The primary aim of development is to improve the well-being of population. There are factors like growth in per capita income and increase in productivity and production by which these goals can be achieved. There are other factors that are also important for the socio-economic development of population in a country and these include education, culture, social welfare, health, etc. But, when the path of development is critical and the benefit of it fails to reach equally to all sections of population, it generates inequality in major aspects of our social life. This inequality is manifested in two important indicators of development namely poverty and mortality. These two aspects of social indicators are inseparable in a sense that it is difficult to ignore the issue of health while addressing the impact of poverty. On the other hand, it is not possible to understand the health status of a population without taking into account of nutrition, food and water security. This linkage established the fact that, hunger and malnutrition which are indicators of poverty are very important determinants of ill-health. The Alma Ata Declaration (health for all) of the World Health Organization (WHO) General Assembly in 1978 clearly pointed out that, surviving well is an essential element of quality of life and poor health is a factor of deprivation (WHO, 1978).

Human survivorship is an important element of development. Poverty increases the risk of failing to survive. Mortality and poor health are two indicators of quality of life that are useful for measuring exposure to poverty. However, the most prominent impacts of poverty and mortality are identified among the children. According to the United Nations, the most sensitive index of development in all its manifestations is the health of children (United Nations, 2006). Maternal deprivation and malnutrition immediately affect the health status of mother and subsequently that of
the newborn, which can be traced across the entire life cycle of the child. Mortality in childhood may be identified as a combined indicator of various aspects, influencing development and growth of any society.

When privileged sections of the population in a society enjoy more benefits or facilities from the development than other classes or sections of people, it may result in disparities among the population. Whether this disparity or inequality in wider term is increasing or declining over time and or whether it varies from one socio economic setup to the other within the country are important questions that need answering through evaluation and also demands for formulation of corrective measures. Now, the burden of socio economic inequality falls excessively on children and for this a significant proportion of infant and child deaths occur during childhood, which may be attributed to poor public health measures and lack of access to health care facilities.

In Indian planning along with other important objectives, health status and improvement in the standard of living of the population has remained one of the important issues for a long time. Most of the Five Year Plans had reflected long term vision about the enhancement in health care and living standard. In different public policies of the government like, National Population Policy, National Health Policy, and National Nutrition Policy, these long term goals are reflected. These policies have directed different guidelines to achieve improvement in the access and utilization of health, family welfare and nutritional services and facilities and, also such services to those who belong to under-served and under-privileged segments of the population. The Government of India has launched various Child Survival and Safe Motherhood Programmes as a part of National Health policy in assistance with different world organisations like, World Bank, United Nations etc. The objectives of the programmes were to improve the health status of infants, child and maternal morbidity and mortality. For reduction in infant and child mortality, attention has been paid to protect children from infectious diseases like, sepsis, measles, malaria, diarrhoea, pneumonia etc. Provisions have been made for nutritional supplement to
children and pregnant mothers. Several health care programmes have been initiated to improve utilization of different health care services for mothers and children.

**There have been considerable efforts to reduce mortality in childhood in India over the last three decades.** The above said policies and programmes have positive effects in terms of reducing under-five mortality and improved child health status in India. The U5MR, which includes infant, neonatal and child mortality has started declining since the late 1970s and the rate of decline has been remarkable (approximately 50 per cent reduction) till 1993. Between 1970 and 2009, the number of deaths among children younger than 5 years has fallen by more than 52% (Rajaratnam et. al, 2010).

**But this overall achievement in regard to under-five mortality is not very inspiring.** In many aspects, success raises many questions about the disparities in child survival with respect to economic class, gender, community, level of literacy, geographic location, accessibility, quality and management of health care services, failure to achieve the future target, etc. **The salient features about the present situation of mortality in childhood can be summarized as follows.**

- Although India’s healthcare system has gradually improved in the last few decades, it continues to lag behind those of its neighboring countries like, Bangladesh, Bhutan, Nepal and Sri Lanka *(Chapter 1)*.
- During the period of 1993-98, the rate of decline of U5MR was very slow and ultimately reached into a stagnant state. Again, from the beginning of the new Millennium, U5MR has again started declining with a decreasing rate *(Chapter 3)*. The UNICEF report published in 2008 shows that the actual number of child deaths has been around 2.1 million (UNICEF, 2008). **India accounts for half the world’s undernourished children, despite having just 29 percent of the developing world's under-five population** (Gragnolati et. al, 2005).
Despite a general decline in infant and child mortality, there exist enormous variations among regions and among states within regions, and these variations are growing over time. India is characterized by a wide range of interregional diversity arising due to differentiation in demographic, social, cultural, economic, and geographic characteristics which create significant differentials in infant and child mortality in the country. The difference between rural and urban indicators of health status and the wide interstate disparity in health status are observed in the country. Clearly the rural urban differentials are substantial and not reducing over time significantly (Chapter 3).

