89600
1967	1	34	0.03332	0.96668	89600	2985.496	87808.7	3053322	0.94703
1968	2	27.375	0.026933	0.973067	86614.5	2332.757	85214.85	2965514	0.97046
1969	3	20.75	0.020495	0.979505	84281.75	1727.341	83245.34	2880299	0.97689
1970	4	14.125	0.014006	0.985994	82554.41	1156.282	81860.64	2797054	0.98337
1971	5	7.5	0.007472	0.992528	81398.13	608.2052	81094.02	2715193	0.99064
1972	6	5.4025	0.005388	0.994612	80789.92	435.2917	80572.27	2634099	0.99357
1973	7	3.8179	0.003811	0.996189	80354.63	306.2014	80201.53	2553527	0.99540
1974	8	2.6822	0.002679	0.997321	80048.43	214.4183	79941.22	2473325	0.99675
1975	9	1.931	0.001929	0.998071	79834.01	154.0108	79757	2393384	0.99770
1976	10	1.5	0.001499	0.998501	79680	119.4304	79620.28	2313627	0.99829
1977	11	1.325	0.001324	0.998676	79560.57	105.348	79507.89	2234007	0.99859
1978	12	1.3418	0.001341	0.998659	79455.22	106.5415	79401.95	2154499	0.99867
1979	13	1.4861	0.001485	0.998515	79348.68	117.8325	79289.76	2075097	0.99859
1980	14	1.6935	0.001692	0.998308	79230.85	134.0639	79163.81	1995807	0.99841
1981	15	1.9	0.001898	0.998102	79096.78	150.1413	79021.71	1916643	0.99820
1982	16	2.0542	0.002052	0.997948	78946.64	162.0058	78865.64	1837621	0.99802
1983	17	2.1573	0.002155	0.997845	78784.63	169.779	78699.74	1758756	0.99790
1984	18	2.2232	0.002221	0.997779	78614.86	174.5825	78527.56	1680056	0.99781
1985	19	2.2661	0.002264	0.997736	78440.27	177.5523	78351.5	1601528	0.99776
1986	20	2.3	0.002297	0.997703	78262.72	179.7975	78172.82	1523177	0.99772
1987	21	2.3357	0.002333	0.997667	78082.92	182.1655	77991.84	1445004	0.99768
1988	22	2.37	0.002367	0.997633	77900.76	184.4063	77808.55	1367012	0.99765
1989	23	2.3965	0.002394	0.997606	77716.35	186.0243	77623.34	1289204	0.99762
1990	24	2.4086	0.002406	0.997594	77530.33	186.5149	77437.07	1211580	0.99760
1991	25	2.4	0.002397	0.997603	77343.81	185.4027	77251.11	1134143	0.99760
1992	26	2.3663	0.002364	0.997636	77158.41	182.3642	77067.23	1056892	0.99762
1993	27	2.3125	0.00231	0.99769	76976.05	177.8015	76887.14	979825	0.99766
1994	28	2.2454	0.002243	0.997757	76798.24	172.2494	76712.12	902937.9	0.99772
1995	29	2.1722	0.00217	0.99783	76625.99	166.2664	76542.86	826225.7	0.99779
1996	30	2.1	0.002098	0.997902	76459.73	160.397	76379.53	749682.9	0.99787
1997	31	2.0358	0.002034	0.997966	76299.33	155.1722	76221.74	673303.4	0.99793

1999	33	1.9595	0.001958	0.998042	75993.04	148.7626	75918.66	521013	0.99803
2000	34	1.9617	0.00196	0.99804	75844.28	148.6379	75769.96	445094.4	0.99804
2001	35	2	0.001998	0.998002	75695.64	75695.64	369324.4	369324.4	0.49264

5. B Life table Survival function, l_x

Table 5.B-1: l_x for males and females from different generation

	male					female				
1966	1971	1974	1975	1976	age interval	1966	1971	1974	1975	1976
100000	100000	100000	100000	100000	0	100000	100000	100000	100000	100000
88200	84670	85750	83490	88640	1-4	89600	85980	86710	81590	88970
79879	76592	83322.35	81393.09	87365.81	5-9	78334	73830	83215.47	78887.07	86761.35
77557	74850	81468.45	80221.38	86323.67	10-14	75450	71648	81079.64	77557.3	84915.82
77132	74217	80981.1	79661.79	85979.06	15-19	74887	71255	80634.92	77093.34	84281.33
76785	73847	80698.17	79343.78	85678.66	20-24	74178	70687	79992.41	76632.17	83819.06
76135	73478	80175.33	78987.54	84911.01	25-29	73330	70124	79474.14	75869.66	82943.55
75680	73002	79139.78	78515.03		30-34	72456	69670	79038.24	75152.3	