For a very long time, the persistence of health inequalities in India has been a matter of discussion and has received an immense attention. The disadvantaged group in the country consists of people with lower than average socio-economic status characterizing low levels of literacy, standard of living, exposure to the media, access to health care system etc. This consequently resulting in under usage of medical services and unhealthy lifestyles, including malnutrition and poor personal hygiene. This inequality in the use of health care services creates social and economic disparity in different states of our country. (Chapter 4).

The inequalities among different social groups lead to deprivation in various aspects in their lives. Therefore, children belonging to disadvantaged groups are also deprived at various stages of their lives. These are some of the reasons for higher rate of mortality among the disadvantaged, particularly among infants and children. It is a fact that infants belonging to disadvantaged group are certainly at higher risk of mortality than those born in advantaged group. Not only are the gaps between the better performing and other states wide with respect to infant and under-five mortality, large differences also exist within the same better performing states among different socio-economic groups (Chapter 5).
In accordance with the United Nations Millennium Development Goals (MDGs), the National Population Policy of India (2000) as well as the National Health Policy (2002) had set a goal of reducing infant mortality to 30 per 1000 by the year 2010. The Millennium Development Goal no.4 (MDG-4) aims at reducing U5MR from 116 deaths per 1000 live births in 1990 to 42 deaths per 1000 in 2015.

At present, we are four years apart from the target date of MDGs. It is important to observe and analyse the present scenario to understand whether India would be able to achieve the targeted goals within the committed time described under the MDGs declaration (Chapter 6).

The poor state of child healthcare in India may be attributed to the lack of government funding on healthcare initiatives, as estimates reveal that the per capita spending on healthcare by the government is far below than most of the developing countries in the world (Economic Research Foundation, 2006). In almost all the states of India, per capita spending on public health is alarmingly reduced over time and expenditure on family welfare particularly has exhibited the greatest fluctuation. India’s healthcare infrastructure has seen steady improvement in the recent past. Despite a steady increase in the number of medical establishments in the country, there still remains a severe shortage of sub-centers, primary health centers, and community health centers. In a country like India where resources are scarce, it is very difficult to increase resources available for the health sector substantially in the short run. Irrespective of the availability of resources, it is very important to utilize the existing resources in efficient manner. This strategy may help to reduce socioeconomic disparity in health outcome. So it is necessary to evaluate the performance of health care systems in India and across states and find out their correlates for their inefficiency and backwardness (Chapter 7).
The inspiration for the present research has come from the strikingly high amount of children dying before the age of five and the unequal distribution of child deaths, both between states of India and between population groups. Given this background, the scope and the objectives of the thesis in summarized form are presented below.

- To observe the changes in each of the components of under-five mortality over the last three decades in India and its major states, the present thesis has tended to look at the levels, trends and differentials of under-five mortality, and tried to explain their impacts on mortality at different stages of childhood (0-5 years) (Chapter 3).
- To measure and determine the economic, social and demographic factors behind the slow progress in reduction of India’s under-five mortality. To find out the determinants of deaths over time, different multi-dimensional characteristics (e.g., regional, demographic, maternal, socio-economic etc.) are introduced to observe their impacts over time and space (Chapter 3).
- To examine the impact of National Health Programmes undertaken by the government over time on utilization of maternal and child health care services, reproductive and child health programmes are evaluated to judge their impact and timeliness against combating early childhood mortality (Chapter 4).
- To identify the inequality in infant and under-five mortality among different social groups in the country, various maternal and child health care indicators are examined. In this respect estimates are also determined for the magnitude and dimensions of inequality (Chapter 5).
- To observe, how far is India to reach Millennium Development Goal of infant and under-five mortality, a time series analysis for forecasting is carried out. Using a probabilistic time series model, above said future mortality rates are determined for different states of India and for the entire country (Chapter 6).
• To identify the states that appear to be less efficient in improving overall health status of mother and child over time, a semi-parametric model of the health production process is estimated. Important factors which are responsible in differentiating efficient and inefficient states have also been identified. Actual aim is to measure the relative “efficiency” of health care systems in different states of the country (Chapter 7).

Review of the empirical literature related to infant and under-five mortality in Indian context shows that there are significant gaps existing in the present literature. This thesis extends the existing literature in a number of ways. First, most of the child survival studies before the availability of National Family Health Survey (NFHS) data are based on small samples and, which creates difficulties in correlating these previous studies to get an idea about the past trends and determinants on under-five mortality. But in the present study, two sources of data based on large samples, mainly Sample Registration System (SRS) and three rounds of National Family Health Survey (NFHS) are utilized to find out the levels and trends of mortality among children for different regions and states of India over last three decades. The impacts of demographic, economic and cultural factors on the components of under-five mortality are examined separately that use multivariate methods to estimate these effects for three rounds (1992-93, 1998-99 and 2005-06) of NFHS data. The magnitude of the effects and their variations are analyzed for different regions of India. Secondly, most of the earlier studies are either focused on specific states or regions to observe the variations in the use of maternal health care services and correlates of health care use over small period of time. Here, attempts have been made to bridge these gaps by considering major states of India and three different time points of NFHS survey. Thirdly, there are very limited studies available in Indian context examining socioeconomic inequalities in child mortality. The available studies examine inequalities based on anthropometric measures, considered only limited states. The present study is an attempt which measures the variation of it
across the regions and states of India, using inequality measures like ‘Concentration Indices’. Thirdly, there are very limited works on the subject of child mortality projection, particularly on the issue of projecting under-five and infant mortalities in the context of Millennium Development Goals (MDGs) with respect to India. In our present study time series analysis for forecasting future mortality (up to the year 2020) among the children is carried out by applying probabilistic projection which includes inherent demographic uncertainty. Lastly, in Indian context probably there are no studies, which put their efforts in determination of health efficiency of different states of India. There is hardly any study which compares and exhibit health care performance and efficiency over a time horizon. In the present thesis, a semi-parametric model of the health production process is used to measure health care efficiency of the Indian states during different Five Year Plans. Thus, the present research is an attempt to fill up these gaps of the existing literature.

What has been achieved in this thesis through extensive literature search and by applying appropriate mathematical and statistical methods and techniques on available data are now summarized chapter wise in the following paragraphs and conclusions are also drawn from the major findings.

The main purpose of Chapter 3 is to examine the levels of each of the components of under-five mortality during the period 1978 to 2008 and its temporal changes. Different components of under-five mortality are estimated separately utilizing Sample Registration System (SRS) and National Family Health survey (NFHS) data. In order to investigate the problem, two different estimation methods are adopted for the analysis of SRS and NFHS data. In case of SRS data, estimates are derived by fitting a regression line to the relationship between infant or under-five mortality rates and their reference dates using weighted least squares (Hill and Aazbek, 1994). Using information on birth history from three rounds of NHFS data, mortality rates for specified periods (namely, 1981-86, 1987-92, 1993-98, 1999-2005) as well as age specific risks have been obtained using Kaplan and Meier method (Kaplan and Meier, 1958). It has been found that the IMR and the U5MR in India have declined
substantially over the past decades. According to findings based on NFHS data, at all India level infant mortality has declined by 38% and under-five mortality by 42% during the study period. Furthermore, the rate of decline of under-five mortality in urban areas has been slower than that in rural areas, and as a result urban–rural mortality differentials have become smaller and from 1998 onwards the gap has remained more or less constant till now.

Under-five mortality has declined due to reductions in the neonatal, post neonatal and child mortality rates. It has been observed that though infant mortality rate has declined in India, the gap between infant mortality and neonatal mortality becomes narrowed. The post-neonatal mortality has declined more than neonatal mortality, increasing the relative importance of early neonatal or neonatal mortality. There are large differences observed in U5MR components among states over the study period. The highest reduction in under-five mortality has been experienced by the states like, Uttar Pradesh, Rajasthan, Madhya Pradesh, Tamil Nadu and Gujarat. Most of the major states experienced a significant reduction in both the infant and under-five mortality over time.