Table 5.B-2: l_x for female from different generation

generation 1974	generation 1975	generation 1976	age interval	generation 1974	generation 1975	generation 1976
Male				Female		
100000	100000	100000	0	100000	100000	100000
85750	83490	88640	1	86710	81590	88970
82531	80157	86560	2	81947	77177	86641
80139	78879	84875	3	79012	74739	83920
79137	77652	83813	4	77143	73320	82278
78546	77142	83246	5-9	76102	72360	81087
76798	76031	82253	10-14	74149	71140	79363
76339	75501	81924	15-19	73742	70715	78770
76072	75199	81638	20-24	73155	70292	78337
75579	74862	80907	25-29	72681	69592	77519
74603	74414		30-34	72282	68934	

Table-5.C: q_x for males and female from different generation

1966	1971	1974	1975	1976	age interval	1966	1971	1974	1975	1976
Male						Female				
0.1180	0.1533	0.1425	0.1651	0.1136	0	0.1040	0.1402	0.1329	0.1841	0.1103
0.0943	0.0954	0.0283	0.0251	0.0144	1-4	0.1257	0.1413	0.0403	0.0331	0.0248
0.0291	0.0227	0.0222	0.0144	0.0119	5-9	0.0368	0.0296	0.0257	0.0169	0.0213
0.0055	0.0085	0.0060	0.0070	0.0040	10-14	0.0075	0.0055	0.0055	0.0060	0.0075
0.0045	0.0050	0.0035	0.0040	0.0035	15-19	0.0095	0.0080	0.0080	0.0060	0.0055
0.0085	0.0050	0.0065	0.0045	0.0090	20-24	0.0114	0.0080	0.0065	0.0100	0.0104
0.0060	0.0065	0.0129	0.0060	0.0070	25-29	0.0119	0.0065	0.0055	0.0095	0.0035
0.0085	0.0065	0.0075	0.0070		30-34	0.0104	0.0060	0.0055	0.0095	

Table-5.D: q_x for males and females from different generation

generation 1974	generation 1975	generation 1976	age interval	generation 1974	generation 1975	generation 1976
Male				Female		
0.1425	0.1651	0.1136	0	0.1329	0.1841	0.1103
0.0375	0.0399	0.0235	1	0.0549	0.0541	0.0262
0.0290	0.0159	0.0195	2	0.0358	0.0316	0.0314
0.0125	0.0156	0.0125	3	0.0237	0.0190	0.0196
0.0075	0.0066	0.0068	4	0.0135	0.0131	0.0145
0.0222	0.0144	0.0119	5-9	0.0257	0.0169	0.0213
0.0060	0.0070	0.0040	10-14	0.0055	0.0060	0.0075
0.0035	0.0040	0.0035	15-19	0.0080	0.0060	0.0055
0.0065	0.0045	0.0090	20-24	0.0065	0.0100	0.0104
0.0129	0.0060	0.0070	25-29	0.0055	0.0095	0.0035
0.0075	0.0070		30-34	0.0055	0.0095	

Table 5-E: ratios as l_x^m / l_x^f

l_x age interval	generation 1966	generation 1971	generation 1974	generation 1975	generation 1976	generation 1977	age interval
0	1	1	1	1	1	1	0
1-4	0.98	0.98	0.99	1.02	1.00	1.00	1
5-9	1.02	1.04	1.01	1.04	1.00	1.02	2
10-14	1.03	1.04	1.01	1.06	1.01	1.04	3
15-19	1.03	1.04	1.03	1.06	1.02	1.04	4
20-24	1.04	1.04	1.03	1.07	1.03	1.05	5-9
25-29	1.04	1.05	1.04	1.07	1.04	1.06	10-14
30-34	1.04	1.05	1.04	1.07	1.04	1.06	15-19
35-39	1.05		1.04	1.07	1.04	1.06	20-24

			1.04	1.08	1.04	1.06	25-29
			1.03	1.08			30-34