Again, utilizing NFHS data on birth history, mortality rates have been determined and analyzed mainly to understand the regional variations over the period. During the study period, the early neonatal mortality is found highest in the central region, followed by the other regions namely, eastern, southern, western and northern. It has been emerged that, all under-five components for central region (which includes the major states like, Madhya Pradesh and Uttar Pradesh) are much higher than any other region over time.

Factors contributing to the slow decline of under-five mortality components include the low socio-economic, cultural and health status of women and children in India. Using hazard models, the adjusted effects (estimated by hazard ratios) of different demographic, maternal and socio-economic variables have been estimated, controlling the effect of other explanatory variables. Unadjusted effects of those variables have also been estimated at all India level to get a comparative view with
the adjusted one. **During neonatal period, biological factors and maternal factors strongly affect the mortality. But, after the neonatal period, post neonatal and child mortality are attributed mainly to childhood diseases and others, which are governed by the social development and programmatic factors. So, the primary causes of childhood mortality change as children grow older, starting with factors related mostly to biological conditions and ending with factors related mostly to their environment.** In most of the regions, among different maternal and socio-cultural variables: early age of pregnancy, first and higher order births, birth interval less than 24 months, female sex of the child, mother’s literacy level below middle school, lower standard of living, backward religion and community are observed to be most important, which are responsible for differential in mortality rates along the mortality components with varying regions and states.

**In the Fourth Chapter,** a review has been done about the maternal and child health care programmes undertaken during the period of 1976-2004 and the present study has examined the effect of programmatic factors like, antenatal and delivery care, especially number of antenatal check-ups during pregnancy, immunization of women against tetanus during pregnancy, receiving of iron folic acid tablets or syrups during pregnancy, delivery in an institutional setup and health status of baby at birth (i.e., size of the baby at birth) on different components of under-five mortality. These programme factors are very important because appropriate and full utilization of health care services is necessary for improvement in overall health status of the mother and child in a society. Birth history information from three NFHS studies is used here to carry out the above analysis. **Multiple regression analysis and Cox regression hazard model are built up to observe the impact of these factors at three different NFHS periods.**

The study shows that utilization of antenatal care services differs to a great extent by states and regions. **However, with a few exceptions, states that do well on any one indicator of antenatal care also perform well on the other health care indicators.**
The best performing states are Kerala, Tamil Nadu, Karnataka, Maharashtra and Andhra Pradesh. These states have 60 or more percentage of utilization of ANC services (like, ANC more than 3, TT doses more than 2 and receiving of IFA) for all three NFHS periods. During NFHS-3 period, more than 60 percent of deliveries are done in an institutional setup and also deliveries are assisted by the health professionals in the states of southern India and in Maharashtra. But at all India level during the same NFHS-3 period, ‘institutional delivery’ and ‘delivery assisted by the health professionals’ are only 47 percent and 55 percent respectively. However, Haryana, Punjab, Jammu and Kashmir, Himachal Pradesh, Gujarat and West Bengal have moderate performances. Their performances in ANC care services are within the range of 40 percent to less than 60 percent. But, the states like, Madhya Pradesh, Uttar Pradesh, Bihar, Orissa, Assam and Rajasthan perform consistently poorly on all antenatal and delivery care indicators. This clearly needs more emphasis to programme efforts to improve the surviving condition of neonates and post-neonates particularly in these poor performing states.

In general, the southern and the western states and, few northern states are improving significantly. The central states plus most of the eastern states with Bihar and Rajasthan perform poorly and their progress is very slow. The performance of all the states in the central region in terms of most of the investigated health care indicators is below the national average for three NFHS periods. The effect of non-institutional delivery on neonatal mortality is observed to be high compared to post-neonatal mortality. Particularly in the northern and central regions the risk of death for the neonates due to non-institutional delivery is very high compared to other regions. Hazard ratios for neonatal mortality due to low birth weight babies (less than 2.5 kg at the time of birth) are high for all the regions and at all India level.

In the Fifth Chapter, both bivariate and multivariate analyses have been done to understand different socio-cultural and developmental correlates of inequalities related with infant and under-five mortalities. The analysis established different correlates of under-five mortality. The variables which may be considered as
major determinants of inequalities in child health are: mother’s age at child birth in earlier ages (<20 years) or in higher ages (>34 years), higher order births, low level of literacy, belongingness to SC-ST families, falling in within poorer or the poorest wealth quintiles, having rural residence, getting delivered by the untrained medical personnel in the non-institutional environment and birth intervals shorter than two years.

In this chapter the extent of interstate disparity has also examined utilising third round of National Family Health Survey (NFHS-III) data. Using infant and under-five mortality data separately, concentration indices (a standard measure of inequality) are calculated based on the distribution of children according to their wealth index quintiles (an indicator of socio-economic status of household) for each of the selected states of India. This has done to compare the levels of inequality in the states under study. From these measures, the extent of inequalities and also the causes behind inequalities have been suggested for constant monitoring and for revision of different policy measures to reduce inequality in under-five mortality. Using these estimates the states are classified into different groups according to the level of inequality in infant and under-five mortalities. In the states of Maharashtra, Uttarakhand, Gujarat, Kerala and Tamil Nadu, the inequality levels have seen high compared to other selected states. Second group consists of Karnataka, Assam, Punjab and Himachal Pradesh. Third group of states are Madhya Pradesh, Haryana, West Bengal and Jammu & Kashmir. The lowest level of inequality exists in the states like Rajasthan, Uttar Pradesh and Bihar. So, it may be argued that the inequality in under-five mortality is more concentrated in the comparatively developed states than the poorer states.

In the Sixth Chapter, the projected figures and values of IMR and U5MR up to 2020 for India and for its major states are presented assuming that in the immediate future the mortality will continue to follow the prevailing trend. To reduce IMR, many states have formulated a state population policy, with their specific goals (Pandey et. al., 2004). This projection may help those state level policies to verify
their targets and short falls. The mortality projections are obtained here using SRS data.

The result shows that, without immediate intervention, India along with its backward and heartland states would not be able to achieve the MDG4 target by 2015. Achievement of the goal will require further acceleration in the reduction of the U5MR, particularly in the highest burden states like, Madhya Pradesh (with Chhattisgarh), Assam, Orissa, Uttar Pradesh (with Uttarakhand), Rajasthan, Bihar (with Jharkhand) and Haryana. This is only possible if the government along with other national and international health care organizations stimulate their efforts in reaching MDGs which calls for adjustments in planning and funding immediately.

The Chapter Seven evaluated the performance of the health care systems across major states and determined correlates for inefficiency and backwardness of these states. To look into the problem, data envelopment analysis (DEA) model is used to assess the efficiency of a health system within various states of our country. The results of the analysis evolved empirical indicators of efficiency. In this study, efficiency in health care-sector across major states in India are evaluated by assessing outputs (under-five survival rate, female life expectancy) against discretionary inputs (doctors, beds) and non-discretionary or environmental variables (female literacy aged 15+, per-capita net state domestic product at constant prices, population below poverty line, institutional delivery and complete child immunization). To do this a two stage semi-parametric model has been built up. Initially by using linear programming techniques, output efficiency scores are estimated by solving a standard ‘Data Envelope Analysis’ (DEA) problem for each of the states and for several planning periods (6th to 10th Five year Plans) of India. In the second stage, these efficiency scores are explained by means of Censored Normal Tobit Regression where, environmental variables are used as independent variables.

This study shows the inadequacy of health infrastructure and manpower in the inefficient states like, Madhya Pradesh, Orissa, Assam, Uttar Pradesh, Rajasthan and Bihar. The health outcomes like under-five survival rate and
female life expectancy are also poor in these states. In contrast, the performances are comparatively better for Tamil Nadu, Maharashtra, West Bengal, Punjab, Andhra Pradesh and Karnataka. These states are improving over the years with respect to efficiency and outcomes. For them, there are scopes for further improvement in outcomes by proper and exhaustive utilization of the existing resources. **Thus, in order to finance reproductive and child health services, efficiency and outcome both must be considered.** Most of the states in the eastern and the central regions are particularly always below the average efficiency scores throughout selected periods. These states need appropriate and efficient management of health care delivery to reach satisfactory outcome levels by increasing efficiency. **Important non-discretionary factors like female education, curative and preventive health care measures like institutional delivery and full immunization of children are proved to be the main variables in explaining inefficiency.**

The conclusion drawn from the present analysis may be utilized for future child health policies, which can give direction to accelerate the rate of decline and help the country to reach towards the Millennium Development Goal of childhood mortality.

The following discussion outlines the policy implications that can be gleaned from this thesis.

- The child health services at present, must take lessons from the past child health care programmes for identification of specific gaps in neonatal, post-neonatal and child health care. The achievement in this direction, which the country so far has made, must be sustained by enhancing quality and efficiency of the services.

- The study has shown that, the relative proportion of neonatal deaths in India has increased as overall child and infant mortality level have decreased. **So, neonatal deaths require a different set of interventions, which give priorities to both the health, and nutrition of young mothers and their**
newborns. Therefore, states in India, where child mortality levels are low but neonatal deaths make up a large proportion of deaths, needs different strategies and package of interventions than those where child mortality and post-neonatal deaths still occupying the largest share of deaths.

- Malnutrition may be considered as a major determinant of childhood illness and death (Bellagio study group, 2003). At present India has many nutritional and social safety net programmes like ICDS (Integrated Child Development Services) and PDS (Public Distribution System). But they are lacking ‘comprehensive nutrition strategy’ which requires incentive and mobilization oriented activities operating through household and community participation. **Thus, high impact health and nutrition interventions are required (Bellagio Study Group, 2003) which can prevent a large percentage of all childhood deaths in India.** With this the county has to develop and expand community participation for the prevention and treatment of childhood illnesses. The referral services including obstetric care and early childhood developmental programmes are needed to prevent death after neonatal period.

- **The states where under-five mortality is high and reducing slowly over time in urban areas, equitable access to quality health care delivery services must be provided.** Quality health care delivery services include availability of trained positive attitude health workers and essential drugs, accessibility to services for vulnerable populations, referral and preventive services, and availability of transport to eliminate long distances to health facilities (Brawley, 2000).

- Priority should also be given to further development of **village-based approaches to case management** that reach into ever less accessible, poor areas, using village health workers and increased education of mothers and families. Still in many remote areas no trained medical personnel are available locally at the time of emergency and villagers have to travel a long distance to access medical care. In this respect availability should be ensured for **well-**
trained traditional birth attendants (TBAs) and female village workers, who can provide the essential package of newborn care. This can contribute to significant reductions in the neonatal and post-neonatal mortality.

- **Strengthening of emergency medical services infrastructure in the district hospitals, community health centres, primary health care centres and sub-centres** to facilitate emergency obstetric and child health care services to prevent infant deaths.

- The first goal that has been declared by the United Nations on MDGs is the eradication of extreme poverty and hunger (UN, 2010). So, to accelerate progress in reducing child mortality, it must be ensured that economic growth and poverty reduction policies reach the poor or vulnerable group.

- **Requirement of adequate health expenditure by establishing more infrastructures and manpower in the areas where poor people concentrate is very important.** There is also an equity case to be made and a public health rational for targeting specific population groups, to disproportionately benefit the poor who disproportionately carry the burden of child mortality.

- Overall, **child health policies** are needed which should take into account state-specific epidemiological and demographic patterns, which are established as the key determinants of state differences in infant and child mortality.

The present study includes important and informative findings. The aim is to contribute to the scientific knowledge on under-five mortality in the country and to improve the design and implementation of policies. But many aspects of mortality in childhood are unexplored here mainly due to unavailability of data in the health surveys of our country over time. For example, we cannot determine the impact of child immunization on infant mortality. This is because data on antenatal and post
natal cares are only available for those who survived till at the time of survey. It is also possible that different mortality rates in childhood (0–5yrs.) are underestimated because birth histories and infant survival data were collected from surviving women only. Nonetheless, these limitations are unlikely to have substantially influenced the validity of the analyses with child survival. Now to improve the present study multi-level analysis on child survival may be done. In that type of study we can use multivariate and multilevel discrete-time event history analysis to evaluate the impact of contextual factors on the risk of dying before age five net of the effect of individual factors. Using multivariate and multilevel event history models, it is possible to separate individual and household level factors from contextual factors associated with child survival. So, using this technique relative importance of individual and community level effects on under-five mortality can be examined systematically.